OVERSIZE PAGES

LOCATED AT

END OF

DOCUMENT

Document Control No. _____

21-02 -02 -03 -02 -9407180018

Environmental Restoration Program

AREA B, OPERABLE UNIT 1 PROPOSAL FOR ADDITIONAL FIELD WORK

VOLUME I – TEXT AND QAPP

MOUND PLANT
MIAMISBURG, OHIO

September 1992

FINAL

Department of Energy
Albuquerque Field Office

Environmental Restoration Program
Technical Support Office
Los Alamos National Laboratory

REFERENCE USE ONLY

ENVIRONMENTAL RESTORATION PROGRAM

AREA B, OPERABLE UNIT 1
PROPOSAL FOR ADDITIONAL FIELD WORK

MOUND PLANT
MIAMISBURG, OHIO

September 1992

DEPARTMENT OF ENERGY
ALBUQUERQUE FIELD OFFICE

ENVIRONMENTAL RESTORATION PROGRAM
TECHNICAL SUPPORT OFFICE
LOS ALAMOS NATIONAL LABORATORY

FINAL

REPLACEMENT PAGES, REVISION NUMBERS, AND DATES

Page(s)	Rev.	Date	Replaces	Page(s)	Rev.	Date
PROPOSAL FOR ADDITIONAL FIELD WORK						
iiii-vi	0	9/92		iii-vi	0	6/92
ACK-1	0	9/92		ACK-1	0	6/92
ES-1 - ES-7	0	9/92		ES-1 - ES-7	0	6/92
1-1 - 1-9	0	9/92		1-1 - 1-9	0	6/92
2-1 - 2-48	0	9/92		2-1 - 2-47	0	6/92
3-1 - 3-48	0	9/92		3-1 - 3-45	0	6/92
4-1 - 4-10	0	9/92		4-1 - 4-10	0	6/92
5-1 - 5-8	0	9/92		5-1 - 5-8	0	6/92
6-1 - 6-2	0	9/92		6-1 - 6-2	0	6/92
7-1 - 7-5	0	9/92		7-1 - 7-5	0	6/92
QUALITY ASSURANCE PROJECT PLAN						
4-9 - 4-12	0	9/92		4-9 - 4-12	0	6/92

CONTENTS

EXECUTIVE SUMMARY ES-1

1. INTRODUCTION 1-1
   1.1. SCOPE 1-6
   1.2. PURPOSE 1-6
   1.3. DECISION TREE 1-7
   1.4. ORGANIZATION 1-7

2. BACKGROUND 2-1
   2.1. SITE DESCRIPTION AND HISTORY 2-1
      2.1.1. Historical Landfill 2-9
      2.1.2. Site Sanitary Landfill 2-17
      2.1.3. Radioactively Contaminated Soils 2-23
      2.1.4. Overflow Pond 2-24
   2.2. HYDROGEOLOGIC SETTING 2-25
   2.3. CONTAMINANT MASS BALANCE 2-34
      2.3.1. Trichloroethene - Mobility and Persistence 2-36
      2.3.2. Tetrachloroethene - Mobility and Persistence 2-38
      2.3.3. 1,2-*Trans*-Dichloroethene - Mobility and Persistence 2-39
      2.3.4. Chloroethene - Mobility and Persistence 2-39
      2.3.5. Acetone - Mobility and Persistence 2-40
      2.3.6. Plutonium-238 - Mobility and Persistence 2-40
      2.3.7. Thorium - Mobility and Persistence 2-41
      2.3.8. Tritium - Mobility and Persistence 2-42
   2.4. CONCEPTUAL MODEL FOR CONTAMINANT TRANSPORT 2-43
      2.4.1. Conceptual Pathway Model 2-43
   2.5. DATA NEEDS 2-45

3. GENERAL REQUIREMENTS 3-1
   3.1. SOIL GAS SURVEY 3-3
      3.1.1. Historical Landfill Trench 3-5
      3.1.2. Site Sanitary Landfill 3-7
   3.2. EXPLORATORY BOREHOLES 3-8
   3.3. PIEZOMETERS AND MONITORING WELLS 3-9
      3.3.1. Source Area Characterization 3-17
      3.3.2. Evaluation of Shallow Bedrock Near Source Area 3-19
      3.3.3. Evaluation of the Tributary Valley Aquifer Input to Area B 3-19
      3.3.4. Upgradient Monitoring Wells 3-20
      3.3.5. Downgradient Monitoring Wells and Piezometers 3-21
   3.4. SURFACE SOIL SAMPLING 3-23
   3.5. SUMMARY OF FIELD EFFORT 3-25
      3.5.1. Soil Gas Survey 3-25
      3.5.2. Subsurface Soil Sampling 3-25
      3.5.3. Surface Soil Sampling 3-41
      3.5.4. Groundwater Sampling 3-41

4. FIELD METHODS 4-1
   4.1. SOIL GAS SURVEY METHODS 4-1
   4.2. DRILLING METHODS 4-7
      4.2.1. Piezometers 4-7
      4.2.2. Monitoring Wells 4-7
      4.2.3. Piezometers and Monitoring Wells Penetrating SSL Encapsulated Waste . . . 4-8

4.3. SAMPLE COLLECTION METHODS 4-9
4.3.1. Shallow Surface Soil 4-9
4.3.2. Subsurface Soil 4-9
4.3.3. Groundwater 4-9
4.4. FIELD DATA COLLECTION METHODS 4-10
4.5. HEALTH AND SAFETY REQUIREMENTS 4-10

5. AQUIFER TEST AND GROUNDWATER SAMPLING 5-1
5.1. SCOPING OF THE AQUIFER TEST 5-1
5.1.1. Introduction 5-1
5.1.2. Aquifer Test 5-1

6. *IN SITU* VOLATILIZATION SYSTEM 6-1
6.1. PROPOSED ACTIVITIES 6-1

7. REFERENCES 7-1

APPENDIX A MOUND PLANT AREA B SCHEDULE
QUALITY ASSURANCE PROJECT PLAN
SITE HEALTH AND SAFETY PLAN

FIGURES

1.1. Decision tree to guide Area B additional work 1-8
2.1. Location of Mound Plant, Miamisburg, Ohio 2-2
2.2. Mound Plant topographic map with Area B outlined. 2-4
2.3. Plan view showing cross section trace line A-A', irregular trench, encapsulated waste of site sanitary landfill, Area 2, and chemical disposal and burn area of the historic landfill 2-5
2.4. Schematic cross section A-A' 2-6
2.5. Area B bedrock topographic map 2-7
2.6. Area B isopach map of unconsolidated deposits 2-8
2.7. Trichloroethene concentrations for Area B wells, December 1991 2-10
2.8. Tetrachloroethene concentrations for Area B wells, December 1991 2-11
2.9. 1,2-*Trans*-dichloroethene concentrations for Area B wells, December 1991 2-12
2.10. Tetrachloromethane concentrations for Area B wells, December 1991 2-13
2.11. Trichloromethene concentrations for Area B wells, December 1991 2-14
2.12. 1,1-Dichloroethene concentrations for Area B wells, December 1991 2-15
2.13. Tritium concentrations for Area B wells, December 1991 2-16
2.14. Soil gas locations adjacent to Area B 2-18
2.15. Shallow and subsurface soil sampling locations 2-21
2.16. Location of cross section trace line B-B_1 2-26
2.17. Location of cross section trace lines B_1-B_3 2-27
2.18. Geologic cross section B-B_1. 2-28
2.19. Geologic cross section B_1-B_3. 2-29
2.20. Average localized groundwater level contour map for September 1990, April and July 1991 2-30
2.21. Localized groundwater level contour map for September 1990 2-31
2.22. Localized groundwater level contour map for April 1991. 2-32
2.23. Localized groundwater level contour map for July 1991. 2-33
2.24. Conceptual pathway model for Area B, Operable Unit 1 (DOE 1992) 2-44
2.25. Decision tree to guide Area B additional work 2-46
3.1. Proposed location of new monitoring wells and piezometers 3-2
3.2. Proposed soil gas sample locations 3-4

3.3 Area B, radiological surface soil sample locations 3-24
3.4 Proposed locations for collection of surface soil samples 3-27
5.1. Wells and piezometers to be monitored during the aquifer test. 5-3

TABLES

ES.1. Data Needs/Study Matrix, Operable Unit 1, Area B, Proposal for Additional Work . . . ES-3
I.1. Data Needs/Study Matrix, Operable Unit 1, Area B, Proposal for Additional Work 1-3
II.1. History of Mound Plant 2-3
II.2. Summary of Soil Gas Data 2-19
II.3. VOCs Detected in Soil Samples 2-20
II.4. Summary of Soil Gas Results from the Site Sanitary Landfill Perforated Drainpipe . . . 2-22
II.5. Chemical and Physical Properties of VOCs of Concern at Area B 2-37
III.1. Subsurface Chemical Soil Sample Summary 3-10
III.2. Subsurface Geotechnical Soil Gas Sample Summary 3-11
III.3. Anticipated Piezometer Completion Specifications 3-12
III.4. Estimated Depth to Water Table and Bedrock for Proposed Monitoring Wells 3-14
III.5. Groundwater Sample Summary 3-16
III.6. Analytical Parameter List for the Operable Unit 1, Area B Surface Soil Investigation 3-26
III.7. Soil Gas Sampling Plan 3-28
III.8. Subsurface Chemical Soil Sampling Plan 3-29
III.9. Subsurface Soil Sampling Rationale 3-40
III.10. Subsurface Geotechnical Soil Sampling Plan 3-42
III.11. Geotechnical Test Purpose and Rationale 3-46
III.12. Surface Soil Sampling Plan 3-48
IV.1. RI/FS Standard Operating Procedures 4-2
V.1. Aquifer Pumping Test Wells and Piezometers with Measuring Instrument, Frequency, and Rationale 5-4
V.2. Time Intervals for Sampling Production Well 0071 and Monitoring Wells 0063, 0305, 0306, 0375, and 0377 During the Aquifer Test 5-8

ACRONYMS

ASTM	American Society for Testing Materials
BNA	base-neutral acid
BVA	Buried Valley aquifer
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquids
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
EP TOX	extraction procedure toxicity metals
ER	Environmental Restoration Program
FFA	Federal Facility Agreement
GAC	granulated activated carbon
ISV	*in situ* volatilization
MCL	maximum contaminant level
NPL	National Priority List
OVA	organic vapor analyzer
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PID	photoionization detector
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Program Plan
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
SDWA	Safe Drinking Water Act
SOP	standard operating procedure
SSL	site sanitary landfill
TCE	trichloroethene
μg/L	micrograms per liter
VOC	volatile organic compound

ACKNOWLEDGMENTS

This report was prepared by Roy F. Weston, Inc., Albuquerque, New Mexico, under subcontract number 9-X58-0146R-1, to the University of California, Los Alamos National Laboratory. The manuscript was prepared by Tom Tharp, Eric Larsen, Peter Middlebrooks, William Little, and Jim Brinkman. The graphics and report were assembled, edited, and produced by WESTON's Albuquerque Office publications staff.

EXECUTIVE SUMMARY

The Mound Plant is one of seven U.S. Department of Energy (DOE) Albuquerque Field Office installations currently being evaluated by the DOE Environmental Restoration (ER) Program. After the Mound Plant was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priority List (NPL) in November, 1989, the DOE and U.S. Environmental Protection Agency (EPA) Region V signed a Federal Facility Agreement (FFA) that prescribes remedial activities, including remedial investigation/feasibility studies (RI/FS). This Proposal for Additional Work has been developed for Area B, Operable Unit 1, which is one of nine operable units at Mound Plant. Additional information on the RI/FS for all nine operable units is included in a Site-wide RI/FS work plan (DOE 1992).

The nature and extent of groundwater contamination in Operable Unit 1 has been well documented. Volatile organic compounds (VOCs) have been detected and monitored in the groundwater in and around Area B since 1986 (DOE 1991e). Tritium in the groundwater in and around Area B has been monitored since the early 1970s. It is reasonably certain that there is a relatively small plume of contaminated groundwater, a few hundred feet in length and width and less than forty feet thick. The groundwater contamination is present at relatively low concentrations, less than 10 μg/l of trichloroethene (TCE) at distances greater than 100 feet from the location of the potential source areas, to a measured maximum of 211 μg/l very near the area of the potential sources. Because groundwater near the plant boundary has been found to contain low levels of contamination, there is probably groundwater contamination off the Plant. The concentration is likely low and the contamination has not been confirmed offsite by monitoring to date. Potential contaminant sources in the area are:

- Residual contamination in the subsoils resulting from historical landfill activities;
- The wastes encapsulated in the site sanitary landfill (SSL);
- Contaminated surface soil and sediment derived from other areas of Mound Plant and relocated to Area B; and
- Stormwater runoff (including entrained sediment) directed to the overflow pond.

TCE contamination has also been detected in the Mound Plant water supply. The TCE contamination is a persistent problem that, in the long term, could constitute a threat to human health and the environment. Therefore, DOE is proposing sufficient additional work to complete an evaluation of potential remedial measures. That is, work included in this proposal, along with the previously completed work, should complete the Operable Unit 1 remedial investigation.

At the conclusion of the work described in this proposal, the DOE will make a decision about the need for and the scope of remedial actions (including removal actions). This conclusion will have to be re-evaluated based on the results of background sampling and as the site-specific action levels for the Mound Plant evolve from Preliminary Remediation Goals (PRGs), Applicable or Relevant and Appropriate Requirements (ARAR) determinations, the Baseline Risk Assessment, and the Record of Decision (ROD). PRGs and background sampling and analysis are currently being developed as part of the site-wide Operable Unit 9 investigations.

The purpose of the proposed work is to fill data needs related to Area B by focusing on the following objectives:

1) Identify and further characterize potential source areas including vadose zone soils, with particular attention to resolving the issue of whether the source is concentrated or diffuse;

2) Quantify and predict plume migration and groundwater flow within Operable Unit 1;

3) Collect data sufficient to determine if there is an unacceptable threat to human health or the environment and, if so, to propose remedial measures, including removal actions; and

4) Collect data sufficient to satisfy all Remedial Investigation data needs in order to proceed with the Feasibility Study and the balance of the CERCLA process.

A summary of the data needs to be met, together with how they are to be met, is presented as Table ES.1. These data needs are drawn from those identified in the RI Technical Memoranda 2 and 3.

It is an objective of this proposal for additional work to specify data collection sufficient to determine if a threat exists to human health or the environment and to propose remedial measures including removal actions, interim remedial actions, and remedial design/remedial action, as well as to continue with the balance of the CERCLA process. The strategy also focuses on confirming or refuting potential source areas such as the historic landfill (especially one trench thereof), the site sanitary landfill, or diffuse areas as a cause of groundwater contamination.

Sampling and analysis of the storm-water retention and discharge system (SRDS) runoff and associated sediment are not included as part of this proposal for additional work. They are being addressed in the Operable Unit 9, Site-Wide Remedial Investigation as an integral part of the overall surface-water evaluation.

A sequential approach to the characterization has been developed to confirm or refute contaminant sources as follows.

Table ES.1. Data Needs/Study Matrix, Operable Unit 1, Area B, Proposal for Additional Work

Objective	What do we need to know?	Why do we need to know it?	How are we going to learn it?
Source characterization	Where are the "hot spots" of VOCs: in the interior of the site sanitary landfill and/or in the historic landfill?	• Determine locations and qualitative magnitude of contamination in vadose zone. • Support interim action (ISV), piezometer and monitoring well locations, permanent remediation, and risk assessment. • To help eliminate future concern about SSL interior as a source.	• Survey historic landfill trench location; perform soil gas analysis in trench location. • Conduct soil gas survey over entire landfill area to locate larger source areas. • Conduct soil gas probes in the interior (cocoon) of site sanitary landfill. • Sample vapors from french drains. • Using a 1 horsepower blower, sample vapors from pipe from inside site sanitary landfill.
	What concentrations and quantities of VOCs, inorganics, and radionuclides, occur in vadose and saturated zones within Area B source(s)? What are the lateral and vertical VOC, inorganic, and radionuclide distributions? How is VOC, inorganic, and radionuclide migration controlled in this area?	• Develop quantitative data to support ISV trial. • Determine nature and extent of source area. • Determine whether contamination is in the vadose zone or saturated zone.	• Install boreholes in area of historic landfill trench. • Collect continuous core. • Perform chemical analyses of core at 5-ft intervals, at capillary fringe, and at water table. • Perform geotechnical and radiological tests at discrete lithologic horizons. • Install piezometers, monitoring wells, and (possibly) venting system for ISV.
	What additional potential sources may exist?	• Confirm or refute that landfill is the only source.	• Sample and analyze soils for list of VOC contaminants of concern, selected radionuclides, and TAL metals.

Table ES.1. (page 2 of 3)

Objective	What do we need to know?	Why do we need to know it?	How are we going to learn it?
Groundwater transport characterization	Is the likely source of groundwater contamination at well 0046 from the vicinity of the pond or is it migrating from the tributary valley or SM/PP Hill? Is there a likely groundwater flowpath from the tributary valley across the northern part of Area B?	• Need to determine source of the contamination detected in well 0046 so that it can be evaluated and remediated, if necessary. • Since well 0046 was not completed to TEGD requirements, data from it are unreliable and conclusions drawn are uncertain.	• Install one well northwest of Area B to replace well 0046. • Install one piezometer and well to north of Area B, northeast of well 0046. • Collect continuous core at both locations and evaluate hydrostratigraphy, soil, and groundwater chemistry, and hydraulic properties.
	What is the input of groundwater from the SM/PP hill slope and bedrock? What potential contamination is within this groundwater?	• Define influx of groundwater and contamination into Area B. • Define horizontal hydraulic gradients. • Evaluate remedial action. • Regulatory compliance.	• Install three monitoring wells east of Area B, probably in bedrock. If saturated zone located in unconsolidated, multiple wells will be considered.
	Has contamination moved offsite? If so, how much, and what are its vertical and lateral distributions?	• Use as calibration point in contaminant transport modeling. • Determine hydraulic gradient across site boundary. • Confirm/refute that the landfill is the only source. • Determine nature and extent of offsite contamination. • Support development of remediation of onsite and possibly offsite groundwater contamination.	• Install piezometers and three offsite monitoring wells west and southwest of Area B.

Table ES.1. (page 3 of 3)

Objective	What do we need to know?	Why do we need to know it?	How are we going to learn it?
Develop remedial action design data	If VOCs are present in the vadose zone in sufficient quantities, how can VOCs best be removed?	• Develop efficient vadose zone remediation. • Decrease VOC concentrations in source area.	• Install pilot-scale ISV system for trial studies if field data suggest ISV likely.
	How can plume migration be most efficiently controlled?	Aquifer Test • To determine if the existing well (0071) can be used as the capture well or if a new well(s) is needed. • Optimize the proper position and pumping rates of a well or wells to accomplish two objectives: (1) to contain the potential for offsite plume migration, and (2) to minimize additional contamination to the Mound Plant production wells. • Help to adequately scope remedial actions.	• Conduct aquifer test of well 0071 (well #1) for approximately 30 days. • Monitor water levels in piezometers and monitoring wells with pressure transducers; record data on datalogger. • Observe river stage and precipitation influences. • Perform water quality sampling at prescribed time intervals.
	If radionuclides and metals are present above background concentrations in the source area.	• Help to adequately scope remedial actions.	• Collect subsurface soil and groundwater samples and analyze for contaminants of concern.

ISV - *in situ* volatilization
RCRA - Resource Conservation amd Recovery Act
TEGD - RCRA Technical Enforcement Guidance Document
VOC - volatile organic compound

The hypothesis that the suspect north-south trending trench is a major source of VOCs in groundwater needs to be confirmed or refuted. If it is a major source, remedial measures can be designed accordingly. A soil gas survey is a relatively quick, iterative method to determine if the trench or other sub-areas are the source.

A soil gas survey (i.e., both areal measurements and vertical sampling), which will include limited soil sampling will begin with the suspect north-south trending trench and will include samples throughout the area covered by the site sanitary landfill. Samples will be collected adjacent to and within the site sanitary landfill. Also, gas samples will be obtained from the drain pipe and the french drains.

Results of the soil gas survey will be used to optimize the placement of soil borings within the suspected source areas. These suspected source areas include the historical trench, the burn cage area, and the SSL.

To date, adequate characterization of Area 2 (see Figure 2.3) has not been performed. Intrusive sampling is proposed (see subsection 3.2) to delineate the extent of contamination associated with radioactive wastes disposed in Area 2. Geotechnical and chemical tests will also be performed in Area 2.

Surface soil and sediment samples will be collected from locations within Area B. The program will focus on the entrained sediments that have collected in the borrow ditches that border the western and southern berms of the SSL, the soils of the SSL cover, and the soils of the northern bank of the overflow pond. The samples will be submitted for chemical analysis 1) to determine if potential contaminants exist within the borrow ditch sediments (possibly transported from the SM/PP Hill) and, 2) to characterize the extent of potential surface soil contamination of the SSL cover and overflow pond banks.

Prior testing and monitoring of groundwater have partially characterized the groundwater system. Installation and sampling of additional monitoring wells are proposed to address the following questions:

- What is the inflow of groundwater from the upland area to the east of the SSL?
- How are measured contaminant concentrations at wells near Area B affected by inflow from other areas of the plant to the north and east?
- Has contamination moved off the Site to the west?

A long-term (30- to 40-day) pumping test of the aquifer is proposed (section 5), including monitoring of existing and proposed new wells. The test is intended to provide the data needed to optimize any interim measures for protection of the Mound Plant supply wells (e.g., pumping an intervening well to create a hydraulic barrier).

An interim measure being considered is an *in situ* volatilization (ISV) system. The implementation of a trial of this technique will depend on evaluation of data collected from the soil gas survey and additional soil and groundwater characterization.

Because this is a phased investigation, there will be many decision points where the scope of the investigation can be adjusted. During or at the end of each phase or sub-part of the investigation, data will be analyzed and interpreted to support the decision process. The ongoing data evaluation will facilitate regulatory agency review and participation in the decision process.

1. INTRODUCTION

The Mound Plant is one of seven U.S. Department of Energy (DOE) Albuquerque Field Office installations currently being evaluated by the DOE Environmental Restoration (ER) Program. After the Mound Plant was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priority List (NPL) in November, 1989, the DOE and U.S. Environmental Protection Agency (EPA) Region V signed a Federal Facility Agreement (FFA) that prescribes remedial activities, including remedial investigation/feasibility studies (RI/FS).

Under Section XIII of the FFA,

> "Any additional work or modification to work determined to be necessary by U.S. DOE shall be proposed by U.S. DOE and will be subject to approval by U.S. EPA prior to initiating any work or modification to work."

This Proposal for Additional Work has been developed for Area B, Operable Unit 1, which is one of nine operable units at Mound Plant. Additional information on the RI/FS for all nine operable units is included in a Site-wide RI/FS work plan (DOE 1992).

The nature and extent of groundwater contamination in Operable Unit 1 has been well documented. Volatile organic compounds (VOCs) have been detected and monitored in the groundwater in and around Area B since 1986 (DOE 1991e). Tritium in the groundwater in and around Area B has been monitored since the early 1970s. It is reasonably certain that there is a relatively small plume of contaminated groundwater, a few hundred feet in length and width and less than forty feet thick. The groundwater contamination is present at relatively low concentrations, less than 10 μg/l of trichloroethene (TCE) at distances greater than 100 feet from the location of the potential source areas, to a measured maximum of 211 μg/l very near the area of the potential sources. Because groundwater near the plant boundary has been found to contain low levels of contamination, there is probably groundwater contamination off the Plant. The concentration is likely low and the contamination has not been confirmed offsite by monitoring to date. Potential contaminant sources in the area are:

- Residual contamination in the subsoils resulting from historical landfill activities;
- The wastes encapsulated in the site sanitary landfill (SSL);
- Contaminated surface soil and sediment derived from other areas of Mound Plant and relocated to Area B; and
- Stormwater runoff (including entrained sediment) directed to the overflow pond.

TCE contamination has been detected in the Mound Plant water supply. The Mound Plant production wells, which are in close proximity to Area B, provide potable water for drinking and sanitary use, and water for single-pass, noncontact cooling water. To date, the yearly average concentrations at the wells used for supply have been less than the maximum contaminant level (MCL) that is enforceable by the Safe Drinking Water Act (SDWA) and the Ohio Administrative Code. However, the TCE contamination is a persistent problem that, in the long term, could constitute a threat to human health and the environment. Therefore, DOE is proposing sufficient additional work to complete an evaluation of potential remedial measures.

The DOE prepared a series of RI/FS work plans (including sampling plans and quality assurance project plans) and conducted a sequence of remedial investigations for Area B prior to the signing of the FFA. These included plans (DOE 1987a) for sampling monitoring wells in existence prior to the ER Program; plans (DOE 1987b) for the installation, sampling, and analysis of new monitoring wells and, based on the results of these first two stages of sampling; the installation, sampling, and analysis of additional monitoring wells (DOE 1989). Besides sampling and analysis, the work plans as implemented also included other monitoring and testing such as aquifer testing and geophysics (DOE 1990a).

Each of the work plans was submitted to US EPA and Ohio EPA (OEPA); regulatory review comments were received; and the plans were revised in response to comments. These work plans, submitted prior to the FFA, were not subject to a formal regulatory approval process and were not approved by EPA or OEPA. However, the work completed pursuant to these work plans was later submitted to EPA and OEPA after the signing of the FFA (DOE 1991c, DOE 1991d, DOE 1991e, DOE 1991j) and those deliverables followed the FFA-prescribed process for submittal, regulatory review, and response to comments. The documents themselves, regulatory review comments, and response to comments identified a series of data needs (Table I.1).

Attachment I to the FFA includes a statement that:

> "DOE has performed and is performing studies using data gathering methods not reviewed and not overseen by the U.S. EPA. Though U.S. EPA recognizes the value of this work for indicating the course of future work, U.S. EPA cannot accept this data without further verification as sufficient for determining the appropriate remedy . . ."

Therefore, this proposed additional work will build on the previously completed work to continue the remedial process.

Table I.1. Data Needs/Study Matrix, Operable Unit 1, Area B, Proposal for Additional Work

Objective	What do we need to know?	Why do we need to know it?	How are we going to learn it?
Source characterization	Where are the "hot spots" of VOCs: in the interior of the site sanitary landfill and/or in the historic landfill?	• Determine locations and qualitative magnitude of contamination in vadose zone. • Support interim action (ISV), piezometer and monitoring well locations, permanent remediation, and risk assessment. • To help eliminate future concern about SSL interior as a source.	• Survey historic landfill trench location; perform soil gas analysis in trench location. • Conduct soil gas survey over entire landfill area to locate larger source areas. • Conduct soil gas probes in the interior (cocoon) of site sanitary landfill. • Sample vapors from french drains. • Using a 1 horsepower blower, sample vapors from pipe from inside site sanitary landfill.
	What concentrations and quantities of VOCs, inorganics, and radionuclides, occur in vadose and saturated zones within Area B source(s)? What are the lateral and vertical VOC, inorganic, and radionuclide distributions? How is VOC, inorganic, and radionuclide migration controlled in this area?	• Develop quantitative data to support ISV trial. • Determine nature and extent of source area. • Determine whether contamination is in the vadose zone or saturated zone.	• Install boreholes in area of historic landfill trench. • Collect continuous core. • Perform chemical analyses of core at 5-ft intervals, at capillary fringe, and at water table. • Perform geotechnical and radiological tests at discrete lithologic horizons. • Install piezometers, monitoring wells, and (possibly) venting system for ISV.
	What additional potential sources may exist?	• Confirm or refute that landfill is the only source.	• Sample and analyze soils for list of VOC contaminants of concern, selected radionuclides, and TAL metals.

Table I.1. (page 2 of 3)

Objective	What do we need to know?	Why do we need to know it?	How are we going to learn it?
Groundwater transport characterization	Is the likely source of groundwater contamination at well 0046 from the vicinity of the pond or is it migrating from the tributary valley or SM/PP Hill? Is there a likely groundwater flowpath from the tributary valley across the northern part of Area B?	• Need to determine source of the contamination detected in well 0046 so that it can be evaluated and remediated, if necessary. • Since well 0046 was not completed to TEGD requirements, data from it are unreliable and conclusions drawn are uncertain.	• Install one well northwest of Area B to replace well 0046. • Install one piezometer and well to north of Area B, northeast of well 0046. • Collect continuous core at both locations and evaluate hydrostratigraphy, soil, and groundwater chemistry, and hydraulic properties.
	What is the input of groundwater from the SM/PP hill slope and bedrock? What potential contamination is within this groundwater?	• Define influx of groundwater and contamination into Area B. • Define horizontal hydraulic gradients. • Evaluate remedial action. • Regulatory compliance.	• Install three monitoring wells east of Area B, probably in bedrock. If saturated zone located in unconsolidated, multiple wells will be considered.
	Has contamination moved offsite? If so, how much, and what are its vertical and lateral distributions?	• Use as calibration point in contaminant transport modeling. • Determine hydraulic gradient across site boundary. • Confirm/refute that the landfill is the only source. • Determine nature and extent of offsite contamination. • Support development of remediation of onsite and possibly offsite groundwater contamination.	• Install piezometers and three offsite monitoring wells west and southwest of Area B.

Table I.1. (page 3 of 3)

Objective	What do we need to know?	Why do we need to know it?	How are we going to learn it?
Develop remedial action design data	If VOCs are present in the vadose zone in sufficient quantities, how can VOCs best be removed?	• Develop efficient vadose zone remediation. • Decrease VOC concentrations in source area.	• Install pilot-scale ISV system for trial studies if field data suggest ISV likely.
	How can plume migration be most efficiently controlled?	Aquifer Test • To determine if the existing well (0071) can be used as the capture well or if a new well(s) is needed. • Optimize the proper position and pumping rates of a well or wells to accomplish two objectives: (1) to contain the potential for offsite plume migration, and (2) to minimize additional contamination to the Mound Plant production wells. • Help to adequately scope remedial actions.	• Conduct aquifer test of well 0071 (well #1) for approximately 30 days. • Monitor water levels in piezometers and monitoring wells with pressure transducers; record data on datalogger. • Observe river stage and precipitation influences. • Perform water quality sampling at prescribed time intervals.
	If radionuclides and metals are present above background concentrations in the source area.	• Help to adequately scope remedial actions.	• Collect subsurface soil and groundwater samples and analyze for contaminants of concern.

ISV - *in situ* volatilization
RCRA - Resource Conservation amd Recovery Act
TEGD - RCRA Technical Enforcement Guidance Document
VOC - volatile organic compound

1.1. SCOPE

The scope of this proposal is to describe the additional work that is necessary, based on known data gaps in available information. As stated above, Section XIII of the FFA requires the DOE to propose additional work. Work included in this proposal, along with the previously completed work, should complete the Operable Unit 1 remedial investigation.

At the conclusion of the work described in this proposal, the DOE will make a decision about the need for and the scope of remedial actions (including removal actions). This conclusion will have to be re-evaluated based on the results of background sampling and as the site-specific action levels for the Mound Plant evolve from Preliminary Remediation Goals (PRGs), Applicable or Relevant and Appropriate Requirements (ARAR) determinations, the Baseline Risk Assessment, and the Record of Decision (ROD). PRGs and background sampling and analysis are currently being developed as part of the site-wide Operable Unit 9 investigations.

1.2. PURPOSE

The purpose of the proposed work is to fill data needs related to Area B by focusing on the following objectives:

1) Identify and further characterize potential source areas including vadose zone soils, with particular attention to resolving the issue of whether the source is concentrated or diffuse;

2) Quantify and predict plume migration and groundwater flow within Operable Unit 1;

3) Collect data sufficient to determine if there is an unacceptable threat to human health or the environment and, if so, to propose remedial measures, including removal actions; and

4) Collect data sufficient to satisfy all Remedial Investigation data needs in order to proceed with the Feasibility Study and the balance of the CERCLA process.

It is also the objective of this proposal to fit within the context of the RI/FS process by supplementing the previously completed work and describing how additional phases of work would be completed. Attachment I to the FFA mandates that data needs and data usage must be identified that will:

A. Define the source areas of contamination;

B. Define the nature and vertical and horizontal extent of contamination;

C. Define potential pathways of contaminant migration;

D. Define potential receptors;

E. Allow a determination of whether and to what extent a threat to human health or the environment exists (sufficient to support the Risk Assessment); and

F. Allow development and evaluation of the remedial action alternatives.

A summary of the data needs to be met, together with how they are to be met, is presented as Table I.1. These data needs are drawn from those identified in the RI Technical Memoranda 2 and 3 (DOE 1991d; DOE 1991e).

It is an objective of this proposal for additional work to specify data collection sufficient to determine if a threat exists to human health or the environment and to propose remedial measures including removal actions, interim remedial actions, and remedial design/remedial action, as well as to continue with the balance of the CERCLA process. The strategy also focuses on confirming or refuting potential source areas such as the historic landfill (especially one trench thereof), the site sanitary landfill, or diffuse areas as a cause of groundwater contamination.

Sampling and analysis of the storm-water retention and discharge system (SRDS) runoff and associated sediment are not included as part of this proposal for additional work. They are being addressed in the Operable Unit 9, Site-Wide Remedial Investigation as an integral part of the overall surface-water evaluation.

1.3. DECISION TREE

A decision tree, providing the overall strategy for executing the complete Proposal for Additional Work, is shown on Figure I.1. This decision tree is discussed further in Section 2 of this document.

1.4. ORGANIZATION

The balance of this proposal for additional work consists of the following sections:

Section 2. BACKGROUND, including a discussion of pathways, an expanded discussion of data needs and a discussion of data quality objectives.

Section 3. GENERAL REQUIREMENTS, an overview of the field program, to include sampling objectives and sampling rationale. The specifics of the program, such as sampling locations and frequencies, and general specifications for piezometers and monitoring wells are included. At the end of the section, there is a concise summary of field activities, suitable for use as a field sampling plan.

Section 4. FIELD METHODS, including Standard Operating Procedures (SOP's), drilling methods, sample collection methods, field data collection methods, and a reference to health and

safety requirements. Any deviations are based on site-specific knowledge. SOPs and related documents are taken from the most current version of the Operable Unit 9 QAPP.

Section 5. AQUIFER TEST AND GROUNDWATER SAMPLING, incorporating the technical (performance) specifications for this aspect of the program. The aquifer test and associated groundwater sampling will determine how plume migration toward the Mound Plant production wells can best be controlled. Since this is a separate and distinct test, it is described separately.

Section 6. *IN SITU* VOLATILIZATION SYSTEM, using data obtained from the source characterization investigation (soil gas probes, soil borings, piezometer and monitor well installation) to determine if VOCs are present in the vadose zone (and their location) in sufficient quantities to warrant the development of a removal action. These data are necessary to develop an efficient vadose zone remediation designed to decrease VOC concentrations in a source area. If VOC concentrations are of sufficient magnitude, and if the geologic setting allows air transport, then soil borings and an *in situ* volatilization (ISV) system trial are proposed at potential source areas. Proposed activities are summarized in Section 6. Because the activities are several phases away, the scope of the ISV program will be sequentially re-evaluated and may be revised. The ISV trial will not be required if a removal action is not warranted.

Appendix A contains the Mound Plant Area B Schedule. Companion documents attached to this Proposal for Additional Work include a Quality Assurance Project Plan (QAPP), tiered to the Operable Unit 9, Site-Wide QAPP, and a Site Health and Safety Plan.

2. BACKGROUND

Background information relevant to the potential sources, and the evaluation of the need for additional sampling, are presented below.

2.1. SITE DESCRIPTION AND HISTORY

The Mound Plant Site is located within the southern city limits of Miamisburg, in Montgomery County, Ohio (Figure 2.1). Mound Plant is operated by EG&G Mound Applied Technologies for the DOE and is currently an integrated research, development, and production facility that operates in support of the DOE weapons and energy programs. Table II.1 summarizes the history of Mound Plant.

Area B is comprised of approximately four acres in the southwestern portion of Mound Plant (Figure 2.2). Cut-and-fill activities and refuse and waste disposal occurred in the historical landfill in Area B from 1948 to 1977. Detailed descriptions of historical waste management at Area B are provided elsewhere (DOE 1991a and DOE 1991i), but important aspects are discussed below.

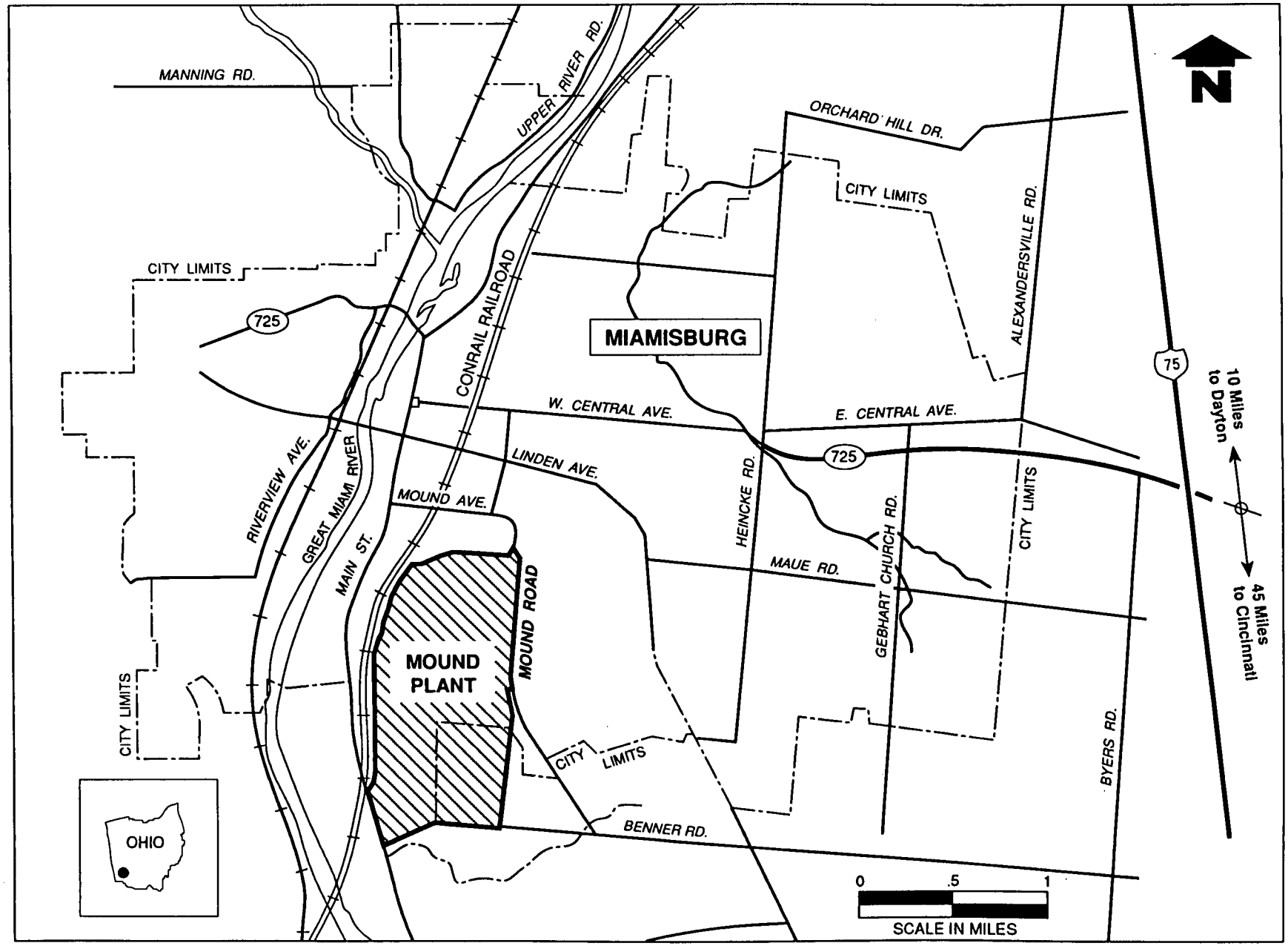
Area B contains three main features:

- The historical landfill formerly encompassed the entirety of Area B until portions were excavated to make room for the overflow pond. Remnants of the historical landfill are still present below and adjacent to the site sanitary landfill.

- The site sanitary landfill (SSL) is a clay-encapsulated (lined and capped) cell that was created by the excavation of 18,000 cubic yards of sanitary trash from the historical landfill. It was constructed in 1977 and 1978 to contain material excavated during the construction of the overflow pond. It overlies the southern portion of the historical landfill.

- The overflow pond or stormwater detention pond was constructed in 1977 in the northern portion of the historical landfill. It is lined with at least 3 ft of natural clay-bearing glacial till, and was designed to detain a 2-year, 24-hour storm and maintain total suspended solids within NPDES limits.

A cross section was constructed which bisects the center of the SSL along a west-to-east trend. The cross section is a schematic representation of all components that comprise both the buried remains of the historical landfill and configuration of the SSL. Figure 2.3 shows a plan view of the cross section trace line in relation to surface landforms and subsurface trenches and burials. The cross section is shown in Figure 2.4. A bedrock topography map and an unconsolidated deposits isopach map are presented as Figures 2.5 and 2.6, respectively.



Mound location map/5-4-92

Figure 2.1. Location of Mound Plant, Miamisburg, Ohio

Table II.1. History of Mound Plant

Activity	Date
Originated at Dayton, Ohio, locations as part of the Manhattan Engineer District to investigate the properties of polonium	1943
Operations moved to 182 acres in Miamisburg, Ohio	1946
Investigations performed involving uranium, plutonium, and protactinium	1950-1963
Separation of noble gases began	1954
Beginning of Mound Plant's major mission: production of nonnuclear weapons components	1954
Production of heat sources using plutonium-238 began	1961
An installation assessment performed under CEARP identified 43 potential release sites at Mound Plant	1986
Groundwater investigations began under CEARP	1987
A RCRA facility assessment identified 101 potential release sites at Mound Plant (including 43 sites identified in 1986)	1988
Negotiations began among EPA, Ohio EPA, and DOE for a Federal Facility Agreement and an Administrative Order on Consent concerning Mound Plant	1988
Eight inactive underground storage tanks added to ER Program, resulting in a total of 109 sites	1989
Mound Plant placed on the National Priority List	November 1989
Signing of the Federal Facilities Agreement between DOE and EPA Region 5	1990
ER Program investigating a total of 109 potential release sites at Mound Plant	Current

CEARP - Comprehensive Environmental Assessment and Response Program
DOE - U.S. Department of Energy
EPA - U.S. Environmental Protection Agency
ER - Environmental Restoration (Program)
RCRA - Resource Conservation and Recovery Act

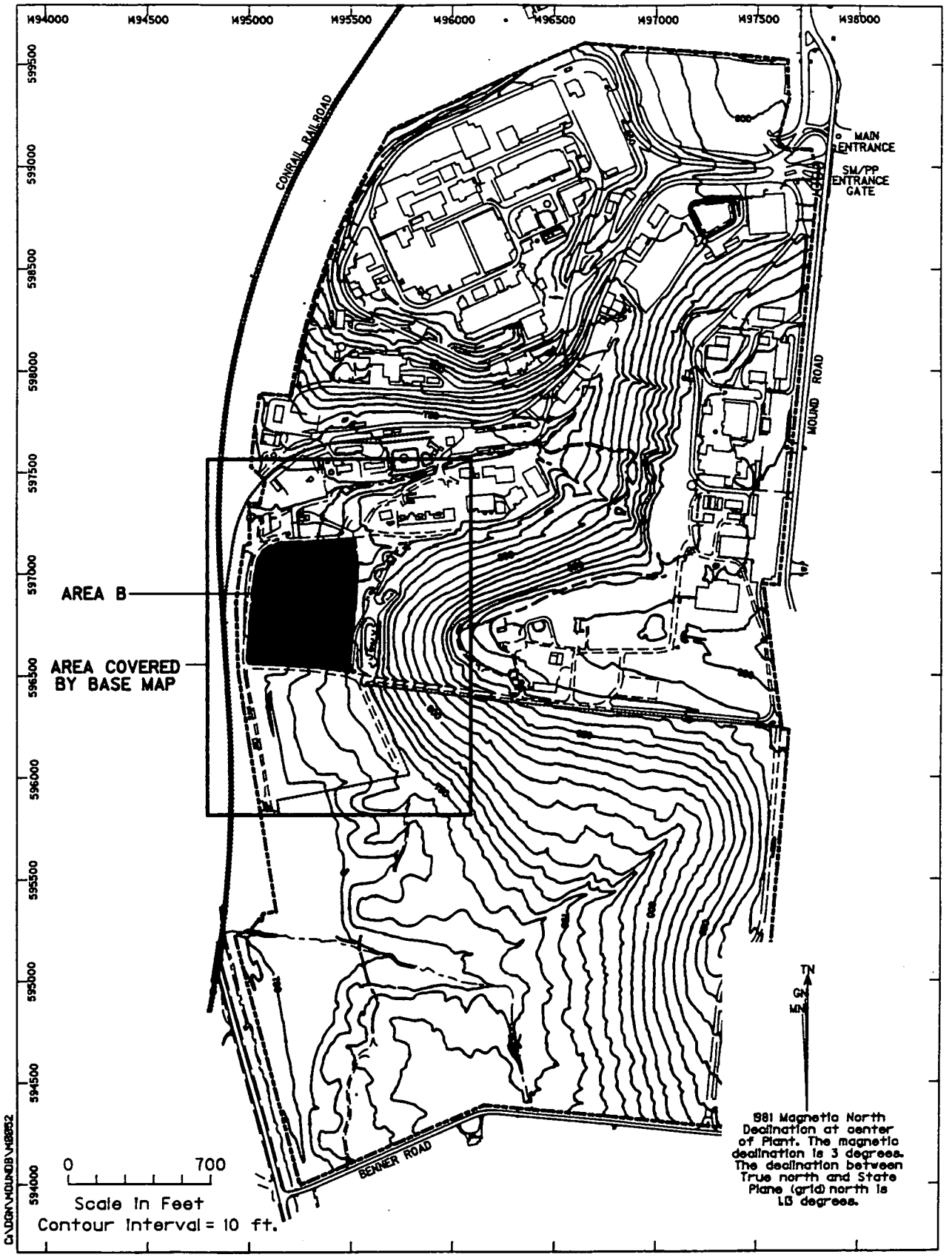


Figure 2.2. Mound Plant topographic map with Area B outlined.

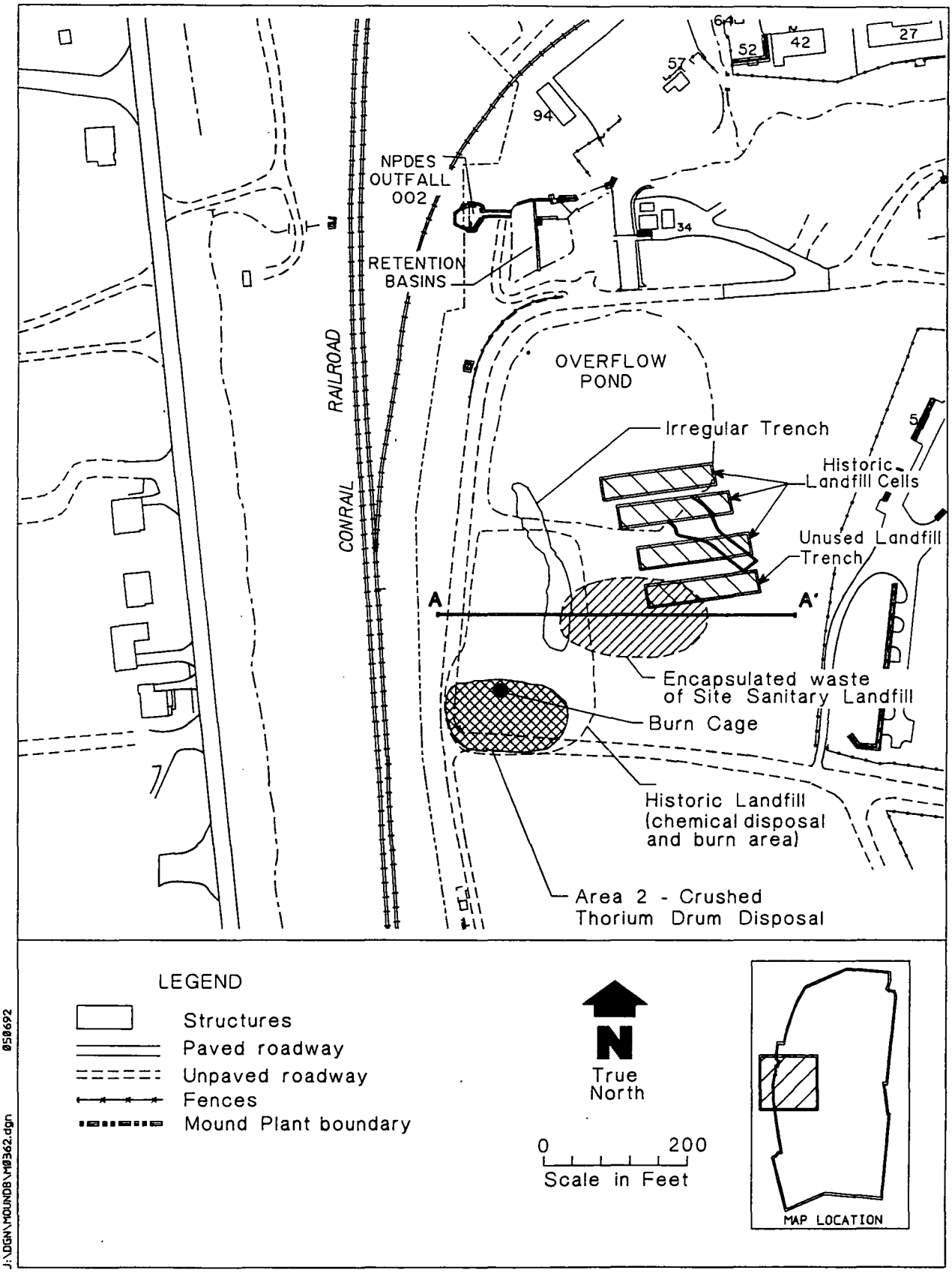


Figure 2.3. Plan view showing cross section trace line A-A', irregular trench, encapsulated waste of site sanitary landfill, Area 2, and chemical disposal and burn area of the historic landfill.

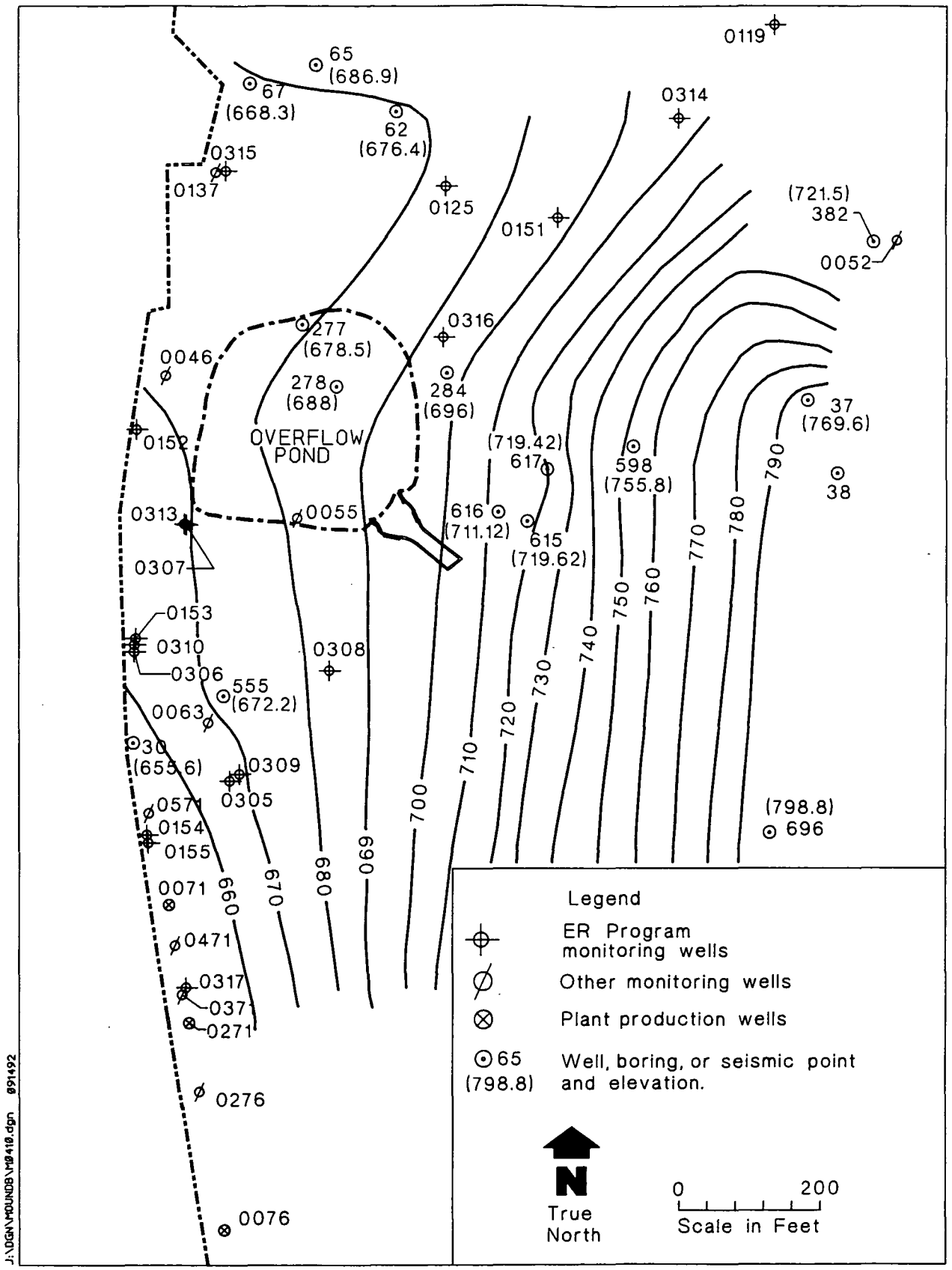


Figure 2.5. Area B bedrock topographic map.

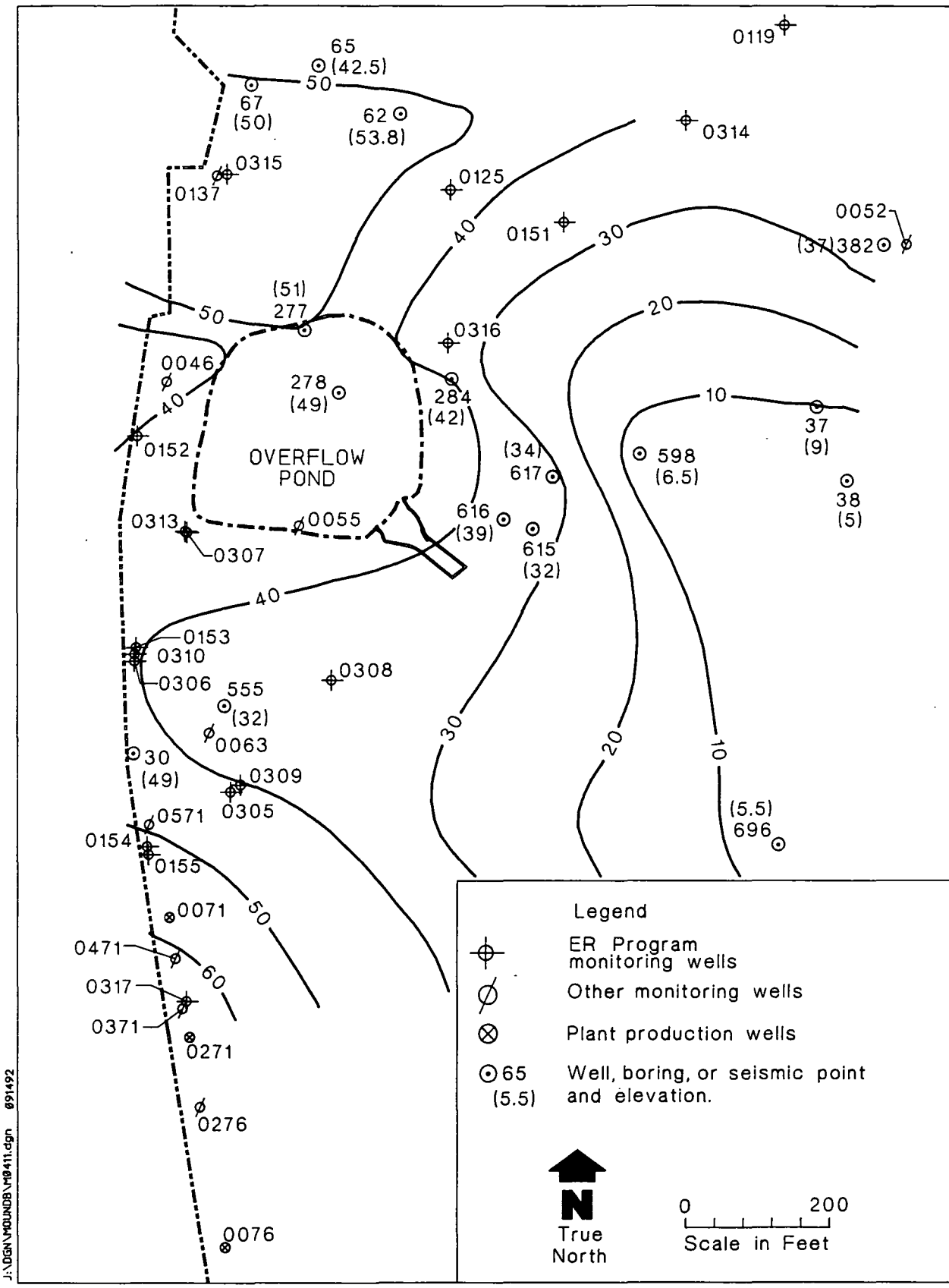


Figure 2.6. Area B isopach map of unconsolidated deposits.

Groundwater monitoring for hazardous constituents has been conducted near Area B since 1986. The data and interpretation have been reported elsewhere (DOE 1991e), but some important findings are:

- The principal groundwater contaminants of concern are trichloroethene (TCE), tetrachloroethene (PCE), 1,2-*trans*-dichloroethene (DCE), and tritium.
- The highest TCE and PCE concentrations were observed in the wells directly south and southwest of the SSL, in wells 0063, 0305, 0306, and 0153.
- Historically, the highest concentrations of DCE were detected beneath the southern part of the overflow pond at well 0055. Well 0055 has not been sampled since September 12, 1988. More recently, high concentrations of DCE have been detected directly south and southwest of the SSL, in wells 0063, 0305, 0154, and 0155.
- VOCs and tritium are present north of Area B.
- The highest tritium concentrations were observed in wells south and southwest of Area B in monitoring wells 0063, 0306, and 0310 (DOE 1991e).

Posted concentration values of TCE, PCE, DCE, tetrachloromethane, trichloromethane, and 1,1-dichloroethene for Area B wells in December 1991 are plotted in Figures 2.7 through 2.12, respectively. Tritium concentrations for Area B wells in August 1991 are plotted in Figure 2.13.

2.1.1. Historical Landfill

The types and quantities of spent solvents disposed in the historical landfill are not well documented in terms of types and quantities disposed. From 1954 to 1969 the area may have received solid and liquid wastes, the latter reportedly including TCE, tetrachloromethane, benzene, and acetone (DOE 1991j). An attachment to a letter from W. E. Sueberling to V. C. Vespe (Sueberling 1965) states that three tons of rubbish were disposed of daily and 150 gallons of waste solvents were disposed of weekly. The rubbish is identified as paper, cartons, rags, floor sweepings, etc. The waste solvents are identified as alcohol, acetone, etc. A letter from J. L. Hebb to D. R. Storey (Hebb 1970) states that open burning of approximately 250 gallons of liquid burnable chemicals occurred every Friday afternoon, weather permitting. In addition, approximately 8 to 10 tons of combustible solids were burned daily. The recommendation in this March 17, 1970 memorandum was to discontinue all open burning at Mound Plant. A memorandum later in 1970 (Ryan and Hebb 1970) states that Mound Plant was accumulating and storing approximately 350 to 400 gallons per week of waste solvents. They began to segregate waste solvents that had been exposed to explosives or radioactivity so that these materials would not leave the site.

A sequence of trenches is visible in historical aerial photographs of Area B (DOE 1991h). In the later period of its use, four cells were constructed on the eastern side of the area. Waste material emplaced

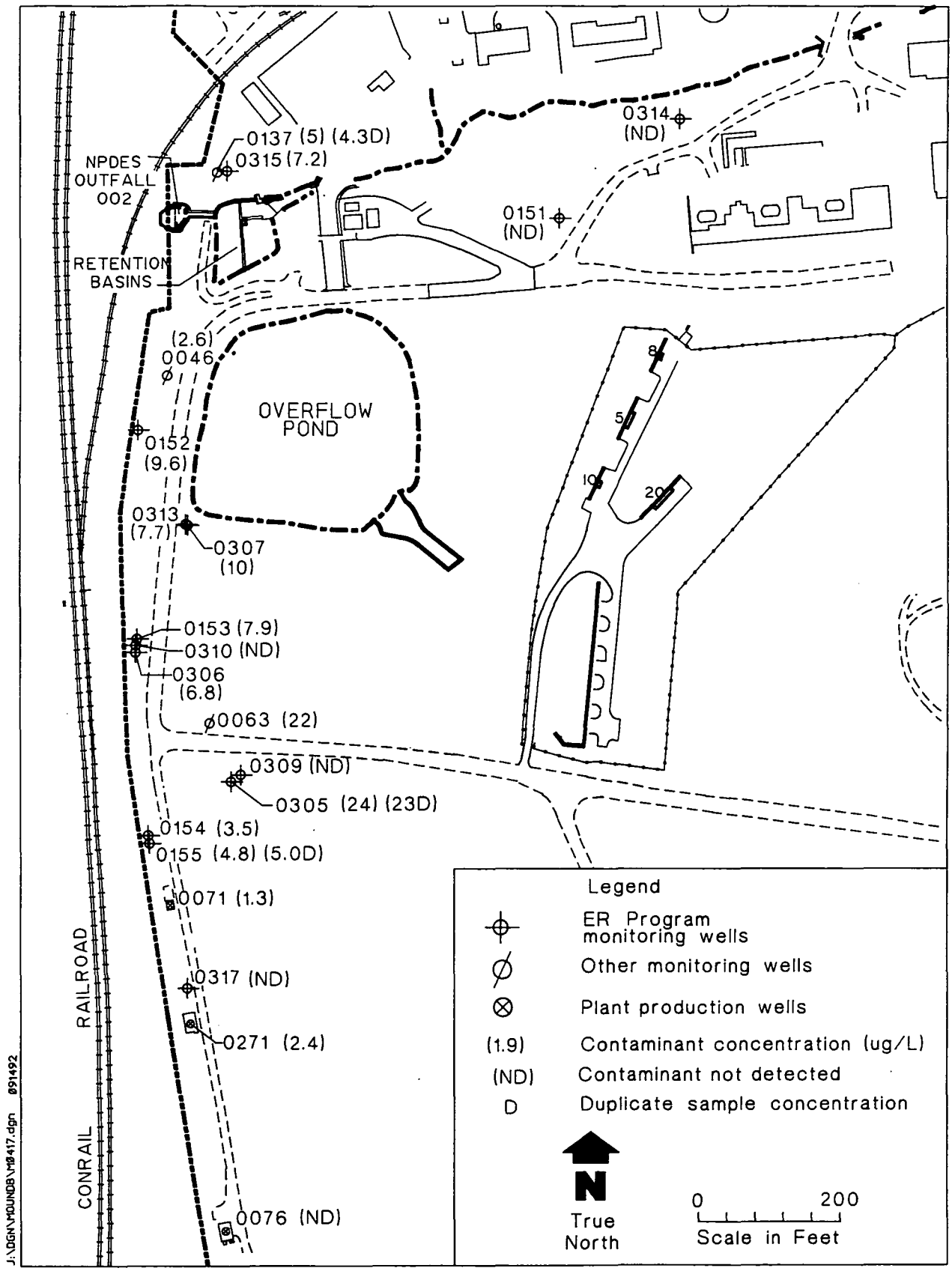


Figure 2.7. Trichloroethene concentrations for Area B wells, December 1991.

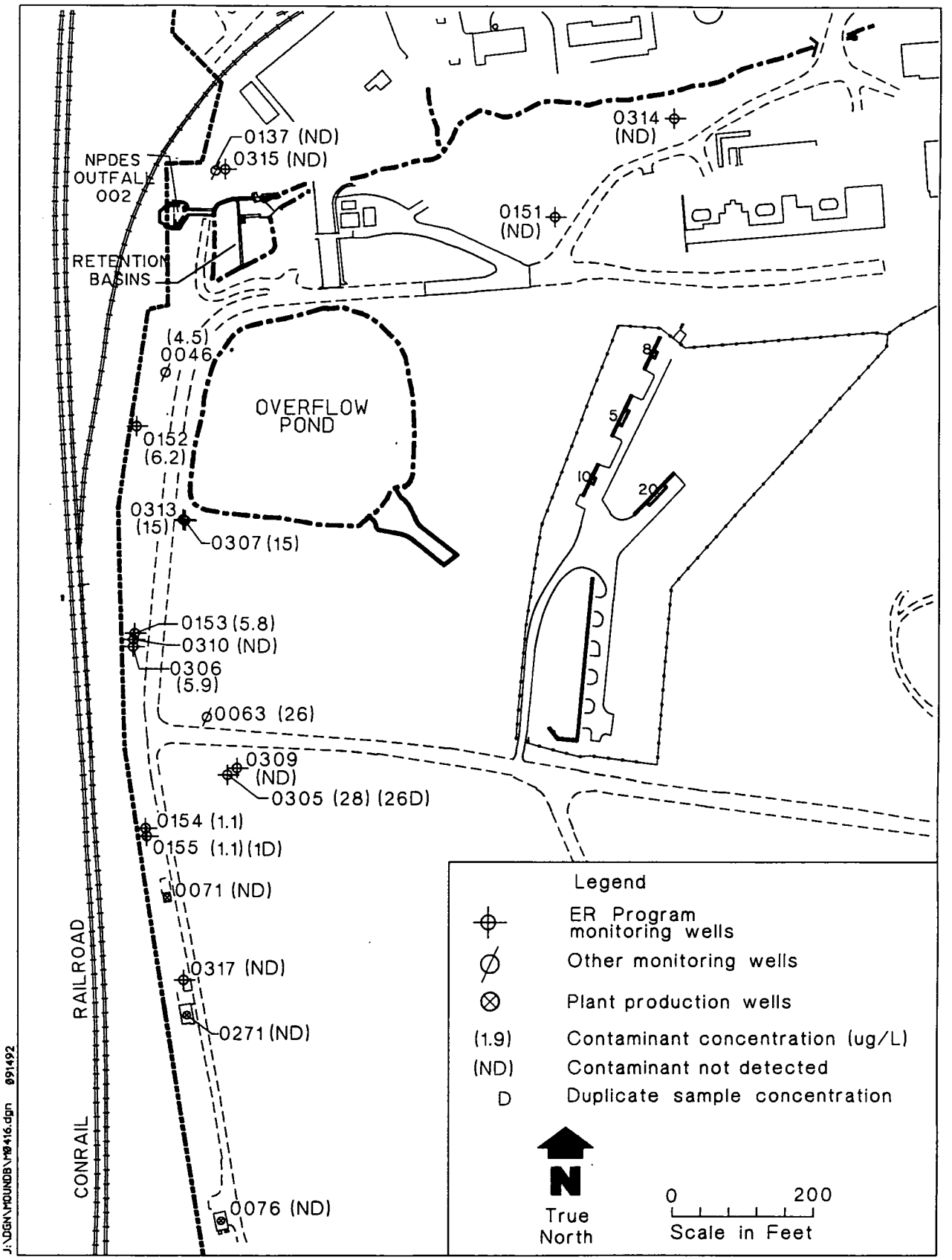


Figure 2.8. Tetrachloroethene concentrations for Area B wells, December 1991.

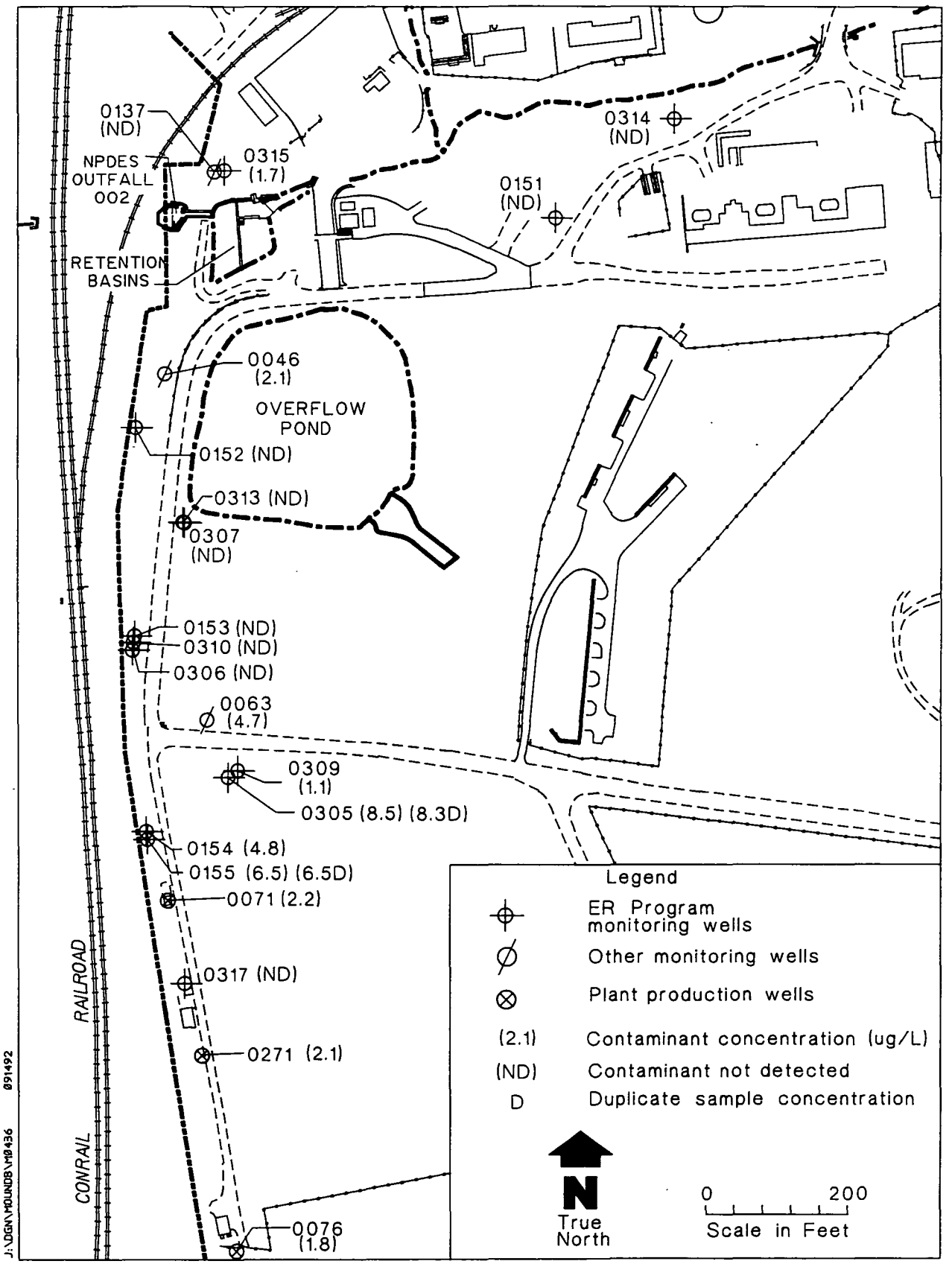


Figure 2.9. 1,2-*Trans*-dichloroethene concentrations for Area B wells December 1991

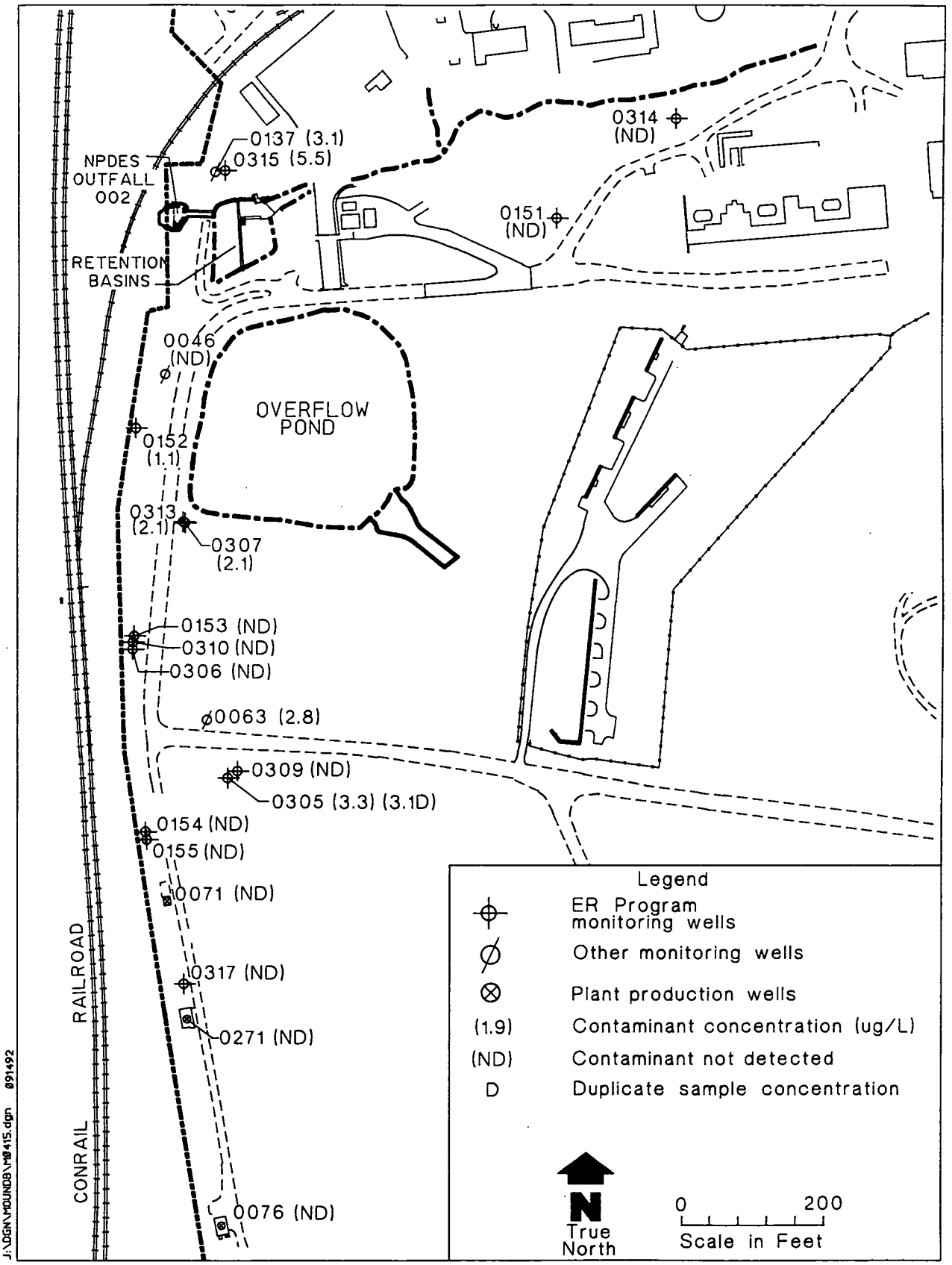


Figure 2.10. Tetrachloromethane concentrations for Area B wells, December 1991.

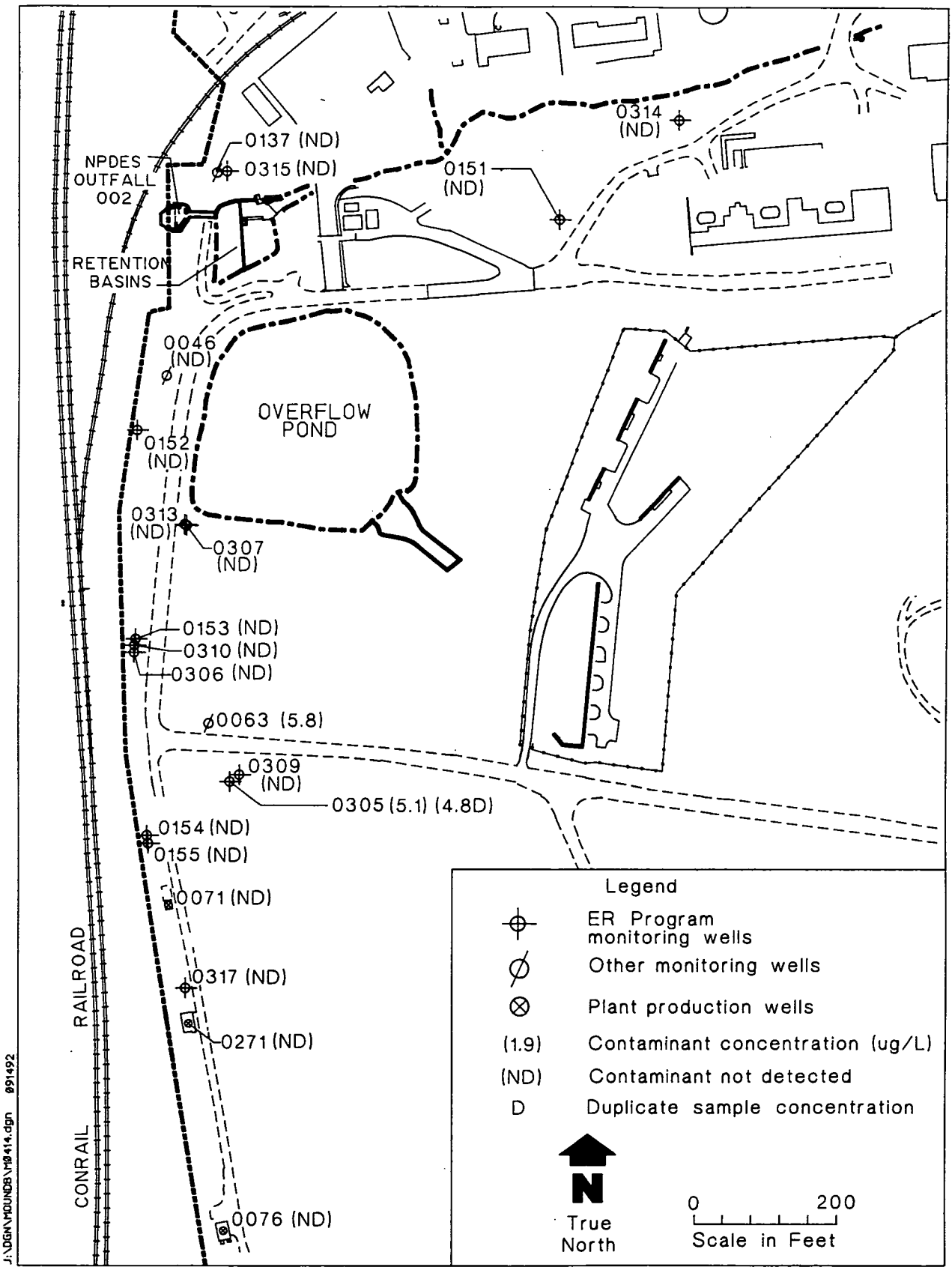


Figure 2.11. Trichloromethene concentrations for Area B wells, December 1991

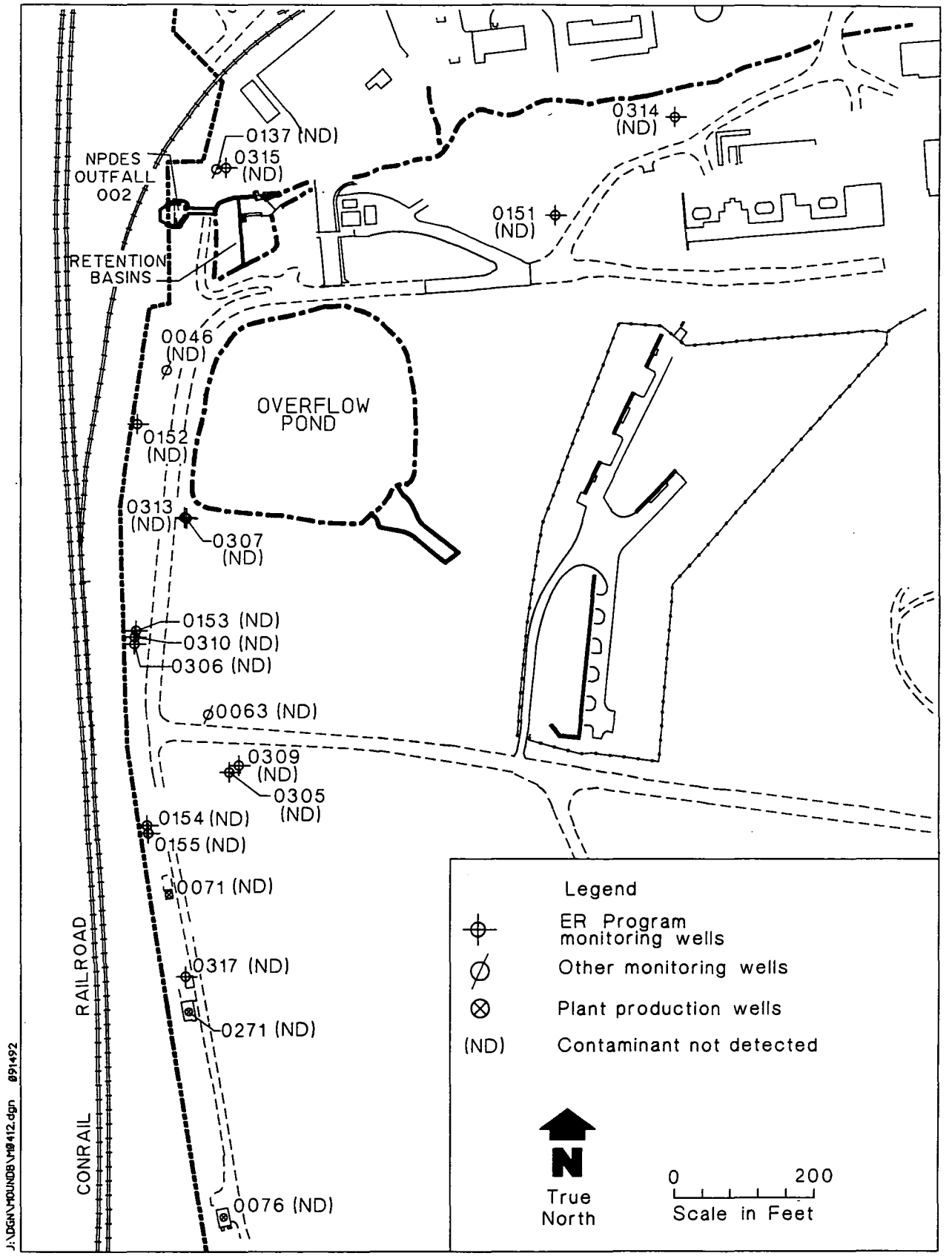


Figure 2.12. 1,1-Dichloroethene concentrations for Area B wells, December 1991

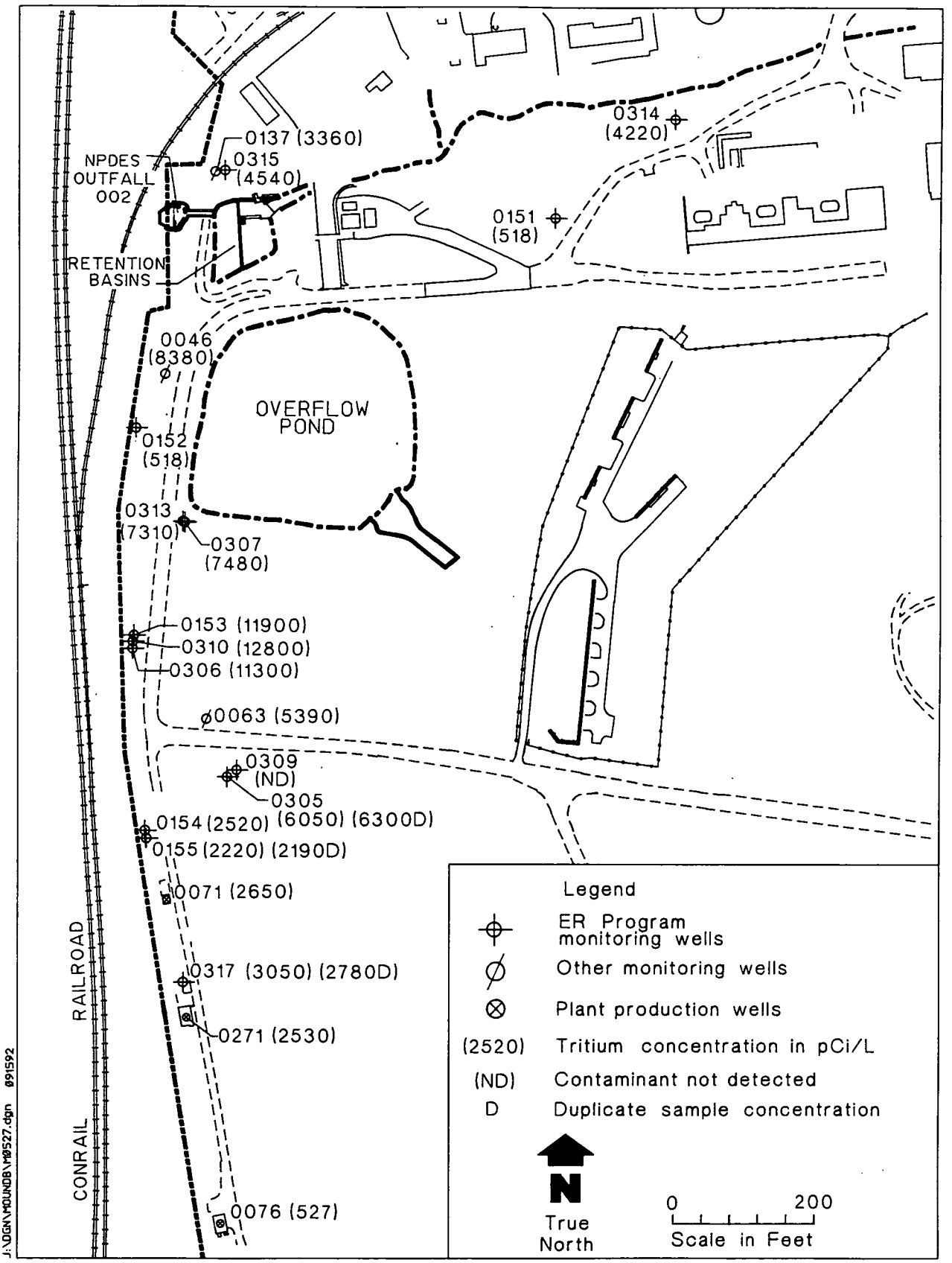


Figure 2.13. Tritium concentrations for Area B wells, December 1991.

in three of these cells was excavated and placed into the SSL. The southernmost fourth cell was never used for waste disposal and consequently served as the base structure for the construction of the SSL. Materials in the historical landfill that are believed to remain intact beneath the SSL include:

- a 200-ft-long, north-south trending, irregular trench filled with burned trash under the western berm of the SSL; and
- most of the burned and piled debris under the southwest corner of the SSL, including sand contaminated with polonium-210 from the cleaning filters in the WD Building and approximately 2000 empty, crushed 55-gallon drums that had contained thorium (Area 2).

Based on the period it was open and because of solvent disposal descriptions in personal interviews, the irregular trench is the main concern relative to VOCs. The burned and piled debris in the southwest corner of the landfill is related to historical burn cage operations and is a secondary concern relative to organic compound contamination.

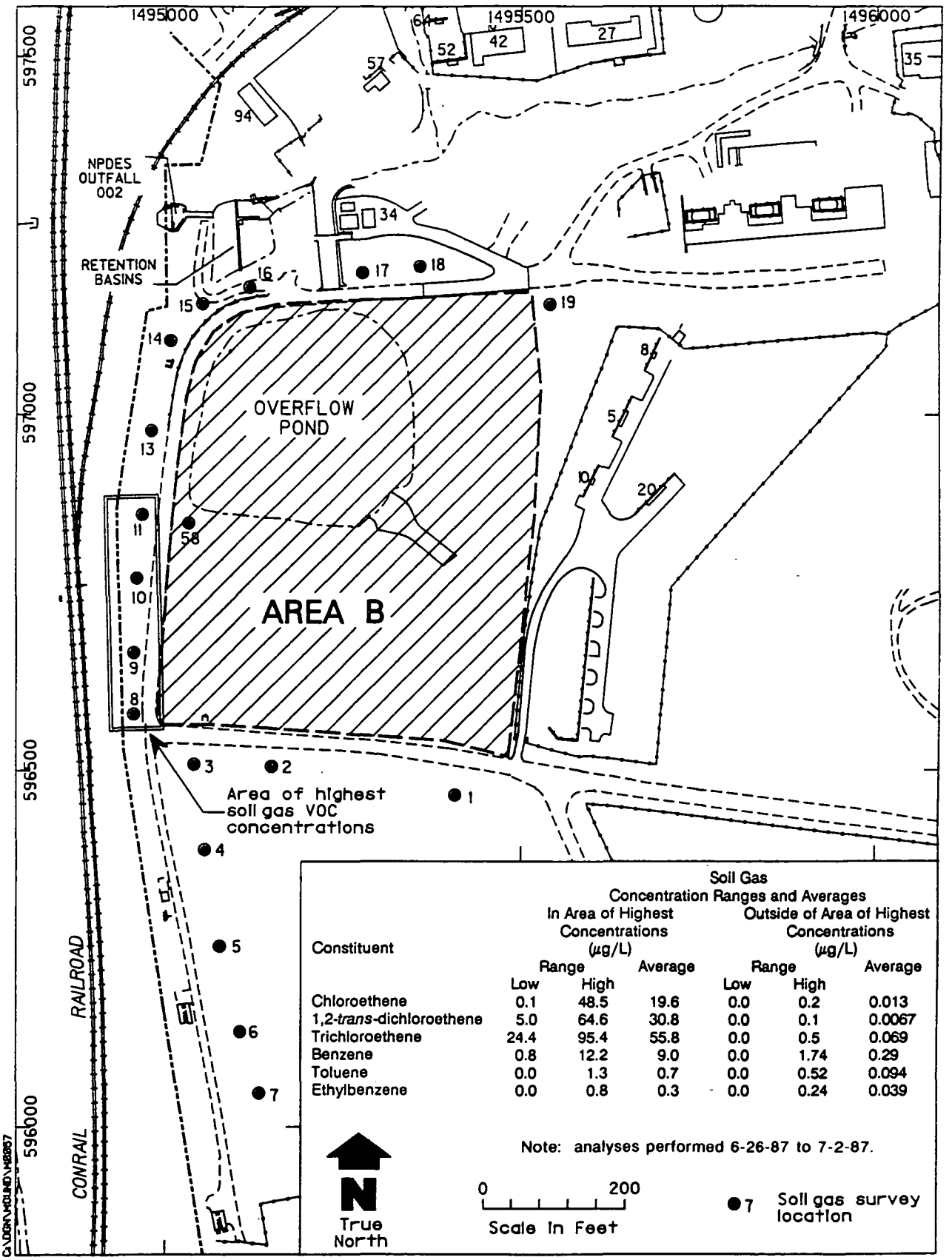
A soil gas survey was completed in 1987 around the periphery of Area B. At 34 locations, a soil gas sample was collected from a depth of approximately 5 ft. The soil gas data showed the highest concentrations of VOCs at four locations directly west of the SSL (Figure 2.14). A summary of results is contained in Table II.2, which supplies the maximum, minimum, and average concentrations for the four locations west of the SSL.

Shallow soil samples were collected west of the SSL in 1990 to corroborate the VOC contamination detected by the soil gas survey (Figure 2.15). During the installation of monitoring wells in 1989, a limited number of soil samples were collected from well boreholes 0305, 0307, 0308, and 0313, at depths ranging from 30.0 to 67.0 ft (Figure 2.15). Table II.3 presents VOCs detected in subsurface soils. Shallow soil data showed low levels of VOC contamination in two of the four samples collected, while the borehole data showed that TCE, PCE, and DCE occur both in the vadose zone and below the water table (DOE 1991d).

A soil gas sample was collected from the perforated drainpipe outlet located near the base of the northern SSL berm. The sample was collected using a vacuum canister. Sample results are shown in Table II.4.

2.1.2. Site Sanitary Landfill

The SSL was constructed with a 14-ft thick clay liner and a minimum 3-ft thick low-permeability clay cap. The base, supporting berms, and liner of the SSL were constructed entirely of virgin high grade



Constituent	Soil Gas Concentration Ranges and Averages: In Area of Highest Concentrations (µg/L) Range Low	High	Average	Outside of Area of Highest Concentrations (µg/L) Range Low	High	Average
Chloroethene	0.1	48.5	19.6	0.0	0.2	0.013
1,2-*trans*-dichloroethene	5.0	64.6	30.8	0.0	0.1	0.0067
Trichloroethene	24.4	95.4	55.8	0.0	0.5	0.069
Benzene	0.8	12.2	9.0	0.0	1.74	0.29
Toluene	0.0	1.3	0.7	0.0	0.52	0.094
Ethylbenzene	0.0	0.8	0.3	0.0	0.24	0.039

Note: analyses performed 6-26-87 to 7-2-87.

Figure 2.14. Soil gas locations adjacent to Area B.

Table II.2. Summary of Soil Gas Data

Data Set	Parameter	Chloroethene	1,2-*trans*-dichloroethene	Trichloroethene	Benzene	Toluene	Ethyl Benzene
4	Number of hits	4	4	4	4	4	3
High	High concentration	48.50	64.60	95.40	12.20	1.30	0.76
Concentrations	Low concentration	0.12	5.02	24.40	0.80	0.02	0.00
Locations	Average concentration	19.56	30.76	55.77	9.03	0.73	0.35

Note: All concentrations in micrograms per liter of gas.

Table II.3. VOCs Detected in Soil Samples

Location Identification	Sample Depth, ft (BGL)	Constituent	Concentration (µg/kg)
0017	0.7	Trichloroethene	3
		Tetrachloroethene	3
		1,1,2,-Trichlorotrifluoroethane	3
0019	0.4	Trichloroethene	3
0305	30.0	1,2-Dichloroethene	10
		Trichloroethene	33
		Tetrachloroethene	31
0307	42.0	Trichloroethene	13
		Tetrachloroethene	40
	47.0	Trichloroethene	10
		Tetrachloroethene	39
0308	60.0	1,2-Dichloroethene	38
		Trichloroethene	85
	67.0	Chloroethene	18
		1,2-Dichloroethene	180
		Trichloroethene	230E
		Tetrachloroethene	8
0313	40.0	Trichloroethene	6
		Tetrachloroethene	12
		Total xylenes	12

BGL - Below ground level
E - Compound exceeded CLP calibration range
Note: No VOC contamination was detected in samples from 0016 and 0018. Both samples were collected at a depth of 0.6 ft.
Samples from 0017, 0019, and 0305 were collected above the water table.
Samples from 0307, 0308, and 0313 were collected below the water table.

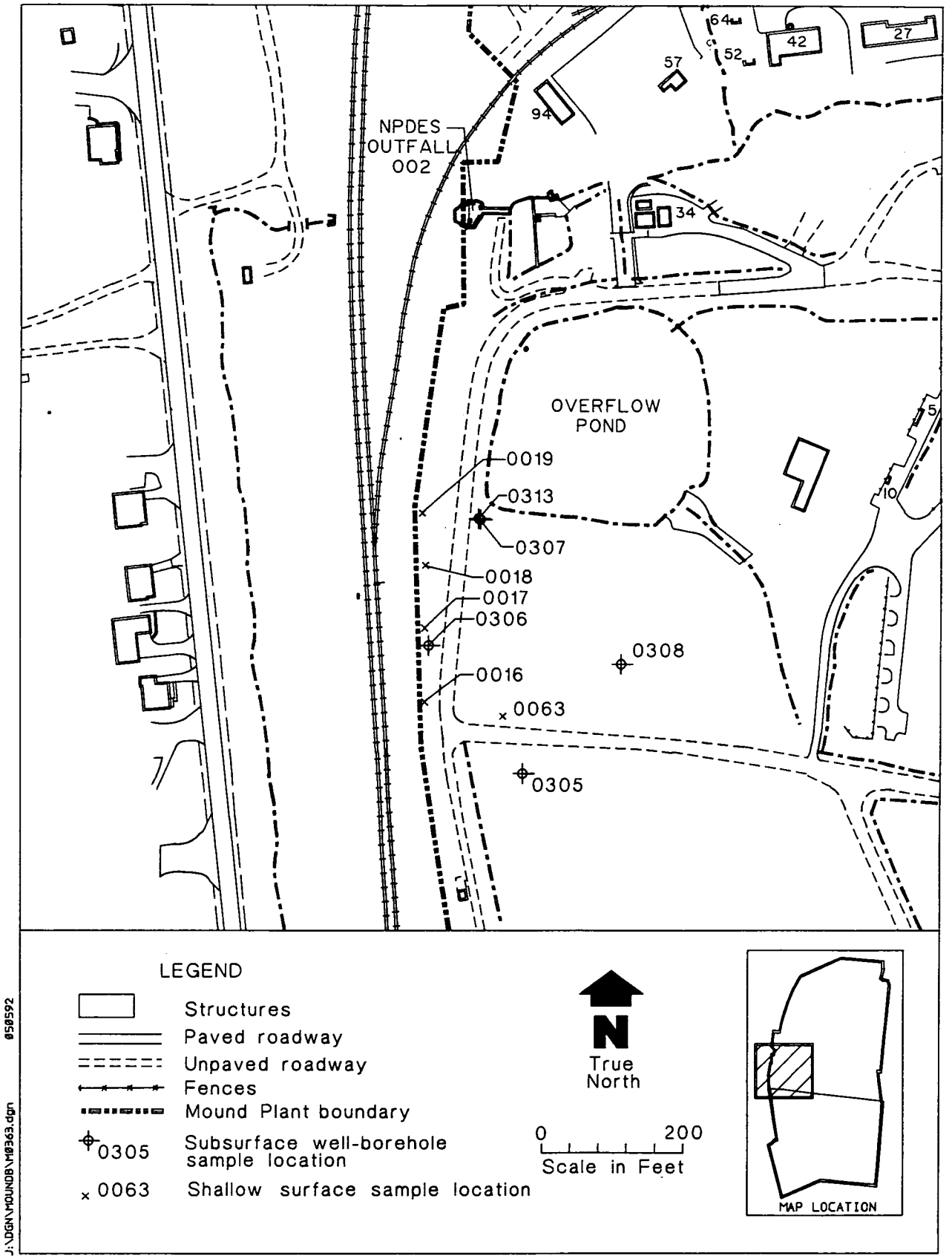


Figure 2.15. Shallow and subsurface soil sampling locations.

Table II.4. Summary of Soil Gas Results from the Site Sanitary Landfill Perforated Drainpipe

Constituent	Result		PQL* (ppbv)
	(μg/cu M)	(ppbv)	
Acetone	13.0	5.0	1.0
Benzene	1.4	0.4	0.1
Tetrachloromethane	5.0	1.5	0.2
Toluene	2.6	0.6	0.2
1,1,1-Trichloroethane	1.3	0.2	0.2
Trichloroethene	1.7	0.29	0.1
Chloroethene	8.0	2.9	0.2
Xylenes, Total	18.0	3.8	0.2

*PQL - Practical Quantitation Limit

clay excavated from undisturbed slopes east and north of the historical landfill (DOE 1991i). Contents from the historic landfill, including sanitary trash such as paper, plastic bags, office trash, and kitchen garbage, were placed in the SSL. Additionally, scintillation cocktails containing tritium and solvents were possibly disposed of in the historical landfill and subsequently placed in the SSL. Important features constructed in connection with the SSL were:

- two 6-inch perforated drain pipes installed near the base of the encapsulated waste. These pipes were connected to a third pipe to drain any liquid leachate from inside the SSL into the new overflow pond to the north.
- five french drains laid down below and prior to constructing the SSL. The french drains were built with limestone gravel lined with a filter fabric to provide stability for the landfill.

2.1.3. Radioactively Contaminated Soils

Widespread, general disposal of radioactively contaminated material did not take place at Area B. There is no record of routine disposal of tritiated waste in the historical landfill that could represent a potential source. However, incidental amounts of tritiated waste may have been disposed of in Area B to produce the elevated levels seen in the groundwater. Other disposals of radioactive material at Area B include (DOE 1991i):

- A one-time accidental disposal occurred when a button of plutonium-238 was burned; however, it is believed that all of the resulting contamination was identified and cleaned up.
- Wood contaminated with polonium-210 was burned at another location and buried in a trench at Area B in 1954 (because of its short half-life, the polonium has completely decayed by now).
- Sand contaminated with polonium-210 from the cleaning of filters in the WD Building was buried in the southwest corner of the historical landfill in 1965, and is now known as Area 2 (the polonium has completely decayed). The sand may potentially be contaminated with bismuth and trace amounts of silver, aluminum, iron, tin, cobalt, tellurium, zinc, and selenium.
- From 1955 to 1964, between 2,000 and 5,000 empty 55-gallon drums containing residual thorium were crushed and buried in what is now known as Area 2.
- A flume installed on the lower reach of the plant drainage ditch in the late 1960s occasionally required the removal of accumulated sediment. These sediments, which would have contained plutonium-238 and thorium, were screened for radioactivity and dumped in the historical landfill. During excavation for the SSL the sediments were incorporated randomly into the structure.

- Urine samples submitted for scintillation analysis ("scintillation cocktails") were possibly disposed of in the historic landfill. These samples contained small amounts of tritium and P-Dioxane (phosphorodithioic acid-5,5).

Existing data on levels of radioactivity within and adjacent to Area B have been reported elsewhere (DOE 1991d; DOE 1991k). The radioactivity that is present is believed to be tritium in groundwater; plutonium-238 in the overflow pond sediments and surface and subsurface soils; and thorium in surface and subsurface soils. The maximum concentrations and general location of these radionuclides relative to Area B are listed below.

Radionuclide	Medium	Maximum Concentration	Location
Tritium	Groundwater	14.20 nCi/L	Within Area B
	Surface soil pore water	12.59 pCi/mL	SM/PP Slope
Plutonium-238	Pond sediments	37.20 pCi/g	Within Area B
	Surface soils	97.50 pCi/g	SM/PP Slope
		163.00 pCi/g	SM/PP Hill
	Subsurface soils	17.10 pCi/g	Within Area B
Thorium	Surface soils	25.25 pCi/g	SM/PP Slope
		32.60 pCi/g	SM/PP Hill
	Subsurface soils	3.31 pCi/g	Within Area B
		3.56 pCi/g	Near retention basins

Intrusive sampling was performed along the periphery of Area 2 but none has been performed within the disposal area to the depth of the thorium drums.

2.1.4. Overflow Pond

Surface water flow from the plant drainage ditch and from another ditch on the SM/PP Hill are routed to the overflow pond. Surface water flow from this system discharges through an NPDES-permitted outfall. The water leaving the Site is routed along the southern portion of the Miami-Erie Canal and discharges into the Great Miami River.

In 1987, International Technology Corporation, under contract to Mound Plant, collected water and sediment samples from the overflow pond. The samples were analyzed for VOCs, pesticides/ polychlorinated biphenyls (PCBs), extraction procedure toxicity metals (EP TOX), ignitability, corrosivity, reactivity, gross alpha (total--not filtered) and gross beta (total--not filtered), and plutonium-238. Organic parameters indicated no significant or unusually high levels of chemical contamination. Quantitative radiological parameter results for total gross alpha, total gross beta, isotopic plutonium-238 and gamma spectrum (sediments only) analysis are summarized below (ITC

1987). These results will be subject to confirmation by further sampling and analysis of water and sediment in the pond as part of the site-wide RI/FS field work (DOE 1992).

Sample Number	Matrix	Gross Alpha	Gross Beta	Gamma Spec		Isotopic Pu-238
				K-40	Cs-137	
H0724	Sediment*	31	<50	22.5	0.395	37.2
H0725	Water**	<0.0033	<0.02	----	----	<0.002

*Units are in pCi/g
**Units are in pCi/mL
"<" indicates that the parameter was not detected at the limit shown

Monitoring well 0055, located at the southern edge of the overflow pond, is not completed according to TEGD protocols. During periods of high water levels in the pond, the base of well 0055 is submerged. Because the water level in the well rises after inundation, this well is suspected to be a conduit for migration of overflow pond water along the 0055 well annulus to the Buried Valley aquifer (BVA). It is proposed that well 0055 be abandoned in accordance with State of Ohio abandonment procedures and replaced with a new monitoring well.

2.2. HYDROGEOLOGIC SETTING

Area B is located in a hydrogeologic transition zone, extending from the thin, less permeable soils of the uplands area to the east to the thicker, more permeable deposits of the BVA to the west (Figures 2.16 through 2.19). Because of the changing hydrogeologic environment and the limited drilling done to date within Area B, additional data are needed to characterize the hydrogeology sufficiently to support remedial measures.

In addition to the topographic and geologic changes across Area B, it is also located at the southern margin of a tributary valley that affects the local groundwater flow. Quarterly water levels are measured, plotted, and analyzed as part of the Operable Unit 1 groundwater sampling and mapping program (Figures 2.20 through 2.23). These maps show that groundwater moves west down the east-west trending valley driven by relatively steep hydraulic gradients. The direction of flow is generally perpendicular to the direction of flow in the main body of the BVA. Near the northwest corner of Area B, the groundwater from the tributary valley intersects the BVA, with decreasing hydraulic gradients and flow diverging to the south. This is another transitional aspect of the groundwater flow near Area B. It is necessary to collect additional data to better characterize the potential inflow of contaminants from other potential sources at Mound Plant into the vicinity of Area B. Once Operable Unit 9 monitoring wells are installed, a monthly groundwater level program will be implemented to provide additional groundwater level data.

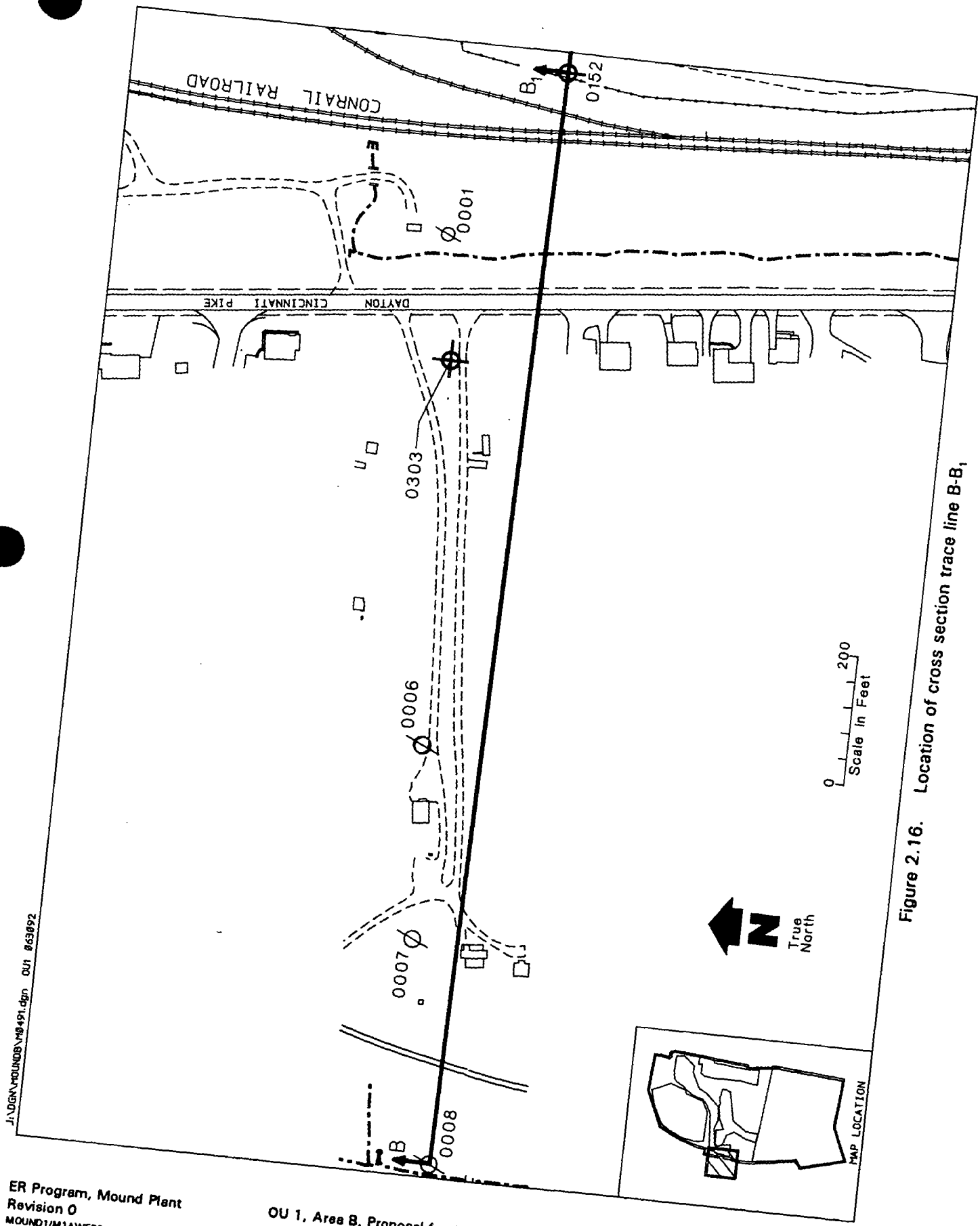


Figure 2.16. Location of cross section trace line B-B$_1$

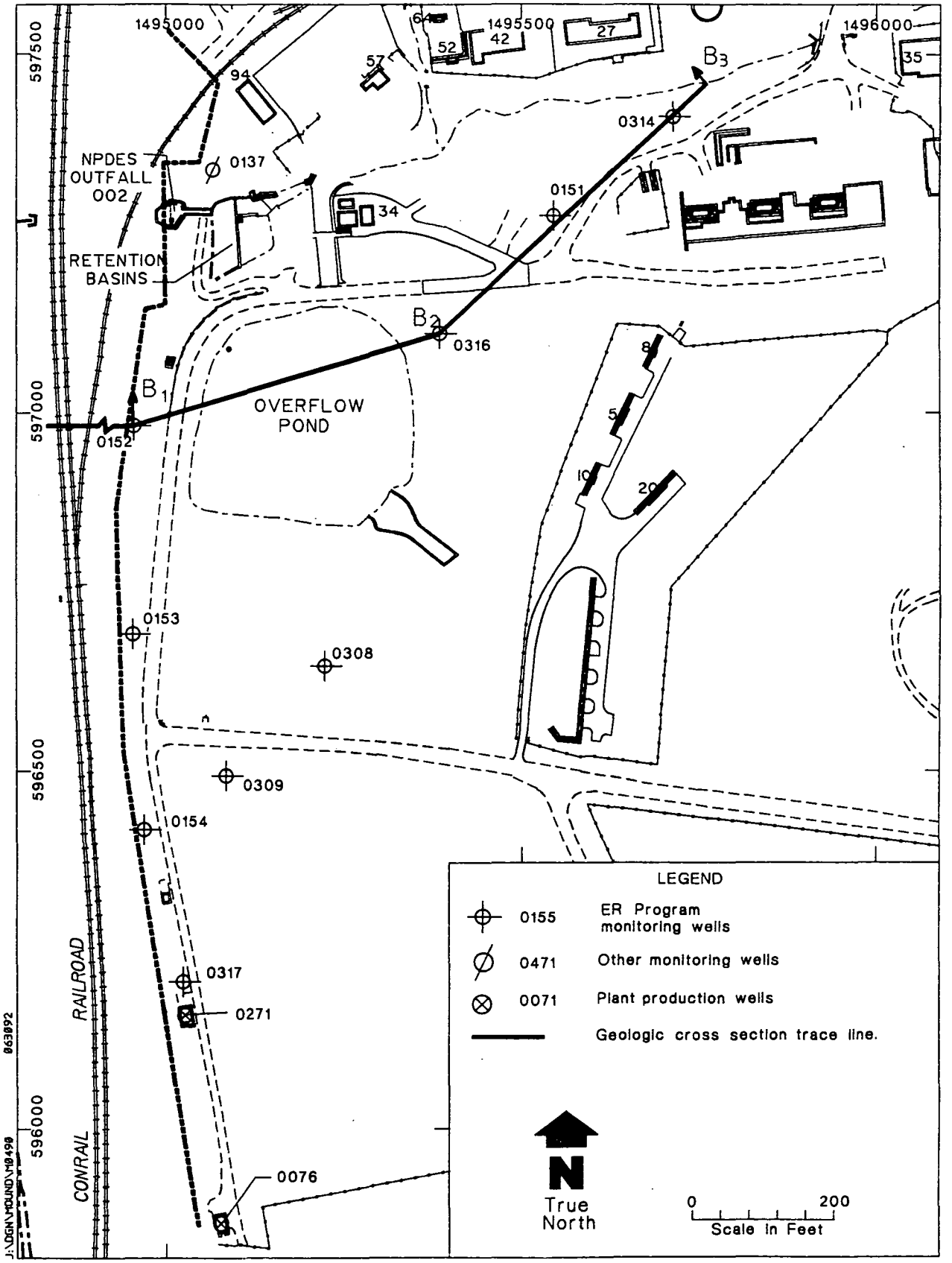


Figure 2.17. Location of cross section trace line B_1 -B_3 .

The primary vehicle for groundwater transport out of Area B is through outwash, due to its high hydraulic conductivity. While till and bedrock provide a means of transport for groundwater out of Area B, the volume they can transport is insignificant compared to outwash, due to their relatively low hydraulic conductivities. Vertical gradient calculations show that outwash is recharging the fill and bedrock, although it cannot be determined if the gradient reverses during periods of reduced recharge.

Several different aquifer tests have previously been conducted in the vicinity of Area B (DOE 1991e). The results of those tests would be used to design any remedial response actions for groundwater, such as pumping and treating groundwater to protect the Mound Plant supply wells. However, the previous pumping tests have had some data gaps, including the following:

- There are an inadequate number of wells located within Area B itself; therefore, there are insufficient data about hydraulic parameters near the potential source.

- The area to the west of Area B is an important part of the groundwater flow field, but there is a gap between 75 ft west to 375 ft west, where access is difficult.

- The previous pumping tests have been of relatively short duration, usually two to seven days.

- Previous pumping tests have not included time-series sampling and analysis of monitoring wells for known contaminants over a significant period of time.

2.3. CONTAMINANT MASS BALANCE

To develop a contaminant mass balance, the mass, distribution, and release history of the source must be known or estimated. Additional information on the amount and type of materials released in Area B has been recently discovered, as discussed in subsection 2.1.1. Although these letters and memoranda provide additional information on waste disposal practices and volumes, the amount that was burned, the amount that was not burned, and the burning end products and volumes cannot be quantified. However, information regarding the mobility and persistence of the observed contaminants are presented in this section.

Results from previous and ongoing investigations indicate that several contaminants have been identified in concentrations above established or proposed regulatory limits in the groundwater in the vicinity of Area B. These contaminants include trichloroethene, tetrachloroethene, 1,2-dichloroethene (total), 1,2-*trans*-dichloroethene, chloroethene, styrene, manganese, and iron. Manganese and iron exceeded secondary drinking water standards, but both concentrations were similar to levels reported

in the ambient groundwater (Spieker 1968). Secondary standards are established for aesthetic purposes rather than potential human health or environmental effects. Manganese and iron will not be further considered in this section.

It should also be noted that several inorganics, including antimony, cadmium, chromium, lead, and nickel have been identified in concentrations above established or proposed regulatory limits in groundwater. Additionally, uranium has been detected above the proposed MCL. Discussion in this section is limited to the previously described contaminants of concern.

Trichloroethene, 1,2-*trans*-dichloroethene, acetone, chloroethene, and tetrachloroethene waste characteristics and behavior are well documented. The rate of migration of an organic compound in soil and groundwater is controlled by the chemical and physical properties of the compound as well as the physical and geochemical properties of the vadose zone and aquifer materials. In general, chlorinated hydrocarbons are more dense and less viscous than water, are not nearly as biodegradable as other organic compounds, are quite soluble relative to the low levels that require regulatory action, and are largely nonsorbing and therefore quite mobile in groundwater systems and rather volatile (Schwille 1988). When spilled in adequate volumes, these compounds are capable of penetrating the capillary fringe and sinking deep into an aquifer system. Three scenarios are postulated (Schwille 1988):

- If the unsaturated zone is fairly permeable to air, such as are very permeable soils during extended periods of little precipitation, the majority of the chlorinated hydrocarbon will evaporate fairly quickly. A gas mound will build around the body of the mass of the chlorinated hydrocarbon, and eventually the mass of the chlorinated hydrocarbon phase will vaporize completely. As a result of its density, the chlorinated hydrocarbon gas will tend to sink and spread out laterally over strata that are not very permeable.

- When the amount of spilled chlorinated hydrocarbon is less than the capacity of the unsaturated zone, the fluid will spread itself out under the influence of gravity until it finally reaches the state of residual saturation. In relatively fine-grained, less permeable strata, chlorinated hydrocarbons will tend to spread laterally, particularly when these less permeable strata contain substantial quantities of water. The water tends to transport chlorinated hydrocarbons to the capillary fringe of the water table in a predominantly horizontal direction by the groundwater flow. A gas mound, or vapor cloud, may also surround the body of the chlorinated hydrocarbon mass.

- When the amount of spilled chlorinated hydrocarbon exceeds the retentive capacity of the unsaturated zone, then excess chlorinated hydrocarbon will force itself into the saturated zone until residual saturation is reached there as well. The effects of impermeable strata are enhanced in the saturated zone because the presence of pore water greatly decreases the soil's permeability to a chlorinated hydrocarbon. If the retentive capacity of the saturated zone is also exceeded, the chlorinated hydrocarbon will spread over the bottom of the aquifer in the form of low-lying mounds, and collect there in basins and depressions.

The flushing influence of groundwater flow will transport solubilized chlorinated hydrocarbons further in the horizontal plane.

Table II.5 summarizes the chemical and physical properties of trichloroethene, tetrachloroethene, 1,2-*trans*-dichloroethene, and chloroethene, that may be used in developing remedial technologies and actions. These properties include water solubility, boiling point, melting point, vapor pressure, molecular weight, specific gravity, octanol-water partition coefficient (K_{ow}), soil adsorption coefficient (K_{oc}), physical form, density, general chemical class, and flash point. Some additional source physical or chemical characteristics were not determined because of the indirect characterization approach or lack of available published information. These characteristics include temperature, pH, viscosity, cohesiveness, photodegradation rates, and hydrolysis rates. The water solubility, K_{ow}, and K_{oc} are the most important controls on a chemical species' mobility in groundwater.

The K_{ow} is a function of the water solubility and the sorptive capacity of the organic compound to organic material in the soils. The K_{ow} is calculated experimentally by measuring the distribution of an organic chemical between octanol and water in contact with each other at equilibrium conditions.

The K_{oc} is also a function of the water solubility and the sorptive capacity of the organic compound onto organic material in the soils. The K_{oc} is calculated experimentally and expressed by the following formula:

$$K_{oc} = \frac{\text{g chemical/g organic carbon}}{\text{g chemical/g water}}$$

The following is a classification scheme for mobility of organic contaminants based on K_{oc} (NWWA 1989):

- $K_{oc} < 75$ = Very High Mobility
- $75 < K_{oc} < 100$ = High Mobility
- $100 < K_{oc} < 500$ = Medium Mobility
- $500 < K_{oc}$ = Low Mobility

2.3.1. Trichloroethene - Mobility and Persistence

K_{oc} for trichloroethene is 126 (Table II.5). This K_{oc} value suggests that trichloroethene has a medium mobility in water and that it will not partition significantly into sediments. Trichloroethene is expected to leach into groundwater once it passes through the shallow soil.

Table II.5. Chemical and Physical Properties of VOCs of Concern at Area B

Contaminant	Water Solubility[a]	Boiling Point°C	Melting Point°C	Vapor Pressure[b]	Vapor Density	Molecular Weight	Specific Gravity[c,m]	K_{ow}	K_{oc}	Physical Form	Density	General Chemical Class	Flash Point
Trichloroethene	1000	87.0	-73.0	60.0	4.54	131.50	1.46[e]	2.4E+02	1.26E+02[e]	Liquid[j]	1.4649[j]	Solvent[k]	89.6°F[j]
Tetrachloroethene	150	121.0	-22.7	14.0	5.83	165.83	1.63[e]	3.98E+2	3.64E+02[e]	Liquid[j]	1.63[j]	Solvent[k]	None[j]
1,2-*trans*-Dichloroethene	600	47.5	-50.0	200.0	3.34	96.95	1.26[e]	3.02E+00	5.9xE+1[e]	Liquid[j]	1.26[j]	Solvent[k]	35.6°F[j]
Chloroethene	1100	-13.4	-153.8	2660.0	2.15	62.50	0.91[e]	2.40E+01	5.70E+01[f]	Liquid[j]	0.9195[j]	Solvent[k]	17.6°F[j]
Acetone	Miscible	56.2[d]	-95[d]	190[g]	2.00	58.08[d]	0.79[e]	5.75E-01	2.2E+00[f]	Liquid[j]	0.7972[j]	Solvent[k]	0°F[j]

[a]Water solubility in mg/L at 25°C
[b]Vapor pressure in mmHg at 20°C
[c]Specific gravity at 20°C
[d]CRC Press 1982
[e]Concawe 1979
[f]Payne and Phillips 1985
[g]IARC 1979
[h]Hansch 1985
[i]Roy and Griffin 1985
[j]Sax 1984
[k]Sittig 1985
[l]g/cm^3
[m]Specific gravity of any substance will be precisely equal numerically to its density specified in g/cm^3
All data were obtained from Clement Associates, Inc. 1985, unless otherwise indicated.
NA - Not Available

The dominant process for removing trichloroethene from shallow soil and surface water is volatilization into the atmosphere. Volatilization rates depend upon water temperature and movement, contaminant depth, and air movement above the water or soil surface. Once in the atmosphere, trichloroethene is degraded through reaction with hydroxyl radicals to form hydrochloric acid, carbon monoxide, carbon dioxide, and carboxylic acid (ATSDR 1988).

Trichloroethene may biodegrade, although the process does not occur to any significant extent in surface soils (ATSDR 1988). Trichloroethene biodegrades to 1,2-*trans*-dichloroethene (and possibly 1,2-*cis*-dichloroethene) and then to chloroethene (Kloepfer et al. 1985; Wilson and Wilson 1985; Cline and Viste 1985; Barrio-Lage et al. 1986; MacKay et al. 1985). Chloroethene and 1,2-*trans*-dichloroethene behave very differently from trichloroethene (subsections 2.3.3 and 2.3.4). The rates of biodegradation of trichloroethene in subsurface soils varies considerably with the type of soil, water chemistry, hydrologic conditions, microbe level, humus content, temperature, pH, Eh, amount of oxygen present, and amount of other nutrients present. Biodegradation of trichloroethene to chloroethene has been accomplished within months under laboratory conditions (Barrio-Lage et al. 1986). However, field conditions are not accurately simulated by laboratory conditions. Hence, the biodegradation rate of trichloroethene to 1,2-*trans*-dichloroethene and, in turn, to chloroethene within and adjacent to Area B may be significantly slower than the rate observed under laboratory conditions. In the absence of biodegradation or volatilization, trichloroethene may be relatively persistent in the environment.

2.3.2. Tetrachloroethene - Mobility and Persistence

Tetrachloroethene is expected to have medium mobility in soil. K_{oc} for tetrachloroethene is 364, indicating that tetrachloroethene will not partition significantly from the water column to sediments (Table II.5). Given the mobility of tetrachloroethene in soil, it readily leaches into groundwater (ATSDR 1987).

Tetrachloroethene has a vapor pressure of 14 mm of mercury at 20°C and is reported to volatilize rapidly from water. Volatilization of tetrachloroethene from surface water depends upon temperature, water movement, and depth, and the movement of air above the water surface. The biodegradation products of tetrachloroethene are much more mobile, as can be seen by comparing the K_{oc} and K_{ow} values in Table II.5.

The most important transformation process for tetrachloroethene in natural water systems and soils is biodegradation, even though this process does not occur rapidly (ATSDR 1987). Rates of

biodegradation of tetrachloroethene in subsurface soils vary considerably with the type of soil, water chemistry, hydrologic conditions, types of microbes, humus content, temperature, pH, Eh, amount of oxygen, and the presence of other nutrients. Tetrachloroethene biodegrades to trichloroethene and, in turn, to 1,2-*trans*-dichloroethene and then to chloroethene (Kloepfer et al. 1985; Wilson and Wilson 1985; Cline and Viste 1985; Barrio-Lage et al. 1986).

2.3.3. 1,2-*Trans*-Dichloroethene - Mobility and Persistence

1,2-*trans*-Dichloroethene is expected to have very high mobility in soil. The K_{ow} of 1,2-*trans*-dichloroethene is 59 (Table II.5), suggesting that adsorption in the soils is an insignificant process, and that this compound will travel quickly through the soil to groundwater.

1,2-*trans*-Dichloroethene has a high vapor pressure (200 mm of mercury; Table II.5), which allows it to volatilize rapidly to the atmosphere. Photo-oxidation in the atmosphere reduces 1,2-*trans*-dichloroethene to formic acid, hydrochloric acid, carbon monoxide, and formaldehyde (ATSDR 1987).

Within saturated and unsaturated soils, 1,2-*trans*-dichloroethene can be an intermediate biodegradation product of trichloroethene and tetrachloroethene, and can further biodegrade to chloroethene (Kloepfer et al. 1985; Wilson and Wilson 1985; Cline and Viste 1985; Barrio-Lage et al. 1986).

2.3.4. Chloroethene - Mobility and Persistence

The K_{oc} for chloroethene is 57 (Table II.5). Given this range, chloroethene is expected to have a very high mobility in saturated and unsaturated soils. Based on this K_{oc}, chloroethene is not expected to adsorb to stream sediments.

Chloroethene has a very high vapor pressure (660 mm of mercury; Table II.5), which allows it to volatilize rapidly from surface water and soils. Once in the atmosphere, photo-oxidation reduces chloroethene to hydrogen chloride and carbon monoxide (ATSDR 1987).

Within saturated and unsaturated soils, chloroethene can be formed by the biodegradation of trichloroethene, tetrachloroethene, and 1,2-*trans*-dichloroethene (Kloepfer et al. 1985; Wilson and Wilson 1985; Cline and Viste 1985, Barrio-Lage et al. 1986). Further biodegradation of chloroethene to carbon dioxide has been documented under laboratory conditions (Wilson and Wilson 1985), but it is not considered to be an important factor in natural environments (ATSDR 1987).

2.3.5. Acetone - Mobility and Persistence

K_{oc} for acetone is 2.2 (Table II.5). This K_{oc} value suggests that acetone has a very high mobility in water and that it will not partition significantly into sediments. Acetone has a higher vapor pressure and therefore would be expected to volatilize readily, but because of its miscibility in water, volatilization is limited. Once in the atmosphere acetone is oxidized. Biodegradation is important in removing acetone (Clement Associates 1985).

2.3.6. Plutonium-238 - Mobility and Persistence

The normal background levels for plutonium-238 in western Ohio are approximately 0.0002 pCi/g of soil, mainly from weapons testing and the burn-up of the SNAP-9A heat source (Stought, Edling, and Draper 1988). Most surface soils at Mound Plant have a baseline level of approximately 0.01 pCi/g as a result of the 40 years of plant operations involving plutonium-238.

The behavior of plutonium-238 in Mound Plant environs is largely determined by its chemical characteristics. With a +4 valence, plutonium is a relatively strong positively charged ion (cation) that is strongly sorbed onto the soils and sediments through a cation exchange process (Rogers 1975). This sorption onto the natural soils and sediments at Mound Plant makes the plutonium relatively immobile. In general, plutonium-238 will form insoluble fluorides, hydroxides, and oxides (Eisenbud 1987). Its solubility depends upon redox potential, pH, and the presence of organic ligands. Studies performed by Mound Plant in 1974 on plutonium-contaminated sediments demonstrated a very low solubility in water of 1×10^{-5} by identifying the distribution ratio (concentration of plutonium in the water/concentration of plutonium in the soil) (Rogers 1975). Very strong acids (e.g., 8M HNO3) are required to significantly increase the plutonium solubility. Given that the Mound Plant calcareous soil/sediment is a natural buffer, an increase of plutonium solubility at Area B is unlikely.

Plutonium-238 in soils and sediments will decrease by one-half due to radioactive decay every 87.74 years. Plutonium-238 decays by emitting an alpha particle with an energy of 5.50 or 5.46 megaelectron volts (MeV) and transmutes into uranium-234, which transmutes to thorium-230. Characteristic x-rays (photons) with an average energy of 17 kiloelectron volts (KeV) are also emitted by the uranium-234, although much less frequently than the alpha particles.

There are four main mechanisms by which contaminants present in the landfill cover could be released to the environment. These are dissolution by precipitation and release via surface water runoff, dissolution by precipitation and infiltration through the cover materials and underlying landfill, transport of contaminated sediments via surface water runoff, and the airborne transport of contaminated

sediments. As demonstrated by previous studies at Mound Plant (summarized above), plutonium is relatively insoluble in water, so dissolution by precipitation followed by release via surface water runoff or infiltration through the landfill is unlikely unless a strong acid driver is introduced. In addition, the cover materials serve to limit the infiltration of precipitation.

Release of plutonium-contaminated sediments by way of water or wind may occur if the heavy vegetation now draping the landfill cover is removed and the cover disturbed, for example by plowing. As both of these scenarios are unlikely under the present conditions, release of plutonium-contaminated sediments also appears to be unlikely. Although some runoff from the steep slopes of the landfill does occur during periods of high rainfall, the vegetation prevents the removal of large quantities of soil or sediment particles from the landfill cover.

A fifth pathway that can result in the exposure of people or animals to radioactivity from the plutonium-238 in the landfill cover is exposure to direct radiation. At standard temperature, the plutonium-238 alpha particles (5.5 and 5.46 MeV) will travel about 3.6 centimeters (cm). In addition, alpha particles are easily stopped or absorbed by even very thin materials, such as a sheet of paper. Of the photons emitted, 17 keV is the most abundant energy, with a half-value layer of about 0.14 cm. (One-half of the 17 keV will be absorbed in only about 0.14 cm of soil.) Therefore, the heavy vegetation and any overlying soil layers would serve to eliminate or greatly absorb any plutonium-238 emissions from the landfill cover.

2.3.7. Thorium - Mobility and Persistence

Normal background concentrations of thorium in soils are dependent on the source rock type and, therefore, vary with geographic location. Natural soils can contain from 0.1 to 15 pCi/g (Eisenbud 1987). The normal background level for thorium in soils in the vicinity of the Mound Plant ranges up to approximately 2 pCi/g (Stought, Edling, and Draper 1988).

Including artificially produced isotopes, there are numerous isotopes of thorium, from thorium-212 to thorium-236. Of these, six are naturally occurring: thorium-227, -228, -220, -230, -231, -232, and -234. Thorium-232 accounts for 99.99% of naturally occurring thorium. At Mound Plant, both thorium-232 and thorium-230 have been used or stored in the past. Thorium-232 has a half-life of 1.4 x 10^{10} years and decays by alpha-particle emission, accompanied by gamma radiation to form daughter products (radium-228, -224, actinium, radon-220, polonium-216, -212, bismuth-212, lead-212, and thorium-228) and eventually stable lead-208.

The principal alpha radiation energy from thorium-232 is 4.01 MeV, with a relative abundance of 76%. The principal photon radiation of thorium-232 is radium L x-rays with an energy of 12 KeV and a relative abundance of 8.4%. Thorium-230 has a half-life of 7.5 x 10^4 years. Its principal particulate radiation is alpha, with an energy of 4.68 MeV and a relative abundance of 76%. Its principal photon radiation is radium L x-rays with an energy of 12 KeV and a relative abundance of 8.5%. Its significant daughter products are radium-226 and radon-222.

The mobility and fate of thorium in soils is strongly influenced by its chemical characteristics. Thorium is a metallic element of the actinide series that is most commonly found in the +4 oxidation state (ATSDR 1989). In most cases, thorium will remain strongly sorbed to soil, and its mobility will be very low (Torstenfelt 1986). The most common thorium compounds do not dissolve in water and do not evaporate from soil or water into the air (ATSDR 1989).

The water solubility of thorium is dependent on the compound in which it is found; chloride, fluoride, nitrate, and sulfate salt compounds are water soluble, whereas oxide, carbonate, hydroxide, oxalate, and phosphate salt compounds are water insoluble (Weast 1983). Leaching thorium into groundwater is possible in some soils with low sorption capacity and the ability to form soluble complexes. The concentration of dissolved thorium in some waters may increase due to the formation of soluble complexes with carbonates, humic materials, or other ligands in the water (LaFlamme and Murray 1987). In surface water, thorium will be present sorbed onto suspended sediment, and the concentration of soluble thorium will be low (Platford and Joshi 1987). Sediment resuspension and mixing may control the transport of particle-sorbed thorium in water.

Due to a low plant/soil transfer ratio (<0.01), insoluble thorium will not bioconcentrate in plants growing in thorium-rich soils (Garten 1978). However, soluble thorium compounds have greater bioavailability than insoluble thorium compounds (ATSDR 1989). The mobility of thorium is very similar to that of plutonium. Therefore, the discussion of the release mechanisms of plutonium (see subsection 2.3.6) also applies to thorium.

2.3.8. Tritium - Mobility and Persistence

Because tritium is an isotope of hydrogen, it readily exchanges with a hydrogen atom in water molecules to form tritiated water (HTO). In the environment, tritiated water released onto soils will behave like water; it will diffuse through the soils, mix with the soil particles, and may eventually reach groundwater (NCRP 1979). Once tritiated water enters the groundwater system, it moves with the groundwater. Tritium has a half-life of 12.3 years, decays by emission of beta particles, and has a

maximum positron energy of 0.0186 MeV, with a relative abundance of 100%. It has no principal photon radiation or significant daughter products.

2.4. CONCEPTUAL MODEL FOR CONTAMINANT TRANSPORT

2.4.1. Conceptual Pathway Model

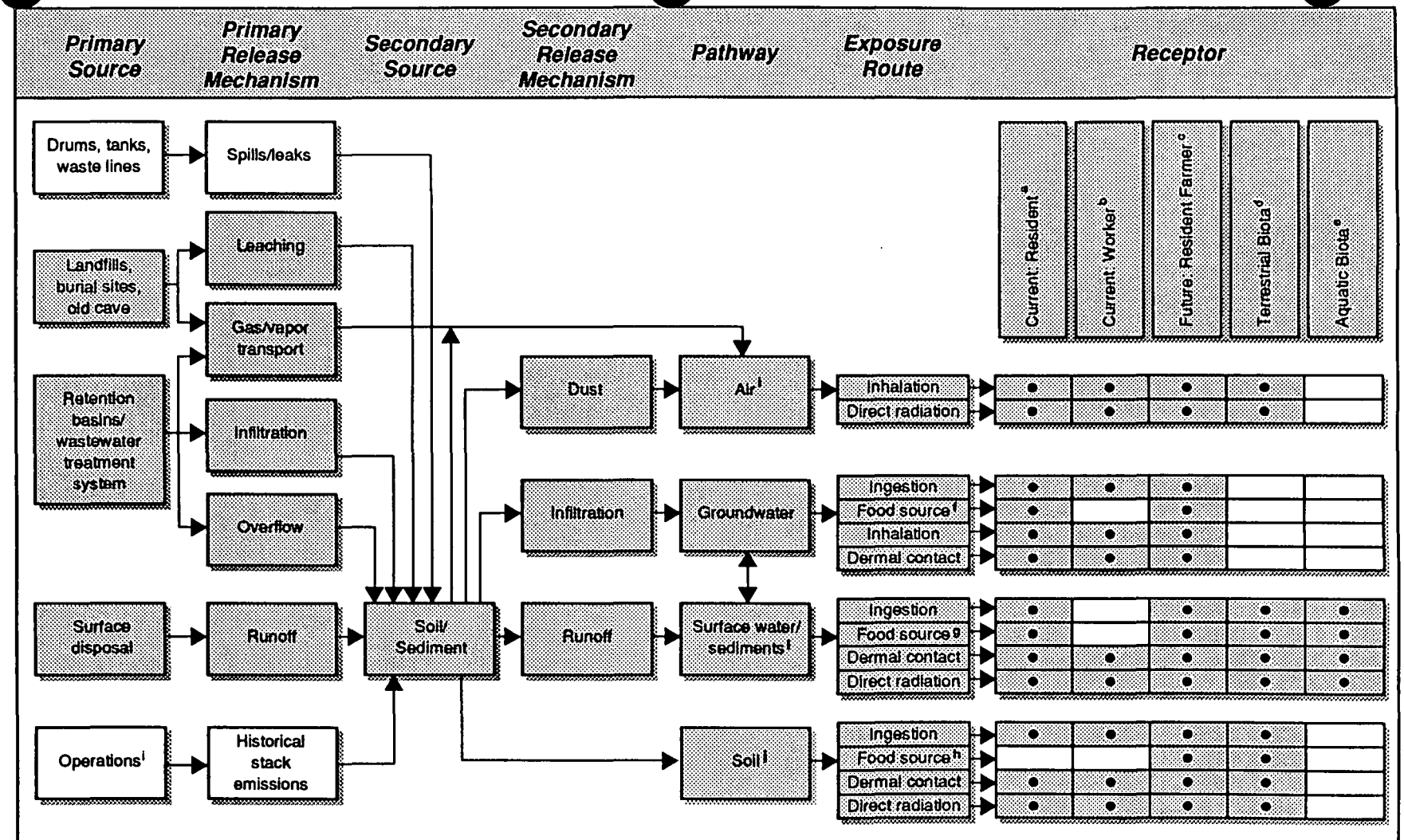
The primary pathway of concern for developing remedial measures is groundwater, specifically in the BVA, because that is where contamination is known and of concern relative to the Mound Plant potable water supply wells. The three main potential contaminant sources that are addressed by this proposal are

- the historical landfill, including residual materials beneath the clay liner of the SSL, especially in a historical north-south trending trench;
- the SSL, including material excavated from three trenches in the historical landfill (see section 2.1.1); and,
- radioactively contaminated soils, including material disposed in Area 2.

An additional potential contaminant source not addressed by this proposal is the overflow pond, including detained water and retained sediment. The Operable Unit 9 Site-wide Work Plan addresses the sampling of the overflow pond. It specifies the collection of two influent water samples, two pond water samples, and five pond sediment samples. If analysis of the pond water and sediments indicates the presence of contamination, then further investigations will be undertaken as part of the continuing Area B study, to address the potential pathways by which the contaminants might enter the groundwater flow system.

The conceptual pathway model for these primary sources is presented in Figure 2.24. The model depicts site-wide conceptualization, shaded boxes depict those parameters relevant to Area B, Operable Unit 1. In the pathway to the groundwater, the primary potential release mechanism for residual materials and subsoils of the historical landfill is percolation through the vadose zone. The primary potential release mechanism for the SSL is leaching and leaks, which may have contaminated the soil beneath it.

The characterization of the three most likely potential contaminant sources, and the determination of contaminant migration pathways proposed herein, is intended to refine the components of the conceptual model pathway. These data will subsequently be used to screen potential remedial response actions.



LEGEND

a CURRENT RESIDENT – Visits the canal as a child, lives downgradient from the site in a house with a current-use domestic well.

b CURRENT WORKER – Works on the site as a laborer. Receptor is exposed to contaminants in environmental media; not an evaluation of occupational exposure.

c FUTURE RESIDENT FARMER – Establishes a farm onsite.

d TERRESTRIAL BIOTA – Analysis of terrestrial biota will include quantitative analysis to the extent possible but will not be possible for all exposure routes such as dermal contact.

e AQUATIC BIOTA – Analysis of potential impacts to aquatic biota does not include quantitative risk assessment.

f FOOD INGESTION from the groundwater pathway will be based on consumption of vegetables grown in gardens irrigated with contaminated groundwater.

g FOOD INGESTION from the surface water pathway will include ingestion of fish.

h FOOD INGESTION from the soil pathway will include ingestion of plants that have taken up contaminants from soil.

i Investigation to be conducted under OU9.

Note: Model depicts site-wide conceptualization, shaded boxes depict those parameters relevant to Area B, Operable Unit 1.

MND-OU1/Con Mod01/6-30-92

Figure 2.24. Conceptual pathway model for Area B, Operable Unit 1 (DOE 1992)

2.5. DATA NEEDS

A sequential approach to the characterization has been developed as a decision tree (Figure 2.25). The approach is designed to confirm or refute contaminant sources as follows.

The hypothesis that the suspect north-south trending trench is a major source of VOCs in groundwater needs to be confirmed or refuted. If it is a major source, remedial measures can be designed accordingly. A soil gas survey is a relatively quick, iterative method to determine if the trench or other sub-areas are the source.

A soil gas survey (i.e., both areal measurements and vertical sampling), which will include limited soil sampling (see subsection 3.1), will begin with the suspect north-south trending trench and will include samples throughout the area covered by the site sanitary landfill. Samples will be collected adjacent to and within the site sanitary landfill. Also, gas samples will be obtained from the drain pipe and the french drains.

Results of the soil gas survey will be used to optimize the placement of soil borings within the suspected source areas. These suspected source areas include the historical trench, the burn cage area, and the SSL. Although its history indicates that the SSL is not a source, this can be confirmed by sampling the contents of the landfill and other potential sources (the trench), sampling adjacent to the SSL to see if contamination is associated with it, and by analyzing the results of the soil gas survey. Special drilling and well installation techniques will be implemented when drilling through the encapsulated waste of the SSL to prevent communication of potential SSL contaminants with the underlying groundwater and assure proper well completion in the saturated zone (see subsection 4.2.3).

In order to determine potential bedrock contamination immediately downgradient from the potential source area, two shallow bedrock wells will be installed near the western edge of the SSL. These monitoring wells will also determine the interconnection between the bedrock and BVA aquifers and ascertain vertical and horizontal groundwater flow direction.

Some soil samples will be collected that represent discrete lithologic horizons. These samples will be submitted for geotechnical analysis to fully evaluate the geotechnical characteristics of each discrete lithologic horizon and provide data for contaminant transport modeling and for remedial alternative evaluations.

To date, adequate characterization of Area 2 (see Figure 2.3) has not been performed. Intrusive sampling is proposed (see subsection 3.2) to delineate the extent of contamination associated with radioactive wastes disposed in Area 2. Geotechnical and chemical tests will also be performed in Area 2.

Surface soil and sediment samples will be collected from locations within Area B. The program will focus on the entrained sediments that have collected in the borrow ditches that border the western and southern berms of the SSL, the soils of the SSL cover, and the soils of the northern bank of the overflow pond. The samples will be submitted for chemical analysis 1) to determine if potential contaminants exist within the borrow ditch sediments (possibly transported from the SM/PP Hill) and, 2) to characterize the extent of potential surface soil contamination of the SSL cover and overflow pond banks.

Prior testing and monitoring of groundwater have partially characterized the groundwater system. Additional alluvial monitoring wells are proposed to address the following questions:

- What is the inflow of groundwater from the upland area to the east of the SSL?
- How are measured contaminant concentrations at wells near Area B affected by inflow from other areas of the plant to the north and east?
- Has contamination moved off the Site to the west or southwest?

A long-term (30- to 40-day) pumping test of the aquifer is proposed (section 5), including monitoring of existing and proposed new wells. The test is intended to provide the data needed to optimize any interim measures for protection of the Mound Plant supply wells (e.g., pumping an intervening well to create a hydraulic barrier). It will address the following data needs:

- The monitoring of newly installed wells and piezometers within Area B, below the known contaminated area, will provide data needed to refine modeling of contaminant transport from a potential source or sources to a recovery well.
- The monitoring of newly installed wells and piezometers to the west of Area B will provide data needed to refine modeling of contaminant transport in an important part of the groundwater flow field and to monitor potential contaminant migration offsite.
- The monitoring of newly installed shallow bedrock wells immediately downgradient from the potential source area will provide data to assess the reaction of the shallow bedrock aquifer. This will help to evaluate the need to install proposed extraction well(s) designed to protect the Mound Plant water supply wells.
- The pumping test will extend to 30 to 40 days to attempt to sufficiently stress the highly transmissive BVA, and for effects to be discernible very near the contaminant source area.
- Water samples will be collected from monitoring wells between the pumping well and the source area including the pumping well, and will be analyzed for VOCs, to study the response of groundwater contamination to the longer term pumping necessary for a remedial response action.

An interim measure being considered is an *in situ* volatilization (ISV) system. The implementation of a trial of this technique will depend on evaluation of data collected from the soil gas survey and additional soil and groundwater characterization.

Because this is a phased investigation (Figure 2.18), there will be many decision points where the scope of the investigation can be adjusted. During or at the end of each phase or sub-part of the investigation, data will be analyzed and interpreted to support the decision process. The ongoing data evaluation will facilitate regulatory agency review and participation in the decision process.

3. GENERAL REQUIREMENTS

This program will incorporate a phased approach: Phase 1 will involve the collection of soil gas samples in and adjacent to the SSL. Phase 2 will involve exploratory borings and the installation of the proposed piezometers and will commence upon the completion and evaluation of data derived from Phase 1; Phase 3 will involve the installation of the proposed monitoring wells, and will commence upon the completion and evaluation of data derived from Phase 2. An important part of the Proposal for Additional Work effort is collection and analysis of surface and subsurface soil samples for both chemical and radiological analyses. Operationally, that effort will be integrated with Phase 2. A subsequent stage of this program will incorporate two additional phases. Phase 4 will consist of a long-term pump test, and an optional Phase 5 will consist of a pilot *in situ* volatilization trial.

The Phase 1 soil gas survey is designed to determine the location and extent of VOC contamination within or adjacent to the SSL, primarily in the vicinity of the historical trench area on the western edge of the historical landfill. The results of the soil gas survey will be used to guide the placement of pilot piezometer boreholes in the suspected source areas.

Phase 2 will begin with the drilling and sampling of pilot boreholes, and the installation of the pilot piezometers in the suspected source areas and areas downgradient of the suspected sources (Figure 3.1). Piezometer clusters will then be installed at selected locations to monitor horizontal and vertical hydraulic gradients within the BVA. One temporary piezometer will also be installed in the center of the spoils area south of Area B. It is designed primarily to monitor water levels during the long-term aquifer test. Upon conclusion of the aquifer test, this piezometer will be removed and abandoned in accordance with State of Ohio well abandonment procedures. In addition to piezometers, two boreholes will be drilled and sampled in Area 2, where empty crushed thorium storage drums have been buried. No piezometers are planned in the upgradient area, where groundwater is expected to be in bedrock.

Phase 3 will involve the drilling, sampling, and installation of monitoring wells in the suspected source area, the area upgradient of the suspected source, and the area downgradient of the suspected source (Figure 3.1). Wells in the suspected source area, and in the area downgradient of the source will be completed based on levels of contamination found in laboratory results from pilot piezometer borehole soil samples and results of PID monitoring performed at those locations. Contaminant concentrations for the contaminants of concern are illustrated on the same base map in the Operable Unit 1, Area B, Technical Memorandum 3: Hydrogeology/Groundwater Contamination (DOE 1991e). If multiple discrete zones of contamination are found in the pilot piezometer boreholes, wells will be clustered at those locations so that each contaminated interval can be separately screened and sampled. Three

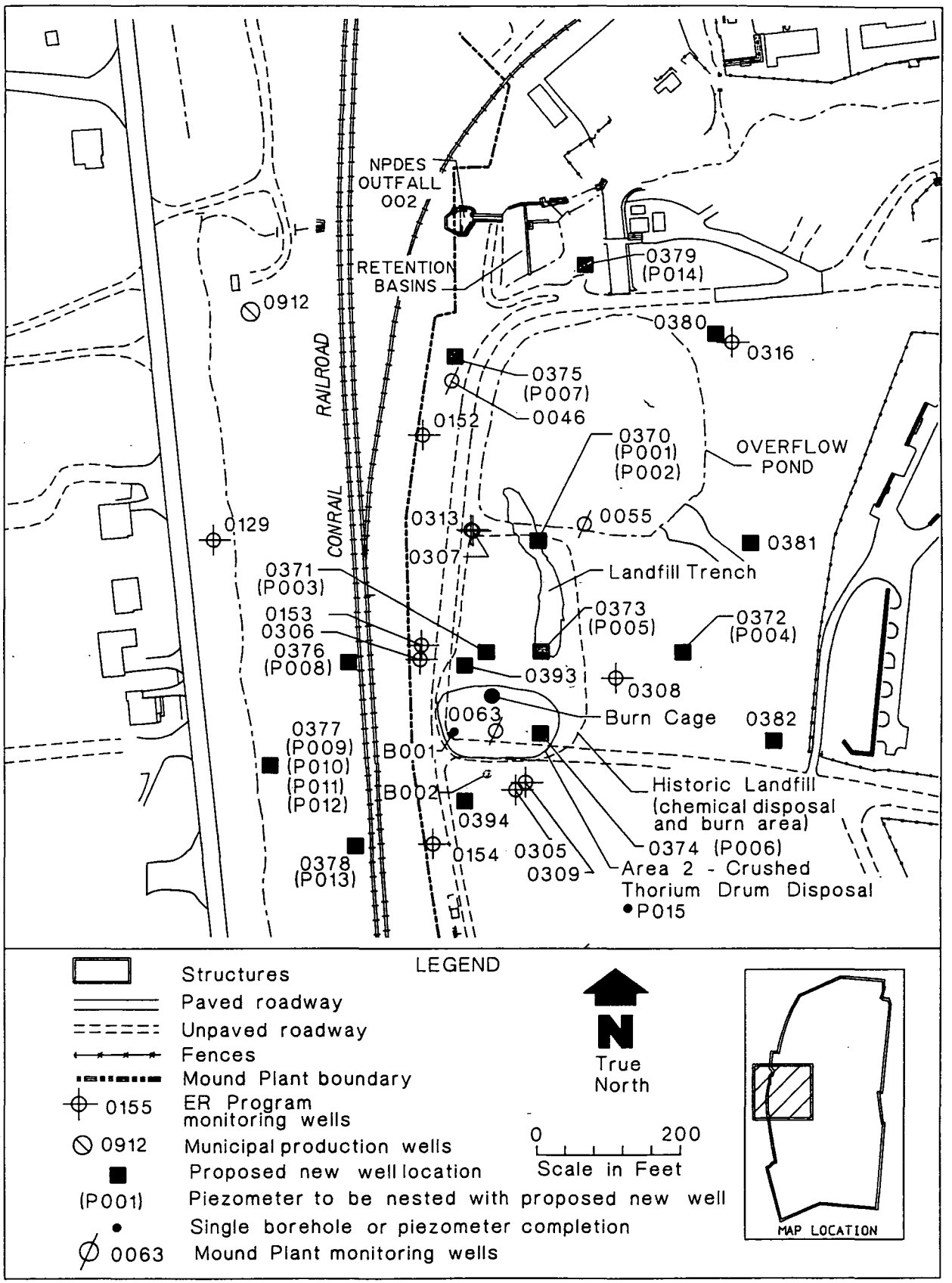


Figure 3.1. Proposed location of new monitoring wells and piezometers.

wells will be drilled upgradient of the suspected source area, and will be completed in bedrock. If the groundwater is found above bedrock in the upgradient area, additional wells may be clustered to investigate water quality in both the unconsolidated sediments and bedrock. Two shallow bedrock wells will be installed downgradient of the SSL. Additional monitoring wells may be needed after groundwater flow directions in the bedrock have been determined.

Following the completion and evaluation of Phase 3, Phase 4 will be implemented to perform a long term aquifer test. The newly installed piezometers and monitoring wells and select existing wells will be sampled and water levels will be monitored while the aquifer test is in progress.

An optional Phase 5 may be implemented to include an *in situ* volatilization (ISV) system trial. The feasibility of proceeding with phase 5 will depend on evaluation of data obtained from phases 1 and 2. The current DOE baseline schedule for the proposed phased approach is presented in Appendix A of this document.

3.1. SOIL GAS SURVEY

The soil gas survey is designed to determine if VOC contamination exists within or adjacent to the SSL, primarily in the vicinity of the trenched area on the western edge of the historical landfill. Soil gas samples will be collected in and around the suspected source areas as shown in Figure 3.2. One additional sample will be collected during the field program. The specific location will be determined from results of the initial soil gas sampling locations and physical constraints limiting the ability to collect the sample in certain areas. Data collected from the soil gas survey will be used to 1) determine locations and qualitative magnitude of contamination in the vadose zone, 2) identify and evaluate potential source areas to support piezometer and monitoring well locations, and 3) evaluate potential for removal actions.

Soil gas samples will be analyzed for TCE, DCE, 1,1,1-trichloroethane (1,1,1-TCA), tetrachloromethane, trichloromethane, chloroethene, 2-butanone, and benzene. Soil samples will be collected at the soil gas sampling location. The conformational soil samples will be analyzed for the same parameters as the soil gas samples. Analyses will be performed with the same instruments used for the soil gas work. The soil samples will also be described geologically using the USCS method. Soil gas samples collected from the SSL encapsulated waste will also be analyzed for methane, carbon dioxide, and oxygen. In addition, an attempt will be made to quantify gas pressures within the cocoon. The parameters for the soil gas survey were selected on the following basis:

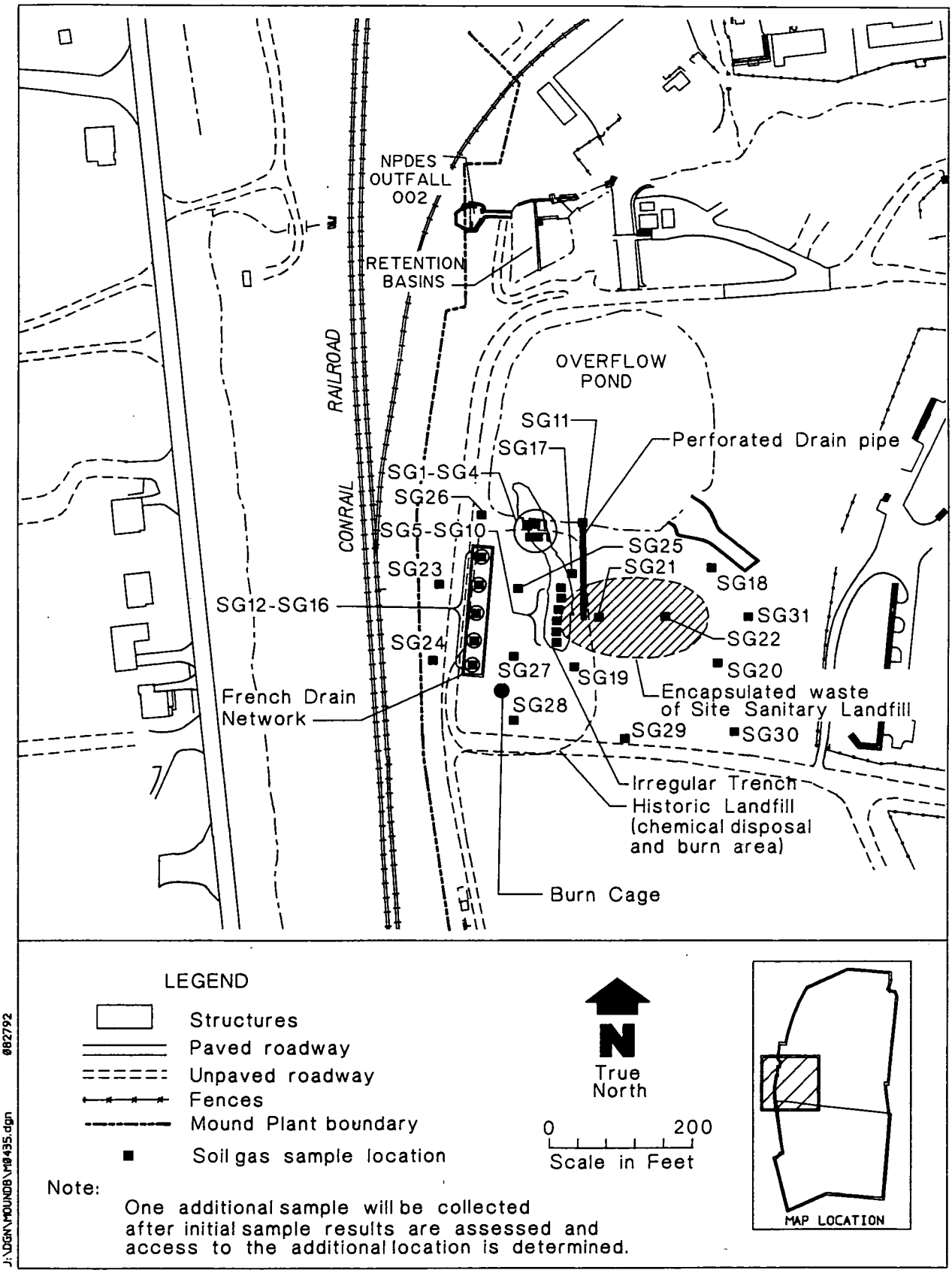


Figure 3.2. Proposed soil gas sample locations.

- In order to optimize analysis time, it was desirable to limit the parameters to the minimum essential number;

- TCE is the primary contaminant of concern;

- DCE has shown the highest reported concentration of any VOC in groundwater, and is associated with TCE;

- 1,1,1-TCA, trichloromethane, and 2-butanone have been reported at low concentrations in groundwater; and,

- Tetrachloromethane was reportedly disposed of at Area B (DOE 1991i), benzene and chloroethene were detected at several locations during the 1987 soil gas survey. These contaminants can be considered contaminants of concern because they are carcinogens, although they have been detected in groundwater infrequently.

- Methane, carbon dioxide, and oxygen potentially exist within the SSL and quantified amounts of these contaminants will indicate if the landfill is an active gas producer. Establishing the presence of positive or negative pressure in the landfill is essential in determining the design of the ISV trial or other VOC removal system.

Soil gas sample collection methods are described in subsection 4.1. A programmatic approach to the soil gas survey is discussed in the following subsections.

3.1.1. Historical Landfill Trench

The location of the historical landfill trench has been determined from a review of historical aerial photographs. Reportedly, this trench received solvent wastes in the past. The trench, approximately 200-ft long and 20-ft wide, is believed to lie in a north-south orientation 45 to 50 ft beneath the surface of the site sanitary landfill (Figures 2.3 and 2.4). The exact trench location has been determined by analyzing registered aerial photographs and determining the coordinates of the trench. The perimeter of the trench will be staked by licensed surveyors.

In plan view, the buried trench extends from the southern edge of the overflow pond to the southwestern edge of the SSL encapsulated waste. The central portion of the trench is located below the northern berm of the SSL, which has a slope of approximately 22 degrees. The steepness of the berm will prevent access by soil gas sampling equipment. It is anticipated that a conventional soil gas pneumatic drilling rig can reach locations with slopes no greater than 10 degrees. Therefore, no samples will be collected along the portion of the trench that underlies the northern berm. Instead, sample locations will be concentrated along the northern and southern portions of the trench. It will be necessary to excavate a level bench at an elevation of approximately 710 feet along the northern portion of the trench. The bench will extend along an east to west trend and intersect a nearby roadway to the west (Figure 2.3). This will allow the soil gas drilling rig to access the study area. The southern portion of the trench underlies the top of the SSL, which will also require benching and

earthmoving to allow access for the soil gas drilling rig. This bench will be constructed at an elevation of approximately 740 feet. The average elevation of the buried trench is between 690 and 700 feet. The average elevation of the static water level in this area is approximately 685 feet and will have no adverse effects on the soil gas samples taken from within the trench.

One parallel line of east-to-west trending sampling points will be spaced at 5-ft intervals across the width of the northern portion of the trench (Figure 3.2). One line of north-to-south trending sampling points will be spaced at 10-ft intervals along the length of the southern portion of the trench.

Soil gas samples will be collected at each location by pneumatically driving a soil gas probe to specified depths below the ground elevation. The estimated depth of the buried historical trench (from the ground elevation) was determined by the examination of "as built" drawings that illustrate the elevation of the former land surface before the SSL was constructed. The drawings used for trench depth calculations are referenced below.

Name of Drawing	Baseline Station	Drawing Number	Description
Overflow pond - sections through pond and fill area	0+50 1+00 1+50 2+00 2+50 3+00 3+50	FSD16666 FSD16666 FSD16667 FSD16668 FSD16669 FSD16977 FSD16978	Cross section in area of historical landfill and landfill cells
Overflow pond - earthwork plan	N/A	FSD16657	Plan view of overflow pond and site sanitary landfill

At each sample location, one soil gas sample will be collected approximately 10 ft above the historical trench. The probe will be pulled from the hole and decontaminated, then driven down an adjacent hole, where a second soil gas sample will be collected from within the historical trench. Soil vapors will be analyzed for TCE, DCE, 1,1,1-TCA, chloroethene, trichloromethane, 2-butanone, benzene, and tetrachloromethane. A total of 41 samples will be collected at the 31 soil gas locations as depicted on Figure 3.2. One additional sample will be collected after initial analytical results are assessed and access to the location is determined. This additional location will be used to further define soil gas contamination in Area B.

The concentrations of soil gas collected from above and within the trench at each sample location will be compared. The historical trench can be confirmed as a contaminant source if the samples collected from within the trench show relatively higher soil gas concentrations than the samples collected from 10 ft above it.

Due to the expected stiff nature of soils in the area, cable-tool auger equipment will be used to drill a pilot hole to a depth 5 to 10 ft above the desired sampling depth. The soil gas probe will then be inserted into the pilot hole and pneumatically driven to the desired depth for sample collection.

Soil gas sample results obtained in Phase I from the historical landfill trench, which indicate elevated concentrations at specific sample depths, can be confirmed by the collection of soil samples using the soil gas drilling rig. The pneumatic drive assembly can be modified to collect an adequate quantity of soil from specific depths adjacent to holes from which soil gas was obtained. The conformational soil samples, also a part of the Phase I plan, will be analyzed for the same parameters as the soil gas samples (listed above). Analyses will be performed with the same instruments used for the soil gas work. Soil samples will also be described geologically using the USCS method.

Analysis of soil gas and soil samples from the historical landfill trench will provide information on the nature and extent of VOC contamination in the trenched area. This information will be used to site monitor wells, piezometers, and possibly wells to be used for an *in situ* removal action.

3.1.2. Site Sanitary Landfill

Several field sampling methods will be used to determine if VOC contamination exists within the encapsulated waste of the SSL.

- The perforated drain pipe installed within the landfill will be sampled for soil gas at its opening near the overflow pond.

- The french drains installed beneath the clay landfill liner will be exposed at their open ends at the base of the western slope of the landfill and sampled for soil gas.

A pneumatically driven soil gas probe will be used to collect intrusive samples of soil gas both from the close proximity and within the SSL.

- One sample will be collected from each corner of the landfill berm.

- Two samples of the encapsulated waste will be collected.

A perforated drain pipe was installed on top of the basal landfill liner prior to emplacement of the encapsulated waste. Soil gas will be withdrawn from the pipe outlet using a one horsepower blower equipped with a sample port or an equivalent sampling device.

The five french drains were installed 2 to 25 ft below the landfill liner. The terminus of the drains will be located using "as-built" engineering drawings. The ends of the french drains will be exposed to allow for the collection of soil gas samples using a one horsepower blower sampling-device or equivalent sampling device.

Four samples of soil gas will be collected by pneumatically driving a soil gas probe into the bermed area that surrounds the encapsulated waste. The device will penetrate approximately 15 to 20 ft below the ground surface, 50 ft above the water table, at each of the four corners of the bermed area. Samples will be taken to determine the nature and extent of contamination at the margins of the landfill.

Two samples of soil gas within the site sanitary landfill will be collected by pneumatically driving a soil gas probe halfway into the encapsulated waste (15 ft below ground surface), approximately 50 ft above the water table. The two samples will be collected from the west-central and east-central areas of the SSL to aid in determining the nature and extent of contamination within the SSL.

All soil gas samples collected will be analyzed for TCE, DCE, 1,1,1-TCA, chloroethene, tetrachloromethane, trichloromethane, 2-butanone, and benzene. Soil gas samples collected from the SSL encapsulated waste will also be analyzed for methane, carbon dioxide, and oxygen. Also, an attempt will be made to quantify gas pressures within the cocoon to determine whether the landfill is still an active gas producer. If the landfill is continuing to generate methane and carbon dioxide, these gases will tend to carry the volatiles out of the landfill under pressure. This information would be used in the design of the ISV trial or other VOC removal system. Soil gas sample results obtained from the each corner of the landfill berm and from the center of the encapsulated waste, that indicate elevated concentrations at specific sample depths, can be confirmed by the collection of soil samples using the soil gas rig as described in section 3.1.1.

Analysis of soil gas samples collected from the encapsulated waste and the surrounding bermed area will provide information on the nature and extent of VOC contamination within and adjacent to the SSL. This information will be used to site piezometers, monitoring wells, and possibly vents for an *in situ* removal action.

3.2. EXPLORATORY BOREHOLES

To characterize the sources of buried radioactive waste located in Area 2, three exploratory boreholes (B001, B002, and P006) are proposed for installation near the southwestern berm of the site sanitary landfill (Figure 3.1). The locations of the proposed boreholes are based on the delineation of the three

highest magnetic anomalies depicted in the "Letter Report: Preliminary Results of Reconnaissance Magnetic Survey," (DOE 1990e). A piezometer will be installed in the third exploratory borehole (P006), hence the location is named for the piezometer. The Area 2 sources consist of WD Building filter waste, and empty, crushed thorium drums. If the proposed exploratory boreholes detect significant contamination in the three magnetic anomalies, additional optional boreholes will be installed.

Hollow-stem auger techniques will be used to collect continuous core from the ground surface to the top of bedrock in each exploratory borehole to characterize the vertical and lateral extent and concentration of the waste materials. If crushed drums are encountered during drilling and refusal occurs, a centerbit will be used to advance the auger string. Soil samples will be collected for chemical, radiological, and geotechnical analysis. Subsurface soil sample collection methods are described in subsection 4.3.1. The number of sample intervals and corresponding parameter analysis for each exploratory borehole is outlined in Tables III.1 and III.2.

3.3. PIEZOMETERS AND MONITORING WELLS

Individual monitoring wells or monitoring well pairs (2) or clusters (3 +) will be paired or clustered with piezometers in the source area, the downgradient area, and the upgradient tributary valley area (Figure 3.1). Two piezometers (P001 and P002) will be clustered with the monitoring well(s) at location 0370. Six piezometers (P003 - P008, and P013) will be individually paired with monitoring well(s) at locations 0371 - 0376, and 0378, respectively. Monitoring well(s) at location 0377 will be clustered with four piezometers (P009 - P012) and monitoring well(s) at location 0379 and will be paired with one piezometer (P014) (Figure 3.1). A single piezometer (P015) will be installed in the spoils area south of the SSL. Single piezometers will be installed to monitor fluctuations of the static water level and will be completed with a 10-ft screened interval across the water table. Clustered piezometers will be installed to monitor potential vertical hydraulic gradients between discrete units of unconsolidated sediments (till/outwash) or between unconsolidated sediments and bedrock. Piezometers installed below the water table will be completed with a 1-ft screened interval. Table III.3 lists anticipated piezometer completion specifications.

Following evaluation of piezometer pilot hole information monitoring wells will be installed at well locations 0370 through 0379. The depth of the screened interval for well(s) installed at each location will be based on piezometer pilot hole lithologic, chemical, and geotechnical data. Pilot hole data may indicate multiple vertically-isolated zones of contamination at particular locations. If so, pairs or clusters of monitoring wells will be installed, with each well individually screened across each zone of contamination to adequately characterize vertical contaminant distributions. If pilot borehole data

Table III.1. Subsurface Chemical Soil Sample Summary

Well Number	Location	Estimated Borehole Depth	VOCs	Number of Sample Intervals per Piezometer/Monitoring Well Borehole for Each Analyte							
				Soil pH, Total Organic Carbon, Tritium	Semivolatiles/ Pesticides-PCBs	Inorganics (Total), Anions	Dioxins, Furans	Isotopic uranium, Isotopic thorium	Gamma Spectrometry (Cs-137, Co-60, K-40, Bi-207, Bi-210m, Ra-226, Am-241, Sr-90/ Y-90	Bismuth, Lithium	Isotopic Plutonium
P001	Source	35	15	11	4	4	2	4	4	2	4
P002		60	2	2	0	0	0	0	0	0	0
P003		45	15	11	3	3	2	3	3	2	3
P004		75	19	15	6	6	5	6	6	4	6
P005		75	22	18	7	7	6	7	7	5	7
P006		40	14	10	4	4	3	4	4	4	4
B001		45	14	10	3	3	2	3	3	3	3
B002		40	13	9	3	2	1	3	3	3	3
P007	Downgradient	40	15	11	3	2	0	3	0	0	3
P008		110	27	23	1	2	0	0	0	0	0
P009		110	28	24	1	2	0	0	0	0	0
P010		35	3	3	0	0	0	0	0	0	0
P011		75	2	2	0	0	0	0	0	0	0
P012		90	2	2	0	0	0	0	0	0	0
P013		110	29	25	2	3	0	0	0	0	0
0393		55	18	14	3	3	2	3	3	2	3
0394		70	21	17	3	3	2	3	3	2	3
P014	Upgradient	75	22	18	3	2	0	0	3	0	3
P015		55	18	14	3	3	2	3	3	2	3
0380		50	14	10	4	3	0	0	3	0	3
0381		60	16	12	3	2	0	0	3	0	3
0382		55	15	11	3	2	0	0	3	0	3
	Totals	1,405	344	272	59	56	27	54	51	29	54

VOC - volatile organic compounds
PCB - polychlorinated biphenyl
Anions include chloride, sulfate, nitrate, nitrite, fluoride, and alkalinity.
Inorganics (total) include Target Analyte List (TAL) metals.
Note: All depth measurements are in feet.
Isotopic uranium analyzed at all pertinent locations.

Table III.2. Subsurface Geotechnical Soil Sample Summary

Well/ Piezometer Number	Maximum Borehole Depth	Location	Number of Sample Intervals per Well Borehole for Each Analyte			
			Bulk Density, Total Porosity, Grain Size, % Organics	Triaxial Permeability, Clay Minerals	Atterberg Limits, Moisture Content, Capillary Moisture Curve, Iron and Manganese Content	Bacterial Culture
P001	44	Source	5	3	2	0
P003	45		4	2	3	0
P004	75		4	0	0	0
P005	75		4	3	3	3
P006	40		4	3	0	0
B001	45		2	1	2	0
B002	40		2	0	1	0
P007	40	Downgradient	4	0	0	0
P008	110		6	3	3	0
P009	110		2	1	1	2
P013	110		2	2	2	0
0393	55		3	3	3	0
0394	70		4	2	0	0
P014	75	Upgradient	1	0	0	0
P015	55		3	3	3	0
0380	50		0	0	0	0
0381	60		2	0	0	0
0382	55		3	0	0	0
Totals	1,155		55	26	23	5

Table III.3. Anticipated Piezometer Completion Specifications

Piezometer Number	Associated Well Number	Location	Expected Borehole Depth	Expected Piezometer Depth	Expected Depth to Ground-water	Expected Depth to Bedrock	Expected Depth of Screened Interval	
							Top	Bottom
P001	370	Source	35	32	25	40	22	32
P002	0370		60	60	25	40	57	58
P003	0371		45	42	35	45	32	42
P004	0372		75	72	65	60	62	72
P005	0373		75	72	65	75	62	72
P006	0374		40	37	30	35	27	37
P007	0375	Downgradient	40	27	20	40	17	27
P008	0376		110	32	25	110	22	32
P009	0377		110	110	25	110	109	110
P010	0377		35	32	25	110	22	32
P011	0377		75	75	25	110	74	75
P012	0377		90	90	25	110	89	90
P013	0378		110	32	25	110	22	32
P014	0379	Upgradient	75	32	25	75	22	32
P015	None		55	52	45	55	42	52
		Total	1,040					

Note: All depth measurements are in feet

indicates no zones of contamination, monitoring wells will still be installed and completed with the screened intervals across the water table.

One monitoring well will be installed at each monitoring well location at the base of the SM/PP Hill (0380-0382) and the western edge of the SSL (0393, 0394). No piezometers will be paired with these wells. Each monitoring well borehole will be drilled 15 ft into bedrock and groundwater levels and recharge will be observed. If there is insufficient groundwater, the borehole will be drilled to a water-producing zone, or an additional 10 ft, whichever comes first. The groundwater level and recharge rate will be noted. The field crew will then consult the project manager before proceeding. If a water table exists in the unconsolidated sediments at monitoring well locations 0380, 0381, and 0382, multiple wells will be considered. The proposed drilling methods (subsection 4.2.2) will allow for reliable detection of groundwater in both unconsolidated deposits and bedrock. The estimated depth to bedrock and water table elevation at each monitoring well location is shown in Table III.4.

Soil samples will be collected from selected piezometers and bedrock monitoring wells for chemical and geotechnical analysis. Subsurface soil sample collection methods are described in subsection 4.3.1. The number of sample intervals and corresponding parameter analysis for each piezometer or monitoring well borehole are is outlined in Tables III.1 and III.2.

The criteria used in the selection of each analyte for soil samples are listed as follows:

- VOCs and tritium: primary historical contaminants found in Area B groundwater.
- Soil pH and total organic carbon (TOC): necessary for the estimation of adsorption capabilities of soil types as input to solute transport evaluations.
- Anions: needed to help understand general soil chemistry and its affect on contaminant migration.
- Metals, semivolatiles/pesticides-PCBs: to adequately determine if these contaminants are present in the subsurface soils of the source area.
- Dioxins, furans: potential by-products of burning that occurred in historical landfill.
- Isotopic plutonium, isotopic thorium, radium-226: historical radiological contaminants of concern at Mound Plant.
- Isotopic uranium: historical radiological contaminant used at Mound Plant and has been detected in monitoring wells within and adjacent to Area B.
- Cesium-137, cobalt-60, potassium-40, bismuth-207, americium-241, strontium-90: historical radiological contaminants used on SM/PP Hill; potential byproducts or impurities derived from plutonium processing.

Table III.4. Estimated Depth to Water Table and Bedrock for Proposed Monitoring Wells

Well Number	Location	Expected Depth to Groundwater	Expected Depth to Bedrock
0370	Source	25	40
0371		35	45
0372		65	60
0373		65	75
0374		30	35
0375	Downgradient	20	40
0376		25	110
0377		25	110
0378		25	110
0393		45	40
0394		60	55
0379	Upgradient	25	75
0380		40	35
0381		50	45
0382		45	40

Note: All depth measurements are in feet.

- Bismuth: potential contaminant related to polonium-210 contaminated sand in Area 2.
- Lithium: disposed of in low-ly8ing, set section of Area B by reacing it with standing water.

Dioxin and furan analyses are proposed for the source area piezometers. The historical landfill is an area where contaminants are known to have been burned. Dioxins and furans are known byproducts of the oxidation (burning) of PCBs and hydrocarbons, and samples for dioxins and furans will be taken in areas where burning is known to have taken place. Piezometer P002 is paired with P001 and does not need to be sampled.

Upon completion of each new monitoring well, groundwater samples will be collected for the analytes outlined in Table III.5. Groundwater sample collection methods are described in subsection 4.3.2. Samples will be collected twice under the Operable Unit 1 Groundwater Sampling and Mapping Program and then the need for additional sampling will be evaluated. Groundwater samples will also be collected twice from all monitoring wells (new and old) under the Operable Unit 9 Site-Wide Work Plan (DOE 1992). The Operable Unit 9 water sampling program will analyze for a more detailed list of analytes.

The criteria used in the selection of each analyte for groundwater samples are listed as follows.

- VOCs and tritium: primary historical contaminants found in Area B groundwater
- Anions, cations: needed to "fingerprint" general groundwater chemistry and allow for determination of anion/cation charge balance.
- Metals, semivolatiles/pesticides-PCBs: to adequately determine if these contaminants are present in the groundwater within the source area
- Dioxins, furans: potential by-products of burning that occurred in the historical landfill; will sample to determine if they are present.
- Plutonium-238, thorium-232, radium-226: historical radiological contaminants of concern at Mound Plant
- Bismuth-207, cobalt-60, cesium-137, americium-241, actinium-227 (calculated from thorium-227), strontium-90, and isotopic plutonium and thorium: radiological contaminants known to exist on the SM/PP Hill, which is located upgradient from Area B
- Isotopic uranium: historical radiological contaminant used at Mound Plant and has been detected in monitoring wells within and adjacent to Area B.

Table III.5. Groundwater Sample Summary

Well Number	Location	Analytes					
		VOC's (8010/8020) Anions, Cations, Tritium	Metals	Semivolatiles, Pesticides/PCBs	Dioxins, Furans	Gamma Spectrometry (Cs-137, Co-60, Bi-210m, Bi-207, K-40), Sr-90/ Y-90, Isotopic Pu, Th, U, and Actinium-227 (calculated from Thorium-227)	Americium-241, Radium-226
0370	Source	X	X	X	X	X	X
0371		X	X	X	X	X	X
0372		X	X	X	X	X	X
0373		X	X	X	X	X	X
0374		X	X	X	X	X	X
0375	Downgradient	X	X			X	X
0376		X	X			X	X
0377		X	X				
0378		X	X			X	X
0393		X	X			X	X
0394		X	X			X	X
0379	Upgradient	X	X			X	X
0380		X	X			X	X
0381		X	X			X	X
0382		X	X			X	X
	Totals	15	15	5	5*	14	14

VOC - Volatile organic compounds
Anions include Cl, SO4, and NO3/NO2; alkalinity will be measured in the field.
Cations include Na, K, Mn, Mg, Ca, Fe
PCB - Polychlorinated biphenyls
Metals - Target Analyte List (TAL), including Bismuth and Lithium

Current OU 1 radionuclide sampling list includes:

Gamma Spectrometry (Cs-137, Co-60, Bi-207, Bi-210m, K-40)
Isotopic plutonium, thorium, uranium
Radium-226
Strontium-90/Yttrium-90
Actinium-227 (calculated from thorium-227)
Americium-241

3.3.1. Source Area Characterization

In order to determine the concentrations and quantities, lateral and vertical distributions, as well as controls on the migration of potential contaminants in the vadose and saturated zones underlying Area B, five monitoring wells (0370 - 0374) are proposed for installation within the area of the site sanitary landfill. Each monitoring well within the potential source area will be paired with a piezometer or piezometer cluster. A total of six piezometers will be installed in the potential source area (Table III.3 and Figure 3.1). The installation of these wells and piezometers will help to 1) determine the nature and extent of contamination in this area, 2) determine whether contamination is in the vadose zone or the saturated zone, or both, and 3) evaluate the feasibility of a removal action.

Two piezometer boreholes (P001 and P005) will be drilled in the area of the north-south trending historical landfill trench (Figures 2.4 and 3.1). Borehole P001 will penetrate the northern portion of the trench and borehole P005 will penetrate the southern portion of the trench. In order to intercept the southern portion of the trench, borehole P005 will also penetrate the SSL encapsulated waste, which overlies the trench. Special drilling and well installation techniques will be implemented when drilling through the encapsulated waste as outlined in subsection 4.2.3.

The suspected location of the historical landfill trench was determined from information obtained from registered historic aerial photographs. The aerial photos have been superimposed on a digitized base map to obtain survey coordinates of the trench. A licensed surveyor will stake the survey coordinates on location to outline the area of the buried trench.

The approximate depth from the land surface to the buried trench can be calculated from Monsanto Research Corporation "as built" drawings of the overflow pond and SSL that show the elevation of the original land surface. These drawings are listed in subsection 3.1.1. In addition, continuous core will be collected from the ground surface to the top of bedrock in boreholes P001 and P005. It is anticipated that interception of the trench will be recognized by visual observation and vapor monitoring of the recovered core. Soil gas sample results from Phase I of this program will also help to pinpoint the location of the historical landfill trench.

Two piezometer boreholes (P003 and P004) will be drilled into the historical landfill area. The location of piezometer boreholes P003 and P004 will be based on zones of elevated soil gas concentrations determined from the soil gas survey. Piezometer borehole P003 will be located west of the SSL and historical landfill trench. Piezometer borehole P004 will be located on top of the SSL and will penetrate the eastern portion of the underlying encapsulated waste. Special drilling and well installation techniques will be implemented for this piezometer as outlined in subsection 4.2.3.

One piezometer borehole (P006) will be drilled at a location along the southern edge of the SSL berm. The borehole will penetrate the southern portion of the disposal and burn area where empty, crushed thorium drums were buried (Figures 2.4 and 3.1).

Continuous core will be collected from the ground surface to the top of bedrock in piezometer boreholes (P001 and P003-P006) to characterize the unconsolidated stratigraphy, and to collect soil samples for chemical and geotechnical analysis. Subsurface soil sample collection methods are described in subsection 4.3.1. The number of sample intervals and corresponding parameter analysis for each piezometer borehole are outlined in Tables III.1 and III.2.

A piezometer will be installed in each borehole and completed with a 10-ft screened interval across the water table. Piezometer borehole P002 will be drilled adjacent to pilot hole P001, however, continuous core and soil samples will be collected only at the water table and the entire screened interval. A piezometer will be installed in this borehole and completed with a 1-ft screened interval approximately 20 ft below the water table to measure vertical hydraulic gradients in the area.

Following evaluation of piezometer pilot hole data, monitoring wells will be installed at locations 0370 - 0374 in the immediate vicinity of past disposal areas. The general location of each proposed monitoring well is shown in Figure 3.1. The monitoring well network will be designed to characterize potential vertically-discrete zones of contamination in the saturated zone within the source area. This may facilitate the installation of a cluster of monitoring wells in a single location.

The monitoring well or wells installed at location 0370 will also serve to replace existing monitoring well 0055, which is not completed according to TEGD protocols. This well is suspected to be a conduit for the downward percolation of overflow pond water along the 0055 well annulus to the BVA. Included in the scope of the Proposal for Additional Work, well 0055 will be abandoned in accordance with state of Ohio well abandonment procedures.

The monitoring well or wells installed at locations 0372 and 0373 will penetrate the eastern and western portions of the SSL encapsulated waste. These wells will help determine the extent of contamination below the SSL. Special drilling and well installation techniques will be implemented for these wells as outlined in subsection 4.2.3.

The monitoring well or wells at location 0374 will serve to substantiate data collected from existing monitoring well 0063, which is also not completed according to TEGD protocols. Based on sample results, well 0063 has historically shown the highest VOC concentrations at Area B. Samples collected from well 0374 would reduce the uncertainty of the groundwater data previously collected at well

0063 and help to verify the source of the contamination in this area. Well 0063 will not be abandoned at this time.

Upon completion of each new monitoring well, groundwater samples will be collected for the analytes outlined in Table III.5.

3.3.2. Evaluation of Shallow Bedrock Near Source Area

To determine potential bedrock contamination immediately downgradient from the potential source area, two shallow bedrock monitoring wells (0393, 0394) will be installed near the western edge of the SSL. The general location of each proposed well is shown in Figure 3.1. Each well is proposed to be completed with a 5-ft well screen interval across the first saturated interval of bedrock. Each monitoring well borehole will be drilled 15 ft into bedrock and groundwater levels and recharge rate will be observed. The installation of these wells will also determine the interconnection between the bedrock and BVA aquifers and ascertain vertical and horizontal groundwater flow direction.

Each monitoring well borehole will be continuously cored to evaluate hydrostratigraphy and soil samples will be collected for chemical and geotechnical analysis. Subsurface soil sample collection methods are described in subsection 4.3.1. The number of sample intervals and corresponding parameter analysis for each monitoring well borehole is outlined in Tables III.1 and III.2. Upon completion of each new monitoring well, groundwater samples will be collected for the analytes outlined in Table III.5.

3.3.3. Evaluation of the Tributary Valley Aquifer Input to Area B

To determine if contaminants are migrating through the unconsolidated sediments or bedrock of the tributary valley toward Area B, one monitoring well (0379) and one piezometer (P014) are proposed for installation north of Area B. The general location of each proposed piezometer and monitoring well is shown in Figure 3.1. To determine if the source of groundwater contamination at well 0046 is originating from the overflow pond or migrating from tributary valley or SM/PP Hill, one monitoring well (0375) and one piezometer (P007) are proposed for installation northwest of Area B. Monitoring well 0375 is designed to substantiate data collected from well 0046. Since well 0046 was not completed to TEGD requirements, data from it are unreliable and conclusions drawn are uncertain. Well 0046 will not be abandoned at this time.

Each piezometer borehole will be continuously cored to evaluate hydrostratigraphy, and soil samples will be collected for chemical and geotechnical analysis. Subsurface soil sample collection methods

are described in subsection 4.3.1. The number of sample intervals and corresponding parameter analysis for each piezometer borehole is outlined in Tables III.1 and III.2.

A piezometer will be installed in each borehole and completed with a 10-ft screened interval across the water table.

Following evaluation of piezometer pilot hole data, monitoring wells will be installed at locations 0375 and 0379. The monitoring wells will be designed to characterize potential vertically-discrete zones of contamination in the saturated zone within the source area. This may facilitate the installation of a cluster of monitoring wells in a single location.

Upon completion of each new monitoring well, groundwater samples will be collected for the analytes outlined in Table III.5. The monitoring well or wells at location 0375 will be tentatively considered as a downgradient location. This area is believed to be at the transitional zone of the hydraulic gradient, as described in subsection 2.2. Water level data collected as part of the Operable Unit 1 and Operable Unit 9 field programs will determine the location of well 0375 relative to the source area (upgradient, downgradient, or cross-gradient).

3.3.4. Upgradient Monitoring Wells

To determine the input to the local groundwater budget at Area B from the SM/PP hill slope and bedrock, and what potential contamination is within this groundwater, three monitoring wells (0380-0382) are proposed to be completed with a 10-ft well screen interval across the first saturated interval (Table III.4). Groundwater is expected to occur in bedrock. Each monitoring well borehole will be drilled 15 ft into bedrock and groundwater levels and recharge rate will be observed. If there is insufficient groundwater, the borehole will be drilled to a water-producing zone or an additional 10 ft, whichever comes first. The groundwater level and recharge zone rate will be noted. The field crew will then call the WESTON project manager before proceeding. If the unconsolidated sediments overlying the bedrock are saturated, the installation of multiple monitoring wells will be considered. The installation of these wells will help to 1) define the influx of groundwater and potential contamination into Area B, 2) define lateral hydraulic gradients, 3) evaluate remedial action alternatives, and 4) satisfy regulatory concerns.

Well 0380 will be installed near well 0316, which is located on the southern edge of the tributary valley in a transitional area near the SM/PP Hill. When well 0316 was drilled in 1989, it was believed that the water table was in the unconsolidated sediments, and the well was screened above bedrock. When water levels are taken at well 0316, only a small amount of water is found in the sump. This

indicates that the screened interval of well 0316 is in the vadose zone. Well 0380 will be drilled into bedrock and the water level in the open borehole will be allowed to equilibrate as previously described, to determine the static water level.

No piezometers will be paired with the three wells at the base of the SM/PP Hill since the wells are expected to be screened across the saturated/unsaturated zone contact in bedrock. If the well borehole is advanced to the top of bedrock using hollow-stem augers without encountering groundwater, the augers will be withdrawn from the borehole, and an appropriate drilling technique will be used to re-enter the borehole and advance the borehole 15 ft into bedrock where groundwater levels and recharge will be observed. If there is insufficient groundwater, the borehole will be drilled to a water-producing zone or an additional 10 ft, whichever comes first. The groundwater level and recharge rate will be noted. The field crew will then call the WESTON project manager before proceeding. Water levels from the newly installed upgradient wells will provide information on groundwater recharge into Area B from the bedrock to the east and from the tributary valley to the northwest. This information will be used to help calculate a groundwater budget. The water level data will also be used to calibrate a groundwater flow model and to determine optimal position(s) for recovery well(s) to enhance plume capture and minimize recovery of clean offsite water.

Each monitoring well borehole will be continuously cored to evaluate hydrostratigraphy and soil samples will be collected for geochemical and geotechnical analysis. Subsurface soil sample collection methods are described in subsection 4.3.1. The number of sample intervals and corresponding parameter analysis for each piezometer borehole is outlined in Tables III.1 and III.2.

Upon completion of each new monitoring well, groundwater samples will be collected for the analytes outlined in Table III.5.

3.3.5. Downgradient Monitoring Wells and Piezometers

It is proposed that piezometers and monitoring wells be installed west of Area B at locations 0376, 0377, and 0378, to determine if groundwater contamination has migrated offsite. If so, the concentrations and vertical and lateral distributions of the contaminants can be evaluated. The installation of these wells will help to 1) determine the hydraulic gradient across the western plant boundary, 2) determine the nature and extent of offsite contamination, 3) support the development of remediation of onsite and possibly offsite groundwater contamination, and 4) comply with regulatory requests. The positions of these wells are ideal for the development of calibration points for contaminant transport modeling. The general locations of the piezometers and monitoring wells are shown in Figure 3.1.

Continuous core will be collected from the ground surface to the top of bedrock in piezometer boreholes P008, P009, and P013 to characterize hydrostratigraphy and collect soil samples for chemical and geotechnical analysis. Subsurface soil sample collection methods are described in subsection 4.3.1. The number of sample intervals and corresponding parameter analysis for each piezometer borehole is outlined in Tables III.1 and III.2. Piezometer boreholes P010, P011, and P012 will not be cored, but split-spoon soil samples will be collected at the water table and across the screened interval of each piezometer.

A piezometer will be installed in boreholes P008, P009, and P013 at locations 0376, 0377, and 0378, respectively. Piezometers P008 and P013 will be completed with a 10-ft screened interval across the water table to allow for seasonal water table fluctuations (Table III.3 and Figure 3.1). Piezometer P009 will be completed with a 1-ft screened interval at the base of the lower outwash unit just above bedrock.

At location 0377, three additional piezometers (P010, P011, and P012) will be clustered with piezometer P009. Piezometer P010 will be completed with a 10-ft screened interval across the potentiometric surface. Piezometers P011 and P012 will be completed with 1-ft screened intervals. P011 will be screened at the base of the upper outwash unit and P012 will be screened at the top of the lower outwash unit (Table III.3). These piezometers will provide information on vertical and lateral hydraulic gradients west of Area B.

Following evaluation of piezometer pilot hole data, monitoring wells will be installed at locations 0376, 0377, and 0378. The general location of each proposed monitoring well is shown in Figure 3.1.

While the primary source of groundwater contamination appears to be in the vicinity of the SSL, it is possible that the chlorinated solvents may be preferentially adsorbing and desorbing from saturated soils immediately downgradient in large enough concentrations to be considered secondary sources. During periods of elevated static water levels and increased groundwater flow, it is possible that these concentrated areas could be flushed and could serve as additional sources of groundwater contamination. Water level and water quality data collected between February and July 1990 indicate that this phenomenon may be occurring. Monitoring wells at locations 0376, 0377, and 0378 will be used to investigate the potential and extent of preferential adsorption in subsurface soils and to locate potential secondary sources downgradient from Area B. These potential secondary sources may exist as vertically-discrete zones of contamination at multiple depths within the saturated zone or capillary fringe. Discovery of secondary sources may necessitate the installation of multiple monitoring wells at a single location with each well screened in individual zones of contamination.

Upon completion of each new monitoring well, groundwater samples will be collected for the analytes outlined in Table III.5. Water quality results in the downgradient wells will provide information to determine if contaminants have migrated offsite, and the vertical and lateral nature and extent of contamination, if it exists. The additional water level data from the new downgradient wells and piezometers will also provide information to be used for calculations of discharge from Area B for a groundwater budget.

3.4. SURFACE SOIL SAMPLING

Between 1982 and 1985, Mound Plant performed a systematic survey of radiological contamination of site soils. Within the boundaries of the Area B base map, 231 surface soil samples were collected (Figure 3.3). The sample locations and associated radiological data can be found in the "Mound Site Survey Project for the Characterization of Radioactive Materials in Site Soils" (Stought, Edling, and Draper 1988). The site survey project included the following:

- field screening with a field instrument for the detection of low-energy radiation (FIDLER) for the detection of gamma radiation;
- analysis of the soil samples using one or more of the following methods: radiochemical analysis for plutonium-238 and the thorium isotopes, gamma spectroscopy for cobalt-60, cesium-137, radium-226, and americium-241, and liquid scintillation for tritium (Stought et al. 1988).

Surface soil data obtained from the site survey project has been compiled and evaluated and is contained in the "Area B, Operable Unit 1 Technical Memorandum 2: Extent of Contamination - Soils" (DOE 1991d). The following conclusions and recommendations are based on the evaluation of the data presented:

- The data indicate widespread, low-level plutonium-238 surface soil contamination. However, except for one surface soil sample, all the concentrations within Area B are below 25 pCi/g.
- The data indicate limited thorium surface soil contamination, mostly east and uphill of Area B. All the concentrations are below the present Mound Plant D&D cleanup guideline.
- All surface soil tritium distillate concentrations are below the drinking water standard.
- The data indicate no surface soil concern within the base map area for cobalt-60, cesium-137, radium-226, and americium-241.

The analytical methods used and the level of quality assurance/quality control qualifies the field and laboratory data as Level I or Level II. The data are sufficient for site reconnaissance and characterization, however, confirmatory, higher-level data are required to support a risk assessment.

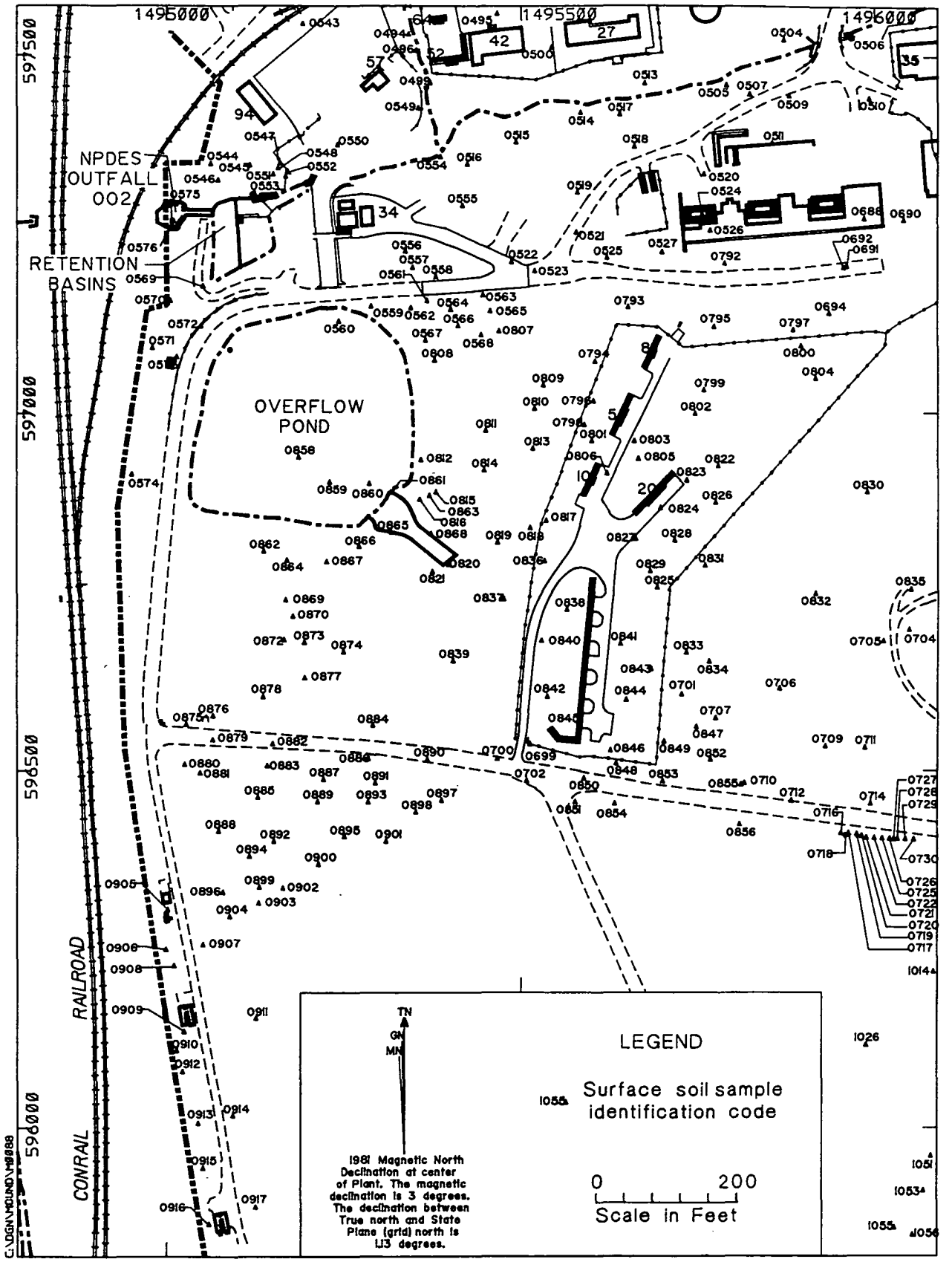


Figure 3.3. Area B, radiological surface soil sample locations.

As part of the Operable Unit 9, Site-Wide Investigation, specific compounds targeted on the basis of combined properties of significant usage, high toxicity and persistence in the environment. The environmental samples collected under this Proposal for Additional Work for Operable Unit 1, are designed to investigate the presence or absence of the compounds most likely to occur in Operable Unit 1. The analytical methods in the accompanying Quality Assurance Project Plan are designed to ensure that accurate and precise analyses are performed.

Surface soil characterization within and adjacent to Area B will focus on 1) the site sanitary landfill cover, 2) the borrow ditch west of the landfill, 3) the borrow ditch south of the landfill, 4) the base of the northern landfill berm, and 5) the area north of the overflow pond. Surface-soil scoop samples will be collected at specific locations within each area as shown in Figure 3.4. The sample will be sent to an offsite laboratory for radiological analysis. Analytical parameter specifications for the surface soil sample investigation are shown in Table III.6.

3.5. SUMMARY OF FIELD EFFORT

This section provides sampling plans for the soil gas survey and surface and subsurface soil sampling. These tables will be provided to all field personnel and will be followed by members of the field team.

3.5.1. Soil Gas Survey

The soil gas survey will focus on the collection of soil gas samples from the historic landfill trench and the site sanitary landfill as discussed in section 3.1. Soil gas samples will be collected at 22 locations (Figure 3.2). Soil gas sample collection methods are described in section 4.1. The soil gas field sampling plan is outlined in Table III.7.

3.5.2. Subsurface Soil Sampling

Subsurface soil samples will be collected from exploratory, selected piezometer, and upgradient monitoring well boreholes as discussed in sections 3.2 and 3.3. Sample locations are shown on Figure 3.1. Sample collection methods are described in section 4.3.2.

Specifications for the collection of subsurface chemical and radiological samples are presented in Table III.8. Samples will be collected at specific depth intervals to fully characterize the vertical and lateral extent of contamination within and adjacent to Area B. Sampling plan rationale is described in Table III.9.

Table III.6. Analytical Parameter List for the Operable Unit 1, Area B Surface Soil Investigation

Analytical Parameter
VOCs
Semivolatile organic compounds
TAL inorganics
Bismuth
Fluoride
TCL pesticides/PCBs
Isotopic plutonium
Isotopic thorium
Isotopic uranium
Radium-226
Strontium-90/Yttrium-90
Tritium
Gamma spectrometry
Nitrate/Nitrite
Chloride
Sulfate
Total organic carbon
Soil pH
Alkalinity

PCB - polychlorinated biphenyl
TAL - Target Analyte List
TCL - Target Compound List
VOC - volatile organic compound

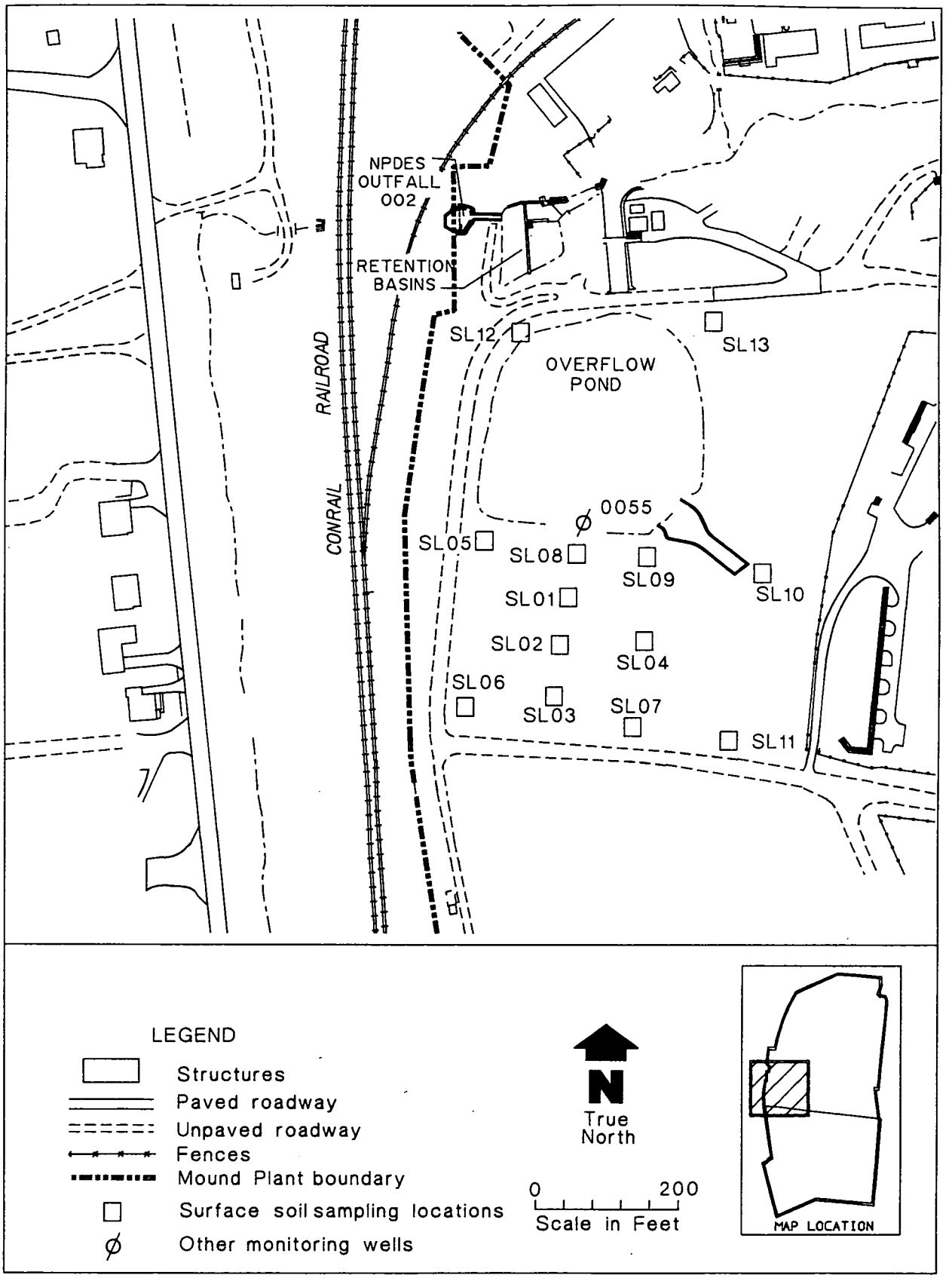


Figure 3.4. Proposed locations for collection of surface soil samples.

Table III.7. Soil Gas Sampling Plan

Location ID	Sample ID	Location Description	Sample Type: Soil Gas	Sample Type: Soil (Optional)*	Sample Depth (ft)	TCE, DCE, Chloroethene, 1,1,1-Trichloromethane, 2-Butanone, Benzene Tetrachloromethane	Metha Oxyg Carb Dioxi
SG01	0001	Historic Landfill Trench	X		10	X	
	0002		X		20	X	
SG02	0001		X		10	X	
	0002		X		20	X	
SG03	0001		X	X	10	X	
	0002		X	X	20	X	
SG04	0001		X		10	X	
	0002		X		20	X	
SG05	0001		X		10	X	
	0002		X		20	X	
SG06	0001		X		10	X	
	0002		X		20	X	
SG07	0001		X		10	X	
	0002		X		20	X	
SG08	0001		X	X	10	X	
	0002		X	X	20	X	
SG09	0001		X		10	X	
	0002		X		20	X	
SG10	0001		X		10	X	
	0002		X		20	X	
SG11	0001	Perforated Drain Pipe	X		Within Pipe	X	
SG12	0001	French Drain Network	X		Within Drain	X	
SG13	0001		X			X	
SG14	0001		X			X	
SG15	0001		X			X	
SG16	0001		X			X	
SG17	0001	Site Sanitary Landfill Berms	X	X	15-20	X	
SG18	0001		X		15-20	X	
SG19	0001		X		15-20	X	
SG20	0001		X		15-20	X	
SG21	0001	Site Sanitary Landfill Encapsulated Waste	X	X	15	X	X
SG22	0001		X		15	X	X

* - Soil gas sample results that indicate elevated concentrations at specific sample depths, will be confirmed by th collection of soil samples using the soil gas drilling rig. Confirmatory soil samples will be collected at soil gas sam depths that show the highest relative concentration at the following frequency:

- 4 above/within the historic landfill trench
- 1 within the SSL berms
- 1 within the SSL encapsulated waste

Table III.8. Subsurface Chemical Soil Sampling Plan

Well Number	Total Depth (ft)	Anticipated Lithology[a]	Depth Range (ft)	Analytes[c]											
				VOC	Tritium	Soil pH	Total Organic Carbon	Anions[d]	Metals[b]	Semivolatiles/ Pest-PCB[b]	Dioxin, Furan[b]	Isotopic, U, Th[b]	Gamma Spectrometry (Cs-137, Co-60, K-40, Bi-207, Bi-210m, Am-241, Ra-226), Sr-90/Y-90[b]	Bi, Li[b]	Isotopic Pu
P001	45	Fill	0-15	3	3	3	3	1	1	1		1	1	1	1
		Clay-1	15-20	1	1	1	1	1	1	1	1	1	1	1	1
		Till	20-25	1	1	1	1	1	1	1	1	1	1		1
		Outwash	25-40	3	3	3	3								
		Screened Interval	22-32	2	2	2	2								
		Static WL	25+	1	1	1	1	1	1	1		1	1		1
		Bedrock	40+												
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	15	11	11	11	4	4	4	2	4	4	2	4
P002	60	Static WL	25+	1	1	1	1								
		Screened Interval	57-58	1	1	1	1								
			Totals	2	2	2	2	0	0	0	0	0			
P003	45	Fill	0-25	4	4	4	4	1	1	1	1	1	1	1	1
		Till	25-35	2	2	2	2	1	1	1	1	1	1	1	1
		Outwash	35-45	2	2	2	2								
		Screened Interval	32-42	2	2	2	2								
		Static WL	35+	1	1	1	1	1	1	1		1	1		1
		Bedrock	45+												
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	15	11	11	11	3	3	3	2	3	3	2	3

Table III.8. (page 2 of 11)

Well Number	Total Depth (ft)	Anticipated Lithology[a]	Depth Range (ft)	Analytes[a]											
				VOC	Tritium	Soil pH	Total Organic Carbon	Anions[d]	Metals[b]	Semivolatiles/ Pest-PCB[b]	Dioxin, Furan[b]	Isotopic, U, Th[b]	Gamma Spectrometry (Cs-137, Co-60, K-40, Bi-207, Bi-210m, Am-241, Ra-226), Sr-90/Y-90[b]	Bi, Li[b]	Isotopic Pu
P004	75	Fill	0-5	1	1	1	1	1	1	1	1	1	1	1	1
		E-Waste	5-35	6	6	6	6	2	2	2	2	2	2	2	2
		Clay-2	35-40	1	1	1	1	1	1	1	1	1	1	1	1
		Till	40-50	2	2	2	2	1	1	1	1	1	1		1
		Outwash	50-60	2	2	2	2								
		Bedrock	60+												
		Screened Interval	62-72	2	2	2	2								
		Static WL	65+	1	1	1	1	1	1	1		1	1		1
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	19	15	15	15	6	6	6	5	6	6	4	6
P005	75	Fill	0-5	1	1	1	1	1	1	1	1	1	1	1	1
		E-Waste	5-25	4	4	4	4	2	2	2	2	2	2	2	2
		Clay-2	25-30	1	1	1	1	1	1	1	1	1	1	1	1
		Fill	30-45	3	3	3	3	1	1	1	1	1	1	1	1
		Till	45-60	3	3	3	3	1	1	1	1	1	1		1
		Outwash	60-75	3	3	3	3								
		Screened Interval	62-72	2	2	2	2								
		Static WL	65+	1	1	1	1	1	1	1		1	1		1
		Bedrock	75+												
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	22	18	18	18	7	7	7	6	7	7	5	7

Table III.8. (page 3 of 11)

Well Number	Total Depth (ft)	Anticipated Lithology[a]	Depth Range (ft)	Analytes[a]											
				VOC	Tritium	Soil pH	Total Organic Carbon	Anions[d]	Metals[b]	Semivolatiles/ Pest-PCB[b]	Dioxin, Furan[b]	Isotopic, U, Th[b]	Gamma Spectrometry (Cs-137, Co-60, K-40, Bi-207, Bi-210m, Am-241, Ra-226), Sr-90/Y-90[b]	Bi, Li[b]	Isotopic Pu
P006	40	Fill	0-1	2	2	2	2	1	1	1	1	1	1	1	1
		Till	10-15	1	1	1	1	1	1	1	1	1	1	1	1
		Outwash	15-20	1	1	1	1								
		Till	20-25	1	1	1	1	1	1	1	1	1	1	1	1
		Outwash	25-35	2	2	2	2								
		Screened Interval	27-37	2	2	2	2								
		Static WL	30+	1	1	1	1	1	1	1		1	1	1	1
		Bedrock	35+												
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	14	10	10	10	4	4	4	3	4	4	4	4
B001	45	Fill	0-15	3	3	3	3	1	1	1	1	1	1	1	1
		Till	15-25	2	2	2	2	1	1	1	1	1	1	1	1
		Outwash	25-45	4	4	4	4								
		Static WL	30+	1	1	1	1	1	1	1		1	1	1	1
		Bedrock	45+												
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	14	10	10	10	3	3	3	2	3	3	3	3

Table III.8. (page 4 of 11)

Well Number	Total Depth (ft)	Anticipated Lithology[a]	Depth Range (ft)	Analytes[e]											
				VOC	Tritium	Soil pH	Total Organic Carbon	Anions[d]	Metals[b]	Semivolatiles/ Pest-PCB[b]	Dioxin, Furan[b]	Isotopic, U, Th[b]	Gamma Spectrometry (Cs-137, Co-60, K-40, Bi-207, Bi-210m, Am-241, Ra-226), Sr-90/Y-90[b]	Bi, Li[b]	Isotopic Pu
B002	40	Fill	0-1	2	2	2	2			1		1	1	1	1
		Till	10-2	2	2	2	2	1	1	1	1	1	1	1	1
		Outwash	20-4	4	4	4	4								
		Static WL	30+	1	1	1	1	1	1	1		1	1	1	1
		Bedrock	40+												
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	13	9	9	9	2	2	3	1	3	3	3	3
P007	40	Clay-1	0-5	1	1	1	1			1		1			1
		Till	5-1	1	1	1	1	1	1	1		1			1
		Outwash	10-25	3	3	3	3								
		Till	25-3	1	1	1	1								
		Screened Interval	17-27	2	2	2	2								
		Static WL	25+	1	1	1	1	1	1	1		1			1
		Outwash	30-4	2	2	2	2								
		Bedrock	40+												
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	15	11	11	11	2	2	3		3			3

Table III.8. (page 5 of 11)

Well Number	Total Depth (ft)	Anticipated Lithology[a]	Depth Range (ft)	Analytes[e]											
				VOC	Tritium	Soil pH	Total Organic Carbon	Anions[d]	Metals[b]	Semivolatiles/ Pest-PCB[b]	Dioxin, Furan[b]	Isotopic, U, Th[b]	Gamma Spectrometry (Cs-137, Co-60, K-40, Bi-207, Bi-210m, Am-241, Ra-226), Sr-90/Y-90[b]	Bi, Li[b]	Isotopic Pu
P008	110	Fill	0-5	1	1	1	1								
		Till	5-15	2	2	2	2	1	1						
		Outwash	15-5	7	7	7	7								
		Screened Interval	22-32	1	1	1	1								
		Static WL	25+	1	1	1	1	1	1	1					
		Till	50-6	2	2	2	2								
		Outwash	60-95	7	7	7	7								
		Till	95-11	3	3	3	3								
		Bedrock	110+												
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	27	23	23	23	2	2	1		0	0	0	0
P009	110	Fill	0-5	1	1	1	1								
		Till	5-15	2	2	2	2	1	1						
		Outwash	15-55	8	8	8	8								
		Screened Interval	109-11	1	1	1	1								
		Static WL	25+	1	1	1	1	1	1	1					
		Till	55-7	3	3	3	3								
		Outwash	70-95	5	5	5	5								
		Till	95-11	3	3	3	3								
		Bedrock	110+												
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	28	24	24	24	2	2	1		0	0	0	0

Table III.8. (page 6 of 11)

Well Number	Total Depth (ft)	Anticipated Lithology[a]	Depth Range (ft)	Analytes[a]											
				VOC	Tritium	Soil pH	Total Organic Carbon	Anions[d]	Metals[b]	Semivolatiles/ Pest-PCB[b]	Dioxin, Furan[b]	Isotopic, U, Th[b]	Gamma Spectrometry (Cs-137, Co-60, K-40, Bi-207, Bi-210m, Am-241, Ra-226), Sr-90/Y-90[b]	Bi, Li[b]	Isotopic Pu
P010	35	Fill	0-5												
		Till	5-15												
		Outwash	15-55												
		Screened Interval	22-32	2	2	2	2								
		Static WL	25+	1	1	1	1								
			Totals	3	3	3	3	0	0	0	0	0	0	0	0
P011	75	Fill	0-5												
		Till	5-15												
		Outwash	15-55												
		Static WL	25+	1	1	1	1								
		Till	55-7												
		Outwash	70-75												
		Screened Interval	74-75	1	1	1	1								
			Totals	2	2	2	2	0	0	0	0	0	0	0	0
P012	90	Fill	0-5												
		Till	5-15												
		Outwash	15-55												
		Static WL	25+	1	1	1	1								
		Till	55-7												
		Outwash	70-9												
		Screened Interval	89-9	1	1	1	1								
			Totals	2	2	2	2	0	0	0	0	0	0	0	0

Table III.8. (page 7 of 11)

Well Number	Total Depth (ft)	Anticipated Lithology[c]	Depth Range (ft)	Analytes[a]											
				VOC	Tritium	Soil pH	Total Organic Carbon	Anions[d]	Metals[b]	Semivolatiles/ Pest-PCB[b]	Dioxin, Furan[b]	Isotopic, U, Th[b]	Gamma Spectrometry (Cs-137, Co-60, K-40, Bi-207, Bi-210m, Am-241, Ra-226), Sr-90/Y-90[b]	Bi, Li[b]	Isotopic Pu
P013	110	Fill	0-5	1	1	1	1								
		Till	5-15	2	2	2	2	1	1						
		Outwash	15-5	7	7	7	7								
		Screened Interval	22-32	2	2	2	2	2	2	2					
		Static WL	25+	1	1	1	1								
		Till	50-6	2	2	2	2								
		Outwash	60-95	7	7	7	7								
		Till	95-11	3		3	3								
		Bedrock	110+												
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	29	25	25	25	3	3	2	0	0	0	0	0
P014	75	Fill	0-15	3	3	3	3			1		1	1		1
		Till	15-25	2	2	2	2	1	1	1		1	1		1
		Outwash	25-75	10	10	10	10								
		Screened Interval	22-32	2	2	2	2								
		Static WL	25+	1	1	1	1	1	1	1		1	1		1
		Bedrock	75+												
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	22	18	18	18	2	2	3	0	3	3	0	3

Table III.8. (page 8 of 11)

Well Number	Total Depth (ft)	Anticipated Lithology[a]	Depth Range (ft)	Analytes[a]											
				VOC	Tritium	Soil pH	Total Organic Carbon	Anions[d]	Metals[b]	Semivolatiles/ Pest-PCB[b]	Dioxin, Furan[b]	Isotopic, U, Th[b]	Gamma Spectrometry (Cs-137, Co-60, K-40, Bi-207, Bi-210m, Am-241, Ra-226), Sr-90/Y-90[b]	Bi, Li[b]	Isotopic Pu
P015	55	Fill	0-15	3	3	3	3	1	1	1	1	1	1	1	1
		Till	15-35	4	4	4	4	1	1	1	1	1	1	1	1
		Outwash	35-55	4	4	4	4								
		Screened Interval	42-52	2	2	2	2								
		Static WL	45+	1	1	1	1	1	1	1		1	1		1
		Bedrock	55+												
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	18	14	14	14	3	3	3	2	3	3	2	3
0380	50	Till	0-2	4	4	4	4	1	1	1		1	1		1
		Outwash	20-3	2	2	2	2								
		Till	30-35	1	1	1	1			1		1	1		1
		Bedrock	35+	1	1	1	1								
		Screened Interval	37-47	2	2	2	2	2	2	2		1	1		1
		Static WL	40+												
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	14	10	10	10	3	3	4	0	3	3	0	3

Table III.8. (page 9 of 11)

Well Number	Total Depth (ft)	Anticipated Lithology[c]	Depth Range (ft)	Analytes[a]											
				VOC	Tritium	Soil pH	Total Organic Carbon	Anions[d]	Metals[b]	Semivolatiles/ Pest-PCB[b]	Dioxin, Furan[b]	Isotopic, U, Th[b]	Gamma Spectrometry (Cs-137, Co-60, K-40, Bi-207, Bi-210m, Am-241, Ra-226), Sr-90/Y-90[b]	Bi, Li[b]	Isotopic Pu
0381	60	Fill	0-5	1	1	1	1			1		1	1		1
		Till	5-25	4	4	4	4	1	1	1		1	1		1
		Outwash	25-45	4	4	4	4								
		Bedrock	45+												
		Screened Interval	47-57	2	2	2	2								
		Static WL	50+	1	1	1	1	1	1	1		1	1		1
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	16	12	12	12	2	2	3	0	3	3	0	3
0382	55	Fill	0-5	1	1	1	1			1		1	1		1
		Till	5-25	4	4	4	4	1	1	1		1	1		1
		Outwash	25-4	3	3	3	3								
		Bedrock	40+												
		Screened Interval	42-52	2	2	2	2								
		Static WL	45+	1	1	1	1	1	1	1		1	1		1
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	15	11	11	11	2	2	3	0	3	3	0	3

Table III.8. (page 10 of 11)

Well Number	Total Depth (ft)	Anticipated Lithology[c]	Depth Range (ft)	Analytes[a]											
				VOC	Tritium	Soil pH	Total Organic Carbon	Anions[d]	Metals[b]	Semivolatiles/ Pest-PCB[b]	Dioxin, Furan[b]	Isotopic, U, Th[b]	Gamma Spectrometry (Cs-137, Co-60, K-40, Bi-207, Bi-210m, Am-241, Ra-226), Sr-90/Y-90[b]	Bi, Li[b]	Isotopic Pu
0393	55	Fill	0-5	1	1	1	1	1	1	1	1	1	1	1	1
		Till	5-20	3	3	3	3	1	1	1	1	1	1	1	1
		Outwash	20-40	4	4	4	4								
		Bedrock	40+	3	3	3	3								
		Screened Interval	43-48	2	2	2	2								
		Static WL	20+	1	1	1	1	1	1	1		1	1		1
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	18	14	14	14	3	3	3	2	3	3	2	3
0394	70	Fill	0-5	1	1	1	1	1	1	1	1	1	1	1	1
		Outwash	5-10	1	1	1	1								
		Till	10-20	2	2	2	2	1	1	1	1	1	1	1	1
		Outwash	20-55	7	7	7	7								
		Bedrock	55+	3	3	3	3								
		Screened Interval	58-63	2	2	2	2								
		Static WL	20+	1	1	1	1	1	1	1		1	1		1
		Lithology Change	----	2											
		Maximum Instrument Reading	----	2											
			Totals	21	17	17	17	3	3	3	2	3	3	2	3

Table III.8. (page 11 of 11)

Explanation of Symbols:

[a]Samples will be collected at 5 ft intervals within each depth range.
[b]Samples will be collected at the top of the till unit.
[c]Samples designated for collection at the static water level will be taken from a zone 3 ft above the water table (capillary fringe is targeted). If the amount of core collected within this zone is insufficient to collect samples for all designated parameters, then remaining sample parameters will be collected from the same interval in the adjacent monitoring well cluster.
[d]Anions consist of chloride, sulfate, nitrate, nitrite, fluoride, and alkalinity.

Explanation of Lithologic Units:

Fill - variable portions of reworked gravel, sand, and clay
Clay-1 - reworked clay-bearing glacial till - clay containing trace amounts of silt or sand (used for Overflow Pond liner)
Clay-2 - reworked clay-bearing glacial till - as above (used for Site Sanitary Landfill liner)
Till - glacial till - clay containing variable portions of fravel sand, and silt
Outwash - glacial outwash - sand and gravel containing some silt and trace amounts of clay
Bedrock - shale with limestone interbeds
E-Waste - Site Sanitary Landfill encapsulated waste
Static WL - average elevation of water table

Table III.9. Subsurface Soil Sampling Rationale

Parameter	Sample Location	Rationale
VOCs	5 ft intervals	Primary contaminant of concern in vadose and saturated zone.
Tritium	5 ft intervals	Primary contaminant of concern in vadose and saturated zone.
Metals	Top of shallow glacial till layer	Metals tend to adsorb to clays in till.
	3 ft zone above water table	Capillary fringe is zone of suspected contamination accumulation.
Semivolatiles	Shallow subsurface fill material	Low solubility - possible to remain where deposited due to limited migration in vadose zone.
	Top of shallow glacial till layer	High specific gravity, moderate solubility - likely semivolatiles would percolate to and settle on top of till layer.
	3 ft zone above water table	Capillary fringe is zone of suspected contamination accumulation.
PCBs	Shallow subsurface fill material	Low solubility - likely to remain where deposited.
	Top of shallow glacial till layer	In the source area, the till layer was near historical land surface before construction of the site sanitary landfill
	3 ft zone above water table	Capillary fringe is zone of suspected contamination accumulation.
Pesticides	Shallow subsurface fill material	Low solubility - possible to remain where deposited due to limited migration in vadose zone.
	Top of shallow glacial till layer	In the source area, the till layer was near historical land surface before construction of the site sanitary landfill
	3 ft zone above water table	Capillary fringe is zone of suspected contamination accumulation.
Dioxin, Furan	Top of shallow glacial till layer	Dioxins and furans are byproducts of burned PCBs - the shallow till in the source area is the most likely location where PCBs would collect. Analysis for dioxins and furans will be performed to verify their existence or non-existence.
Isotopic U, Th	Shallow subsurface fill material	Potential source area - likely to remain where deposited.
	Top of shallow glacial till layer	Potential source area - till layer was near historical land surface before construction of the site sanitary landfill
	3 ft zone above water table	Capillary fringe is zone of suspected contamination accumulation.
Bi-207, Co-60, Sr-90/Y-90, Ra-226	Shallow subsurface fill material	Possible that these contaminants were deposited in Area 2 and SM/PP Hill.
	Top of shallow glacial till layer	In the source area, the till layer was near historical land surface before construction of the site sanitary landfill - possible that these contaminants were deposited in Area 2 or were transported by surface runoff from the SM/PP Hill.
	3 ft zone above water table	Capillary fringe is zone of suspected contamination accumulation within Area 2 and at base of SM/PP Hill.
Lithium, bismuth	Shallow subsurface fill material	Possible that these contaminants were deposited in Area 2.
	Top of shallow glacial till layer	In the source area, the till layer was near historical land surface before construction of the site sanitary landfill - possible that lithium and bismuth were deposited in Area 2 in the past.
	3 ft zone above water table	Capillary fringe is zone of suspected contamination accumulation within Area 2
Isotopic Pu	Shallow subsurface fill material	Possible that these contaminants were deposited in Area 2 and SM/PP Hill.
	Top of shallow glacial till layer	In the source area, the till layer was near historical land surface before construction of the site sanitary landfill - possible that these contaminants were deposited in Area 2 or were transported by surface runoff from the SM/PP Hill.
	3 ft zone above water table	Capillary fringe is zone of suspected contamination accumulation within Area 2 and at base of SM/PP Hill.

Similar specifications for the collection of geotechnical samples are presented in Table III.10. Samples will be collected at specific depth intervals to further characterize the physical properties of individual lithologic units in the area. The purpose and rationale for selected geotechnical tests is described in Table III.11.

3.5.3. Surface Soil Sampling

Surface soil samples will be collected from locations in the vicinity of the site sanitary landfill as discussed in subsection 3.4. Sample locations are shown on Figure 3.4. Sample collection methods are described in subsection 4.3.1. Sampling specifications are presented in Table III.12.

3.5.4. Groundwater Sampling

Groundwater samples will be collected from newly installed monitoring wells for the analytes outlined in Table III.5. Sample locations are shown on Figure 3.1. Groundwater sample collection methods are described in section 4.3.3.

Table III.10. Subsurface Geotechnical Soil Sampling Plan

Well Number	Total Depth (ft)	Anticipated Lithology	Depth Range (ft)	Bulk Density, Total Porosity, Grain Size, % Organics	Triaxial Permeability, Clay Minerals	Atterberg Limits Moisture Content, Capillary Moisture Curve, Iron and Maganese Content	Bacterial Culture
P001	45	Fill	0-15	2	1		
		Clay-1	15-20	1			
		Till	20-25	1 (Unsaturated)	1 (Unsaturated)	1 (Unsaturated)	
		Outwash	25-40	1 (Unsaturated)	1 (Unsaturated)	1 (Unsaturated)	
		Static WL	25 +				
		Bedrock	40 +				
P003	45	Fill	0-25	2	1	1	
		Till	25-35	1 (Unsaturated)		1	
		Outwash	35-45	1 (Saturated)	1 (Saturated)	1	
		Static WL	35 +				
		Bedrock	45 +				
P004	75	Fill	0-5	1			
		E-Waste	5-35				
		Clay-2	35-40	1			
		Till	40-50				
		Outwash	50-60	1 (Saturated)			
		Bedrock	60 +	1 (Saturated)			
		Static WL	65 +				
P005	75	Fill	0-5	1	1	1	1
		E-Waste	5-25				
		Clay-2	25-30	1			
		Fill	30-45				
		Till	45-60	1 (Unsaturated)	1 (Unsaturated)	1	1 (Unsaturated)
		Static WL	65 +				
		Outwash	60-75	1 (Unsaturated)	1 (Unsaturated)		
		Bedrock	75 +				
P006	40	Fill	0-10	1			
		Till	10-15				
		Outwash	15-20		1 (Unsaturated)		
		Till	20-25	1 (Unsaturated)	1 (Unsaturated)		
		Outwash	25-35	1 (Saturated)			
		Static WL	30 +				
		Bedrock	35 +	1 (Saturated)	1		

Table III.10. (page 2 of 4)

Well Number	Total Depth (ft)	Anticipated Lithology	Depth Range (ft)	Bulk Density, Total Porosity, Grain Size, % Organics	Triaxial Permeability, Clay Minerals	Atterberg Limits Moisture Content, Capillary Moisture Curve, Iron and Maganese Content	Bacterial Culture
B001	45	Fill	0-15	2	1		
		Till	15-25			1	
		Outwash	25-45			1	
		Static WL	30+				
		Bedrock	45+				
B002	40	Fill	0-10	1		1	
		Till	10-20				
		Outwash	20-40	1 (Unsaturated)			
		Static WL	30+				
		Bedrock	40+				
P007	40	Clay-1	0-5	1			
		Till	5-10	1 (Unsaturated)			
		Outwash	10-25	1 (Unsaturated)			
		Till	25-30	1 (Saturated)			
		Static WL	25+				
		Outwash	30-40				
		Bedrock	40+				
P008	110	Fill	0-5	1		1	
		Till	5-15	1 (Unsaturated)		1 (Unsaturated)	
		Outwash	15-50	1 (Unsaturated)		1 (Unsaturated)	
		Static WL	25+				
		Till	50-60	1 (Saturated)	1 (Saturated)		
		Outwash	60-95	1 (Saturated)	1 (Saturated)		
		Till	95-110				
		Bedrock	110+	1 (Saturated)	1 (Saturated)		
P009	110	Fill	0-5	1			
		Till	5-15				
		Outwash	15-55			1	1 (Saturated)
		Static WL	25+				
		Till	55-70		1 (Saturated)		1 (Saturated)
		Outwash	70-95				
		Till	95-110	1 (Saturated)			
		Bedrock	110+				

Table III.10. (page 3 of 4)

Well Number	Total Depth (ft)	Anticipated Lithology	Depth Range (ft)	Bulk Density, Total Porosity, Grain Size, % Organics	Triaxial Permeability, Clay Minerals	Atterberg Limits Moisture Content, Capillary Moisture Curve, Iron and Maganese Content	Bacterial Culture
P013	110	Fill	0-5	1			
		Till	5-15				
		Outwash	15-50		1 (Saturated)	1	
		Static WL	25+				
		Till	50-60	1 (Saturated)		1	
		Outwash	60-95				
		Till	95-110		1 (Saturated)		
		Bedrock	110+				
P014	75	Fill	0-15	1			
		Till	15-25				
		Outwash	25-75				
		Static WL	25+				
		Bedrock	75+				
P015	55	Fill	0-15	1	1	1	
		Till	15-35	1 (Unsaturated)	1 (Unsaturated)	1 (Unsaturated)	
		Outwash	35-55	1 (Saturated)	1 (Saturated)	1 (Saturated)	
		Static WL	45+				
		Bedrock	55+				
0381	60	Fill	0-5	1			
		Till	5-25				
		Outwash	25-45				
		Bedrock	45+	1 (Unsaturated)			
		Static WL	50+				
0382	55	Fill	0-5	1			
		Till	5-25				
		Outwash	25-40	1 (Unsaturated)			
		Bedrock	40+	1 (Unsaturated)			
		Static WL	45+				
0393	55	Fill	0-5	1	1	1	
		Till	5-20	1 (Unsaturated)	1 (Unsaturated)	1 (Unsaturated)	
		Outwash	20-40	1 (Saturated)	1 (Saturated)	1 (Saturated)	
		Static WL	20+				
		Bedrock	40%				

Table III.10. (page 4 of 4)

Well Number	Total Depth (ft)	Anticipated Lithology	Depth Range (ft)	Bulk Density, Total Porosity, Grain Size, % Organics	Triaxial Permeability, Clay Minerals	Atterberg Limits Moisture Content, Capillary Moisture Curve, Iron and Maganese Content	Bacterial Culture
0394	70	Fill	0-5	1			
		Outwash	5-10	1 (Unsaturated)	1 (Unsaturated)		
		Till	10-20				
		Outwash	20-50	1 (Saturated)			
		Static WL	20+				
		Bedrock	55+	1 (Saturated)	1 (Saturated)		

Explanation

Fill: variable portions of reworked gravel, sand, and clay
Clay-1: reworked clay-bearing glacial till - clay containing trace amounts of silt or sand (used for Overflow Pond liner)
Clay-2: reworked clay-bearing glacial till - as above (used for Site Sanitary Landfill liner)
Till: glacial till - clay containing variable portions of fravel sand, and silt
Outwash: glacial outwash - sand and gravel containing some silt and trace amounts of clay
Bedrock: shale with limestone interbeds
E-Waste: Site Sanitary Landfill encapsulated waste
Static WL: average elevation of water table

Note: Grain size analysis will not be performed on bedrock sample.

Table III.11. Geotechnical Test Purpose and Rationale

Test	Purpose	Rationale
Atterberg Limits	To determine the plastic limit and liquid limits. This information will be used in conjunction with soil moisture content to determine liquidity index.	Liquid or plastic limits aid in evaluating a soil for use as structural fill, for construction, and for building support. The liquidity index provides an indication of the soil's consistency, including an indirect indication of the individual clay constituents. This information can be used in the selection process of usable a process options.
Bulk Density	To determine the shear strength and the resistance to compression of the soil. Also related to total porosity.	Shear strength, resistance to compression, and the void ratio can be useful information in the selection process of viable process options. Also used as input to determine partition coefficients.
Moisture Content	To determine ratio of the weight of water in a soil to the dry weight of the material.	Water content can have a significant effect on the soil's engineering properties and on contaminant migration rates. Also, water content can be a limiting factor for several potential process options.
Grain Size including hydrometer	To determine the size range of particles in the soil, and the percentage of particles in each of the sizes between the maximum and minimum. To determine the relative abundances in a sample of particles within the major soil types, clay, silt, sand, and gravel.	Primary index property test to indicate type and condition of soil. Information regarding maturity of soils and void ratio potential can be acquired from these data. This information will be used in the feasibility study process in selecting a viable remedial alternative. Percentage of clays relates to strength of the soil. This information can be used to predict contaminant migration rates and adsorption to the soil matrix. It can be used in the feasibility study and risk assessment process.
Bacterial Culture	To determine the bacteria presently degrading contaminants into nonhazardous compounds.	First step in determining if *in situ* bioremediation is a feasible process option.
Clay Minerals	To determine type of clay minerals in the soil.	Shrinking/swelling and sorbing properties of the soil, and contaminant transport rates are controlled by the type and abundance of specific clay minerals. Particular clays also have differing natural attenuation capabilities. This information will be used in the feasibility study and risk assessment processes.
Triaxial Permeability	To determine saturated hydraulic conductivity of core samples. The test is generally successful for a wide range of hydraulic conductivities.	Used in determining contaminant transport rates in saturated and unsaturated media. Can support contaminant transport modeling used in risk assessment and evaluation of remedial alternatives.

Table III.12. Surface Soil Sampling Plan

Location ID	Sample Location	Chemical Analysis	Radiological Analysis
SL01	Landfill Cover	X	X
SL02		X	X
SL03		X	X
SL04		X	X
SL05	Borrow Ditch	X	X
SL06		X	X
SL07		X	X
SL08	Northern Landfill Berm	X	X
SL09		X	X
SL10	East of Landfill	X	X
SL11	Borrow Ditch	X	X
SL12	North of overflow pond	X	X
SL13		X	X

PCB - polychlorinated biphenyl
TAL - Target Analyte List
TCL - Target Compound List

Chemical analysis includes:

Volatile organic compounds
Semivolatile organic compounds
TCL pesticides/PCBs
TAL inorganics
TAL inorganics (dissolved in water)
Bismuth
Fluoride
Nitrate/Nitrite
Chloride
Sulfate
Alkalinity
Total organic carbon
Soil pH

Radiological analysis includes:

Isotopic plutonium
Isotopic thorium
Isotopic uranium
Radium-226
Strontium-90/Yttrium-90
Tritium
Gamma Spectrometry

Table III.11. (page 2 of 2)

Test	Purpose	Rationale
Capillary Moisture Curves	Determine relationship of soil moisture content to suction in samples.	Used with values of saturated hydraulic conductivity in empirical formulas to develop relationships of soil moisture content to unsaturated hydraulic conductivity. These relationships are input to fluid flow and contaminant transport models, which can be used to support risk assessments, treatability studies, and feasibility studies.
Iron and Manganese Content	To determine concentration of iron and manganese in groundwater.	High iron and manganese content limits the efficiency of several groundwater treatment process options. Also, excessive concentrations of these elements can kill advantageous bacterial growth. Also, these metals in the soil can lower the pH in the associated pore water.
Percent Organics	Determine percentage of organics in soils.	Organic material mixed with the nonorganic soil can have detrimental effects on the strength and compressibility properties of the material. Also, percentage of organic material within a soil controls contaminant sorbing and natural attenuation. This information is needed input for contaminant transport modeling.
Porosity - Total	Determine total porosity.	Total porosity is the ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment. This information can be used in the selection process of viable process options.

4. FIELD METHODS

This section describes methods for field investigations according to the requirements of the Mound Plant ER Program Standard Operating Procedures (SOPs). The SOPs applicable to this field investigation are listed in Table IV.1 and provided in the Operable Unit 9 Quality Assurance Program Plan (QAPP) (DOE 1992) and the Operable Unit 1 QAPP (DOE 1992) (Appendix B). Otherwise, accepted industry methodology will be utilized.

The Operable Unit 1 QAPP will outline the content of each applicable SOP that describes appropriate field methods. A separately bound copy of all SOPs and the Operable Unit 1 and Operable Unit 9 QAPPs will be provided to all field personnel and will be followed by all members of the field team. A general description of protocols related to the Proposal for Additional Work investigation will be discussed in pertinent sections below.

4.1. SOIL GAS SURVEY METHODS

To define a method that ensures acceptable, consistent soil gas sampling and onsite analysis with a gas chromatograph for volatile organic contaminants, soil gas samples will be collected and analyzed according to the subcontractors' SOPs, which will be submitted to the USEPA and OEPA upon receipt from the subcontractor.

Methane, carbon dioxide, and oxygen will be added to the list of analytes for soil gas samples collected from within the SSL. This will be accomplished by monitoring for each analyte using hand-held instruments as soil gas is purged from SSL encapsulated waste. A final recorded measurement will be made after three volumes of air have been purged through the sampling probe. In addition, landfill gas pressures within the encapsulated waste will be quantified using onboard instrumentation. The instrumentation can determine positive or negative pressures to within 0.01 atmospheres.

Gas will be extracted from the SSL leachate pipe at the normal flow rate of 50 L/minute for a period of 500 minutes based on the following calculation of pipe volume:

- Volume (L) = $(3.142 \cdot r^2 \cdot l)/1000$, where r = pipe radius (cm) and l = pipe length including both forks (cm).

The gas will be extracted by a one horsepower blower. On the effluent side of the blower, a sampling port will be made. Samples will be collected into a Tedlar bag using a hand vacuum pump.

Table IV.1 RI/FS Standard Operating Procedures

SOP		Effective Date	Revision Number	Purpose
Section 1 - General				
1.1	General Instructions for Field Personnel	February 1992	2	To provide field personnel with instructions regarding activities to be performed before, during, and after field investigations
1.9	Personnel Decontamination-- Level C Protection	February 1992	1	To describe the equipment and procedures required for the decontamination of persons who have performed field activities in Level C protective clothing.
1.3	Sample Control and Documentation	February 1992	1	To define the steps necessary for sample control and identification, data recording, and chain-of-custody documentation.
1.4	Sample Containers and Preservation	February 1992	2	To provide guidance in the selection and preservation of suitable containers for samples, container cleaning, required sample volumes, sample collection, times, and the recommended holding preservation techniques for water, wastes, sediments, sludges, and soil samples.
1.5	Guide to the Handling, Packaging, and Shipping of Samples	May 1991	1	To provide a general guide for packaging and shipping samples of environmental and hazardous materials to the laboratory. In addition, instructions are provided to select the correct category for packaging and shipping samples of unknown contents.
1.6	General Equipment Decontamination	February 1992	2	To describe methods for the decontamination of field equipment potentially contaminated during sample collection.
1.8	Personnel Decontamination-- Level D Protection	February 1992	1	To describe the equipment and procedures required for the decontamination of persons who have performed field activities in Level D protective clothing.
1.15	Guide to Waste Management (currently under review)	TBD	0	To provide guidance on the proper handling of investigation derived waste.

Table IV.1. (page 2 of 5)

SOP	Effective Date	Revision Number	Purpose
Section 2 - Water Sampling			
2.1 Presample Purging of Wells	February 1992	1	To identify well-purging procedures for evacuation of stagnant water from the well bore and its replacement by groundwater in sufficient quantities so that a water sample representative of the formation of completion can be collected.
2.2 Field Measurements on Ground and Surface Water Samples	February 1992	2	To obtain reliable and accurate measurements of the field chemistry of water quality samples.
2.3 Sampling Monitoring Wells with a Bladder Pump	February 1992	3	To use a bladder pump to obtain representative groundwater samples at shallow depths that are beyond the capabilities of a peristaltic pump.
2.4 Sampling Monitoring Wells with a Bucket-Type Bailer	June 1991	1	To obtain a representative groundwater sample at depths beyond the range (or capability) of suction lift pumps when bailer volatile air stripping is of concern, well-casing diameters are too narrow to accept submersible pumps, or other difficult conditions are present.
2.7 Sampling Commercial/Municipal/Domestic Wells	June 1991	1	To define guidelines for field personnel to follow in sampling commercial, municipal, and domestic wells.
2.8 Sampling for Volatile Organics	January 1991	0	To outline procedures for collecting a representative groundwater sample and transporting it from its original environment to the laboratory for analysis of trace volatile organics.
Section 3 - Hydraulic Testing			
3.1 Water Level Measurement	February 1992	1	To determine the depth-to-water in an open borehole, cased borehole, monitoring well, or piezometer.
3.3 Operational Check of Pressure Transducers Used in Measuring Water Levels in Wells	January 1991	0	To describe procedures for office and field checks of pressure transducers.

Table IV.1. (page 3 of 5)

SOP	Effective Date	Revision Number	Purpose
3.4 Aquifer Pumping Test	January 1991	0	To define procedures to conduct pumping tests for the *in situ* determination of the hydraulic properties of water-bearing soils and rocks.
Section 4 - Drilling and Logging			
4.1 Soil Boring	February 1992	2	To ensure acceptable, consistent soil-boring procedures for all pertinent aspects of hazardous waste investigations.
4.1.1 Methods to Control Communications of Subsurface Contaminants with Groundwater	February 1992	0	To ensure that acceptable, consistent soil-boring procedures are used to prevent communication of subsurface contaminants in vadose zone soils or landfill materials with underlying groundwater.
4.2 Rock Boring	February 1992	1	To ensure acceptable, consistent rock boring procedures for all pertinent aspects of hazardous waste investigations.
4.3 Monitoring Well Installation	February 1992	1	To ensure acceptable, consistent monitoring well installation.
4.4 Monitoring Well Development	February 1992	1	To remove foreign materials that may have been introduced into the groundwater, well annulus, or well screen during well installation and to facilitate hydraulic communication between the screened formation and the monitoring well.
4.7 Piezometer Installation	February 1992	0	To ensure acceptable, consistent piezometer installation.
4.8 Piezometer Development	February 1992	0	To remove foreign materials that may have been introduced into the groundwater, well annulus, or well screen during well installation and to facilitate hydraulic communication between the screened formation and the piezometer.

Table IV.1. (page 4 of 5)

SOP	Effective Date	Revision Number	Purpose
Section 5 - Soil Sampling			
5.1 Soil and Rock Borehole Logging and Sampling	February 1992	1	To describe the physical nature of consolidated or unconsolidated subsurface earthen materials encountered during auger, rotary, or other drilling or trenching activities and collect samples of the earthen materials for further evaluation.
5.2 Soil Sampling with a Spade and Scoop	February 1992	3	To describe a method for collecting a soil sample less than 4 ft below the land surface.
5.3 Subsurface Solid Sampling with Hand Auger and Thin-Wall Sampler	February 1992	2	To define a method of collecting subsurface solid samples with a hand auger and thin-wall tube sampler.
5.4 General Soil Gas Sampling and Field Chemical Analysis	February 1992	0	To define a method that ensures acceptable, consistent soil gas sampling and on-plant analysis with a gas chromatograph for volatile organic contaminants.
5.8 Soil Sampling with a Stainless Steel Surface Soil Sampler	October 1991	1	To define procedures for collecting surface soil samples to determine the chemical and physical soil properties.
5.9 Sediment Sampling Procedures for Streams, Rivers, and Ponds	February 1992	0	To describe the methods for collecting deposited sediment samples in streams, rivers, and ponds.
Section 6 - Health and Safety			
6.1. Health and Safety Monitoring of Combustible Gas Levels	February 1992	1	To describe the equipment and proper method for monitoring combustible gas levels in order to determine when an explosion hazard exists in the work environment.
6.2. Health and Safety Monitoring of Organic Vapors with a Photoionization Detector	February 1992	1	To describe the equipment and proper method for environmental monitoring of toxic gases and vapors using a portable photoionization detector (PID).

Table IV.1. (page 5 of 5)

SOP		Effective Date	Revision Number	Purpose
6.4	Total Alpha Surface Contamination Measurements	January 1991	0	To provide guidance for determining levels of total surface alpha contamination on equipment, vehicles, and personnel that have been in contact with material that was potentially contaminated with alpha-emitting radionuclides.
6.7	Near Surface and Soil Sample Screening for Low-Energy Gamma Radiation Using the FIDLER	January 1991	0	To describe the procedure in which a field instrument for the detection of low-energy radiation (FIDLER) is used to monitor surfaces and soil samples for the presence of low-energy gamma radiations that accompany some alpha emissions.
6.15	Measurement of Gamma-Ray Fields Using a Sodium Iodide (NaI) Detector	January 1991	0	To describe the procedure for making count-rate measurements of a gamma-ray field with a sodium iodide (NaI) detector.
6.16	Heat Stress Monitoring	January 1991	0	To outline the procedure for monitoring heat stress and other measures for protecting workers from heat exhaustion and heat stroke in warm environments.

4.2. DRILLING METHODS

4.2.1. Piezometers

Piezometer clusters are proposed at some locations. The first drilled piezometer borehole at each well location will be drilled to the top of bedrock and will serve as a pilot hole to promote the proper installation of the subsequent, adjacent piezometers or monitoring wells.

Hollow stem auger techniques will be used to drill each pilot hole to 1) collect continuous core without the use of drilling fluids, 2) obtain soil samples for geochemical and geotechnical analysis at selected intervals, 3) adequately characterize the subsurface stratigraphy to the top of bedrock, 4) determine zones of contamination and identify drilling problems, and 5) formulate the precise completion specifications for each proposed piezometers or monitoring well. The continuous core that is not used for chemical or geotechnical analyses will be archived in core boxes for future study.

The additional piezometers to be clustered near selected monitoring wells will be drilled using hollow-stem augers equipped with a centerbit. As a result, no stratigraphic information will be obtained, however, split-spoon drive samples may be collected at selected intervals to verify sample results obtained from adjacent, continuously-cored pilot holes. Split-spoon samples will be collected at the water table and along the entire screened interval from each piezometer borehole drilled with a centerbit. Piezometer completion specifications will be based on information obtained from adjacent pilot holes in which piezometers have already been installed and the split-spoon sample collected at the potentiometric surface.

The unconsolidated sediments underlying Area B consist primarily of glacially transported material. During drilling, intermittent lenses of glacial till are likely to be encountered that may prevent further penetration using hollow stem augers. If this occurs, appropriate drilling methods allowing the collection of continuous core will be implemented to complete the borehole to the specified depth.

4.2.2. Monitoring Wells

Monitoring wells proposed for the source area (0370-0374), the downgradient area (0375-0378), and the upgradient tributary valley area (0379) will be drilled using hollow-stem augers equipped with a centerbit. This technique prohibits the collection of continuous core, however, split-spoon drive samples can be collected if necessary. Split-spoon samples will be collected at the water table and along the entire screened interval from each monitoring well borehole drilled. The depth to groundwater will be determined from adjacent piezometer pilot hole information. Well completion

specifications for each monitoring well will be calculated based on stratigraphic information obtained from adjacent piezometer pilot holes and the split-spoon sample collected at the potentiometric surface. If auger refusal is encountered, appropriate drilling techniques will be implemented to advance the well borehole to total depth.

The bedrock monitoring wells proposed for the upgradient SM/PP Hill area, at locations 0380, 0381, and 0382, and the near source SSL area, at locations 0393 and 0394, will be drilled using hollow-stem auger techniques. Continuous core will be collected from the ground surface to the top of bedrock in each well borehole to characterize the underlying unconsolidated stratigraphy, and to collect soil samples for chemical and geotechnical analysis. If auger refusal is encountered, appropriate drilling techniques will be implemented allowing for collection of continuous core to the top of bedrock. If the well borehole is advanced to the top of bedrock using hollow-stem augers without encountering groundwater, the augers will be withdrawn from the borehole, and appropriate drilling techniques will be implemented to collect continuous core in the bedrock until the first water producing zone is encountered. If groundwater is encountered in the unconsolidated sediments at locations 0380, 0381, and 0382, the installation of multiple wells will be considered.

4.2.3. Piezometers and Monitoring Wells Penetrating SSL Encapsulated Waste

During drilling activities in the source area, the SSL encapsulated waste will be penetrated by two piezometer borings (P004 and P005), and at least two monitoring well borings (0372 and 0373). The following protocols will be implemented to prevent the communication of potential contaminants from the encapsulated waste to the water table and assure proper well completion within the saturated zone. Refer to Figure 2.4 for a schematic cross-section of the stratigraphy associated with the SSL.

Hollow-stem auger drilling techniques will be used to allow for the collection of continuous core. Monitor the core for volatile vapors using a photoionization detector (PID) and an organic vapor analyzer (OVA). Examine the core to determine the contact between the encapsulated waste and the compacted clay basal liner of the SSL. Remove the augers and ream the borehole with larger augers to a depth approximately 1 ft below the base of the encapsulated waste. Seat the surface casing into the SSL basal liner and pressure grout the annulus between the outside of surface casing and the borehole wall (inject a maximum of 2 cu yds of grout to seal the base of the surface casing only). If after initial investigation it is determined that more grout is needed to properly seal the casing annulus, continue to grout until a proper seal can be assured. Allow 24 hrs for the grout to harden. Trip in the smaller augers, resume drilling at base of the grout plug, and collect continuous core to the top of bedrock. Install the well string assembly inside the auger string. Begin withdrawal of the auger string, emplace filter pack around the well screen, and inject a bentonite slurry seal above the well screen.

Continue withdrawal of the auger string to the base of the surface casing and stem borehole annulus with a cement/bentonite grout mixture. Remove the auger string from the borehole. Begin withdrawal of the surface casing and inject grout simultaneously. If the encapsulated waste is poorly consolidated, excessive amounts of grout may percolate into encapsulated waste material. If this occurs, pressure-grout the surface casing in place.

4.3. SAMPLE COLLECTION METHODS

4.3.1. Shallow Surface Soil

Surface soil samples will be collected from 1) the site sanitary landfill cover; 2) the borrow ditch west of the landfill; 3) the borrow ditch south of the landfill; 4) the base of the northern landfill berm; and 5) the area north of the overflow pond. Specific sample locations are shown in Figure 3.4. The samples will be sent to an offsite laboratory for chemical and radiological analysis. Analytical parameter specifications for the surface soil sample investigation are shown in Table III.6.

4.3.2. Subsurface Soil

At a minimum, soil samples will be collected from continuously-cored boreholes at 5-ft intervals from the ground surface to the total depth of the borehole. Additional samples will be collected 1) at the water table; 2) along the entire proposed screened interval of the piezometer or well; 3) from zones where instruments show relatively high levels of contamination; and 4) where changes in lithology are encountered. In piezometer and monitoring well boreholes that are not continuously cored, soil samples will be collected at the water table and along the length of the screened interval. All soil samples collected will be submitted to an offsite laboratory for chemical and radiological analysis (Table III.1). Some soil samples will be collected that represent discrete lithologic horizons, (e.g., unsaturated till, unsaturated outwash, saturated till, saturated outwash, and bedrock). These samples will be submitted to an offsite laboratory for geotechnical analysis (Table III.5). The number of sample intervals and type of geotechnical analysis per piezometer or monitoring well borehole listed in Table III.5 are based on the need to fully evaluate the geotechnical characteristics of each discrete lithologic horizon and provide data for contaminant transport modelling.

4.3.3. Groundwater

A dedicated bladder pump will be used to collect groundwater samples from monitoring wells installed in the source area, the downgradient area, and the upgradient tributary valley area. A bailer will be used to collect groundwater samples from monitoring wells installed in the upgradient SM/PP Hill area.

All new monitoring wells will be sampled for VOCs, general ions, and tritium. Specific monitoring wells will be sampled for TAL metals, TCL semivolatile organic compounds, TCL pesticides/PCBs, and select radionuclides. Sample totals and specific analysis parameters are outlined in Table III.6 for groundwater samples to be collected from proposed new monitoring wells at each well location. The initial sampling of Operable Unit 1 wells will be conducted under the Operable Unit 1 Quarterly Groundwater Sampling and Mapping Program. At a later date, as part of the Operable Unit 9 investigation, the newly installed Operable Unit 1 wells, along with all other monitoring wells, will be sampled twice for the full parameter list shown in the Operable Unit 9 Site-Wide Work Plan.

4.4. FIELD DATA COLLECTION METHODS

The description of methods for the collection of surface soil samples is presented in Mound Plant ER Program SOP 5.2, Soil Sampling with a Spade and Scoop. Methods used to describe the physical nature of consolidated or unconsolidated subsurface soils encountered during auger, rotary, or other drilling activities and the collection of subsurface soil samples are described in Mound Plant ER Program SOP 5.1, Soil and Rock Borehole Logging and Sampling.

To obtain reliable and accurate measurements of the field chemistry of groundwater, samples will be collected and analyzed according to guidelines presented in Mound Plant ER Program SOP 2.2, Field Measurements on Ground and Surface Water Samples (revision 2) (DOE 1991f). Groundwater samples from each new well will be collected for measurement of field parameters using a bladder pump or a bailer as outlined in Mound Plant ER Program SOP 2.3, Sampling Monitoring Wells with a Bladder Pump (revision 3), or SOP 2.4, Sampling Monitoring Wells with a Bucket-Type Bailer (revision 1) (DOE 1991f).

4.5. HEALTH AND SAFETY REQUIREMENTS

A detailed Health and Safety Plan outlining health and safety guidelines for this field effort is presented in Appendix C of this document.

5. AQUIFER TEST AND GROUNDWATER SAMPLING

An aquifer test is proposed to delineate the capture zone created by pumping well 0071 and determine how plume migration toward the Mound Plant production wells can be most efficiently controlled. This additional characterization at Area B is required to support risk assessment and remedial action design. Data acquired from the aquifer test will determine the proper positions and pumping rates of a well or wells that can minimize additional contamination to the Mound Plant production wells. Analysis of the data from the proposed aquifer test to better define transmissivity, storativity, and boundary conditions will be performed. Aquifer test data will be analyzed using the "Well Hydraulics Interpretation Program" (WHIP™) produced by Hydro Geo Chem, Inc. (Hydro Geo Chem 1988), and by the use of distance-drawdown graphs (Driscoll 1986). The pumped production well and select monitoring wells will be time-series sampled for the contaminants of concern during the pump test to better define possible contaminant transport.

5.1. SCOPING OF THE AQUIFER TEST

5.1.1. Introduction

An aquifer test will be performed to directly measure drawdown created by pumping 0071 at approximately 500 gpm. Another production well (0076) will be pumped concurrently at approximately 500 gpm for production of the Mound Plant water supply. A step drawdown test for preevaluation of pumping rates is not required due to past step drawdown and pumping tests. T and S values calculated from the 1990 aquifer test conducted at Mound Plant are considered representative but will be verified from values calculated for this aquifer test. Transmissivity values calculated from individual well responses ranged from 37,000 ft^2/d to 83,000 ft^2/d. Storativity values ranged from 0.04 to 0.24. Also, monitoring water levels at the new piezometers, which will be installed west of Area B, will improve the characterization of the relative volumes of water drawn from the north, east, and west when pumping Mound Plant production wells.

5.1.2. Aquifer Test

Presently, Mound Plant production well #2 (0271) is being pumped for the plant's potable water supply. Thirty days before the test Mound Plant production well #3 (0076) will be pumped and well #2 will be turned off. This will allow adequate time for the pumping effects of well 0271 to become negligible. Water samples will be collected at production well 0071 and monitoring wells 0063, 0305, 0306, 0375, and 0377 every ten days during the 30-day period to establish baseline contaminant concentrations.

Water levels will be monitored in select existing monitoring wells and piezometers located in and adjacent to Area B for a period of 15 days prior to initiating the aquifer test (Figure 5.1). Table V.1 indicates the water level instrument to be used and the frequency of measurement. Barometric pressures will be recorded from an onsite barometer before, during, and at the conclusion of the aquifer test. Great Miami River stage will also be monitored 15 days before the aquifer test to determine its effects on the local potentiometric surface. The water levels will be measured according to Mound Plant ER Program SOP 3.1, Water Level Measurement (revision 1) (DOE 1991f). Discharge will be routed to NPDES outfall 002 if treatment of the pumped water is not required. Water sampling frequency and criteria were negotiated with Ohio EPA with respect to discharge permit requirements (Spitler 1991). Weekly samples will be collected and analyzed for chlorinated hydrocarbons by EPA method 8010 and for total organic carbon (TOC) by methods 415.1 and 415.2. If a TOC increase of 25% or more occurs from the initial sample, Mound Plant shall contact the EPA Southwest District Office regarding continuation of the discharge. Permissible organic contaminant action levels will be established at 10 times the maximum contaminant level for each constituent. Volatilization of organic contaminants between pump discharge (sample collection point) and the Great Miami River and dilution of contaminants within the Great Miami River determined the organic contaminant action level. The samples will be analyzed at a laboratory that can provide EPA method analysis turnaround in less than a week.

The aquifer test is scheduled to last 30 to 40 days. Water levels will be measured using pressure transducers in monitoring wells 0063, 0154, 0155, 0305, 0306, 0307, 0309, 0317, 0353, 0380, 0381, 0382, 388, 393, 394, and 912, piezometers P001, P002, P003, P004, P005, P006, P007, P008, P009, P010, P011, P012, P013, P014, P015, P025, P026, P028, and Mound Plant production wells 0071, 0271, 0271, and 0076 (Figure 5.1) (Table V.1). The measurements will be recorded on electronic data loggers or another continuous monitoring device. Transducers will be calibrated according to Mound Plant ER Program SOP 3.3, Operational Check of Pressure Transducers Used in Measuring Water Levels in Wells (revision 1) (DOE 1991f). If pressure transducers cannot be used in the production wells, water level measurements will be taken 1 per day with a well sounder. Water levels in all continuously monitored aquifer test these wells and piezometers will also be measured once a day with a sounder along with monitoring wells 0118, 0129, 0152, 0313, and 0320 (Table V.1).

When water levels are measured, barometric pressure will also be recorded. River stage influences of the Great Miami River will be monitored by comparison of fluctuations of river gage height with fluctuations of static water levels in the monitoring wells and piezometers. The river gage will be installed under Operable Unit 9 at the outfall 001 bulkhead. Further installation details and measurement frequency are discussed in the Operable Unit 9 Field Sampling Plan (DOE 1992). In addition, daily precipitation totals will be monitored with a precipitation gauge onsite near Mound Plant production well 0071 and compared with changes in local static water levels.

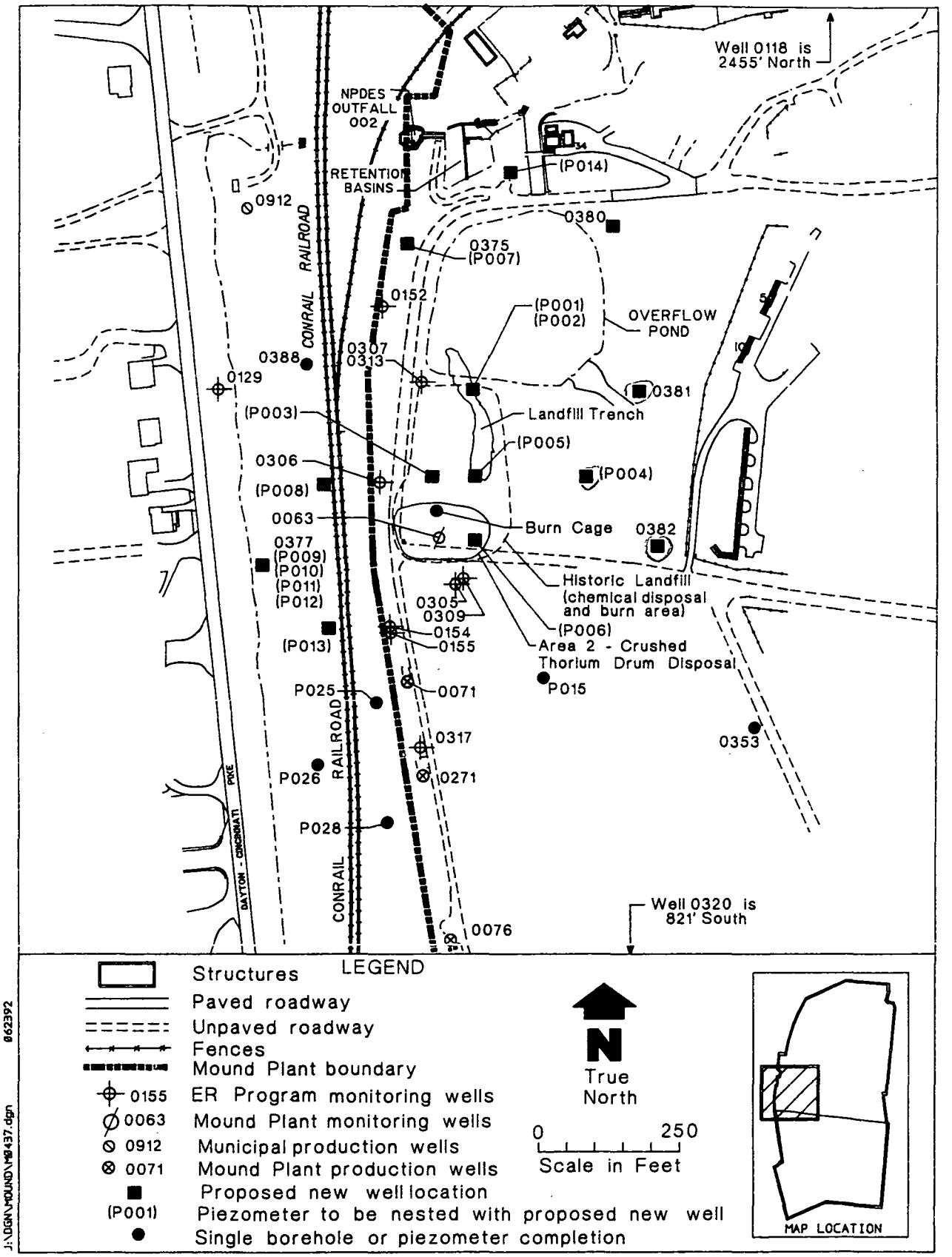


Figure 5.1. Wells and piezometers to be monitored during the aquifer test.

Table V.1. Aquifer Pumping Test Wells and Piezometers with Measuring Instrument, Frequency, and Rationale

Well/Piezometer	Water Level Measurement Instrument/Frequency	Rationale
0063	Data Logger - Transducer or Equivalent/Continuous	Use to determine pumping effects of 0071 in source area.
0071	Data Logger - Transducer or Equivalent/Continuous*	To determine drawdown in pumping well.
0076	Data Logger - Transducer or Equivalent/Continuous*	Use in conjunction with production well 0071 and monitoring well 0317 to define groundwater divide between production wells.
0118	Electric Sounder/Daily	To determine background water fluctuations in relationship to precipitation, river stage, etc.
0129	Electric Sounder/Daily	Use to determine radius of influence of 0071. Located west of source area and Mound Plant boundary.
0152	Electric Sounder/Daily	Use to determine radius of influence of 0071. Located west of source area within Mound Plant boundary.
0154	Data Logger - Transducer or Equivalent/Continuous	Use in conjunction with monitoring well 0155 to define vertical gradients near pump well 0071.
0155	Data Logger - Transducer or Equivalent/Continuous	Use in conjunction with monitoring well 0155 to define vertical gradients near pump well 0071.
0271	Data Logger - Transducer or Equivalent/Continuous	Use in conjunction with production wells 0071 and 0076 and monitoring well 0317 to define groundwater divide between pump wells.
0305	Data Logger - Transducer or Equivalent/Continuous	Use in conjunction with monitoring well 0309 to determine unconsolidated/bedrock relationship. Also determine pumping effects near source area.
0306	Data Logger - Transducer or Equivalent/Continuous	Use to determine extent of capture zone created by pumping 0071. Located between source and Mound Plant boundary.
0307	Data Logger - Transducer or Equivalent/Continuous	Use to determine pumping effects in source area.
0309	Data Logger - Transducer or Equivalent/Continuous	Use in conjunction with monitoring well 0305 to determine unconsolidated/bedrock relationship. Also determine pumping effects near source area.
0313	Electric Sounder/Daily	Use to determine pumping effects of 0071 in source area. Well 0307 will be monitored continually.
0317	Data Logger - Transducer or Equivalent/Continuous	Use in conjunction with production wells 0071, 0271, and 0076 to define groundwater divide between pump wells.
0320	Electric Sounder/Daily	Use to determine radius of influence of 0071.
0353	Data Logger - Transducer or Equivalent/Continuous	To determine bedrock aquifer characteristics and potential aquifer interconnection (OU 9 well).

Table V.I. (page 2 of 3)

Well/Piezometer	Water Level Measurement Instrument/Frequency	Rationale
0380	Data Logger - Transducer or Equivalent/Continuous	To determine bedrock aquifer characteristics and potential aquifer interconnection.
0381	Data Logger - Transducer or Equivalent/Continuous	To determine bedrock aquifer characteristics and potential aquifer interconnection.
0382	Data Logger - Transducer or Equivalent/Continuous	To determine bedrock aquifer characteristics and potential aquifer interconnection.
0388	Data Logger - Transducer or Equivalent/Continuous	Use to determine effects of pumping 0071 in transition zone.
0393	Data Logger - Transducer or Equivalent/Continuous	To determine bedrock aquifer characteristics and potential aquifer interconnection.
0394	Data Logger - Transducer or Equivalent/Continuous	To determine bedrock aquifer characteristics and potential aquifer interconnection.
0912	Data Logger - Transducer or Equivalent/Continuous	Use to determine radius of influence of 0071 in critical offsite location, downgradient of tributary valley.
P001	Data Logger - Transducer or Equivalent/Continuous	Use to determine 0071 pumping effects in historic trench potential source area. Use in conjunction with P002 to determine vertical gradient in potential source area.
P002	Data Logger - Transducer or Equivalent/Continuous	Use to determine 0071 pumping effects in historic trench potential source area. Use in conjunction with P001 to determine verification gradients in potential source area.
P003	Data Logger - Transducer or Equivalent/Continuous	Use to determine 0071 pumping effects in potential source area west of historic trench location.
P004	Data Logger - Transducer or Equivalent/Continuous	Use to determine radius of influence of 0071 in potential source area, south of SSL cocoon.
P005	Data Logger - Transducer or Equivalent/Continuous	Use to determine 0071 pumping effects in historic trench potential source area.
P006	Data Logger - Transducer or Equivalent/Continuous	Use to determine radius of influence of 0071 in potential source area, south of SSL cocoon.
P007	Data Logger - Transducer or Equivalent/Continuous	Use to determine radius of influence of 0071 west of Area B.
P008	Data Logger - Transducer or Equivalent/Continuous	Use to determine radius of influence of 0071 in transition zone.
P009	Data Logger - Transducer or Equivalent/Continuous	Use in conjunction with piezometers P010, P011, and P012 to calculate vertical gradients before, during, after pump test.
P010	Data Logger - Transducer or Equivalent/Continuous	Use in conjunction with piezometers P009, P010, P012 to calculate vertical gradients before, during, and after pump test.

Table V.I. (page 3 of 3)

Well/Piezometer	Water Level Measurement Instrument/Frequency	Rationale
P011	Data Logger - Transducer or Equivalent/Continuous	Use in conjunction with monitoring well 0155 to define vertical gradients near pump well 0071.
P012	Data Logger - Transducer or Equivalent/Continuous	Use in conjunction with piezometers P009, P010, P011 to calculate vertical gradient before, during, and after pump test.
P013	Data Logger - Transducer or Equivalent/Continuous	Use to determine radius of influence of 0071 in transition zone.
P014	Data Logger - Transducer or Equivalent/Continuous	Use to determine radius of influence of 0071 north of Area B.
P015	Data Logger - Transducer or Equivalent/Continuous	Use to determine boundary conditions east of 0071.
P025	Data Logger - Transducer or Equivalent/Continuous	Use to determine effects of pumping 0071 in transition zone.
P026	Data Logger - Transducer or Equivalent/Continuous	Use to determine effects of pumping 0071 in transition zone.
P028	Data Logger - Transducer or Equivalent/Continuous	Use to determine effects of pumping 0071 in transition zone.

*It is desired to use a continuous monitoring device. However, because of pump operations it may be impossible. In that case an electric sounder or equivalent will be used to monitor the water level once per day.

During the aquifer test time series sampling will be performed at well 0071 and monitoring wells 0063, 0305, 0306, 0375, and 0377 at time intervals specified in Table V.2. The samples will be analyzed for VOCs using EPA Method 8010/8020. Time series sampling will aid in defining Area B source areas and possible additional sources, and evaluating the response of the plume at the monitoring wells as a result of long-term pumping.

Analysis of the aquifer test data will be performed using the "Well Hydraulics Interpretation Program" (WHIP) produced by Hydro Geo Chem (Hydro Geo Chem 1989), and the use of distance-drawdown graphs (Driscoll 1986). WHIP uses a nonlinear least-squares algorithm to produce a best fit smooth curve to the observed drawdown/recovery data and then uses a numerical method of Laplace Transforms to approximate the Theis (Theis 1935) solution (Hydro Geo Chem 1988). Equations used in the WHIP modeling analysis are found in Carslan and Jaeger (1959). The algorithm has the capability to use variable pumping rate data to produce model drawdown curves that closely approximate observed drawdown curves. The distance-drawdown analysis uses the log-linear relationship of the distances between the pumping well and monitoring wells, and the drawdown in the monitoring wells (Driscoll 1986).

Upon conclusion and evaluation of the aquifer test data, it will be determined if production well 0071 can contain and capture the southern portion of the contaminant plume, thereby protecting the Mound Plant production well field. If an alternative or additional pump well is needed to protect the Mound Plant water supply wells, groundwater flow and solute transport modeling can be performed to optimize the location of the new well(s). The pumping test will improve the understanding of the groundwater hydraulics in the area, including better definitions of the hydraulic barrier to the east of Area B, and relative volumes of water drawn from the tributary valley north of Area B and the main portion of the BVA west of Area B. This information will facilitate a more efficient remedial action design.

Table V.2. Time Intervals for Sampling Production Well 0071 and Monitoring Wells 0063, 0305, 0306, 0375, and 0377 During the Aquifer Test

Time	Sample Number
Initiation of test	1
2 hours	2
4 hours	3
8 hours	4
12 hours	5
18 hours	6
1 day	7
2 days	8
3 days	9
4 days	10
6 days	11
8 days	12
10 days	13
15 days	14
20 days	15
25 days	16
30 days	17
40 days (or end of test)	18

6. *IN SITU* VOLATILIZATION SYSTEM

were based

Data obtained from the source characterization investigation (soil gas program, shallow soil sampling, piezometer, and monitoring well installations) ~~will~~ which were to be used to determine if VOCs are present in the vadose zone (and their location) in sufficient quantities to warrant the development of a removal action. These data are necessary to develop an efficient vadose zone remediation designed to decrease VOC concentrations in the source area.

If it is determined that a removal action is warranted, soil borings and an *in situ* volatilization (ISV) system trial are proposed at potential source areas. A description of proposed activities is summarized below. Because the activities are several phases away, the scope of the program will be sequentially re-evaluated and may be revised.

6.1. PROPOSED ACTIVITIES

A land survey will be conducted to define the historical location of the landfill trench as part of the Phase 1 soil gas survey. Four borings will be drilled for installation of an ISV treatment system trial. An additional four borings will be drilled for installation of vacuum gages, which will be used to evaluate the effectiveness of the trial and develop design criteria for an expanded ISV system. All boring locations will be based on Phase 1 soil gas analysis and will be terminated at the water table or capillary fringe.

Continuous core will be collected in all borings. The recovered core will be monitored with a PID or OVA immediately upon collection. Selected sections of core that have elevated PID or OVA readings will be collected and quantitatively analyzed for VOCs. Selected core samples believed to be from or directly under the trench, will be collected and submitted for laboratory analyses of VOCs.

Soil vents and vacuum gages will be installed in areas indicated by the soil gas, PID or OVA, and VOC soil sampling results. Suitable valving and piping, a power supply, and a blower will be installed to operate the ISV system.

As stated above, the french drains are going to be tested by soil gas sampling and analysis. If sufficient VOCs are detected to make an ISV trial effective, the french drains could be incorporated into the ISV system.

Two of the existing french drains will be exposed and a vent installed in each if soil gas results indicate elevated concentrations of VOCs. A clay (glacial till) backfill will be emplaced and compacted around

each vent. The vents will be connected from the french drains to the ISV system. The system operation will be monitored to determine if the removal action is feasible. If VOCs are present, the removal action will be continued.

7. REFERENCES

ASTM. 1988. Annual Book of ASTM Standards. Volume 0.408, Soil and Rock, Building Stones; Geotextiles. American Society for Testing and Materials, Philadelphia, Pennsylvania.

ATSDR. 1987. "Toxicological Profile for Tetrachloroethylene [DRAFT]." Prepared by Oak Ridge National Laboratory for the Agency for Toxic Substances and Disease Registry."

ATSDR. 1988. "Toxicological Profile for Trichloroethylene [DRAFT]." Prepared by Oak Ridge National Laboratory for the Agency for Toxic Substances and Disease Registry."

Barrio-Lage, G., F. Z. Parson, R. S. Nassar, and P. A. Larenzo. 1986. "Sequential Dehalogenation of Chlorinated Ethenes." *Environmental Science and Technology* 20(1):96-99.

Carslaw, H. S., and J. C. Jaeger. 1959. *Conduction of Heat in Solids, 2nd Edition*. Oxford University Press, Oxford, Great Britain. 1959.

CFR. 1989. "Hazardous Materials Tables, Hazardous Materials Communications Requirements and Emergency Response Information Requirements," and "Shippers General Requirements for Shipments and Packaging." Title 49, Code of Federal Regulations, Parts 172 and 173. Research and Special Program Administration, U.S. Department of Transportation. October 1, 1989.

Cherry, John A. 1991. "A Twenty-Five Point Synopsis of the DNAPL Paradigm and Implications." *Chlorinated Solvents in the Subsurface*. University Consortium Solvents in Groundwater Program, University of Waterloo, Colorado State University, and Oregon Graduate Institute, Denver, Colorado. June 17-19, 1991.

Clement Associates. 1985. "Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites." Final report prepared for the U.S. Environmental Protection Agency. Clement Associates, Inc., 1515 Wilson Blvd., Arlington, Virginia. September 1985.

Cline, P. V., and D. R. Viste. 1985. "Migration and Degradation Patterns of Volatile Organic Compounds." *Waste Management and Research* 3:351-60.

COE. 1970. "Engineering and Design Laboratory Soils Testing." Department of the Army, U.S. Army Corps of Engineers, Engineers Manual EM1110-2-1906, Appendix A, Washington, D.C. November 30, 1970. Includes Change 1 dated May 1, 1980 and Change 2 dated August 20, 1986.

Concawe. 1979. Protection of Groundwater from Oil Production.

DOE. 1983. "EML Procedures Manual HASL-300." U.S. Department of Energy, Environmental Measurements Laboratory, 26th edition, 1983.

DOE. 1987a. "Phase 2: Mound Installation Generic Monitoring Plan/Site Specific Monitoring Plan [DRAFT]." U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico. January, 1987.

DOE. 1987b. "Phase 2: Installation Generic Monitoring Plan/Site Specific Monitoring Plan - Stage 2 Supplement Mound [DRAFT]." U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico. September, 1987.

DOE. 1989. "Remedial Investigation Mound Plant, Task AL-MD-1, Groundwater Stage 3 Supplement [DRAFT]." U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico. February, 1989.

DOE. 1990a. "Preliminary Results of Reconnaissance Magnetic Survey of Mound Plant Areas 2, 6, 7, and C." Letter report prepared for Department of Energy, Albuquerque Operations Office, by Roy F. Weston, Inc., Albuquerque, New Mexico. November, 1990.

DOE. 1990b. "Remedial Investigation/Feasibility Study, Operable Unit 9, Site-Wide Work Plan, Mound Plant, Miamisburg, Ohio. [DRAFT]." Environmental Restoration Program, U.S. Department of Energy, Albuquerque Operations Office. April 1990.

DOE. 1990c. "Letter Report: Production Well Field Solute Transport Simulations, Mound Plant [DRAFT]." Environmental Restoration Program, U.S. Department of Energy, Albuquerque Operations Office. December 1990.

DOE. 1990d. "Radiation Protection of the Public and the Environment," DOE Order 5400.5. U.S. Department of Energy, Office of Environment, Safety and Health, Washington, D.C. February 8, 1990.

DOE. 1990e. "Letter Report: Preliminary Results of Reconnaissance Magnetic Survey." Environmental Restoration Program, U.S. Department of Energy, Albuquerque Operations Office. November 1990.

DOE. 1991a. "Area B, Operable Unit 1, DOE Mound Plant, History of Area B [DRAFT]." Environmental Restoration Program, U.S. Department of Energy, Albuquerque Operations Office. February 1991.

DOE. 1991b. "Operable Unit 9, Site Scoping Report, Volume 8 - Environmental Monitoring Data: 1976-1989 [DRAFT]." Environmental Restoration Program, U.S. Department of Energy, Albuquerque Operations Office. May 1991.

DOE. 1991c. "Area B, Operable Unit 1 Technical Memorandum, History of Area B [Draft]." U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico. January 1991.

DOE. 1991d. "Area B, Operable Unit 1 Technical Memorandum 2: Extent of Contamination - Soils [DRAFT]." Environmental Restoration Program, U.S. Department of Energy, Albuquerque Field Operations Office. March 1991.

DOE. 1991e. "Operable Unit 1, Area B Technical Memorandum 3: Hydrogeology/Groundwater Contamination [DRAFT]." Environmental Restoration Program, U.S. Department of Energy, Albuquerque Operations Office. April 1991.

DOE. 1991f. "Standard Operating Procedures." Mound Plant, Environmental Restoration Program, U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico, January 1991.

DOE. 1991g. "Remedial Investigation/Feasibility Study, Operable Unit 9, Site-Wide Field Sampling Plan Mound Plant, Miamisburg, Ohio [DRAFT] (Revision 2)." Environmental Restoration Program, U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico, and Environmental Restoration Program, Technical Support Office, Los Alamos National Laboratory, Los Alamos, New Mexico. June 1991.

DOE. 1991h. "Operable Unit 9, Site Scoping Report Volume 7 - Photo History Report [DRAFT]." Environmental Restoration Program, U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico. May 1991.

DOE. 1991i. "Operable Unit 9, Site Scoping Report Volume 7: Waste Management [DRAFT]." Environmental Restoration Program, U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico. November 1991.

DOE. 1991j. "Operable Unit 1, Area B Technical Memorandum Related to the Baseline Risk Assessment (4d): Risk Characterization." U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico. May 1991.

DOE. 1991k. "Operable Unit 9, Site Scoping Report Volume 3 - Radiological Site Survey [DRAFT]." Environmental Restoration Program, U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico. April 1991.

DOE. 1991l. Standard Operating Procedure 1.15, Guide to Waste Management. Mound Plant, Environmental Restoration Program, U.S. Department of Energy, Albuquerque Field Office, Albuquerque, New Mexico, November 1991.

DOE. 1991m. "Operable Unit 9, Site-Wide Remedial Investigation Quality Assurance Project Plan (Draft)." U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico, November 1991.

DOE. 1992. "Operable Unit 9, RI/FS Site-Wide Work Plan, Field Sampling Plan." Environmental Restoration Program, U.S. Department of Energy, Albuquerque Field Office. May, 1992.

Draper, D.G. 1988. "Rapid Screening of Soil for Radioactivity." Technology Update - 88. Monsanto Research Corporation. July 1988.

Driscoll, F.G. 1986. Groundwater and Wells, 2nd Edition. Johnson Filtration Systems, Inc., St. Paul, Minnesota. 1986.

Eisenbud, M. 1987. Environmental Radioactivity: From Natural, Industrial, and Military Sources. 3rd ed. Academic Press, Inc. Orlando, Florida.

EPA. 1980. "Prescribed Procedures for Measurement of Radioactivity in Drinking Water." U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, EPA-600/4-80-032. August 1980.

EPA. 1983. "Methods for Chemical Analysis of Water and Wastes." U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, EPA-600/4-79-020. Revised March 1983.

EPA. 1986. "Test methods for Evaluating Solid Waste, Physical/Chemical Methods." U.S. Environmental Protection Agency, SW-846, 3rd edition. November 1986.

EPA. 1988a. "U.S. Environmental Protection Agency Contract Laboratory Program, Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration." U.S. Environmental Protection Agency, SOW 2/88 including revisions 9/88 and 6/89 or most recent versions. February 1988.

EPA. 1988b. "U.S. Environmental Protection Agency Contract Laboratory Program, Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration." U.S. Environmental Protection Agency, SOW 2/88 including revisions 9/88 and 6/89 or most recent versions. February 1988. Pesticides/PCBs will be analyzed according to Contract Laboratory Program SOW Document No. OLM01.0, including revisions 0.1 (December 1990) and 0.2 (January 1991).

EPA. 1988c. "U.S. Environmental Protection Agency Contract Laboratory Program, Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration." U.S. Environmental Protection Agency, SOW 7/88 including revisions 2/89 and 6/89 or most recent versions. July 1988.

Garten, C. T. 1978. "A Review of Parameter Values Used to Assess the Transport of Plutonium, Uranium, and Thorium in Terrestrial Food Chains." *Environmental Res* 17:437-452.

Hebb, J. L. 1970. Memo to D. R. Storey describing burning practices within Area B. March 17, 1990.

Hydro Geo Chem, Inc. 1988. "WHIP™: Well Hydraulics Interpretation Program, Users Manual," Version 3.22, Tucson, Arizona. July 1988.

ITC. 1987. "Water and Sediment Sampling/Analysis U.S. DOE-Mound Run-Off Ponds [FINAL REPORT]." Prepared for Monsanto Research Corporation. July 13, 1987.

Johnson, Rick. 1991. "Dissolution of DNAPLs and Related Plume Behavior." *Chlorinated Solvents in the Subsurface*. University Consortium, Solvents in Groundwater Program, Oregon Graduate Institute, Denver, Colorado. June 17-19, 1991.

Kaplan, E., S. Banerjee, D. Ronen, M. Magaritz, A. Machlin, M. Sosnow, and E. Koglin. 1991a. Multilayer Sampling in the Water-Table Region of a Sandy Aquifer." *Ground Water*. Volume 29. Number 2. pp. 191-198. March-April 1991.

Kloepfer, R. D., C. J. Wurrey, P. M. Easley, B. B. Haas, Jr., D. E. Jackson, and T. G. Deihl. 1985. "Anaerobic Degradation of Trichloroethylene in Soil." *Environmental Science and Technology* 19(3):277-280.

LaFlamme, B. D. and J. W. Murray. 1987. "Solid/Solution Interaction: the Effect of Carbonate Alkalinity on Absorbed Thorium." *Geochim Comochim Act* 51:243-250.

NCRP. 1979. "Tritium in the Environment." National Council on Radiation Protection and Measurements, Report No. 62. Washington, D.C. Issued March 9, 1979.

NWWA. 1989. Introduction to Ground Water Geochemistry short course.

Payne, J. R., and C. R. Phillips. 1985. Petroleum Spills in the Marine Environment. Lewis Publishers. Chelsea, MI.

Platford, R. F. and S. R. Joshi. 1987. "The Chemistry of Uranium and Related Radionuclides in Lake Ontario Waters." *Journal of Radioanalytical Nuclear Chemistry* 106:333-344.

Ronen D., M. Magaritz, and F. J. Molz. 1990. "Comparison Between Natural and Forced Gradient Tests to Determine the Vertical Distribution of Horizontal Transport Properties of Aquifers" (unpublished). Contribution No. 8, Department of Environmental Sciences and Energy Research, The Weizman Institute of Science.

Ryan, B. G. and J. L. Hebb, Memo to J. L. Ricks and D. R. Storey describing burning practices in Area B. November 9, 1990.

Schwille, F. 1988. "Dense Chlorinated Solutions in Porous and Fractured Media, Model Experiments." Lewis Publishers.

Spitler, J. P. 1991. Letter to Art Kleinrath dated December 5, 1991, from OEPA Southwest District Office.

Sueberling, W. E. 1965. Memo from W. Sueberling to V. C. Vespe describing procedureal requirements regarding air pollution control permits for federal facilities. October 20, 1965.

Theis, C.V. 1935. "The Lowering of the Piezometric Surface and the Rate and Discharge of a Well Using Ground-water Storage." Transactions of the American Geophysical Union 16: 519-24.

Torstenfeelt, B. 1986. "Migration of the Actinides, Thorium, Protactinium, Uranium, Neptunium, Plutonium, and Americium in Clay." *Radiochem Acta* 39:105-112.

Weast, R. C., ed. 1983. "CRC Handbook of Chemistry and Physics." 64th ed. CRC Press, Inc., Boca Raton, Florida.

WESTON. 1991. "ER Program, Mound Plant Protocols for Waste Management." Letter from Michael P. Mauzy, Roy F. Weston, Inc., to Kenneth Rea, University of California, Los Alamos National Laboratory, Los Alamos, New Mexico. Letter dated August 13, 1991.

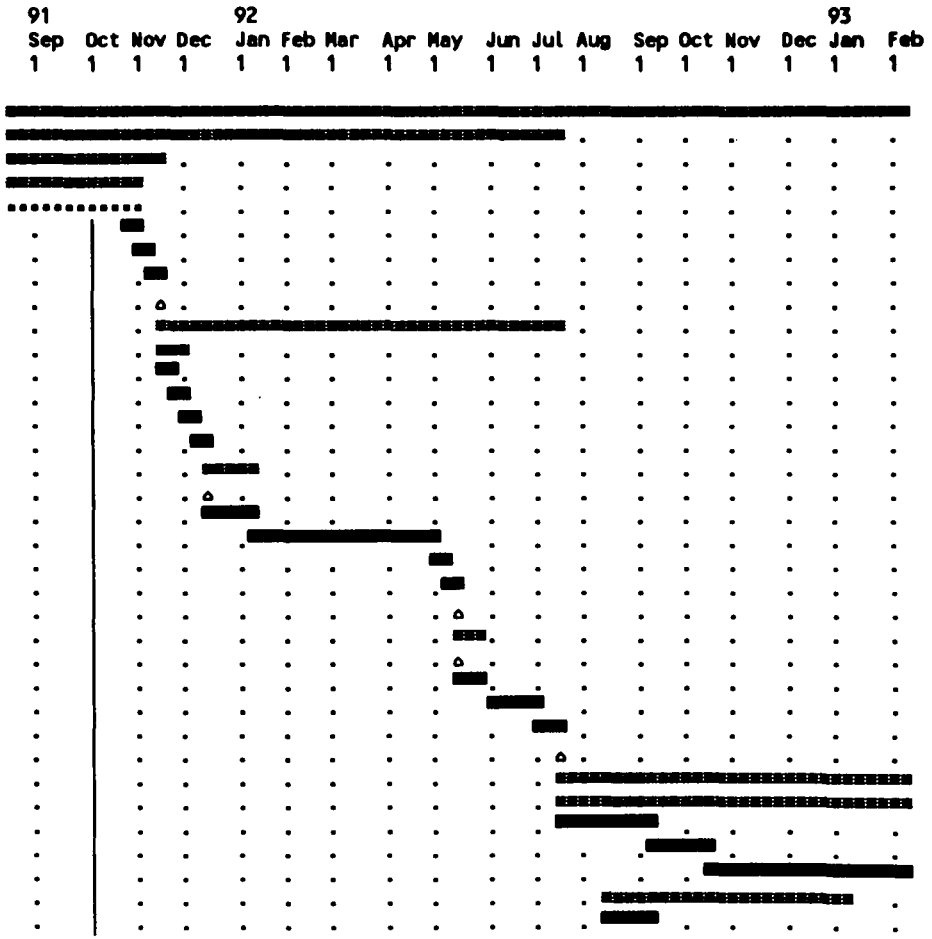
Wilson, J. T., and T. S. H. Wilson. 1985. "Biotransformation of Trichloroethylene in Soil." *Applied and Environmental Microbiology* (January 1985): pp. 242-43.

APPENDIX A

MOUND PLANT AREA B
SCHEDULE

Schedule Name : MOUND AREA B PAW
Responsible : EG&G MOUND/LANE METCALF
As-of Date : 1-Oct-91 Schedule File : F:\DATA\TL4\ERMR\92LOCKED\92MND\OU1PAW
Printed : 16-Apr-92 8:26am

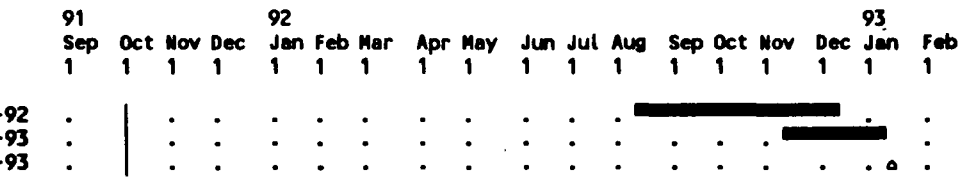
Task Name	Start Date	Duratn (Days)	End Date
RI ADD'L FIELD WORK	12-Aug-91	548	9-Feb-93
PREPARE WORK PLAN	12-Aug-91	338	14-Jul-92
PREPARATION STEP	12-Aug-91	93	12-Nov-91
PREPARE WORK PLAN (WP)	12-Aug-91	83	2-Nov-91
PREPARE WORK PLAN (WP) FY91	12-Aug-91	83	2-Nov-91
CONTR. SENIOR REVIEW	27-Oct-91	7	2-Nov-91
PRODUCTION	2-Nov-91	8	9-Nov-91
DISTRIBUTE WORKING DRAFT	10-Nov-91	3	12-Nov-91
DELIVER WORKING DRAFT WP	13-Nov-91	0	13-Nov-91
REVIEW STEP	13-Nov-91	245	14-Jul-92
DOE REVIEW	13-Nov-91	16	28-Nov-91
REVIEW	13-Nov-91	8	20-Nov-91
RESPOND TO COMMENTS	21-Nov-91	8	28-Nov-91
PRODUCTION	29-Nov-91	8	6-Dec-91
DISTRIBUTE TO EPA	7-Dec-91	3	9-Dec-91
REGULATORY REVIEW CYCLE	10-Dec-91	33	11-Jan-92
DELIVER DRAFT WP	10-Dec-91	0	10-Dec-91
REGULATORY REVIEW	10-Dec-91	33	11-Jan-92
RESPOND TO COMMENTS	12-Jan-92	110	30-Apr-92
PRODUCTION/REVIEW	1-May-92	8	8-May-92
DAO DIST/DRAFT FINAL	9-May-92	3	11-May-92
RESPONSE COMPLETE	12-May-92	0	12-May-92
REGULATORY APPROVAL CYCLE	12-May-92	20	31-May-92
DELIVER DRAFT EPA	12-May-92	0	12-May-92
REGULATORY REVIEW	12-May-92	20	31-May-92
RESPOND TO COMMENTS	1-Jun-92	30	30-Jun-92
REGULATORY APPROVAL	1-Jul-92	14	14-Jul-92
REGULATORY APPROVAL RECEIVED	15-Jul-92	0	15-Jul-92
RI FIELD WORK	15-Jul-92	210	9-Feb-93
CONDUCT FIELD WORK	15-Jul-92	210	9-Feb-93
SOIL GAS	15-Jul-92	60	12-Sep-92
MONITOR WELL INSTALLATION	13-Sep-92	30	12-Oct-92
PUMP TEST	13-Oct-92	120	9-Feb-93
ADDITIONAL SAMPLING	14-Aug-92	150	10-Jan-93
SOIL SAMPLING	14-Aug-92	30	12-Sep-92



Detail Task — Summary Task — Baseline
(Progress) — (Progress) — Conflict
(Slack) — (Slack) — Resource delay
Progress shows Percent Achieved on Actual — Milestone
Scale: 7 days per character

Schedule Name : MOUND AREA B PAW
Responsible : EG&G MOUND/LANE METCALF
As-of Date : 1-Oct-91 Schedule File : F:\DATA\TL4\ERMR\92LOCKED\92MND\OU1PAW
Printed : 16-Apr-92 8:26am

Task Name	Start Date	Duratn (Days)	End Date
CONDUCT SAMPLE ANALYSIS	14-Aug-92	120	11-Dec-92
DATA VALIDATION	12-Nov-92	60	10-Jan-93
RI FIELD WORK COMPLETE	11-Jan-93	0	11-Jan-93



Detail Task — Summary Task — Baseline
(Progress) — (Progress) — Conflict
(Slack) — (Slack) — Resource delay
Progress shows Percent Achieved on Actual — Milestone
Scale: 7 days per character

ENVIRONMENTAL RESTORATION PROGRAM

REMEDIAL INVESTIGATION
OPERABLE UNIT 1, AREA B
QUALITY ASSURANCE PROJECT PLAN

MOUND PLANT
MIAMISBURG, OHIO

September 1992

DEPARTMENT OF ENERGY
ALBUQUERQUE FIELD OFFICE

ENVIRONMENTAL RESTORATION PROGRAM
TECHNICAL SUPPORT OFFICE
LOS ALAMOS NATIONAL LABORATORY

FINAL
(REVISION 0)

OPERABLE UNIT 1, AREA B REMEDIAL INVESTIGATION

PROPOSAL FOR ADDITIONAL WORK

QUALITY ASSURANCE PROJECT PLAN

U.S. DEPARTMENT OF ENERGY, MOUND PLANT

MIAMISBURG, OHIO

Approved by _____ Date 9/8/92
U.S. EPA Region V Remedial Project Manager

Approved by _____ Date 9/4/92
DOE Dayton Area Office Remedial Project Manager

Approved by C. S. Spiedman Date 9/2/92
ER Program Manager, Mound Plant

CONTENTS

1. INTRODUCTION 1-1
   1.1. OVERVIEW 1-1
   1.2. ENVIRONMENTAL RESTORATION PROGRAM DESCRIPTION 1-2
   1.3. MOUND PLANT ER PROGRAM 1-2
   1.4. PROJECT DESCRIPTION 1-2

2. PROJECT ORGANIZATION AND RESPONSIBILITY 2-1

3. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA IN TERMS OF PRECISION, ACCURACY, COMPLETENESS, REPRESENTATIVENESS, AND COMPARABILITY 3-1

4. SAMPLING PROCEDURES 4-1
   4.1. GENERAL PROCEDURES FOR SAMPLING 4-1
   4.2. GROUNDWATER SAMPLING 4-1
   4.3. SOIL/SEDIMENT SAMPLING 4-7
   4.4. SOIL GAS SAMPLING 4-7
   4.5. AQUIFER TEST SAMPLING 4-7
   4.6. OTHER FIELD ACTIVITIES 4-8
   4.7. SUMMARY OF SAMPLING ACTIVITIES 4-8

5. SAMPLE CUSTODY 5-1

6. ANALYTICAL PROCEDURES 6-1
   6.1. FIELD MEASUREMENTS AND SCREENING 6-1
      6.1.1. Methane, Oxygen, and Carbon Dioxide 6-1
      6.1.2. Soil Gas Analysis 6-1
      6.1.3. Pressure Measurements 6-11
   6.2. LABORATORY ANALYTICAL METHODS 6-11
      6.2.1. Radiological Methods 6-11
      6.2.2. Dioxin/Furan 6-12
      6.2.3. Total Porosity, Triaxial Permeability, Capillary Moisture Curves, Atterburg Limits, Bulk Density, and Bacterial Culturals 6-12

7. CALIBRATION PROCEDURES AND FREQUENCY 7-1
   7.1. GAS ANALYZER 7-1
   7.2. GAS CHROMATOGRAPHY FOR SOIL GAS ANALYSES 7-1
   7.3. GAS CHROMATOGRAPHY/MASS SPECTROMETRY FOR DIOXIN/FURAN ANALYSES 7-1

8. INTERNAL QUALITY CONTROL CHECKS 8-1
   8.1. SCREENING AND FIELD MEASUREMENTS 8-1
   8.2. FIELD SAMPLING 8-1
   8.3. LABORATORY ANALYSES 8-1

9. DATA REDUCTION, VALIDATION, AND REPORTING 9-1

10. PERFORMANCE AND SYSTEM AUDITS 10-1

12. SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS 12-1

13. CORRECTIVE ACTION PROTOCOLS 13-1

14. QUALITY ASSURANCE REPORTS TO MANAGEMENT 14-1

15. REFERENCES 15-1

ATTACHMENT A STANDARD OPERATING PROCEDURES

APPENDIX A VOLATILE ORGANIC SAMPLING AND ANALYSES IN SOIL GAS, SOILS, WATER, AND ATMOSPHERE BY MODIFIED EPA 8021 HYDROGEO CHEM, INC.

TABLES

I.1. Summary of Analytical Levels for Field and Laboratory Parameters 1-3
III.1. Summary of Quality Control Procedures for Field Measurements 3-2
III.2. Summary of Quality Control Procedures for Field Activities and Laboratory Measurements: Groundwater and Soil Samples 3-4
III.3. Laboratory Advisory Limits for Matrix Spikes and Matrix Spike Duplicates: Water and Soil Samples 3-7
IV.1. Mound Plant ER Program SOPs Applicable to Operable Unit 1 4-2
IV.2 Operable Unit 1 Field Sampling Identification Plan 4-3
IV.3. Sample Containers, Volumes, Preservation, and Holding Times: Groundwater Samples 4-4
IV.4. Sample Containers, Volumes, Preservation, and Holding Times: Soil Sediment Samples 4-5
IV.5. Summary of Sampling and Analysis Program - Operable Unit 1 4-9
VI.1. Analytical Methods, Parameters, and Quantitation Limits for Surface Water/Groundwater and Soil/Sediment Samples 6-2

ACRONYMS

ASTM	American Society for Testing Materials
CLP	Contract Laboratory Program
CN	cyanide
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration (Program)
HPLC	high-performance liquid chromatography
MS	mass spectrometry
MSD	matrix spike duplicate
PCB	polychlorinated biphenyl
PQL	practical quantitation limit
QAPP	Quality Assurance Project Plan
QAM	quality assurance manager
QAO	quality assurance officer
QA/QC	quality assurance/quality control
RSD	relative standard deviation
RPD	relative percent difference
SOP	Standard Operating Procedure
TAL	Target Analyte List
TCL	Target Compound List
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
VOC	volatile organic compound

1. INTRODUCTION

1.1. OVERVIEW

Quality assurance is a system of measures taken to ensure that a desired product meets a defined level of quality. This Quality Assurance Project Plan (QAPP) presents the system of quality assurance to be implemented for the Operable Unit 1 Proposal for Additional Work at the Mound Plant. The plan provides specific procedures that delineate how field and laboratory data of known and accepted quality will be generated.

A system of quality assurance consists of two elements: quality control and quality assessment. Quality control is a system of procedures performed to control the quality of the product, usually with defined standards of performance for those procedures. Quality assessment is a program of activities to evaluate the performance of implemented quality control procedures and the quality of the product.

This QAPP describes the quality control procedures for sampling activities (sampling procedures in section 4 and sample custody in section 5), for field screening and field measurements (section 6), and for laboratory analyses (section 6). Specific quality control steps, defined as quality control checks, for these activities are discussed in section 8. The standards of performance, defined as acceptance criteria, for these checks are presented in section 3. Quality control procedures for calibration of field and laboratory instrumentation are outlined in section 7. The procedures for data reduction, validation, and reporting are included in section 9. As part of the quality control program, preventive maintenance procedures for equipment and instrumentation are summarized in section 11. Corrective actions for the planned field and laboratory activities are necessary for a quality control program in order to keep the quality of generated data under control. The corrective actions for these activities are provided in section 13.

Quality assessment activities for this investigation include evaluation of field and laboratory quality control data, performance and system audits, and issuing of quality assurance reports to management. Procedures for these activities are described in sections 12, 10, and 14, respectively.

In fulfilling its role of ensuring that the goals of the project are met, the quality assurance program relies on the structure of the project organization and on the effectiveness of key individuals in carrying out their responsibilities. This report describes the project organization and identifies the individuals

who are responsible for assessing the collection and generation of data and for ensuring that these data are of defined quality (section 2).

The technical content for most of the elements of the Operable Unit 1 QAPP is contained within the Mound Plant, Operable Unit 9, Remedial Investigation, Site-Wide QAPP (DOE 1992). To eliminate unnecessary duplication and ensure the uniform application of quality assurance/quality control (QA/QC) activities at Mound Plant, the Operable Unit 1 QAPP references, where applicable, the Operable Unit 9, Site-Wide QAPP. In areas where the Operable Unit 1 QAPP differs from the Operable Unit 9, Site-Wide QAPP, the information and/or procedures pertinent to the Operable Unit 1 program are identified and addressed.

1.2. ENVIRONMENTAL RESTORATION PROGRAM DESCRIPTION

The description of the Environmental Restoration (ER) Program is provided in subsection 1.2 of the Operable Unit 9, Site-Wide QAPP and applies to the Operable Unit 1 QAPP as presented.

1.3. MOUND PLANT ER PROGRAM

The Mound Plant ER Program is described in subsection 1.3 of the Operable Unit 9, Site-Wide QAPP and applies to the Operable Unit 1 QAPP as presented.

1.4. PROJECT DESCRIPTION

The Operable Unit 1 investigation consists of two distinct tasks:

1. Quarterly groundwater sampling (executed separately) (DOE 1991), and
2. Additional sampling and analysis as presented in sections 3, 4, 5, and 6 of this Operable Unit 1 Proposal for Additional Work.

Both documents provide the current understanding of existing data, data needs, site setting, and work plan rationale, including the design of the sample network for this investigation.

Parameters to be analyzed in the field and laboratory for this investigation are listed in Table I.1. The selected laboratory methods of analysis are either based on the U.S. Environmental Protection Agency's (EPA's) Contract Laboratory Program (CLP) (EPA 1990a; EPA 1990b), where appropriate, or on approved and known methodologies, where available.

Table I.1. Summary of Analytical Levels for Field and Laboratory Parameters

Task	Purpose	Media	Field Parameters	Laboratory Parameters	Analytical Levels
Initial groundwater monitoring of wells installed under PAW.	Quantitatively assess nature and extent of groundwater contamination in newly installed wells.	Groundwater	Temperature		II
			pH		II
			Specific conductivity		II
			Dissolved oxygen		II
			Alkalinity		II
			Redox potential		II
			Water level		I
				VOCs	IV
				TCL semivolatile organic compounds	IV
				TCL pesticide/PCBs	IV
				TAL metals or cations	IV
				Gamma spectroscopy	V
				Isotopic plutonium	V
				Isotopic thorium	V
				Isotopic uranium	V
				Strontium-90/yttrium-90	V
				Americium-241	V
				Radium-226	V
				Chloride	IV
				Sulfate	IV
				Nitrate/nitrite	IV
				Tritium	V
				Dioxin/Furan	IV
Soil sampling during monitoring well installation	Determine nature and extent of contamination	Subsurface soils	Lithologic logs		I
			Well completion data		I
				VOCs	IV
				TCL semivolatile organic compounds	IV
				TCL Pesticide/PCBs	IV
				TAL metals	IV
				Isotopic plutonium	V
				Isotopic thorium	V
				Isotopic uranium	V

Table I.1. (page 2 of 3)

Task	Purpose	Media	Field Parameters	Laboratory Parameters	Analytical Levels
Soil sampling during monitoring well installation (cont.)				Gamma spectroscopy	V
				Tritium	V
				Bismuth	IV
				Nitrate/nitrite	IV
				Fluoride	IV
				Sulfate	IV
				Chloride	IV
				Alkalinity	III
				Soil pH	III
				Total organic carbon	III
				Dioxin/furan	IV
				Lithium	IV
				Strontium-90/yttrium-90	V
Surface soil sampling of suspected areas of contamination	Determine nature and horizontal extent of contamination	Surface soils		VOCs	IV
				TCL semivolatile organic compounds	IV
				TCL pesticide/PCBs	IV
				TAL metals	IV
				Isotopic plutonium	V
				Isotopic thorium	V
				Isotopic uranium	V
				Gamma spectroscopy	V
				Tritium	V
				Soil pH	III
				Alkalinity	III
				Total organic carbon	III
				Nitrate/nitrite	IV
				Chloride	IV
				Sulfate	IV
				Fluoride	IV
				Strontium-90/yttrium-90	V
				Bismuth	IV
Characterization of regional soil units	Understand the geotechnical characteristics to provide data for contaminant transport modeling	Subsurface soils	Well completion data		I

Table I.1. (page 3 of 3)

Task	Purpose	Media	Field Parameters	Laboratory Parameters	Analytical Levels
Characterization of regional soil units (cont.)				Particle size analysis	III
				Clay mineralogy	III
				Organic content	III
				Moisture content	III
				Bulk density	III
				Total porosity	III
				Triaxial permeability	III
				Atterburg limits	III
				Capillary moisture	III
				Iron	IV
				Manganse	IV
				Bacterial culture	II
Aquifer tests - Pretest and time series	Determination of migration pathway of contaminants and proximity of source	Groundwater	Temperature		II
			pH		II
			Specific conductivity		II
			Dissolved oxygen		II
			Alkalinity		II
			Redox potential		II
			Water level		I
				VOCs	IV
Aquifer tests - Discharge water requirements	To meet NPDES discharge requirements	Groundwater		Purgeable halocarbons	IV
				TOC	III
Soil gas survey	Qualitative analysis used to optimize borehole, piezometer, and monitor well locations	Subsurface soil gas	Trichloroethene		II
			1,2-*trans*-Dichloroethene		II
			1,1,1-Trichloroethane		II
			Tetrachloromethane		II
			Trichloromethane		II
			Chloroethene		II
			2-Butanone		II
			Benzene		II
	Determination of landfill characteristics	Subsurface soil gas	Methane		II
			Carbon dioxide		II
			Oxygen		II
			Pressure		II

PCB - polychlorinated biphenyl
Redox - oxidation reduction
TAL - Target Analyte List
VOC - volatile organic compound

Objectives for data quality are discussed in the following sections of this QAPP. However, analytical levels, as defined by the EPA's "Data Quality Objectives for Remedial Response Activities" (EPA 1987), may be assigned to the planned analyses. These analytical levels were designed by the EPA to serve as guidance for obtaining data of appropriate quality for their intended use. The analytical levels for each parameter group are presented on Table I.1 for each task. The purpose for data collection and the media to be investigated for each task are also included on the table.

2. PROJECT ORGANIZATION AND RESPONSIBILITY

The project organization of the DOE ER Program for the Mound Plant and the responsibilities of individuals for operations, field teams, laboratories, and quality assurance are defined in section 2 of the Operable Unit 9, Site-Wide QAPP. In addition, specific responsibilities for the Operable Unit 1 program are the following:

- The WESTON site manager for Operable Unit 1 is William Little. The site manager's responsibilities are defined in subsection 2.1 of the Operable Unit 9, Site-Wide QAPP.
- The sampling team leaders (field team leaders) for Operable Unit 1 will be identified for each separate portion of the field work. The sampling team leader's responsibilities are identical to those described for the field team leader in subsection 2.2 of the Operable Unit 9, Site-Wide QAPP. The other field positions will be identified by the sampling team leaders.
- Individual team leaders will be identified for
  - soil gas survey,
  - soil sampling,
  - piezometer and monitoring well installation,
  - aquifer testing; and
  - groundwater sampling and analysis.

3. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA IN TERMS OF PRECISION, ACCURACY, COMPLETENESS, REPRESENTATIVENESS, AND COMPARABILITY

The overall quality assurance objectives for field sampling, field measurements, and laboratory analysis are to produce data of known and sufficient quality to support the site evaluation and the selection of remedial alternatives. Appropriate procedures and quality control checks will be used so that known and acceptable levels of accuracy and precision are maintained for each data set. Section 3 of the Operable Unit 9, Site-Wide QAPP defines the objectives (goals) for accuracy, precision, completeness, representativeness, and comparability for measurement data. These goals are primarily expressed in terms of acceptance criteria for the quality control checks performed.

The field parameters and test methods for field screening and measurements for the Operable Unit 1 investigation are listed in Table III.1. The quality control checks addressed in Table III.1 of the Operable Unit 9 QAPP for these parameters are applicable to the Operable Unit 1 QAPP. Additional field parameters for the Operable Unit 1 investigation include soil gas analyses for selected volatile organic compounds and measurements for carbon dioxide, oxygen, and methane. A summary of quality control checks for these additional field analyses is presented in Table III.1.

The parameters and analytical methods for subsurface soil, surface soil, and groundwater samples for the Operable Unit 1 investigation are listed in Table III.2. The quality control procedures addressed in Table III.2 of the Operable Unit 9 QAPP for these parameters are applicable to the Operable Unit 1 QAPP. As part of the Operable Unit 1 investigation, subsurface soil samples will be analyzed for additional geotechnical parameters. Groundwater and subsurface soil samples will also be analyzed for dioxin/furans. These parameters and the associated quality control procedures are summarized in Table III.2. Table III.3 presents the advisory limits for matrix spike and matrix spike duplicates for dioxin/furans.

Completeness for the Operable Unit 1 program will be assessed for field measurements, laboratory measurements, and sample collection. Completeness is defined in subsection 3.3 of the Operable Unit 9, Site-Wide QAPP. The equations to be used for calculating completeness are provided on Table III.4 of the Operable Unit 9, Site-Wide QAPP. Completeness will be calculated for the following activities as part of the additional work:

- groundwater sampling,

Table III.1. Summary of Quality Control Procedures for Field Measurements

Analytical Method	Parameter	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
SOP 2.2 SOP 2.2 SOP 2.2	pH Electrical conductivity Temperature	Per Operable Unit 9, Site-Wide QAPP, Table III.1	Per Operable Unit 9, Site-Wide QAPP, Table III.1	Per Operable Unit 9, Site-Wide QAPP, Table III.1	Per Operable Unit 9, Site-Wide TAPP, Table III.1
SOP 2.2	Alkalinity	Second titration (for accuracy)	Once per well sampled	± 10% of first titration	Retitrate new sample
		Duplicate sample (for precision	One per ten or fewer field samples collected	≤ 20% RPD	Evaluate data for usability
SOP 2.2 SOP 2.2 SOP 3.1 SOP 3.3	Dissolved oxygen Reduction-oxidation potential Water level Operational check of pressure transducer used in measuring water levels in wells	Per Operable Unit 9, Site-Wide QAPP, Table III.1	Per Operable Unit 9, Site-Wide QAPP, Table III.1	Per Operable Unit 9, Site-Wide QAPP, Table III.1	Per Operable Unit 9, Site-Wide QAPP, Table III.1
IR Spectrometry[a]	Carbon dioxide Methane	Calibration check (1 standard) (for accuracy)	Once per day	± 10% of true value	Recalibrate
		Duplicate sample (for precision)	1 per 10 or fewer field samples measured	≤35% of RPD	Evaluate data for useability
Electrolytic[a]	Oxygen	Calibration check (1 standard) (for accuracy)	Once per day	± 10% of expected value	Recalibrate
		Duplicate sample (for precision)	1 per 10 or fewer field samples measured	≤35% RPD	Evaluate data for useability
SW8021 (modified)	VOCs	Field Quality Control			
	- trichloroethene - 1,2-*trans*-dichloroethene - 1,1,1-trichloroethane - tetrachloromethane - trichloromethane - chloroethene - 2-butanone - benzene	Trip blank	Once per sampling round	≤10 x level in associated samples	Evaluate source, evaluate data for useability
		Equipment blank	Once per day	≤10 x level in associated samples	Evaluate source, evaluate data for useability
		Duplicate	1 per 10 or fewer field samples measured	NA	Evaluate data for variability

Table III.1. (page 2 of 2)

Analytical Method	Parameter	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
SW 8021 (modified) (continued)	VOCs (continued)	Laboratory Quality Control			
		System blank	Once per day and after saturation	≤PQL	Identify and correct problem. Reanalyze system blank prior to sample analyses.
		Initial calibration (gaseous standard)[b]	Single point in triplicate; when calibration criteria exceeded	≤20% RSD of average calibration factors	Recalibrate
		Calibration check (gaseous standard)	1 per 10 samples analyzed	±20% recovery	Recalibrate
		Surrogate	Per every sample or calibration run	±20% recovery	Identify and correct problem. Recalibrate as necessary.
		Retention time window	Per every calibration check	±0.1 minutes from initial calibration retention time	Identify and correct problem.

[a]"Infrared Gas Analyzer Operating Manual" (1991). Geotechnical Instruments.
[b]Linearity must be documented for sample results that are greater than 10% of the standard concentration.
NA - not applicable
PQL - practical quantitation limit
RPD - relative percent difference
RSD - relative standard deviation
SOP - Standard Operating Procedure
VOC - volatile organic compound

Table III.2. Summary of Quality Control Procedures for Field Activities and Laboratory Measurements: Groundwater and Soil Samples[a]

Analytical Method	Parameter	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
SW8010/8020[b]	Volatile organic compounds	Per Operable Unit 9, Site-Wide QAPP, Table III.2	Per Operable Unit 9, Site-Wide QAPP, Table III.2	Per Operable Unit 9, Site-Wide QAPP, Table III.2	Per Operable Unit 9, Site-Wide QAPP, Table III.2
CLP SOW[c]	TCL semivolatile organic compounds	Field Quality Control Per Operable Unit 9 Site-Wide QAPP	Field Quality Control Per Operable Unit 9 Site-Wide QAPP	Field Quality Control Per Operable Unit 9 Site-Wide QAPP	Field Quality Control Per Operable Unit 9 Site-Wide QAPP
	TCL pesticide/PCBs	Laboratory Quality Control per CLP SOW	Laboratory Quality Control per CLP SOW	Laboratory Quality Control per CLP SOW	Laboratory Quality Control per CLP SOW
	Volatile organic compounds				
Laboratory SOP[e]	Gamma spectroscopy	Per Operable Unit 9, Site-Wide QAPP, Table III.2	Per Operable Unit 9, Site-Wide QAPP, Table III.2	Per Operable Unit 9, Site-Wide QAPP, Table III.2	Per Operable Unit 9, Site-Wide QAPP, Table III.2
	Isotopic plutonium				
	Isotopic thorium				
	Isotopic uranium				
	Strontium-90/yttrium-90				
	Radium-226				
E325.1[i]/SW9250[b]	Chloride				
E375.2[i]	Sulfate				
E353.2[i]	Nitrate/Nitrite				
R906.0[g]	Tritium				
CLP SOW[d] (Modification A)	TAL metals and bismuth, lithium or calcium, potassium, sodium, magnesium, iron, and manganese[k]				
E340.2[i]	Fluoride				
SW9045[b]	Soil pH				
E310.1	Alkalinity				
E415.1[i]/415.2[i]	Total organic carbon				
ASTM D422-63[h]	Particle size analysis				
ASTM D2974[h]	Organic content				
	Moisture content				

Table III.2. (page 2 of 3)

Analytical Method	Parameter	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
EM-1110-2-1906[i] EM-1110-2-1906[i] SW9100[b]	Total porosity Bulk density Triaxial permeability	Laboratory Quality Control			
ASTM D4318[h] ASTM D2325[h] Standard Method 907A[i]	Atterberg Limits Capillary moisture Bacterial culture	Sample replicate	1 per 20 samples analyzed (every sample for bacterial culture)	≤20% RPD (NA for bacterial culture)	Correct problem; reanalyze replicate
SW8280[b]	PCDDs[m] PCDFs[m] 2,3,7,8-TCDD 2,3,7,8-TCDF	Field Quality Control			
		Duplicate	1 every 10 or fewer field samples	Not applicable	Evaluate variability.
		Equipment (rinsate) blank	1 every 20 or fewer field samples	≤ 10 x level in associated samples	Evaluate potential sources. Evaluate associated data for usability.
		Laboratory Quality Control			
		Method blank	1 per 20 samples or fewer of a given matrix	≤ quantitation limit	Investigate source; reextract and reanalyze associated samples with positive results for the same analyte(s).
		Matrix spike	1 per 20 samples or fewer of a given matrix	See Table III.3	Evaluate data for usability.
		Matrix spike duplicate	1 per 20 samples or fewer of a given matrix	See Table III.3	Evaluate data for usability.
		Tuning criteria	Daily or each 12-hour period, whichever is more frequent	Per SW8280	Correct problem; reanalyze required standards; recalibrate if necessary.
		Calibration	Initial 5 point	Per SW8280	Recalibrate before sample analysis.

Table III.2. (page 3 of 3)

Analytical Method	Parameter	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
SW8280[b] (continued)	PCDDs, PCDFs, 2,3,7,8-TCDD, 2,3,7,8-TCDF (continued)	Internal standard	Every sample	25% - 200% recovery of internal standard	Evaluate data for usability.
		System performance check compound-2,3,7,8-TCDD only	Beginning and end of each 12-hour period and every calibration	≤ 25% resolution for TCDD	Identify source and correct.
		Continuing calibration check compounds	Once at beginning of 12-hour period	≤ 30% difference from mean RRF	Identify source and correct. Recalibrate if source not found and corrected.
		PCDD/PCDF GC window definition	Daily and with every calibration	Windows within mass spectrometer descriptor switch-points	Adjust mass spectrometer switch-points.

[a]All quality control procedures listed on Table III.2 of the Operable Unit 9, Site-Wide QAPP (DOE 1992) that pertain to the above analyses, are applicable to the OU 1 QAPP.
[b]"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, USEPA, November 1986.
[c]"USEPA Contract Laboratory Program Statement of Work for Organic Analysis, Document No. OLM01.8, August 1991.
[d]USEPA Contract Laboratory Program Statement of Work for Inorganic Document No. ILM01.0, March 1990.
[e]Laboratory developed SOP, based on either USEPA methods ("Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032, August 1980) or USDOE EML Procedures Manual, 27th Edition.
[f]"Methods for Chemical Analysis of Water and Wastes," USEPA, EPA-600/4-79-020, revised March 1983.
[g]"Prescribed Procedures for Measurement of Radioactivity in Drinking Water," U.S. EPA-600/4-80-032, latest revision.
[h]Soil and Rock; Dimension Stone, Geosythetics Vol. 4.08, 1991 Annual Book of ASTM Standards, Section 4 "Construction."
[i]COE. 1970. "Engineering and Design Laboratory Soils Testing." Department of the Army, U.S. Army Corps of Engineers, Engineer Manual EM 1110-2-1906, Appendix A, Washington, D.C., November 30, 1970. Includes Change 1 dated May 1, 1980, and Change 2 dated August 20, 1986.
[j]"Standard Methods for the Examination of Water and Wastewater," latest edition.
[k]Calcium, potassium, sodium, magnesium, iron, and manganese are cations.
[m]PCDDs and PCDFs shall include each 2378-CDD/CDF congener, as well as total homolog concentrations for tetra- through octa-CDD/CDF.

2,3,7,8-TCDD - tetrachlorodibenzo-p-dioxin
2,3,7,8-TCDF - tetrachlorodibenzofuran
ASTM - American Society of Testing and Materials
CLP - Contract Laboratory Program
GC - gas chromatography
HPLC - high-performance liquid chromatography
MDL - method detection limit
MS - matrix spikes
PCDD - polychlorinated dibenzo-p-dioxin
PCDF - polychlorinated dibenzofuran
PCB - polychlorinated biphenyl
RPD - relative percent difference
SOW - Statement of Work
TAL - Total Analyte List
USATHAMA - U.S. Army Toxic and Hazardous Materials Agency

Table III.3. Laboratory Advisory Limits for Matrix Spikes and Matrix Spike Duplicates: Water and Soil Samples

Analytical Method	Spiking Compounds	Spike Concentration		Advisory Limits	
		Soil (µg/kg)	Water (ng/L)	Percent Recovery (%)	Relative Percent Difference (%)
SW8280[a]	2,3,7,8-TCDD	1.25	12.5	60 - 140	± 50
	2,3,7,8-TCDF	1.25	12.5	60 - 140	± 50
	1,2,3,7,8-PeCDD	1.25	12.5	60 - 140	± 50
	1,2,3,7,8-PeCDF	1.25	12.5	60 - 140	± 50
	1,2,3,6,7,8-HxCDD	3.13	31.3	60 - 140	± 50
	1,2,3,4,7,8-HxCDF	3.13	31.3	60 - 140	± 50
	1,2,3,4,6,7,8-HpCDD	3.13	31.3	60 - 140	± 50
	1,2,3,4,6,7,8-HpCDF	3.13	31.3	60 - 140	± 50
	1,2,3,4,5,6,7,8-OCDD	6.25	62.5	60 - 140	± 50
	1,2,3,4,5,6,7,8-OCDF	6.25	62.5	60 - 140	± 50

[a]"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, EPA, November 1986 or most recent version.
2,3,7,8-TCDD - tetrachlorodibenzo-p-dioxin
2,3,7,8-TCDF - tetrachlorodibenzofuran
1,2,3,7,8-PeCDD - pentachlorodibenzo-p-dioxin
1,2,3,7,8-PeCDF - pentachlorodibenzofuran
1,2,3,6,7,8-HxCDD - hexachlorodibenzo-p-dioxin
1,2,3,6,7,8-HxCDF - hexachlorodibenzofuran
1,2,3,4,6,7,8-HpCDD - heptachlorodibenzo-p-dioxin
1,2,3,4,6,7,8-HpCDF - heptachlorodibenzofuran
1,2,3,4,5,6,7,8-OCDD - octachlorodibenzo-p-dioxin
1,2,3,4,5,6,7,8-OCDF - octachlorodibenzofuran

- aquifer test sampling,
- soil sampling, and
- soil gas sampling.

The completeness goal for sample collection for groundwater and soil sampling and laboratory analysis is 90%. The completeness goal for field measurements and soil gas analyses is 90%. There are no critical data points that require 100% completeness.

4. SAMPLING PROCEDURES

The Operable Unit 1 investigation will follow Mound Plant ER Program standard operating procedures (SOPs) in performing environmental sampling and other specific field activities. Activities that will be performed as part of this investigation include the sampling of groundwater, surface soils, and subsurface soils. Additional activities to be performed include water level measurements, drilling and logging, installation of monitoring wells, aquifer pumping tests, and health and safety screening. The procedures for these activities will be summarized in this section as part of the quality assurance plan for the investigation. The current revision of the SOPs developed for the Mound Plant ER Program that will be followed are listed in Table IV.1 and are provided in Appendix A of the Operable Unit 9, Site-Wide QAPP. Mound Plant ER Program SOPs 1.15, 3.4, and 6.16 are included as Attachment A to this Operable Unit 1 QAPP.

4.1. GENERAL PROCEDURES FOR SAMPLING

The general procedures for sampling activities are those specified in subsection 4.1 of the Operable Unit 9, Site-Wide QAPP. This includes the following procedures:

- Instructions to Field Personnel (Mound Plant ER Program SOP 1.1)
- Sample Control and Documentation (Mound Plant ER Program SOP 1.3)
- Sample Containers and Preservation (Mound Plant ER Program SOP 1.4). Containers and preservation requirements specific to this investigation are summarized in Tables IV.3 and IV.4.
- Sample Shipment (Mound Plant ER Program SOP 1.5)
- Equipment Decontamination (Mound Plant ER Program SOP 1.6)

A field sample identification plan is provided in Table IV.2.

Tables IV.3. and IV.4 summarize the required sample containers, sample volumes, preservation techniques, and holding times for the Operable Unit 1 parameters and media to be analyzed.

4.2. GROUNDWATER SAMPLING

The Mound Plant ER Program SOPs to be followed for groundwater sampling include protocols for 1) purging wells, and 2) sampling and monitoring commercial/municipal/domestic wells (Table IV.1).

Table IV.1. Mound Plant ER Program SOPs Applicable to Operable Unit 1

SOP Number	Revision Number	Title
1.1	2	General Instructions for Field Personnel
1.3	1	Sample Control and Documentation
1.4	2	Sample Containers and Preservation
1.5	1	Guide to the Handling, Packaging, and Shipping of Samples
1.6	2	General Equipment Decontamination
1.8	1	Personnel Decontamination - Level D Protection
1.9	1	Personnel Decontamination - Level C Protection
1.15[a]	1	Guide to Waste Management (currently under review)
2.1	1	Presample Purging of Wells
2.2	2	Field Measurements on Ground and Surface Water Samples
2.3	3	Sampling Monitoring Wells with a Bladder Pump
2.4	1	Sampling Monitoring Wells with a Bucket-Type Bailer
2.7	1	Sampling Commercial/Municipal/Domestic Wells
2.8	0	Sampling for Volatile Organics
3.1	1	Water Level Measurement
3.3	0	Operational Check of Pressure Transducers Used in Measuring Water Levels in Wells
3.4[a]	0	Aquifer Pumping Test
4.1	2	Soil Boring
4.1.1	0	Methods to Control Communications of Subsurface Contaminants with Groundwater
4.2	1	Rock Boring
4.3	1	Monitoring Well Installation
4.4	1	Monitoring Well Development
4.7	0	Piezometer Installation
4.8	0	Piezometer Development
5.1	1	Soil and Rock Borehole Logging and Sampling
5.2	3	Soil Sampling with a Spade and Scoop
5.3	2	Subsurface Solid Sampling with Hand Auger and Thin-Wall Sampler
5.8	1	Soil Sampling with a Stainless Steel Surface Soil Sampler
6.1	1	Health and Safety Monitoring of Combustible Gas Levels
6.2	1	Health and Safety Monitoring of Organic Vapors with a Photoionization Detector
6.4	0	Total Alpha Surface Contamination Measurements
6.7	0	Near Surface and Soil Sample Screening for Low-Energy Gamma Radiation Using the FIDLER
6.15	0	Measurement of Gamma-Ray Fields Using a Sodium Iodide (NaI) Detector
6.16[a]	0	Heat Stress Monitoring

[a]Included in Attachment A of this document.

Table IV.2. Operable Unit 1 Field Sample Identification Plan

Sample Matrix	Identification Scheme
Field Samples:	
Groundwater	MND20-YYYY-ZZZZ
Surface water	MND21-YYYY-ZZZZ
Sediment	MND22-YYYY-ZZZZ
Soil	MND23-YYYY-ZZZZ
Field Quality Control Samples:	
Trip blank	MNDXX-YYYY-2ZZZ
Sample bank blank/ambient blank	MNDXX-YYYY-3ZZZ
Duplicate	MNDXX-YYYY-1ZZZ
Equipment blank	MNDXX-YYYY-4ZZZ
Bottle lot blanks	MNDXX-YYYY-6ZZZ

Notes:

MND = Mound Plant
XX = sample matrix identifier
YYYY = sample location number
ZZZZ = sample round or sample depth (soils)

Field quality control will be assigned a sample location number and sample round number of the last sample of the associated sample batch.

Laboratories performing the analyses will not receive this table in their copy of the QAPP.

Table IV.3. Sample Containers, Volumes, Preservation, and Holding Times: Groundwater Samples

Parameters	Analytical Method	Container[a]	Minimum Volume	Preservation	Holding Time[b]
Purgeable halocarbons and purgeable aromatic compounds	SW5030/SW8010 SW5030/SW8020	40 mL glass vial with Teflon-lined septum (No headspace)	Two 40 mL vials	Cool 4°C HCl to pH <2	14 days
Semivolatile organic compounds	CLP SOW	Amber glass bottle with Teflon-lined lid	Two 1,000 mL bottles	Cool 4°C	7 days extraction/ 40 days analysis[c]
Pesticides/PCBs	CLP SOW	Amber glass bottle with Teflon-lined lid	Two 1,000 mL bottles	Cool 4°C	7 days extraction/ 40 days analysis[c]
Metals	CLP SOW	Polyethylene bottle	1,000 mL	HNO_3 to pH <2, Cool 4°C	6 months, 28 days (Mercury)
Nitrate-nitrite	E353.2	Polyethylene bottle	500 mL	H_2SO_4 to pH <2 Cool 4°C	28 days
Sulfate Chloride	E375.2 E325.1	Polyethylene bottle	500 mL	Cool 4°C	28 days
Radionuclides Gamma spectroscopy Plutonium isotopes Thorium Isotopes Radium-226 Americium-241 Uranium isotopes Strontium-90/Yttrium-90	Laboratory SOP[d]	Plastic cubetainer	2x4 liter	HNO_3 to pH <2 (15 mL 1 N HNO_3 liter)	NA
Tritium	R906.0	Glass bottle	250 mL	None	None
Dioxin/Furan	SW8280	Amber glass bottle with Teflon-lined lid	2x1,000 mL	Cool 4°C	30 days extraction/ 45 days analysis[b]
Total organic carbon	E415.1/E415.2	Amber glass bottle with Teflon-lined lid	250 mL	H_2SO_4 or HCl to pH <2, Cool 4°C	28 days

Note: Holding times for CLP analyses are based on "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses," EPA, February 1, 1988 and "Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses," EPA, July 1, 1988.

[a]Sample containers will be certified cleaned by the manufacturer according for EPA standards.

[b]From date of collection.

[c]From date of extraction.

[d]Laboratory-developed SOP, based on either USEPA methods ("Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80- 032, August 1980) or USDOE EML Procedures Manual, 27th Edition.

Table IV.4. Sample Containers, Volumes, Preservation, and Holding Times: Soil/Sediment Samples

Parameters	Analytical Method	Container[a]	Minium Volume/Weight	Preservation	Holding Time[b]
Volatile Organic Compounds	CLP SOW	Glass vial or jar with Teflon-lined septum/lid	120 mL (no headspace)	Cool 4°C	14 days
Semivolatile Organic Compounds	CLP SOW	Amber glass jar with Teflon-lined lid	100 grams	Cool 4°C	7 days extraction/40 days analysis[c]
Pesticides/PCBs	CLP SOW	Amber glass jar with Teflon-lined lid	100 grams	Cool 4°C	7 days extraction/40 days analysis[b]
Soil pH	SW9045	Wide-mouth polyethylene bottle	50 grams	NA	48 hours
Metals	CLP SOW	Wide-mouth polyethylene bottle	100 grams	Cool 4°C	6 months/28 days (mercury) 14 days
Fluoride	E340.2	Wide-mouth polyethylene bottle	50 grams	Cool 4°C	28 days
Nitrate/nitrite Alkalinity Chloride Sulfate Total Organic Carbon	E353.2 E310.1 SW9250 E375.2 E415.1/E415.2	Wide-mouth polyethylene bottle	300 grams	Cool 4°C	28 days (14 days - alkalinity)
Particle Size Analysis Atterberg Limits	ASTM D422 ASTM D4318	1-gallon wide-mouth plastic jar	5 lbs	NA	NA
Moisture Content	ASTM D2974	Wide-mouth polyethylene bottle	500 grams	Airtight Cool 4°C	7 days
Organic Content	ASTM D2974	125-mL wide-mouth amber glass jar with Teflon-lined lid	100 grams	Cool 4°C	7 days

Table IV.4. (page 2 of 2)

Parameters	Analytical Method	Container[a]	Minium Volume/Weight	Preservation	Holding Time[b]
Triaxial Permeability Total Porosity Capillary Moisture Bulk Density	SW9100 EM-1110-2-1906 ASTM D2325 EM-1110-2-1906	3-inch-diameter by at least 6-inch-length shelby tube	5 lbs or 700 g each	Must be sent and received as undisturbed material	NA
Bacterial Culture	Standard Method 907A	100-mL sterile glass with ground glass or Teflon-lined lid	10 g	Cool 4°C	12 hours from time of collection
Radionuclides Gamma Spectroscopy Tritium Plutonium Isotopes Thorium Isotopes Uranium Isotopes Strontium-90/ytrrium-90	Laboratory SOP[d] (except tritium, which remains E906.0)	Wide-mouth nalgene bottle	750 grams	None	NA
Dioxin/Furan	SW8280	Amber glass jar with Teflon-lined lid	50 grams	Cool 4°C	30 days extraction/ 45 days analysis[b]

Note: Holding times for CLP analyses are based on "Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses," EPA, February 1, 1988 and "Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses," EPA, July 1, 1988.

[a]Sample containers will be certified cleaned by the manufacturer according to EPA standards.

[b]From date of collection.

[c]From date of extraction.

[d]Laboratory-developed SOP, based on either USEPA methods ("Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4- 80-032, August 1980) or USDOE EML Procedures Manual, 27th Edition.

CLP - Contract Laboratory Program

NA - not applicable

PCB - polychlorinated biphenyl

SOW - Statement of Work

Mound Plant ER Program SOP 2.1 provides the protocol for purging wells. Sampling techniques for monitoring wells using a bladder pump and bucket-type bailer are provided in Mound Plant ER Program SOPs 2.3 and 2.4, respectively. Protocols for sampling commercial/municipal/domestic wells are defined in Mound Plant ER Program SOP 2.7.

4.3. SOIL/SEDIMENT SAMPLING

Subsurface soil samples will be collected with either a spade or scoop as detailed in Mound Plant ER Program SOP 5.2 (revision 3), or with a hand auger and thin wall sampler according to Mound Plant ER Program SOP 5.3 (revision 2). Surface soil sampling will be performed with a stainless steel surface soil sampler according to Mound Plant ER Program SOP 5.8 (revision 1). Soil and rock borehole logging and sampling procedures to be followed are presented in Mound Plant ER Program SOP 5.1 (revision 1).

4.4. SOIL GAS SAMPLING

Subsurface soil gas samples will be collected during this investigation. Sampling probes, consisting of five-foot sections of nickel plated drill rod, will be hydraulically driven to the desired sampling depth. A stainless steel cartridge, connected to the sampling probe, houses a glass sample tube containing three types of adsorptive carbon material: Carbotrap®, Carbopack B®, and Carbosieve III®. A measured volume of soil gas will be passed through the adsorbents and the volatile organic compounds of interest will be trapped for analysis.

4.5. AQUIFER TEST SAMPLING

Groundwater samples will be collected during the aquifer tests. Mound Plant ER Program SOP 2.1 provides the protocol for purging wells. In accordance with this SOP, three bore volumes will be purged prior to sampling the first and last samples collected at each well; however, only one bore volume will be purged prior to collecting samples taken during the time series sampling. Sampling techniques for monitoring wells using a bladder pump and bucket-type bailer are provided in Mound Plant ER Program SOPs 2.3 and 2.4, respectively.

4.6. OTHER FIELD ACTIVITIES

Additional Operable Unit 1 field activities to be included as part of the quality assurance plan are water level measurements, drilling and logging, aquifer pumping tests, and specific analytical field measurements. Water level measurements of depth-to-water in boreholes, monitor wells, or potentiometers will be performed according to Mound Plant ER Program SOP 3.1, Water Level Measurement (revision 1) (DOE 1992). Drilling and logging procedures for soil and rock borings and monitor wells are specified in Mound Plant ER Program SOPs 4.1, (revision 2), 4.1.1 (revision 0), 4.2, 4.3, 4.4, and 5.1 (revision 1). Procedures for analytical field measurements are discussed in section 6 of this QAPP.

4.7. SUMMARY OF SAMPLING ACTIVITIES

Table IV.5 summarizes the number of investigative samples for each task for the Operable Unit 1 investigation.

Table IV.5. Summary of Sampling and Analysis Program - Operable Unit 1

Sample Matrix	Field Parameters	Laboratory Parameters	Investigative Samples			Field Quality Control Samples[a]									Matrix Total[c]
						Duplicate			Equip. Rinsate Blank			MS/MSD[b]			
			No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	
Surface soil	Soil gas screening using PID/FID, screening for radioactive constituents, soil classification	TAL metals	13	1	13	2	1	2	2	1	2	1	1	1	17
		Bismuth	13	1	13	2	1	2	2	1	2	1	1	1	17
		Fluoride	13	1	13	2	1	2	2	1	2	1	1	1	17
		TCL pesticides/PCBs	13	1	13	2	1	2	2	1	2	1	1	1	17
		Isotopic plutonium	13	1	13	2	1	2	2	1	2	1	1	1	17
		Isotopic thorium	13	1	13	2	1	2	2	1	2	1	1	1	17
		Isotopic uranium	13	1	13	2	1	2	2	1	2	1	1	1	17
		Strontium-90/yttrium-90	13	1	13	2	1	2	2	1	2	1	1	1	17
		Tritium	13	1	13	2	1	2	2	1	2	1	1	1	17
		Gamma spectromstry	13	1	13	2	1	2	2	1	2	1	1	1	17
		Nitrate/nitrite	13	1	13	2	1	2	2	1	2	1	1	1	17
		Chloride	13	1	13	2	1	2	2	1	2	1	1	1	17
		Sulfate	13	1	13	2	1	2	2	1	2	1	1	1	17
		Alkalinity	13	1	13	2	1	2	2	1	2	1	1	1	17
		TOC	13	1	13	2	1	2	2	1	2	1	1	1	17
		VOCs	13	1	13	2	1	2	2	1	2	1	1	1	17
		TCL semivolatile organic compounds	13	1	13	2	1	2	2	1	2	1	1	1	17
		Soil pH	13	1	13	2	1	2	2	1	2	1	1	1	17
Subsurface soil	Soil gas screening using PID/FID, screening for radioactive constituents, soil classification	TAL metals	56	1	56	6	1	6	6	1	6	3	1	3	68
		Bismuth	29	1	29	3	1	3	3	1	3	2	1	2	35
		Fluoride	56	1	56	6	1	6	6	1	6	3	1	3	68
		Lithium	29	1	29	3	1	3	3	1	3	2	1	2	35
		TCL pesticides/PCBs	59	1	59	6	1	6	6	1	6	3	1	3	71
		Isotopic plutonium	54	1	54	6	1	6	6	1	6	3	1	3	66

Table IV.5. (page 2 of 4)

Sample Matrix	Field Parameters	Laboratory Parameters	Investigative Samples			Field Quality Control Samples[a]									Matrix Total[c]
						Duplicate			Equip. Rinsate Blank			MS/MSD[b]			
			No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	
Subsurface soil (continued)	Soil gas screening using PID/FID, screening for radioactive constituents, soil classification (continued)	Isotopic thorium	54	1	54	6	1	6	6	1	6	3	1	3	66
		Isotopic uranium	54	1	54	6	1	6	6	1	6	3	1	3	66
		Strontium-90/yttrium-90	51	1	51	6	1	6	6	1	6	3	1	3	63
		Tritium	272	1	272	28	1	28	28	1	28	14	1	14	342
		Gamma spectrometry	51	1	51	6	1	6	6	1	6	3	1	3	63
		Nitrate/nitrite	56	1	56	6	1	6	6	1	6	3	1	3	68
		Chloride	56	1	56	6	1	6	6	1	6	3	1	3	68
		Sulfate	56	1	56	6	1	6	6	1	6	3	1	3	68
		Alkalinity	56	1	56	6	1	6	6	1	6	3	1	3	68
		TOC	272	1	272	28	1	28	28	1	28	14	1	14	328
		pH	272	1	272	28	1	28	28	1	28	14	1	14	328
		VOCs	344	1	344	35	1	35	35	1	35	18	1	18	414
		TCL semivolatile organic compounds	59	1	59	6	1	6	6	1	6	3	1	3	71
		Dioxin/furan	27	1	27	3	1	3	3	1	3	2	1	2	33
		Particle size analysis	55	1	55	-	-	-	-	-	-	-	-	-	55
		Capillary moisture	23	1	23	-	-	-	-	-	-	-	-	-	23
		Total porosity	55	1	55	-	-	-	-	-	-	-	-	-	55
		Moisture content	23	1	23	-	-	-	-	-	-	-	-	-	23
		Organic content	55	1	55	-	-	-	-	-	-	-	-	-	55
		Triaxial permeability	26	1	26	-	-	-	-	-	-	-	-	-	26
		Bulk density	55	1	55	-	-	-	-	-	-	-	-	-	55
		Bacterial culture	5	1	5	-	-	-	-	-	-	-	-	-	5
		Clay mineralogy	26	1	26	-	-	-	-	-	-	-	-	-	26
		Atterburg Limits	23	1	23	-	-	-	-	-	-	-	-	-	23
		Iron/manganese	23	1	23	-	-	-	-	-	-	-	-	-	23

Table IV.5. (page 3 of 4)

Sample Matrix	Field Parameters	Laboratory Parameters	Investigative Samples			Field Quality Control Samples[a]									Matrix Total[c]
						Duplicate			Equip. Rinsate Blank			MS/MSD[b]			
			No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	
Groundwater	pH	TAL metals	15	1	15	2	1	2	2	1	2	1	1	1	19
	Temperature	TCL pesticides/PCBs	5	1	5	1	1	1	1	1	1	1	1	1	7
	Dissolved oxygen	Isotopic plutonium	14	1	14	2	1	2	2	1	2	1	1	1	18
	Redox potential	Isotopic thorium	14	1	14	2	1	2	2	1	2	1	1	1	18
	Specific conductivity	Isotopic uranium	14	1	14	2	1	2	2	1	2	1	1	1	18
	Alkalinity	Strontium-90/yttrium-90	14	1	14	2	1	2	2	1	2	1	1	1	18
	Water level measurement	Tritium	15	1	15	2	1	2	2	1	2	1	1	1	19
		Radium-226	14	1	14	2	1	2	2	1	2	1	1	1	18
		Gamma spectroscopy	14	1	14	2	1	2	2	1	2	1	1	1	18
		Americium-241	14	1	14	2	1	2	2	1	2	1	1	1	18
		Nitrate/nitrite	15	1	15	2	1	2	2	1	2	1	1	1	19
		Chloride	15	1	15	2	1	2	2	1	2	1	1	1	19
		Sulfate	15	1	15	2	1	2	2	1	2	1	1	1	19
		Cations[e]	15	1	15	2	1	2	2	1	2	1	1	1	19
		VOCs	15	1	15	2	1	2	2	1	2	1	1	1	19
		TCL semivolatile organic compounds	5	1	5	1	1	1	1	1	1	1	1	1	7
		Dioxins/furans	5	1	5	1	1	1	1	1	2	1	1	1	7[d]
		TOC[f]	5	1	5	1	1	1	-	-	-	-	-	-	6
		VOCs (Method 8010 only)[f]	5	1	5	1	1	1	-	-	-	-	-	-	6
Soil gas[d]	Methane Carbon Dioxide Oxygen Pressure	VOCs	42	1	42	5	1	5	5	1	5	-	-	-	52

Table IV.5. (page 4 of 4)

[a]The field quality control samples include: duplicate (1 per 10 investigative samples); matrix spike/matrix spike duplicate (MS/MSD, 1 per 20 investigative samples); equipment rinsate blank (1 per 10 investigative samples); trip blank (1 per shipping container to lab with VOC samples); sample bank blank (1 per 20 investigative samples; VOC analysis only); ambient blank (1 per 20 investigative samples; VOC analysis only).

[b]Numbers given are for pairs of samples (triple volume is needed); only an MS (no MSD) is collected for TAL Inorganics (total and dissolved), isotopic plutonium, isotopic thorium, isotopic uranium, strontium-90, tritium, radium-226, and gamma spectrometry (double volume is needed).

[c]The number of samples to be collected for MS/MSD, trip blanks, sample bank blank, and ambient blank are not included in the matrix total.

[d]MS/MSDs will not be performed for soil gas samples.

[e]Cations are calcium, potassium, sodium, magnesium, iron, and manganese.

[f]Sample to be collected during long-term aquifer tests.

FID - flame ionization detector
MS - mass spectrometry
MSD - matrix spike duplicate
PCB - polychlorinated biphenyl
PID - photoionization detector
TAL - Target Analyte List
TCL - Target Compound List
TOC - total organic carbon

5. SAMPLE CUSTODY

The sample custody procedures for the Operable Unit 1 program are described in section 5 of the Operable Unit 9, Site-Wide QAPP. The topics discussed in this section are sample custody (field and laboratory), documentation, sample handling, packaging and shipping, and final evidence file documentation.

6. ANALYTICAL PROCEDURES

6.1. FIELD MEASUREMENTS AND SCREENING

The field measurements to be performed for the Operable Unit 1 groundwater samples are specific conductance, alkalinity, pH, water level, dissolved oxygen, temperature, and oxidation-reduction (redox) potential. The procedures to be followed for these measurements are described in subsection 6.1 of the Operable Unit 9, Site-Wide QAPP. The Mound Plant ER Program SOPs to be followed for these measurements are listed on Table IV.1.

Field screening procedures will include combustible gas and organic vapors and are described in subsection 6.1 of the Operable Unit 9, Site-Wide QAPP.

Field measurements to be performed as part of the additional work include soil gas analysis and measurement of methane, oxygen, and carbon dioxide. The analytical methods and expected quantitation limits for these additional analytes are included in Table VI.1. The following subsections describe the procedures for measuring these parameters.

6.1.1. Methane, Oxygen, and Carbon Dioxide

A Geotechnical Instruments model GA-90 gas analyzer, or its equivalent, will be used to measure soil gas concentrations of methane, oxygen, and carbon dixoide. This instrument uses an infrared detector to monitor methane and carbon dixoide and a gold electrode to detect oxygen concentration. The procedures to be followed for these measurements are those found in the instrument operating manual.

6.1.2. Soil Gas Analysis

Soil gas samples will be analyzed for selected volatile organic compounds. Samples are collected by drawing soil gas through a cartridge containing absorptive carbon materials (Carbotrap®, Carbopack B®, and Carbosieve III®). The trapped compounds are transferred by desorption to a gas chromatograph equipped with both Hall and photoionization detectors. The analytical procedure is described in detail in Appendix B of the Proposal for Additional Work, and is based on EPA method 8021 (EPA 1987).

Table VI.1. Analytical Methods, Parameters, and Quantitation Limits for Surface Water/Groundwater and Soil/Sediment Samples

Parameters	Analytical Methods		Quantitation Limits[a]	
	Water	Soil/Sediment	Water (µg/L)	Soil/Sediment (µg/kg)
1. Volatile Organic Compounds, Groundwater				
1.1. Purgeable Halocarbons	SW5030/SW8010[b]	NA		
Vinyl chloride			1.0	NA
Trichlorofluoromethane			2.0	NA
1,1-dichloroethene			1.3	NA
Methylene chloride (dichloromethane)			5.0	NA
1,1-dichloroethane			0.7	NA
Trichloromethane (chloroform)			0.5	NA
1,1,1-trichloroethane			0.3	NA
Carbon tetrachloride			1.2	NA
1,2-dichloroethane			0.3	NA
Trans-1,2-dichloroethene			1.0	NA
Cis-1,2-dichloroethene			1.0	NA
Trichloroethene			1.2	NA
1,2-dichloropropane			0.4	NA
Bromodichloromethane			1.0	NA
Dibromomethane			2.0	NA
2-chloroethyl vinyl ether			1.3	NA
1,3-*cis*-dichloropropene			3.4	NA
1,3-*trans*-dichloropropene			3.4	NA
1,1,2-trichloroethane			0.2	NA
Tetrachloroethene			0.3	NA
Dibromochloromethane			0.9	NA
1-chlorohexane			1.0	NA
Chlorobenzene			2.5	NA
1,1,1,2-tetrachloroethane			1.0	NA
Bromoform			2.0	NA
1,1,2,2-tetrachloroethane			0.3	NA
1,2,3-trichloropropane			1.0	NA
Phenyl bromide (bromobenzene)			2.0	NA
Chlorotoluene			1.0	NA
1,3-dichlorobenzene			3.2	NA

Table VI.1. (page 2 of 9)

Parameters	Analytical Methods		Quantitation Limits[a]	
	Water	Soil/Sediment	Water (µg/L)	Soil/Sediment (µg/kg)
1,4-dichlorobenzene			2.4	NA
1,2-dichlorobenzene			1.5	NA
Bis(2-chloroisopropyl)ether			20	NA
1.2. Purgeable Aromatic Compounds, Groundwater	SW5030/SW8020[b]	NA		
Benzene			2.0	NA
Chlorobenzene			2.0	NA
1,2-Dichlorobenzene			4.0	NA
1,3-Dichlorobenzene			4.0	NA
1,4-Dichlorobenzene			3.0	NA
Ethylbenzene			2.0	NA
Toluene			2.0	NA
Xylenes			2.0	NA
2. Volatile Organic Compounds, Soil (VOCs)	NA	CLP SOW[c]		Low Soil/ Sediment[d]
Chloromethane			NA	10
Bromomethane			NA	10
Vinyl Chloride			NA	10
Chloroethane			NA	10
Methylene chloride			NA	5
Acetone			NA	10
Carbon disulfide			NA	5
1,1-Dichloroethene			NA	5
1,1-Dichloroethane			NA	5
1,2-Dichloroethene (total)			NA	5
Chloroform			NA	5
1,2-Dichloroethane			NA	5
2-Butanone			NA	10
1,1,1-Trichloroethane			NA	5
Carbon Tetrachloride			NA	5
Vinyl Acetate			NA	10
Bromodichloromethane			NA	5
1,2-Dichloropropane			NA	5
cis-1,3-dichloropropene			NA	5
Trichloroethene			NA	5

Table VI.1. (page 3 of 9)

Parameters	Analytical Methods		Quantitation Limits[a]	
	Water	Soil/Sediment	Water (µg/L)	Soil/Sediment (µg/kg)
Dibromochloromethane			NA	5
1,1,2-Trichloroethane			NA	5
Benzene			NA	5
trans-1,3-dichloropropene			NA	5
Tribromomethane			NA	5
4-Methyl-2-pentanone			NA	10
2-Hexanone			NA	10
Tetrachloroethene			NA	5
Toluene			NA	5
1,1,2,2-Tetrachloroethane			NA	5
Chlorobenzene			NA	5
Ethylbenzene			NA	5
Styrene			NA	5
Xylenes (total)			NA	5
3. **Semivolatile Organic Compounds**	CLP SOW[c]	CLP SOW[c]		Low Soil/ Sediment[d]
Phenol			10	330
bis(2-chloroethyl) ether			10	330
2-Chlorophenol			10	330
1,3-Dichlorobenzene			10	330
1,4-Dichlorobenzene			10	330
Benzyl alcohol			10	330
1,2-Dichlorobenzene			10	330
2-Methylphenol			10	330
bis(2-chloroisopropyl) ether			10	330
4-Methylphenol			10	330
N-nitroso-di-n-dipropylamine			10	330
Hexachloroethane			10	330
Nitrobenzene			10	330
Isophorone			10	330
2-Nitrophenol			10	330
2,4-Dimethylphenol			10	330
Benzoic acid			50	1600
bis(2-chloroethoxy) methane			10	330
2,4-Dichlorophenol			10	330

Table VI.1. (page 4 of 9)

Parameters	Analytical Methods		Quantitation Limits*	
	Water	Soil/Sediment	Water (µg/L)	Soil/Sediment (µg/kg)
1,2,4-Trichlorobenzene			10	330
Naphthalene			10	330
4-Chloroaniline			10	330
Hexachlorobutadiene			10	330
4-chloro-3-methylphenol (para-chloro-meta-cresol)			10	330
2-Methylnaphthalene			10	330
Hexachlorocyclopentadiene			10	330
2,4,6-Trichlorophenol			10	330
2,4,5-Trichlorophenol			50	1600
2-Chloronaphthalene			10	330
2-Nitroaniline			50	1600
Dimethylphthalate			10	330
Acenaphthylene			10	330
2,6-Dinitrotoluene			10	330
3-Nitroaniline			50	1600
Acenaphthene			10	330
2,4-Dinitrophenol			50	1600
4-Nitrophenol			50	1600
Dibenzofuran			10	330
2,4-Dinitrotoluene			10	330
Diethylphthalate			10	330
4-Chlorophenyl-phenyl ether			10	330
Fluorene			10	330
4-Nitroaniline			50	1600
4,6-Dinitro-2-methylphenol			50	1600
N-nitrosodiphenylamine			10	330
4-bromophenyl-phenylether			10	330
Hexachlorobenzene			10	330
Pentachlorophenol			50	1600
Phenanthrene			10	330
Anthracene			10	330
Di-n-butylphthalate			10	330
Fluoranthene			10	330
Pyrene			10	330

Table VI.1. (page 5 of 9)

Parameters	Analytical Methods		Quantitation Limits[a]	
	Water	Soil/Sediment	Water (µg/L)	Soil/Sediment (µg/kg)
Butylbenzylphthalate			10	330
3,3'-Dichlorobenzidine			20	660
Benzo(a)anthracene			10	330
Chrysene			10	330
bis(2-Ethylhexyl)phthalate			10	330
Di-n-octylphthalate			10	330
Benzo(b)fluoranthene			10	330
Benzo(k)fluoranthene			10	330
Benzo(a)pyrene			10	330
Indeno(1,2,3-cd)pyrene			10	330
Dibenz(a,h)anthracene			10	330
Benzo(g,h,i)perylene			10	330
4. Pesticides and PCBs	CLP SOW[c]	CLP SOW[c]		
alpha-BHC			0.05	1.7
beta-BHC			0.05	1.7
delta-BHC			0.05	1.7
gamma-BHC (Lindane)			0.05	1.7
Heptachlor			0.05	1.7
Aldrin			0.05	1.7
Heptachlor epoxide			0.05	1.7
Endosulfan I			0.05	1.7
Dieldrin			0.10	3.3
4,4'-DDE			0.10	3.3
Endrin			0.10	3.3
Endosulfan II			0.10	3.3
4,4'-DDD			0.10	3.3
Endosulfan sulfate			0.10	3.3
4,4'-DDT			0.10	3.3
Methoxychlor			0.5	17.0
Endrin ketone			0.10	3.3
Endrin aldehyde			0.10	3.3
alpha-Chlordane			0.05	1.7
gamma-Chlordane			0.05	1.7
Toxaphene			5.0	170.0

Table VI.1. (page 6 of 9)

Parameters	Analytical Methods		Quantitation Limits[a]	
	Water	Soil/Sediment	Water (µg/L)	Soil/Sediment (µg/kg)
Aroclor-1016			0.5	33.0
Aroclor-1221			0.5	67.0
Aroclor-1232			0.5	33.0
Aroclor-1242			0.5	33.0
Aroclor-1248			0.5	33.0
Aroclor-1254			0.5	33.0
Aroclor-1260			0.5	33.0
5. Metals (Target Analyte List)	CLP SOW[e] - Modification A'	CLP SOW[e] - Modification A'		(mg/kg)
Aluminum			20	4
Antimony			10	2
Arsenic			10	2
Barium			200	40
Beryllium			1	0.2
Cadmium			5	1
Calcium			5000	1000
Chromium			10	2
Cobalt			50	10
Copper			25	5
Iron			100	20
Lead			3	0.6
Magnesium			5000	1000
Manganese			15	3
Mercury			0.2	0.04
Nickel			40	8
Potassium			5000	1000
Selenium			5	1
Silver			10	2
Sodium			5000	1000
Thallium			10	2
Vanadium			10	2
Zinc			20	4
Additional Elements:				
Bismuth			150	30
Lithium			100	10

Table VI.1. (page 7 of 9)

Parameters	Analytical Methods		Quantitation Limits[a]	
	Water	Soil/Sediment	Water (µg/L)	Soil/Sediment (µg/kg)
6. Dioxin/Furans	SW8280[b]	SW8280[b]	(ng/L)	
2,3,7,8-TCDD			10	0.5
Total TCDD			20	0.5
2,3,7,8-PcCDD			20	0.5
Total PeCDD			20	0.5
2,3,7,8-HxCDD			20	0.5
Total HxCDD			20	0.5
1,3,7,8-HpCDD			20	0.5
Total HpCDD			20	0.5
OCDD			20	0.5
2,3,7,8-TCDF			10	0.5
Total TCDF			20	0.5
2,3,7,8-PeCDF			20	0.5
Total PeCDF			20	0.5
2,3,7,8-HxCDF			20	0.5
Total HxCDF			20	0.5
2,3,7,8-HpCDF			20	0.5
Total HpCDF			20	0.5
OCDF			20	0.5
7. Common Anions			(mg/L)	(mg/kg)
Nitrate-Nitrite	E353.2[g]	E353.2[g]	0.2	2[f]
Chloride	E325.1[g]/SW9250[b]	SW9250[b]	1.0	5[f]
Sulfate	E375.2[g]	E375.2[g]	5	50
Fluoride	E340.2[g]	E340.2[g]	0.1	0.025
8. Total Organic Carbon	E415.1/E415.2[g]	NA	1	25
9. Alkalinity	NA	E310.1[g]	NA	10
10. Particle Size Analysis	NA	ASTM D-422-63[h]	NA	NA
11. Moisture Content	NA	ASTM D-2216[h]	NA	NA
12. Organic Content	NA	ASTM D-2974[h]	NA	NA
13. Bulk Density	NA	EM-1110-2-1906[i]	NA	NA
14. Atterberg Limits	NA	ASTM D4318[h]	NA	NA
15. Triaxial Permeability	NA	SW9100[b]	NA	NA
16. Total Porosity	NA	EM-1110-2-1906[i]	NA	NA
17. Capillary Moisture	NA	ASTM D2325[h]	NA	NA

Table VI.1. (page 8 of 9)

Parameters	Analytical Methods		Quantitation Limits[a]	
	Water	Soil/Sediment	Water (µg/L)	Soil/Sediment (µg/kg)
18. Bacterial Culture	NA	Standard Method 907A[i]	NA	1CFU
19. Radionuclides	Laboratory SOP[n]	Laboratory SOP[n]	(pCi/L)	(pCi/g dry)
Gamma Spectroscopy				
cobalt-60			20[k,l]	1[m]
cesium-137			20[k,l]	1[m]
bismuth-210 metastable			15[k,l]	1[m]
bismuth-207			15[k,l]	1[m]
potassium-40			20[k,l]	10[m]
radium-226 (soils)			NA	0.3[m]
americium-241 (soil)			NA	1[m]
Plutonium Isotopes			1[l]	1.0[p]
Thorium Isotopes			1[l]	1.0[p]
Radium-226 (water)			1[q]	NA
Uranium Isotopes			1	0.6
Strontium-90/Yttrium-90			5	1.0
Americum-241 (water)			1	NA
Tritium	R906.0[o]	R906.0[o]	500 pCi/L	50 pCi/g
20. Volatile Organic Compounds, Soil Gas Analysis	NA	SW8021[b] (modified)		(µg/L) (soil gas)
Trichloroethene			NA	0.01
1,2-trans-Dichloroethene			NA	0.01
1,1,1-Trichloroethane			NA	0.01
Tetrachloromethane			NA	0.01
Trichloromethane			NA	0.01
2-Butanone			NA	0.01
Benzene			NA	0.01
Chloroethene			NA	0.01

[a]For non-CLP analyses, these are expected method detection limits based on reagent grade water or a purified solid matrix. Actual quantitation limits may be higher depending upon the nature of the sample matrix. The limit reported on final laboratory reports will take into account the actual sample volume or weight, percent moisture (where applicable), and the dilution factor, if any. The quantitation limits for the additional nonroutine analytes may vary, depending upon the results of the method validation study.

[b]"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd edition, U.S. EPA, November 1986.

[c]"U.S. EPA Contract Laboratory Program, Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration." Document No. OLM01.8. Quantitation limits are contract-required quantitation limits (CRQLs). The minimum quantitation limits will be reported by the laboratory.

Table VI.1. (page 9 of 9)

[d]Medium Soil/Sediment CRQLs are 125 times the low soil/sediment CRQLs for volatile organic compounds and 60 times the low soil/sediment CRQLs for semivolatile organic compounds. Estimated detection limits for metals in soil are based on a 1-gram sample diluted to 200 mL.
[e]"U.S. EPA Contract Laboratory Program, Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration." Document No. ILM01.0. Quantitation limits are CRDLs except for vanadium, beryllium, antimony, aluminum and additional elements. The minimum quantitation limits will be reported by the laboratory.
[f]Based on a 10-gram soil sample and 100 mL volume of extractant and a soil moisture content between 0 and 10 percent (rounded). Actual quantitation limit will vary with the sample and extractant amounts and will depend upon the nature of the soil matrix.
[g]"Methods for Chemical Analysis of Water and Wastes," U.S. EPA, EPA-600/4-79-020 revised March 1983
[h]"1991 Annual Book of American Society of Testing Materials Standards," Section 4, Construction, Volume 04.08, Soil and Rock, Dimension Stone, Geosynthetics," ASTM 1991.
[i]COE. 1970. "Engineering and Design Laboraotry Soils Testing." Department of the Army, U.S. Army Corps of Engineers, Engineer Manual EM 1110-2-1906, Appendix A, Washington, D.C., November 1970.
[j]"Standard Methods for the Examination of Water and Wastewater," latest edition.
[k]Assumes no interfering lines.
[l]Based on 900-mL sample size.
[m]Based on 650-gram dry sample
[n]Laboratory-developed SOP, based on either USEPA methods ("Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032, August 1980) or USDOE EML Procedures Manual (27th Edition).
[o]"Prescribed Procedures for Measurement of Radioactivity in Drinking Water," U.S. EPA, EPA-600/4-80-032, latest version.
[p]Based on 2-gram dry sample.
[q]Based on 1,000 mL sample size.
[r]Modification A provides for the analysis of four additional metals. Only lithium and bismuth will be additional anlytes for this investigation.

2,3,7,8-TCDD - tetrachlorodibenzo-p-dioxin
2,3,7,8-TCDF - tetrachlorodibenzofuran
CFU - colony forming unit
CLP - Contract Laboratory Program
HpCDD - heptachlorinated dibenzo-p-dioxin
HpCDF - heptachlorinated dibenzofuran
HxCDD - hexachlorinated dibenzo-p-dioxin
HxCDF - hexachlorinated dibenzofuran
NA - Not Applicable
OCDD - octachlorinated dibenzo-p-dioxin
OCDF - octachlorinated dibenzofuran
PCB - polychlorinated biphenyl
PeCDD - pentachlorinated dibenzo-p-dioxin
PeCDF - pentachlorinated dibenzofuran
SOW - Statement of Work
TCDD - tetrachlorinated dibenzo-p-dioxin
TCDF - tetrachlorinated dibenzofuran
USATHAMA - U.S. Army Toxic and Hazardous Materials Agency

6.1.3. Pressure Measurements

The subsurface gas pressure of the landfill cocoon will be monitored using a pressure transducer. Measurements will include actual atmospheric pressure and landfill pressures. Procedures for these measurements are found in the instrument operating manuals.

6.2. LABORATORY ANALYTICAL METHODS

Groundwater and soil samples will be analyzed for the parameters listed on Table VI.1. With the exception of radiological methods, all analytical methods are based on either the EPA's CLP, approved EPA procedures or other standard analytical methods (e.g., American Society for Testing and Materials (ASTM). The exact radiological methods will be specified in laboratory specifications attachments. The analytical methods listed on Table VI.1 are described in subsection 6.2 of the Operable Unit 9, Site-Wide QAPP. Also listed on Table VI.1 are the expected quantitation limits to be reported on final laboratory reports. It should be noted that these limits may vary depending upon the sample matrix, weight, or volume of sample used, any dilution factor, and the instrument capability of the laboratory. The laboratory will be required to meet, to the extent possible, these quantitation limits. EPA methods 8010 and 8020 were selected for analyses of groundwater for volatile organic compounds in order to achieve lower detection limits than obtained in gas chromatography/mass spectrometry. Additional geotechnical parameters for the Operable Unit 1 investigation not discussed in the Operable Unit 9 QAPP include clay mineralogy, porosity, triaxial permeability, capillary moisture, Atterburg limits, and bacterial cultures.

6.2.1. Radiological Methods

Groundwater and soil samples will be analyzed for isotopic plutonium, isotopic thorium, isotopic uranium, americium-241, radium-226, and strontium-90/yttrium-90 using methods based on EPA or DOE procedures, where applicable. Alpha spectrometry is used to detect alpha emission from these isotopes, with the exception of strontium-90. It is expected that strontium-90 will be analyzed using a flow proportional detector to measure beta activity. Actinium-227 will be calculated from the analysis of thorium-227. Chemical separation procedures will be used to separate the isotopes of interest from the sample matrix. These procedures will be presented in subcontractor laboratory-developed SOPs.

Tritium will continue to be determined using EPA Method 906.0, as described in subsection 6.2.6 of the Operable Unit 9, Site-Wide QAPP.

Gamma spectroscopy measures gamma radiation over a given spectrum and will be used to determine the gamma radiation levels in groundwater and soil samples. Particular isotopes of interest that will be detected as gamma radiation are radium-226 (soil), bismuth-210 metastable, americium-241 (soil), cobalt-60, bismuth-207, polonium-210, and potassium-40. The analyses will be based on EPA or DOE methods. Isotope separation procedures will be specified in the subcontractor laboratory-developed SOPs.

6.2.2. Dioxin/Furan

Groundwater and subsurface soil samples will be analyzed for dioxin/furan content, if the results for PCBs are above the quantitation limits. EPA method 8280 will be used to perform the dioxin/furan analysis, using gas chromatography/mass spectrometry (GC/MS). Samples will be analyzed for all 2,3,7,8-substituted isomers of dioxin/furan, total isomer homologs (tetra through octa) for polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, and for the specific isomers 2,3,7,8-tetrachlorodibenzo-p-dioxin and 2,3,7,8-tetrachlorodibenzofuran.

6.2.3. Total Porosity, Triaxial Permeability, Capillary Moisture Curves, Atterburg Limits, Bulk Density, and Bacterial Cultures

Selected soil samples will be analyzed for total porosity, bulk density, triaxial permeability, capillary moisture, Atterburg limits, and bacterial cultures by the procedures specified on Table VI.1.

7. CALIBRATION PROCEDURES AND FREQUENCY

Procedures for the calibration of field and laboratory equipment presented in section 6 are discussed in section 7 of the Operable Unit 9, Site-Wide QAPP, with the exception of soil gas analysis and gas chromatography mass spectrometry (GC/MS) analysis of dioxin/furans.

7.1. GAS ANALYZER

The Geotechnical Instruments model GA-90 gas analyzer, or equivalent, will be used to measure soil gas concentrations of methane, oxygen, and carbon dioxide. At a minimum, the instrument calibration will be checked daily using at least one Matheson gas standard, or equivalent, for methane and carbon dioxide, and using atmospheric air for oxygen. Procedures to be followed are those specified in the instrument operating manual.

7.2. GAS CHROMATOGRAPHY FOR SOIL GAS ANALYSES

The gas chromatograph will be calibrated using a single concentration standard, run in triplicate, of the analytes of interest. Calibration factors are calculated from the three standard runs. Linearity will be assumed if the relative standard deviation is less than or equal to 20% among the calibration factors.

A continuing calibration check sample will be analyzed after every tenth sample. The recovery of this check sample must be within ± 20% of the known value. If this criteria is exceeded, a new calibration curve will be generated.

The acceptable retention time window is ±0.10 minutes form the average retention time derived from the daily calibration curve. If calibration checks exceed this window, the retention times will be redefined.

7.3. GAS CHROMATOGRAPHY/MASS SPECTROMETRY FOR DIOXIN/FURAN ANALYSES

GC/MS will be used for analysis of PCDDs and PCDFs according to methodology based on SW8280 (EPA 1986). A mixture of PCDD/PCDF isomers will be used to calibrate the GC/MS and must meet specific ion ratio criteria as established in method SW8280. Meeting these criteria is demonstrated each time the instrument is calibrated with a calibration check mixture. The tuning is also verified

whenever a corrective action to the GC/MS system is taken that affects the tuning (e.g., ion source cleaning or repair).

Initial calibration of the GC/MS system is accomplished with a minimum of five concentrations of the target compounds. Relative response factors (RRFs) are calculated for the target compounds. The relative standard deviations for the RRFs must be less than 15% or initial calibration is not valid.

The initial calibration is verified every 12 hours with a column performance check sample mixture and a midpoint calibration standard. The column performance check mixture is used to verify column resolution for 2,3,7,8-TCDD. RRFs calculated from the midpoint calibration standard must be within ±30% of the initial RRF mean value for the initial calibration to be valid. If these conditions are not met, the GC/MS system should be evaluated and corrective action taken (e.g., recalibrate).

8. INTERNAL QUALITY CONTROL CHECKS

Internal quality control checks are performed as part of a field investigation in order to monitor and assess the quality of the data generated. Quality control checks are used to evaluate the accuracy and precision of field screening, field measurements, sampling technique, and laboratory analyses. Acceptance criteria for the quality control checks, and corrective actions to be taken if criteria are not met, have been established for this program so that data of known quality are obtained (Table III.2 of the Operable Unit 9, Site-Wide QAPP). The following subsections summarize those internal quality control checks.

8.1. SCREENING AND FIELD MEASUREMENTS

Quality control procedures for screening and field measurements are limited to checking the reproducibility of the measurement by obtaining multiple readings and by calibrating the instruments (when appropriate) with either internal references or external standards. The frequency of these checks and acceptance criteria are presented in Table III.1 of the Operable Unit 9, Site-Wide QAPP. The checks for carbon dioxide, methane, and oxygen measurements, and soil gas analysis are presented on Table III.1 of this QAPP.

8.2. FIELD SAMPLING

Field conditions and sampling techniques will be assessed by the collection of trip blanks, sample bank blanks, equipment (rinsate) blanks, ambient blanks, and duplicate samples for selected laboratory analyses. Collection procedures are described in subsection 8.2 of the Operable Unit 9, Site-Wide QAPP.

8.3. LABORATORY ANALYSES

The internal quality control checks for the planned analyses are listed on Table III.2 of the Operable Unit 9, Site-Wide QAPP. A description of these checks is provided in subsection 8.3 of the Operable Unit 9, Site-Wide QAPP.

In addition, a system blank will be checked for soil gas analysis. A system blank is a randomly selected sampling cartridge that is analyzed daily to detail interferences from cartridges or the analytical system.

9. DATA REDUCTION, VALIDATION, AND REPORTING

Data reduction, validation, and reporting procedures for field data, technical data, and laboratory-generated data are provided in section 9 of the Operable Unit 9, Site-Wide QAPP.

Laboratory data reporting requirements for soil gas analysis will be equivalent to those specified for volatile organic compounds by the 8010/8020 method in subsection 9.2.3 of the Operable Unit 9, Site-Wide QAPP, with the following additions: 1) sample and standard injection volumes and 2) example calculations.

Data reporting requirements for total porosity, bulk density, capillary moisture curves, Atterburg limits, triaxial permeability, and bacterial cultures will be equivalent to those specified for physical soil parameters in subsection 9.2.3 of the Operable Unit 9, Site-Wide QAPP.

Data reports for dioxin/furan analyses will be similar to a CLP data package in content. Laboratory data report packages for PCDD/PCDF analyses will consist, at a minimum, of the following items where applicable:

- a case narrative for each laboratory batch of samples analyzed, as defined in subsection 9.2.3 of the Operable Unit 9 QAPP;
- a cross-reference of laboratory sample identification numbers to the project sample identification numbers;
- a description of data qualifiers used in the laboratory report;
- a record of sample extraction/preparation for all field samples and laboratory quality control checks;
- a summary page starting the extraction and analysis dates for each field sample and laboratory quality check;
- instrument run logs;
- sample results;
- example calculations;
- results of matrix spikes, matrix spike duplicates, method blank, initial calibration, continuing calibration checks, and replicate samples; and
- labeled and dated chromatograms/spectra of sample results and the laboratory quality control checks listed above.

A copy of the chain-of-custody with all requisite signatures will accompany each data package.

10. PERFORMANCE AND SYSTEM AUDITS

The procedures for performance and system audits for field, laboratory, and project activities are provided in section 10 the Operable Unit 9, Site-Wide QAPP. A technical performance audit for the additional work will be conducted by the quality assurance officer (QAO) (defined in subsection 2.4 of the Operable Unit 9, Site-Wide QAPP), as necessary. A field performance audit will be conducted by the QAO one time during the sampling efforts for the additional work.

A laboratory system audit will be performed by the quality assurance manger (QAM) (defined in subsection 2.4 of the Operable Unit 9, Site-Wide QAPP) or a designated auditor prior to any sample analyses. If the identified laboratory has had a systems audit for another operable unit for the same analyses within one year, then an audit will not be performed.

A laboratory performance audit will be conducted by the QAM as necessary, and will include the review described in subsection 10.4.2 of the Operable Unit 9, Site-Wide QAPP.

11. PREVENTIVE MAINTENANCE

Preventive maintenance procedures for the Operable Unit 1 program are those described in section 11 of the Operable Unit 9, Site-Wide QAPP.

12. SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

The routine laboratory procedures for assessing data precision, accuracy, and completeness include the review of results of the required laboratory quality control checks and conducting required corrective actions identified in section 3 of the Operable Unit 9, Site-Wide QAPP for the analyses applicable to the Operable Unit 1 program.

Procedures for data assessment are described in section 12 of the Operable Unit 9, Site-Wide QAPP.

13. CORRECTIVE ACTION PROTOCOLS

Field and laboratory corrective action protocols for the Operable Unit 1 program are those described in section 13 of the Operable Unit 9, Site-Wide QAPP.

14. QUALITY ASSURANCE REPORTS TO MANAGEMENT

Quality assurance reports to management are described in section 14 of the Operable Unit 9, Site-Wide QAPP.

15. REFERENCES

DOE. 1991. OU 1 Area B Tech Memo (3) Hydrogeology/Groundwater Contamination.

DOE. 1992. Remedial Investigation/Feasibility Study, Quality Assurance Project Plan. Operable Unit 9, Site-Wide QAPP, Draft Final, Revision 0. U.S. Department of Energy, Albuquerque Field Office, Albuquerque, New Mexico.

EPA. 1987. Data Quality Objectives for Remedial Response Activities. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response and Office of Waste Programs Enforcement. Report No. EPA 540/G-87/003. Washington, D.C. March 1987.

EPA. 1990a. "U.S. EPA Contract Laboratory Program, Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration." Document No. ILM01.0 including revisions 1.1 through 1.8. U.S. Environmental Protection Agency. March 1990.

EPA. 1990b. "U.S. EPA Contract Laboratory Program, Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration." Document No. ILM01.0. U.S. Environmental Protection Agency. March 1990.

ATTACHMENT A

STANDARD OPERATING PROCEDURES

1.15 Guide to Waste Management

3.4 Aquifer Pumping Test

6.16 Heat Stress Monitoring

STANDARD OPERATING PROCEDURE 1.15

GUIDE TO WASTE MANAGEMENT

1. PURPOSE

To provide a general guide for the management of investigation-derived wastes at the Mound Plant.

2. DISCUSSION

This standard operating procedure (SOP) describes the procedures used by the Environmental Restoration (ER) Program technical assistance contractor for the sampling, storing, and disposal of investigation-derived wastes (IDW). Part of this procedure includes the discussion of waste segregation and drum reuse. Other procedures or requirements used by installation subcontractors must conform to this SOP.

Wastes generated during a site investigation are classified as either environmental or hazardous materials. In general, wastes generated during environmental site investigations are derived from soil borings, well construction and installation, aquifer testing, and water quality sampling of wells and decontamination of sampling equipment (rinsate). Soil and water are stored in drums, with the drums containing soil stored at the original sampling site when possible and the drums containing water stored at a central staging location. The wastes are stored pending the results from the analytical tests to determine whether the wastes are hazardous based on CERCLA and RCRA criteria.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, SOPs 1.1 through 1.10 must be reviewed. These SOPs contain information on the performance of field activities. They should be consulted for specific information on equipment and supplies, decontamination procedures, and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.3	Sample Control and Documentation
1.5	Guide to the Handling, Packaging and Shipping of Samples
1.6	General Equipment Decontamination

3.2. Preparation

3.2.1. Office

A. Review the Workplan or Sampling and Analysis Plan, and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Determine that sufficient drums and labeling materials are available for storage of waste.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Obtain a sufficient number of the appropriate ER Program data collection forms. Consult Mound Plant ER Program SOP Table of Contents (DOE 1991).

C. Consult the ER Program data administrator for a current list of information management codes, location IDs, and sample numbers used in the completion of data forms and drum labels.

3.3. Operation

The following step-by-step procedure will ensure that all agreed to practices are followed in the management of investigation-derived wastes. A decision tree illustrating these procedures is shown on Figure 1.

3.3.1. Drum Labeling

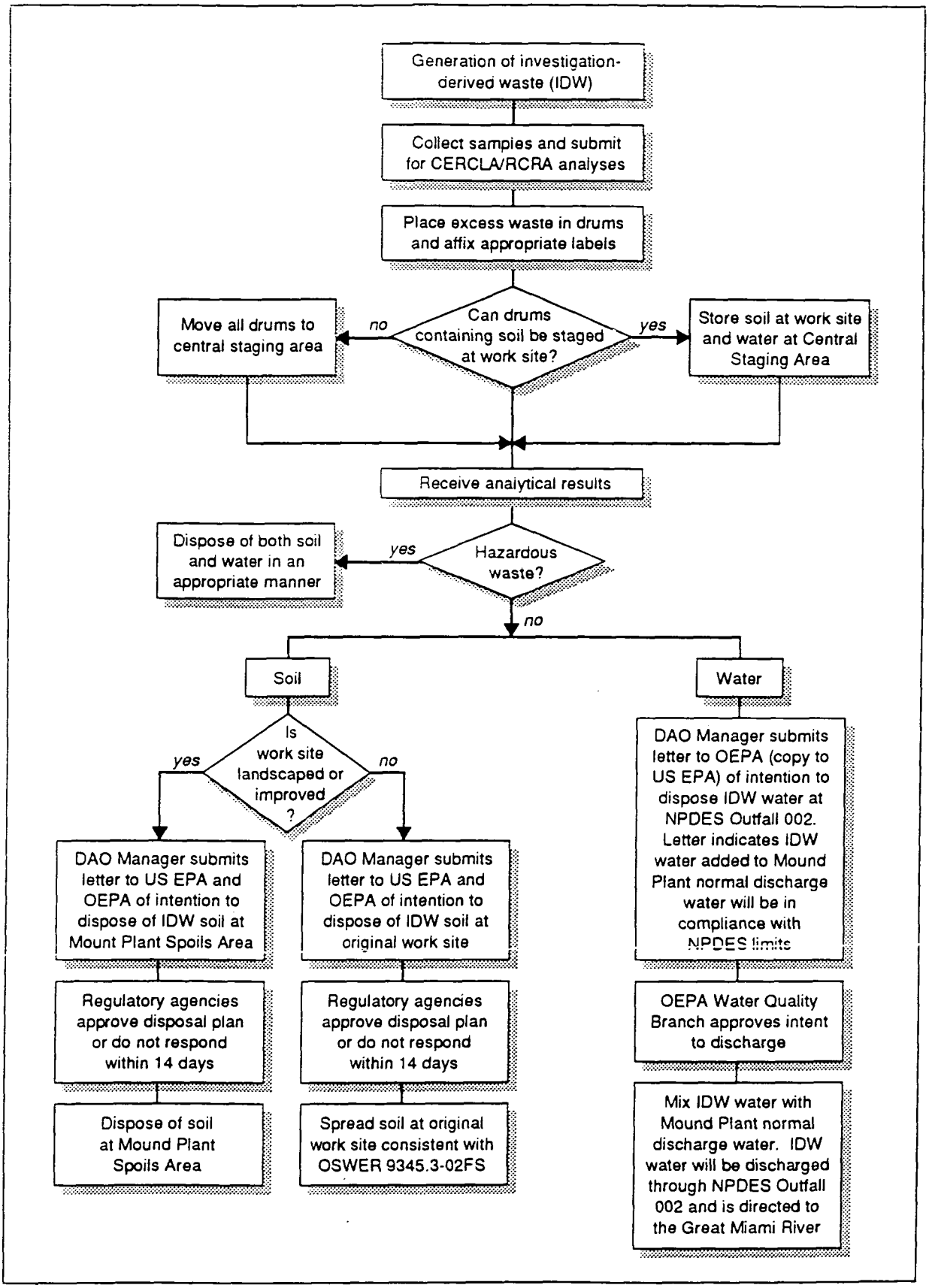
Drums will be marked with waterproof labels with the following information:

- date filled;
- source location ID (release site/well [for decon water]);
- medium (soil, water, or personal protective equipment);
- statement to the effect: "Investigation-derived waste from CERCLA RI/FS; for more information contact subcontractor manager (name, phone number), Kathy Koehler (x 4486), or Monte Williams (x 4543)";
- marking with head space analysis value, if applicable; and
- sample numbers

3.3.2. Soil

A. The soil samples that have been collected at the work site will be transmitted to the laboratory for CERCLA and RCRA analyses.

B. Remaining soil that is not sampled will be placed in open-top metal drums, which will be labeled and stored at the original sampling site whenever possible.



MND SOP 1.15-01/11-22-91

C. Drum groups within the staging area will be placed on wooden pallets and will be covered with tarps to prevent weathering of the drums and to protect label integrity.

D. A sign posted within each staging area will identify the drums as "Investigation-Derived Wastes" and will include the same information described in Section 3.3.1.

E. After receiving analytical results, the soil will be determined to be either hazardous or non-hazardous.

F. If the soil is non-hazardous, the remedial project manager at DAO will submit a letter to U.S. EPA and OEPA that will address the points below. An example letter is included here as Attachment A.

- general summary of results;

- criteria for release; and

- intent to return the IDW soil to the designated work site if U.S. EPA/OEPA approves the disposal or does not respond to the contrary within 14 days. A sketch map of the area to be used will accompany the notice letter. The ER-defined work site is considered to be synonymous with the area of contamination discussed in OSWER 9345.3-02FS (EPA 1991).

Upon U.S. EPA/OEPA approval or non-response, soils determined to be non-hazardous will be spread over unimproved areas of the original work site (consistent with OSWER 9345.3-02FS). At the work site, soils will be spread over the minimum area to allow leveling to the approximate original grade of the site. If the soils cannot be returned to the work site, they will be disposed at the Mound Plant spoils area. At the spoils area, soils will be disposed in a manner that is consistent with operating protocols of that location.

In cases involving borehole drilling, the soil cuttings will not be returned to the original borehole. Instead, the open borehole will have been grouted to the ground surface and the area surrounding the borehole will be considered the work site. In cases when the work site has undergone construction, landscaping, or general improvement, the soil will be disposed of at the Mound Plant spoils area.

G. If the soil is determined to be hazardous, it will be disposed of in an appropriate manner.

H. Solid waste generated by the technical assistance contractor and subcontractor(s) (e.g., wipes, protective clothing, visqueen, garbage) will be segregated and disposed of separately in a proper disposal area.

I. Bulk (large pieces) of asphalt or concrete waste generated by breaking through pavement will be segregated and disposed of separately in a proper disposal area.

3.3.3. Water

A. The water samples that have been collected at the work site will be transmitted to the laboratory for CERCLA and RCRA analyses.

B. The remaining water that is not sampled will be placed in closed-top polyethylene drums, which will be labeled and stored at a central staging area, currently the Waste Oil Drumfield, a potential release site on the SM/PP Hill.

C. Drum groups will be placed on wooden pallets and covered with tarps to protect label integrity.

D. A sign posted within each staging area will identify the drums as "Investigation Derived Wastes" and will include the same information described in Section 3.3.1.

E. After receiving analytical results, the water will be determined to be either hazardous or non-hazardous.

F. If the water is non-hazardous, the DAO remedial project manager will submit a letter to the OEPA water quality branch indicating that the IDW water will be added to normal Mound Plant discharge and will be in compliance with NPDES limits. A copy of this letter will be submitted to U.S. EPA by DAO.

   Upon approval from OEPA, the water will then be discharged through Mound Plant NPDES Outfall 002 and directed offsite to the Great Miami River. DAO will simultaneously notify U.S. EPA of the intent to discharge.

G. If the water is determined to be hazardous, it will be disposed of in an appropriate manner.

H. Liquid waste generated by the technical assistance contractor and subcontractor(s) (e.g., motor oil, additives, detergent solutions) will be segregated and disposed of separately at a proper disposal area.

3.3.4. Central Staging Area

A. The Central Staging Area is currently the Waste Oil Drumfield. It will be used to store

   - purge water from wells;

   - soil that cannot be stored at the work site because it hinders Mound Plant operations; and

   - soil from areas off the site (e.g., the Miami-Erie Canal).

B. The Waste Oil Drumfield will be used immediately with the knowledge that it is a release site and remedial activities are in progress.

C. After results of sampling and analysis are available, assuming that no remediation is required, the Waste Oil Drumfield will become a semi-permanent staging area for CERCLA wastes. It will be fenced and locked, with ER Program (EG&G and its contractors) to retain control of the area. It is presumed that at the conclusion of the ER Program, the area may need to be sampled again to verify that it was not contaminated by spills.

3.3.5. Waste Segregation

A. Waste Segregation will be practiced at a central staging area. Drums presumed to contain radioactive soil (e.g., from Miami-Erie Canal) will be labeled as such and will be kept in a separate zone from those presumed to contain hazardous waste. This is to prevent the creation of mixed waste if both types were to spill.

3.3.6. Drum Database

A database will be created and maintained for the duration of time that drums contain IDW soil/ water. The database will contain information described in Section 3.3.1 and include a timeline documenting waste management procedures.

3.3.7. Drum Reuse

A. Empty drums used to store non-hazardous solid wastes that are disposed of at the work site or spoils area will be rinsed of visible solid residue on location. Drums used to store non-hazardous liquid wastes that are disposed of into NPDES Outfall 002 are not expected to contain solid residue and will not be rinsed. When these procedures are completed, empty drums may be reused for subsequent wastes generated by the ER Program (it is assumed that drums will be reused only within the ER Program).

B. Drums that previously held low-specific activity (LSA) waste and have been emptied into LSA containers should be marked and retained only for radioactive soil that is unlikely to be hazardous waste.

C. It is assumed that drums containing waste that is determined to be hazardous will be shipped off the site with the waste.

3.4. Postoperation

3.4.1. Documentation

A. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

3.4.2. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/ she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

4. REFERENCES

DOE. 1991. "Standard Operating Procedures." Mound Plant, Environmental Restoration Program, U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico, January 1991.

EPA. 1991. "Guide to Management of Investigation-Derived Wastes." U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Publication: 9345.3-02FS, May 1991.

Attachment 1

EXAMPLE OF NOTIFICATION LETTER TO DISPOSE OF INVESTIGATION-DERIVED WASTE

This is to notify you of DOE's intent to return nonhazardous investigation-derived waste (IDW) to the original work site [OR to place IDW in the Mound Plant spoils disposal area].

Particulars are as follows:

1) Source of the materials: Cuttings from potential release site _XYZ_, Operable Unit _N_, generated _DATE_. The materials include [DESCRIPTION].

2) Results of chemical analysis/hazardous waste testing are attached.

3) The materials will be spread on the land surface at the work site at the location shown on the attached sketch map [OR the materials cannot be returned to the work site because...].

4) Unless we hear to the contrary by _DATE_, DOE will proceed with the disposal. [NAME] is the Project Engineer and is available at [PHONE NUMBER] to answer any further questions.

[DOE DAO SIGNATURE BLOCK]

STANDARD OPERATING PROCEDURE 3.4

AQUIFER PUMPING TEST

1. PURPOSE

To define procedures to conduct pumping tests for the *in situ* determination of the hydraulic properties of water-bearing soils and rocks.

2. DISCUSSION

An aquifer test is a controlled field experiment to determine the hydraulic properties of water-bearing soils and rocks. Groundwater flow varies in space and time and depends on the hydraulic properties of the saturated, odorous, or fractured medium and the boundary conditions imposed on the groundwater system. Pumping tests provide results that are more representative of aquifer characteristics than those predicted by slug tests, can be used to determine the hydraulics of interaquifer flow, require a greater degree of activity and expense than slug tests, and are not always justified for all levels of investigation. As an example, slug tests may be acceptable at the reconnaissance level, but pumping tests are usually performed as part of a feasibility study in support of designs for aquifer reclamation.

The rationale for the selection of a specific program of aquifer testing is contained in the Field Sampling Plan (FSP) or Work Plan (WP) for the site. Refer to the FSP or WP for the duration of the pumping test, the location of the observation well, and the data to be collected. Collection of measurements and documentation of data will be performed as described in the associated procedures.

Aquifer characteristics that may be obtained from pumping tests include hydraulic conductivity (K), transmissivity (T), specific yield (Sy) for unconfined aquifers, and storage coefficient (S) for confined aquifers and the vertical hydraulic conductivity of confining layers. Also, the occurrence and position of recharge or impermeable boundaries can be identified. These parameters can be determined by graphical solutions and computerized programs.

3. PROCEDURES

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

3.1. Associated Procedures

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination

3.1 Water Level Measurement

3.3 Operational Check of Pressure Transducers Used in Measuring Water Levels in Wells

3.2. Preparation

3.2.1. Office

A. Review the FSP or WP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Ensure that permission to discharge is obtained or a containment system is available for collecting water that will be pumped during the test. This is especially important for wells that may produce contaminated water.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information management codes and location IDs used in the completion of data forms.

3.2.3. Field

A. Obtain the following information, equipment, and equipment modifications necessary to conduct a pumping test and check the equipment for proper functioning. Obtain assurances from the drilling contractor concerning the completion of the well installation and development and the availability of the necessary equipment to conduct the pumping test. The drilling contractor is responsible for completing the following tasks and supplying the equipment listed below before the arrival of field personnel.

1. Drilling, installing, completing, and developing all pump wells and one observation well to the proper specifications identified in the FSP or WP.

2. Installing a submersible or turbine pump. The pumping well should be properly developed before testing.

3. Installing a totalizer meter and a flow meter in the discharge line of the pump well to accurately measure and monitor the volume and role of discharge.

4. Installing sufficient pipe to transport the discharge from the pumping well away from the area to prevent infiltration in the pumped zone.

5. Installing a gate valve on the discharge pipe to control the pumping rate.

6. Placing an outlet near the well head, but past the totalizer and flow meters, for water quality determination and sampling.

B. Calibrate all gauges, transducers, flow meters, and other equipment used in conducting pumping tests before use. Obtain copies of the documentation for instrumentation calibration and file them with the records of test data. Calibration records should contain laboratory measurements. If necessary, perform any onsite zero adjustment or calibration. Where possible, check all flow-measurement devices onsite using a container of measured volume and a stopwatch. Verify the accuracy of the meters before testing proceeds.

C. If funds are available, it is normally advisable to monitor pretest water levels at the test site for about one week before performing the test. This can be accomplished by using a continuous recording device like a Stevens Recorder. These records establish the barometric efficiency of the aquifer. The records also help determine if the aquifer is experiencing an increase or decrease in head with time caused by recharge or pumping in the nearby area or diurnal variations. Record changes in barometric pressure during the test (preferably with an onsite barograph) in order to correct water levels for any possible fluctuations that may occur from changing atmospheric conditions. Project the pretest water level trends for the duration of the test. These trends or barometric changes may be used to correct water levels during the test so that they are representative of the hydraulic response of the aquifer from pumping the test well.

D. The duration of the test is determined by the needs of the project and the aquifer properties. In general, longer tests produce more definitive results. If the budget permits, a duration of one to several days is desirable, followed by a similar period of monitoring the recovery of the water level. A knowledge of the local hydrogeology and a clear understanding of the overall objectives of the FSP or WP are necessary in determining the direction of the test. The effect of any hydrogeologic boundaries should be considered. There is no need to continue the test if the water level becomes constant with time. This normally indicates that a hydrogeologic source has been intercepted and that additional useful information will not be collected by continued pumping. One simple test for determining the adequacy of data is when the log time compared to drawdown for the most distant observation well begins to plot as a straight line on the semilog graph paper. There are several exceptions to this simple rule of thumb, so it should be considered a minimum criterion.

E. Decontaminate the transducer(s) and cable(s) as specified in the Sampling Plan and SOP 1.6, General Equipment Decontamination.

3.3. Operation

A. The procedure to conduct pumping tests includes monitoring the water level over time in the pumping well and each observation well while the pumping well is discharged at a constant rate.

B. When the pumping test is performed using an electronic data logger and pressure transducer, store all data internally or on computer diskettes or tape. Directly transfer the information to the main computer and analyze it. Maintain a computer printout of the data in the files for documentation. Take manually determined measurements periodically to verify data recorded by the data logger.

C. If an electronic data logger and pressure transducer are not used, record all data on the Pump/Recovery Test Data form (Appendix 5.2). Data collected manually during a logger-transducer pumping test will also be recorded on the form. Fill out the form as described in Appendix 5.3.

D. During a pumping test, measure water levels as often as necessary to produce a meaningful indication of hydraulic properties of the aquifer. Measure water levels as specified in SOP 3.1, Water Level Measurement.

During the early part of the test, station at least one person at each observation well and at the pumping well. After the first two hours, two people are usually needed to continue the test. It is not necessary for readings at the wells to be taken simultaneously. It is very important that depth-to-water readings are measured accurately and recorded at the exact time they are measured.

NOTE: Pressure transducers and electronic data loggers may be used to reduce the field personnel hours required for the pumping test.

E. After pumping is concluded, measure recovering water levels to verify the results obtained from the pumping portion of the test. Measure the recovering water levels in the pumping well and the observation wells for a period immediately following the cessation of pumping. Monitoring during recovery should occur for at least half the length of the pumping portion of the aquifer test. The decision to cease monitoring water levels will be based on aquifer recovery.

3.4. Postoperation

3.4.1. Field

A. If using an electronic data logger, follow the steps listed below.

1. Stop the logging sequence.

2. Print the data or send it to the computer by telephone.

3. Save memory and disconnect the battery at the end of the day's activities.

B. Put the testing equipment in storage containers.

C. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

D. Restore the site to pretesting conditions as specified in the FSP or WP.

E. Make sure all wells are properly labeled and the location ID is readily visible on the guard pipe.

3.4.2. Documentation

A. Record cleanup and hole abandonment procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Interpret the pumping test results with the project hydrogeologist or site manager. Analyze data using appropriate analytical solution(s).

D. If necessary, send data logger or pressure transducers to the factory for recalibration.

4. SOURCES

Boulton, N. S. 1954. "The Drawdown of the Water-Table under Non-Steady Conditions Near a Pumped Well in an Unconfined Formation." Proceedings of the Institution of Civil Engineers 3, paper 5979: 564.

Boulton, N. S. 1954. "Analysis of Data from Non-Equilibrium Pumping Tests Allowing for Delayed Yield from Storage." Proceedings of the Institution of Civil Engineers 26, paper 6693: 469-82.

Bouwer, H. 1978. Groundwater Hydrology. New York: McGraw-Hill Book Company.

Bredehoeft, J. D. and S. S. Papadopulos. 1980. "A Method for Determining the Hydraulic Properties of Tight Formations." Water Resources Research 16, no. 1: 233-38.

Cooper, Jr., H. H., J. D. Bredehoeft, and S. S. Papadopulos. 1967. "Response of a Finite-Diameter Well to an Instantaneous Charge of Water." Water Resources Research 13, no. 1.

Cooper, Jr., H. H. and C. E. Jacob. 1946. "A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well-Field History." American Geophysical Union Transactions 27, no. 4: 526-34.

Earlougher, R. C. 1977. Advances in Well Test Analysis. Society of Petroleum Engineers of AIME publication, Houston, Texas.

Freeze, R. Allen, and John A. Cherry. 1979. Groundwater. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

5. APPENDIXES

5.1. Equipment and Supplies Checklist

5.2. Pump/Recovery Test Data Form

5.3. Data Form Completion

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

Water level measuring device:

_____ Water pressure transducer

_____ Electric water level indicator

_____ Weighted tapes with plopper

_____ Steel tape (subdivided into tenths of feet)

_____ Electronic data logger (if transducer method is used)

_____ Tape measure (subdivided into hundredths of feet)

_____ Watch or stopwatch with second hand

_____ Semilog graph paper (if required)

_____ Waterproof ink pen

_____ Thermometer

_____ Appropriate references and calculator

_____ Barometer or recording barograph (for tests conducted in confined aquifers)

APPENDIX 5.2

PUMP/RECOVERY TEST DATA FORM

PUMP/RECOVERY TEST DATA

PAGE 1 OF ____

FACILITY CODE _____ **DISTANCE FROM PUMPED WELL (FT)** _____

LOCATION ID _____ **LOGGER CODE** _____

LOG DATE _____ **ACCEPTANCE CODE** _____

TEST START:

DATE _____

TIME _____

STATIC WATER LEVEL (FT) _____

TEST END:

DATE _____

TIME _____

WATER LEVEL (FT) _____

AVERAGE PUMPING RATE (GAL/MIN) _____

MEASUREMENT METHODS _____

COMMENTS _____

PUMP TEST			RECOVERY TEST	
ELAPSED TIME (MIN)	**DEPTH TO WATER (FT)**	PUMPING RATE (GAL/MIN)	**ELAPSED TIME (MIN)**	**DEPTH TO WATER (FT)**
0.00			0.00	

ACCEPTANCE CODES: A–ACCEPTABLE R–RECONNAISSANCE U–UNACCEPTABLE N–NOT DETERMINED

COMPLETE BOLDED DATA FOR ENTRY INTO TIMS

PTD–011 (1/88)

FORM COMPLETED BY/DATE _____

TECHNICAL REVIEWER/DATE _____

APPENDIX 5.3

DATA FORM COMPLETION INSTRUCTIONS

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

PUMP/RECOVERY TEST DATA FORM

1. Facility Code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Location ID. Four-character code assigned sequentially to each borehole, test pit, or surface location where chemical, biological, radiological, and other measurements are taken.

3. Log Date. The date when the measurement was made in the format DD-MMM-YY (01-JAN-88).

4. Distance From Pumped Well (Ft). Distance the observation well is from the pumping well in feet and tenths of feet.

5. Logger Code. Three-character code identifying the company responsible for performing field measurements or collecting samples.

6. Acceptance Code. One-character code assigned by the installation manager, but entered on the form by field personnel.

7. Test Start Date. The date when pumping was initiated in the format DD-MMM-YY (01-JAN-88).

8. Test Start Time. The time when pumping was initiated using the 24-hr clock with the format of hours:minutes (08:37 for 8:37 a.m. and 19:12 for 7:12 p.m.).

9. Static Water Level (Ft). Depth-to-water in feet and hundredths of feet in the observation well at the beginning of the pumping test.

10. Test End Date. The date when pumping ceased.

11. Test End Time. The time when pumping ceased.

12. Water Level (Ft). Depth-to-water in feet and hundredths of feet in the observation well at the end of the pumping test.

13. Average Pumping Rate (Gal/Min). Total volume pumped (from totalizer meter) divided by the total elapsed time.

14. Measurement Methods. Type of instrument used to measure depth-to-water (may include steel tape, electric sounding probes, Stevens recorders, or pressure transducers).

15. Comments. Any additional information.

PUMP TEST:

a. Elapsed Time (Min.). Time of measurement recorded continuously from time 0.00 (start of test) in minutes.

b. Depth-to-Water (Ft). Depth-to-water in feet and hundredths of feet in the pump or observation well at the time of the water level measurement.

c. Pumping Rate (Gal/Min). Flow rate in gallons per minute of pumping measured from the in-line flow meter. This column should be completed only for the form used with the pumped well.

RECOVERY TEST:

a. Elapsed Time (Min). See above PUMP TEST a.

b. Depth-to-Water (Ft). See above PUMP TEST b.

STANDARD OPERATING PROCEDURE 6.16

HEAT STRESS MONITORING

1. PURPOSE

To outline the procedure for monitoring heat stress and other measures for protecting workers from heat exhaustion and heat stroke in warm environments.

2. DISCUSSION

The Field Sampling Plan (FSP) or Work Plan (WP) provides information on the scope of a given operation, related health and safety requirements, and the applicability of this procedure to the activities.

Heat stress is often the major hazard facing workers at hazardous waste sites, especially when respirators and clothing that is semipermeable (Tyvek coveralls) or impermeable are worn in warm or hot weather. Although monitoring heat stress is an important factor in preventing heat-related injuries, the proper planning, budgeting, and scheduling of site activities are equally important. In addition to monitoring heat stress, heat-stress problems can be mitigated by employing some of the measures described below.

- Have workers drink plenty of fluids.
- Provide shade.
- Schedule work in the early morning, evening hours, or at night.
- Schedule work during the cool part of the year.
- Provide workers with cooling vests.
- Provide workers with a cool-down room in the contaminated zone next to the area in which they are working.
- Set up a tent and refrigerate the work area.
- Have two or more crews work on alternate shifts. One or more crews can cool down, while the other crew works in the heat.

3. PROCEDURE

3.1. Associated Procedures

Information that applies to most field activities is provided in SOPs 1.1-1.10. In addition to the FSP or WP, those SOPs provide guidance that may supplement the information in this procedure. They should be consulted as necessary to obtain specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination

3.2. **Preparation**

3.2.1. **Office**

A. Review the FSP or WP, the SOPs listed in Section 3.1, and the Health and Safety Plan.

B. Obtain and confirm the accurate operation of field equipment listed in Appendix 5.1.

3.2.2. **Documentation**

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of codes used in the completion of data forms.

3.2.3. **Field**

A. Place a thermometer in a shaded location of the work area to measure the ambient air temperature.

B. As described in Appendix 5.3, Data Form Completion, record the time, temperature, and personnel baseline pulse rates and indicate whether the day is cloudy or sunny on the Heat Stress Monitoring Record form (Appendix 5.2).

C. Calculate the adjusted air temperature as shown below.

$$\text{ta adj } F^\circ = \text{ta } F^\circ + [13 \times (\%\ \text{sunshine}/100)]$$

where

ta F° = the temperature indicated on the thermometer in F°

3.3. **Operation**

3.3.1 **Monitoring Heat Stress**

A. Complete the Heat Stress Monitoring Record form by following instructions in Appendix 5.3.

B. Record baseline data obtained in Section 3.2.3.B. and set the timer for the period of time indicated on the National Institute of Safety and Health (NIOSH) Heat Stress Monitoring Table (Appendix 5.4).

C. When the working time has elapsed, have workers find their own pulse and count the number of times their heart beats in 15 or 30 sec. Convert pulse rates to beats per minute (bpm) and record the time and weather conditions on the Heat Stress Monitoring Record form.

D. Have the workers take a break in the shade (or cooler room) until their pulse rates drop to a value close to their baseline rates. This length of time will vary with site-specific conditions.

1. If no crew member had a pulse rate that was above 110 bpm at the beginning of the break, continue following the suggested work durations shown in Appendix 5.4.

2. If a crew member had a pulse rate above 110 bpm, the next work period should be two-thirds as long as the previous work period.

EXAMPLE: It is 80°F in the shade. There is no cloud cover, and the crew is working in impermeable clothing. The effective temperature would be 93°F, and the table in Appendix 5.4 suggests a 15-min work period. If a worker had a pulse rate above 110 bpm at the beginning of a break, the next work period should be 10 min long. If hot weather conditions remain unchanged and a worker had a pulse rate above 110 bpm at the beginning of the next break, then the third work period should be shortened to 6 and 2/3 min.

E. Identify heat-sensitive workers and assign some of their duties to individuals with a lower sensitivity to heat.

F. Take appropriate action if you observe any of the early signs of heat stress listed below.

1. Clumsiness or lack of coordination

2. Mental confusion or poor judgment

3. Frequent bending over or leaning against objects

4. Going to unusual lengths to get out of sun

5. Workers who claim that they are not too hot when demonstrating one or more of these symptoms

G. Be prepared to give first aid and transport workers suffering from severe heat stress or heat stroke to medical facilities.

3.4. Postoperation

3.4.1. Field

Ensure that all equipment is accounted for and decontaminated (see SOP 5.6, General Equipment Decontamination).

3.4.2. Documentation

A. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

B. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the document control officer (with copies to the site manager and files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

4. SOURCES

American Red Cross. 1979. Standard First Aid and Personal Safety. 2d ed. Garden City, New York: Doubleday and Company, Inc.

NIOSH. 1985. "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities." U.S. Department of Health and Human Services, Center for Disease Control, National Institute for Occupational Safety and Health, Atlanta, Georgia.

5. APPENDIXES

5.1. Equipment and Supplies Checklist

5.2. Heat Stress Monitoring Record Form

5.3. Data Form Completion

5.4. NIOSH Heat Stress Monitoring Table

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

_____ 60-min timer

_____ Stopwatch

_____ Thermometer

APPENDIX 5.2

HEAT STRESS MONITORING RECORD

HEAT STRESS MONITORING RECORD

FACILITY CODE _____ **LOG DATE** _____

LOGGER CODE _____ FIELD REP _____

ACCEPTANCE CODE _____

WORKER NO 1 NAME AND SS NO _____

WORKER NO 2 NAME AND SS NO _____

WORKER NO 3 NAME AND SS NO _____

WORKER NO 4 NAME AND SS NO _____

WORKER NO 5 NAME AND SS NO _____

TIME (HH:MM)	AIR TEMP	% SUNSHINE	ADJ TEMP (°F)	ACTIVITY CODE	PULSE RATE OF WORKER (BEATS PER MINUTE)				
					WORKER 1	WORKER 2	WORKER 3	WORKER 4	WORKER 5

ACCEPTANCE CODES: A–ACCEPTABLE R–RECONNAISSANCE U–UNACCEPTABLE N–NOT DETERMINED

ACTIVITY CODES: BL – BASELINE W – WELL SAMPLING D – DRILLING O – OTHER (SPECIFY)
M – SURFACE MEASUREMENTS BR – BREAK T – TEST PITTING S – SURFACE SAMPLING Z – OBSERVING

COMPLETE BOLDED DATA FOR ENTRY INTO TIMS

HSM–105 (1/88)

_____ FORM COMPLETED BY/DATE

_____ TECHNICAL REVIEWER/DATE

APPENDIX 5.3

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

HEAT STRESS MONITORING RECORD

1. Facility Code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Log Date. The date that information recorded on the form was obtained in the format DD-MMM-YY (01-JAN-88).

3. Logger Code. Three-character or four-character code identifying the company responsible for collecting the information recorded on the form.

4. Field Representative. The name of the field representative.

5. Acceptance Code. One-character code assigned by the site manager.

6. Worker Name and SS No. Name(s) and social security number(s) of the worker(s).

7. Time (HH:MM). The 24-hr clock (see conversion table below) will be used.

Conversion Table

Conventional Time	24-Hr Time
1:00 a.m.	1:00
12:00 noon	12:00
1:00 p.m.	13:00
2:00 p.m.	14:00
3:00 p.m.	15:00
4:00 p.m.	16:00
5:00 p.m.	17:00
6:00 p.m.	18:00
7:00 p.m.	19:00
8:00 p.m.	20:00
9:00 p.m.	21:00
10:00 p.m.	22:00
11:00 p.m.	23:00
12:00 midnight	24:00

8. Air Temperature. The air temperature (°F) measured in the shade.

9. % Sunshine. If cloudy, enter a 0; if sunny, enter 100. If partly cloudy, enter 50.

10. Adj. Temp (°F). The adjusted temperature in °F determined by the formula below.

$$\text{ta adj } F^\circ = \text{ta } F^\circ\,[13 \times (\%\ \text{sunshine}/100)]$$

11. Activity Code. Code describing ongoing activity.

Activity Code Table

Activity	Code
Baseline	BL
Break	BR
Drilling	DR
Grouting	GR
Logging	LO
Measurements	ME
Sampling	SA
End of Break	EB

12. Pulse Rate of Worker (Beats per minute). Pulse rate is measured in beats per minute.

APPENDIX 5.4

NIOSH HEAT STRESS MONITORING TABLE[a]

ADJUSTED TEMPERATURE[b]	NORMAL WORK EMSEMBLE[c]	IMPERMEABLE ENSEMBLE
90°F(32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5°-90°F(30.8°-32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5°-87.5°F(28.1°-30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°-82.°F(25.3°-28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5°F (22.5°-25.3°C)	After each 150 minutes of work	After each 120 minutes of work

Source: Reference [13]

[a]For work levels of 250 kilocalories/hour.

[b]Calculate the adjusted air temperature (ta adj) by using this equation: ta adj F° = ta. F° + [13 x (% sunshine/100)]. Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percentage of sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow 0 percent sunshine = no shadows).

[c]A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

APPENDIX A

VOLATILE ORGANIC SAMPLING AND ANALYSES IN SOIL GAS, SOILS, WATER, AND ATMOSPHERE BY MODIFIED EPA 8021

HYDROGEO CHEM, INC.

VOLATILE ORGANIC SAMPLING AND ANALYSES IN SOIL GAS, SOILS, WATER, AND ATMOSPHERE BY MODIFIED EPA 8021 HYDRO GEO CHEM, INC.

Hydro Geo Chem, Inc.
1430 North Sixth Avenue
Tucson, Arizona 85705
(602)623-6981

TABLE OF CONTENTS

Page

INTRODUCTION 1

Summary of Method 2

1. SAMPLING 5

1.1 Scope and Application 5
1.2 Sampling Equipment 5
1.3 Sample Collection 10
1.4 Decontamination of Equipment 13

2. ANALYSIS 15

2.1 Scope 15
2.2 Detection Limits 15
2.3 Apparatus and Equipment 15
2.4 Calibration 22
2.5 Quality Control 25
2.6 Procedures 32
2.7 Calculations 35

List of Figures

Figure Page

1 Soil Gas Sampling Probe 6
2 Soil Gas Sample Housing 8
3 Soil Gas Sample Collection 11
4 Mobile Laboratory Analytical Schematic 17
5 Purge Apparatus for Shallow Water Samples 20
6 Field Data Sheet 33

TABLE OF CONTENTS (CONTINUED)

List of Tables

Table		Page
1	Compounds EPA Method 8021 (Hall/PID Analysis)	3
2	Breakthrough Volumes for Selected Hydrocarbons on the Carbosieve S-III/Carbopack B/Carbotrap C Thermal Desorption Tube	9

VOLATILE ORGANIC SAMPLING AND ANALYSES IN SOIL GAS, SOILS, WATER, AND ATMOSPHERE BY MODIFIED EPA 8021
HYDRO GEO CHEM, INC.

INTRODUCTION

On site analysis of volatile organic compounds (VOC) is increasingly important to environmental assessments. The ability to perform real-time chemical analysis during investigations of potentially contaminated soils, water, and air allows field decisions to be made regarding the depth and areal extent of the investigation.

The applications of on-site VOC analysis include: soil analysis for evaluation of subsurface spills and leaking tanks; atmospheric analysis for evaluation of VOC emissions from landfills, contaminated soils, and industrial facilities; water analysis for identification and definition of the vertical and areal extent of groundwater VOC plumes; and soil gas surveys in which VOC's in the soil atmosphere are sampled and analysed in order to determine the vertical and areal distribution of VOC's in site soils.

Because VOC's are readily transported in soils by diffusive and advective processes, soil gas surveys have proved to be a powerful technique for determining whether spills have taken place on the site, for locating these spills, and, if subsurface conditions are favorable, for finding and delineating groundwater VOC plumes by the presence of VOC's in overlying soils.

The analytical requirements for real-time mobile-laboratory analysis are different than the conventional VOC analyses prescribed by EPA protocols. The laboratory productivity, that is, the number of analyses required per unit time, must be much greater for the mobile facility. Otherwise, the value of using the data to modify the investigation is diminished.

Despite the need for greater productivity, the other analytical requirements for detection limits, variety of analytes, and freedom from laboratory contamination are, if anything, more stringent than those of fixed laboratory facilities.

The following sampling and analytical protocols have been adopted by Hydro Geo Chem to meet these stringent requirements of on-site VOC analysis.

Summary of Method

In summary, the analytical method consists of the recently approved EPA 8021 protocol, modified to allow greater throughput and to minimize the potential for laboratory contamination. These modifications include temperature programming and flow changes to reduce analytical time, the use of gas rather than water-solution standards, purging of VOA bottles (40 or 250 ml bottles sealed with a teflon septum) directly rather than using a conventional water purging apparatus (a technique recently independently developed and used in EPA Region 5 RI/FS studies), methanol solvent extraction of soils and subsequent stripping of a methanol-water solution; and splitting of the sample injection stream to allow simultaneous analysis on a separate column and detector of other compounds not analyzed by the 8021 protocol. Table 1 lists the compounds that can be analyzed using EPA 8021 protocol.

Table 1. Compounds EPA Method 8021 (Hall/PID Analysis)

Benzene
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromoform
Bromomethane
n-Butylbenzene
sec-Butylbenzene
tert-Butylbenzene
Carbon tetrachloride
Chlorobenzene
Chloroethane
Chloroform
Chloromethane
2-Chlorotoluene
4-Chlorotoluene
Dibromochloromethane
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
Dibromomethane
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Dichlorodifluoromethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
1,2-*cis*-Dichloroethene
1,2-*trans*-Dichloroethene
1,2-Dichloropropane
1,3-Dichloropropane
2,2-Dichloropropane
1,1-Dichloropropane
Ethylbenzene
Hexachlorobutadiene
Isopropylbenzene
p-Isopropyltoluene
Methylene chloride
Naphthalene
n-Propylbenzene
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethene
Toluene
1,2,3-Trichlorobenzene
1,2,4-Trichlorobenzene
1,3,5-Trichlorobenzene
1,1,2-Trichloroethane
1,1,1-Trichloroethane
Trichlorofluoromethane
1,2,3-Trichloropropane
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
Vinyl chloride
o-Xylene
m-Xylene
p-Xylene
Trichloroethene

The sampling methods included in the protocol have been designed to allow accurate, contamination-free sampling of soils, water, atmosphere, and soil gas. These methods offer a detection limit of at least 0.1 μg/kg (soil), 0.01 μg/l (soil gas or water), and 0.001 μg/l (atmosphere) for any compounds listed in Table 1. Additional, simultaneous analysis is provided for total petroleum hydrocarbons, methane, and total chlorinated hydrocarbons. The following sections document the materials, apparatus, and procedures used.

1. SAMPLING

1.1 Scope and Application

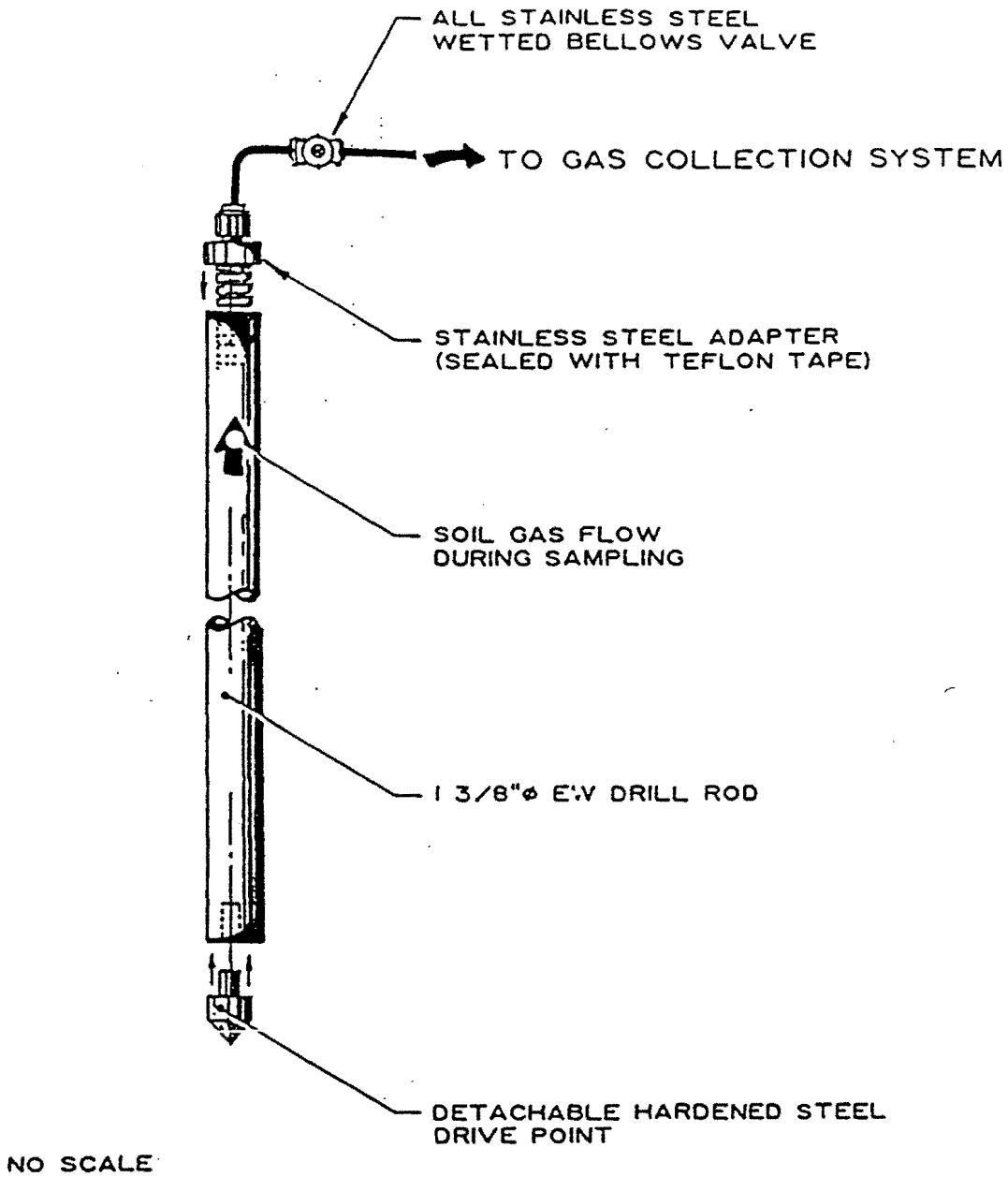
This section covers the materials, equipment and procedures utilized by Hydro Geo Chem, Inc. for collecting soil gas, atmospheric, soil, and shallow groundwater samples in the field.

1.2 Sampling Equipment

1.2.1 Sampling Probes and Drive Point Rigs

Sampling probes consist of 5 foot sections of nickel plated $1^3/_8$" hardened EW drill rod with Acme threads. The high carbon steel points are left behind when the pipe is hydraulically pulled back to expose the formation to pumping. Figure 1 shows our probe design. The probes are driven to the sampling depth using a heavy duty hydraulic hammer mounted on Ford F-450 trucks. These rigs are capable of driving sampling pipe to a depth in excess of 50 feet under normal driving conditions. The drive point rigs are equipped with hydraulic outriggers, pipe racks and a steam cleaner. The probes are removed by the drive point rig using a hydraulically activated pulling dog. Latex gloves are worn during handling and assembling of the sampling apparatus.

HYDRO GEO CHEM, INC.



NO SCALE

SOIL GAS SAMPLING PROBE

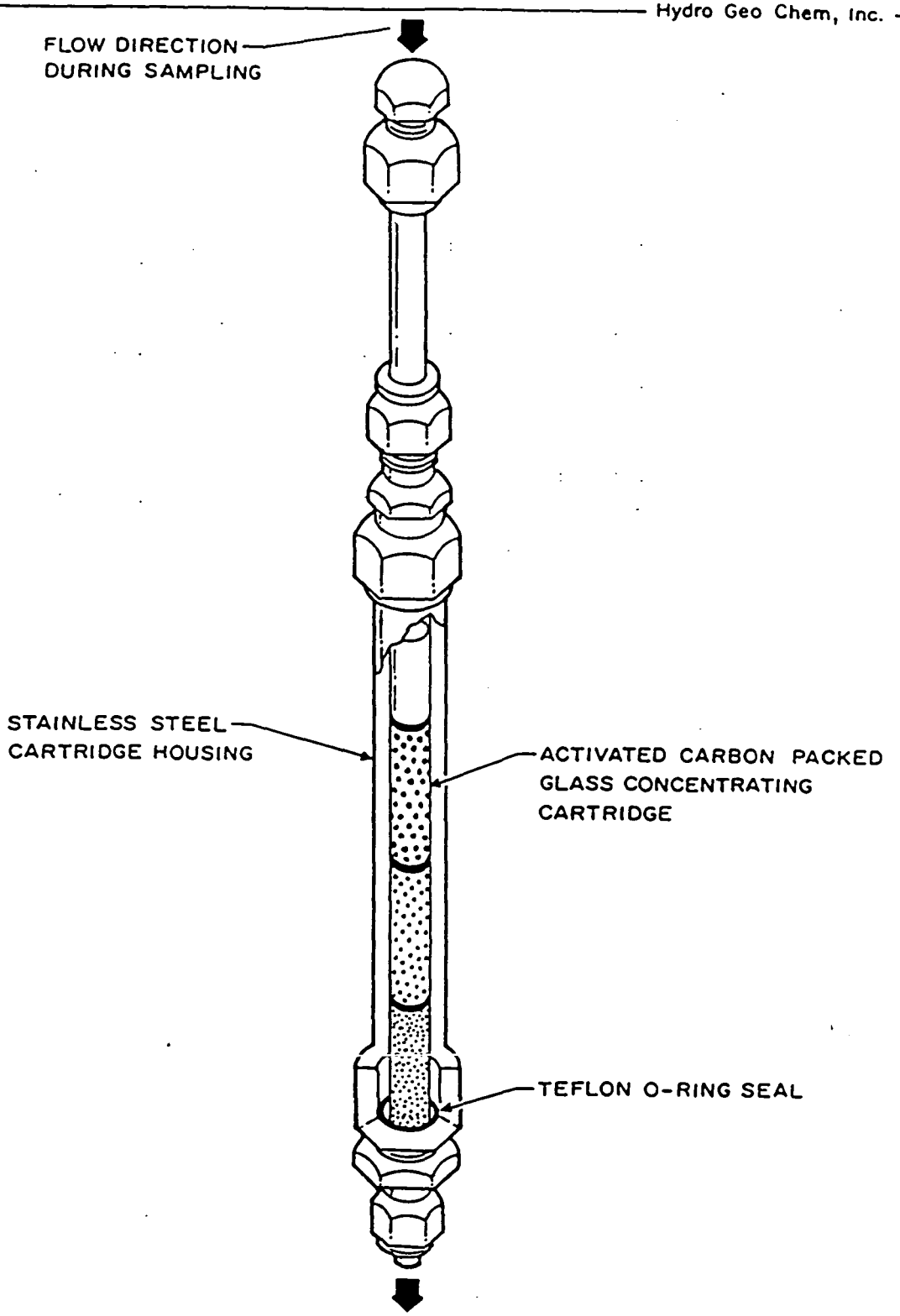
FIGURE 1

1.2.2 Sampling Adaptors

Soil gas samples are collected from the probes via adaptors constructed of stainless steel pipe caps welded to stainless steel tubing connected to an inline stainless steel bellows valve.

1.2.3 Soil Gas Cartridges

Atmospheric or soil gas samples are collected in stainless steel cartridges housing a glass tube (Supelco) filled with a three layer packing of various types of adsorptive hydrophobic carbon (see Figure 2). The soil gas is passed through these layers, the first, Carbotrap, absorbing "heavy" volatiles such as dichlorobenzene, the second, Carbopack B, the lighter volatiles such as TCE and DCE, and the third, Carbosieve III, the ultralights such methylene chloride or vinyl chloride. The most mobile constituent, vinyl chloride, has a breakthrough volume of 158 liters (vinyl chloride detected at the tube outlet after 158 liters of 25 ppb vinyl chloride are passed through the cartridge). These cartridges are therefore rated to absorb at least 158 liters of soil gas or atmospheric gas before breakthrough of any of the priority pollutants listed in EPA method 8021. Table 2 shows some breakthrough volumes for the types of carbon sorbents making up the adsorption cartridge. Thus the sampling capacity of this technique far exceeds that of syringe collection. The high capacity is necessary to meet the wide range of specified detection limits encountered in site investigations.



SOIL GAS SAMPLE HOUSING

Figure 2

Table 2

Breakthrough Volumes (in Liters) for Selected Hydrocarbons on the Carbosieve™ S-III/Carbopack B/Carbotrap C Thermal Desorption Tube

Hydrocarbon	Carbosieve S-III (125 mg)	Carbopack B (200 mg)	Carbotrap C (300 mg)
Vinyl Chloride	158		
Chloroform		1.1	
1,2-Dichloroethane		0.4	
1,1,1-Trichloroethane		2.7	
Carbon tetrachloride		4.7	
1,2-Dichloropropane		6.8	
Trichloroethylene		2.5	
Bromoform		1.7	
Tetrachloroethylene		2.2	
Chlorobenzene		316	
n-Heptane		262	
1-Heptene		284	
Benzene		2.3	
Toluene		130	
Ethylbenzene		4060	12.9
p-Xylene			11.2
m-xylene			11.0
o-xylene			11.0
Cumene			27.8

1.2.4 Groundwater Samples

Groundwater is sampled through the $1^3/_8$ inch EW drill rod using $^3/_8$" stainless steel bailers.

1.2.5 Soil Samplers

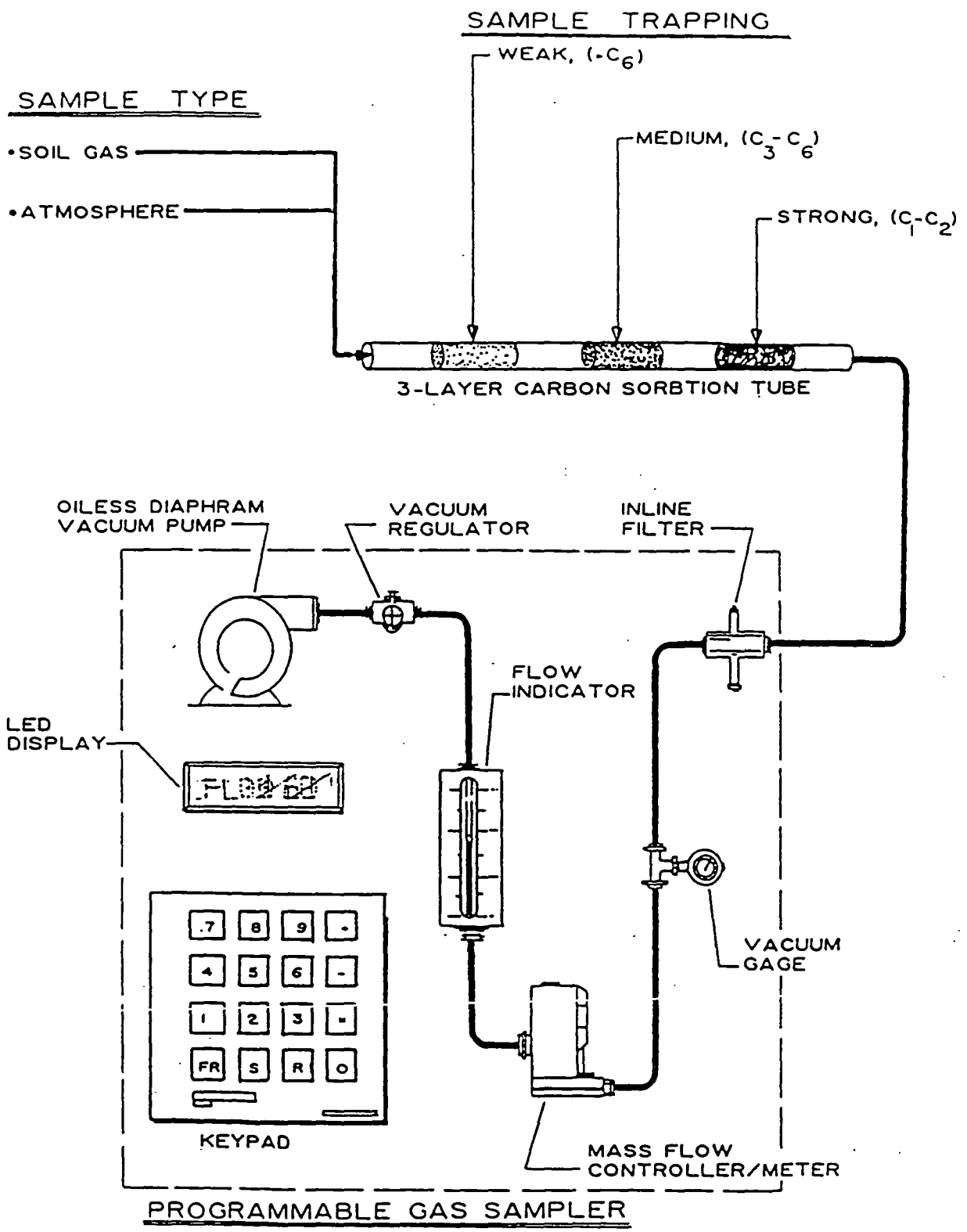
Soil is sampled at specified intervals using a 1 inch diameter by 12 inch length ring-barrel sampler containing multiple stainless steel sleeves.

1.3 Sample Collection

1.3.1 Soil Gas Sampling

After purging 3 probe volumes from the sampling train, the bellows valve on the adaptor is shut off and the stainless steel sample cartridge housing is attached in line using Swagelok compression fittings. The cartridge inlet leads to the adaptor and the outlet to a programmable mass flow controller equipped with a vacuum regulated oilless diaphragm vacuum pump (see Figure 3). The flow controller is typically programmed to pump 200 ml of soil gas at a flow rate of 100 ml/min. When the specified flow volume has been obtained, a

fig 3



SOIL GAS SAMPLE COLLECTION

Figure 3

solenoid valve is automatically closed and the sample collection is complete. The mass flow meter delivers sample volumes between 20 and 5000 standard ml with less than 2% error independent of temperature and vacuum conditions.

1.3.2 Atmospheric Sampling

Atmospheric samples are collected by positioning the probe in the area of interest, and programming the mass flow controller to the appropriate pumping rate and total sample volume. If desired, the probe can be moved through a sampling volume at a specified rate to collect an integrated sample. No purging is necessary for atmospheric samples.

1.3.3 Soil Sampling

Soil samples are collected using 1" ring samplers equipped with three 4" stainless steel sleeves. The $1^3/_8$" sampling probe is first equipped at its end with a retrievable point and emplaced to depth. The sampling probe is then fully extracted and the retrievable point is replaced with the 1" ring sampler. The sampling probe is then run back into the original hole and the sampler is driven 12" beyond the hole bottom. The sampling probe is extracted again and the 1.0" ring sampler detached. No liquids (i.e., drilling mud, water, foam) are used

during the probe placement or sampling procedure. All soil samples to be analyzed or sent out for analysis are retained in the stainless steel tubes (1.0 inch diameter, 4 inches long). Immediately following removal of the stainless steel sleeves from the sampler, the center tube is capped with aluminum foil and plastic slip caps. The slip caps are then duct taped to the stainless steel sleeves to maintain a proper seal. Samples are labeled and placed in a zip lock plastic bag and stored in a cooler.

1.3.4 Water Sampling

Groundwater samples are collected using $^{3}/_{8}$" stainless steel bailers. The bailers are lowered down the inside of the probe using a nylon cord that is replaced before each sampling. The water sample is carefully poured in 40 ml VOA vials in a manner not to allow air bubbles to pass through the water sample. The liquid full vials are then immediately capped with a teflon-lined septum cap and delivered to the mobile lab for analysis.

1.4 Decontamination of Equipment

1.4.1 Prior to each use and reuse, each soil sampler, stainless steel sleeve, sampling probe, point and bailer are steam cleaned and stored in clean storage areas on the drive point rigs. Care is taken with this equipment to eliminate both soil-surface and cross-hole contamination.

Vinyl or latex surgical gloves are worn during handling and assembly of the sampling apparatus.

1.4.2 Adaptors, stainless steel bottles, and stainless steel cartridge holders are heated to 120°C using a convection oven and held for 1 hour at that temperature. Carbon packed desorption cartridges are purged at 400°C with helium for 8 minutes.

1.4.3 Separate storage areas are provided for used and cleaned equipment. No equipment is reused without cleaning.

2. ANALYSIS

2.1 Scope

This section covers the equipment, materials, and procedures used to determine the concentrations of various volatile organic compounds in the soil gas, atmospheric, soil, and shallow groundwater samples.

2.2 Detection Limits

Method detection limits (MDL's) are matrix dependent. The MDL for soil gas samples is 0.01 μg/l, 0.01 μg/l for water and 0.1 μg/kg for soils. The MDL for atmospheric samples is 0.001 μg/L. The applicable concentration range of this method is influenced by sample size and instrument limitations.

2.3 Apparatus and Equipment

2.3.1 Gas Chromatographs

Hydro Geo Chem's mobile laboratories, used to provide on-site analyses, are housed in 18 foot custom built non-motorized trailers. The mobile laboratories are stand-alone vehicles that operate separately from the drive point rig, thereby allowing efficient operation of both. Each mobile lab has a Varian 3400 temperature programmable gas chromatograph (GC) equipped with cryogenics capable of cooling the column to below 0°C using carbon dioxide. The chromatograph is connected to an Envirochem thermal desorber (Model 850) which accepts the glass sorption tubes used to collect the soil gas, atmospheric,

or the purged water or soil samples. Figure 4 is a schematic of the analytical apparatus. Helium flow is opposite to the flow direction of sample collection. The thermal desorber rapidly heats the sample sorption tube to 380 ± 4°C in 26 ± 2 seconds releasing the volatile organic compounds from the activated carbon. The released compounds are transferred from the desorber unit to the analytical columns via heated (250°C) nickel lines. The compounds are held in the cooled columns (cryofocused) at the start of the chromatographic run.

The carrier gas is ultra high purity helium at 10-20 ml/minute. The carrier gas flow is augmented with an additional 25 ml/minute helium before entering the photoionization detector (PID) to optimize response of both PID and Hall electrolytic conductivity (Hall) detectors.

2.3.2 GC Columns

A DB 624 Megabore column, 30 m x 0.53 mm (J&W Scientific) is used in the Varian 3400 chromatograph. The helium flow rate is adjusted to approximately 7.0 ml/minute. The temperature program varies with the client needs. A typical temperature program is as follows: the column temperature is held at 2°C for 3 minutes, then

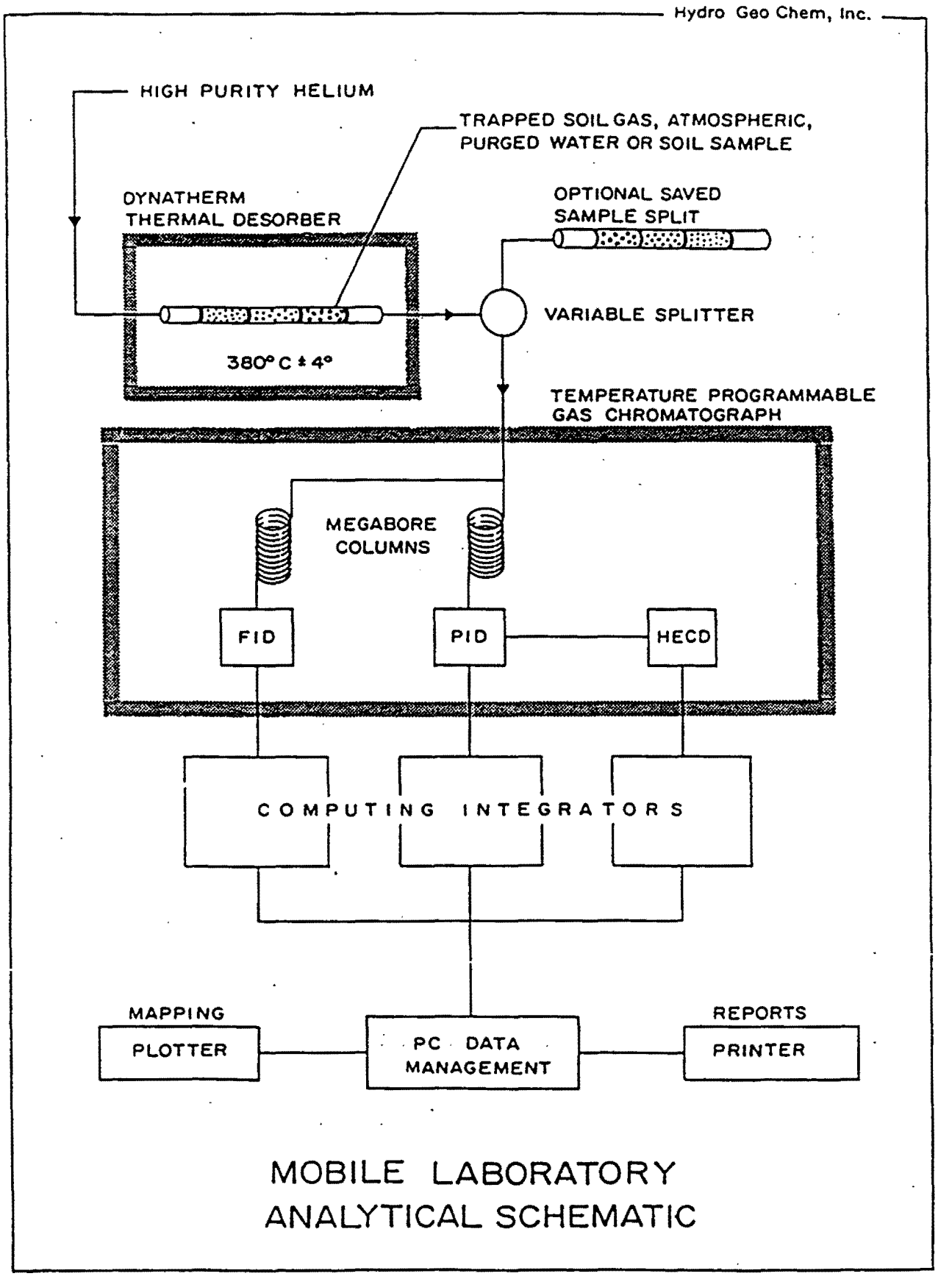

Hydro Geo Chem, Inc.
HIGH PURITY HELIUM
TRAPPED SOIL GAS, ATMOSPHERIC, PURGED WATER OR SOIL SAMPLE
DYNATHERM THERMAL DESORBER
OPTIONAL SAVED SAMPLE SPLIT
VARIABLE SPLITTER
380° C ± 4°
TEMPERATURE PROGRAMMABLE GAS CHROMATOGRAPH
MEGABORE COLUMNS
FID
PID
HECD
COMPUTING INTEGRATORS
MAPPING
PLOTTER
PC DATA MANAGEMENT
REPORTS
PRINTER
MOBILE LABORATORY ANALYTICAL SCHEMATIC

Figure 4

programmed to 35°C at 15 C°/minute, no hold time, to 145°C at 8 C°/minute, no hold, to 230°C at 35 C°/minute.

Additional columns are available for the analysis of pesticides and classes of hydrocarbons other than aromatic and halogenated. Columns available include DB-WAX, 30m x 0.53mm, DB-5, 30m x 0.53mm, and DB 608, 15m x .53mm. All columns are obtained from J&W Scientific.

The GC is also equipped with a 1/8" x 18" Carbosphere column, 60/80 mesh, used to analyze for nonsorbable gases, such as methane, by direct injection. This column is operated at ambient temperatures.

2.3.3 Detectors

2.3.3.1 A photoionization detector (PID) equipped with a 10.2ev lamp (Tracor Model 703) is used.

2.3.3.2 A Hall electrolytic conductivity detector (HECD) (Tracor Model 700A) is also used. Operation conditions are as follows:

Reaction tube:	Nickel 1/16" OD
Reactor temperature:	900°C
Reactor base temperature:	250°C

Electrolyte:	n-propyl alcohol
Electrolyte flow rate:	0.7 ml/min
Reaction gas:	hydrogen at 35 ml/min.
Carrier gas plus make up:	helium at 32 ml/min.

2.3.3.3 Hydro Geo Chem also has available an Electron Capture Detector, ECD (Varian).

2.3.3.4 A Flame Ionization Detector, FID (Varian), is also provided for total hydrocarbon analyses.

2.3.4 Integrators

The mobile laboratories are equipped with Spectra Physics dual channel integrators (Model 4400) and Varian integrating printer/plotters.

2.3.5 Purge and Trap Apparatus

An in-house designed and built purging apparatus (Figure 5) is used in the analysis of soil and water samples. High purity, inert (He

PURGE APPARATUS FOR SHALLOW WATER SAMPLES

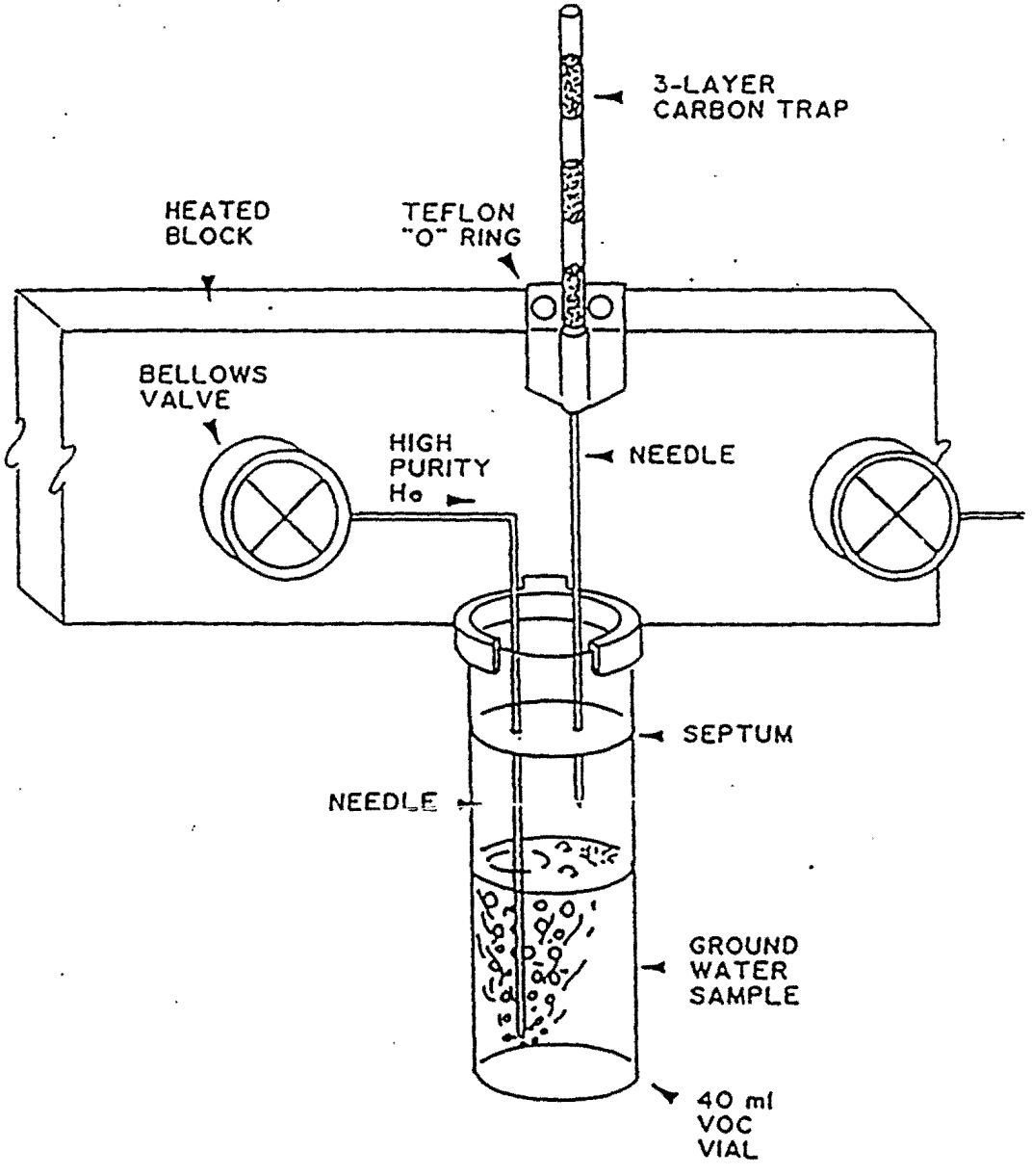


Figure 5

or N_2) gas is bubbled through the sample at 200 ml/min for 15 minutes. In addition, a temperature programmable Dynatherm Thermal Dynamic Stripper is also used for purging both soil and water samples. Purged sample components are trapped in activated carbon cartridges.

2.3.6 Standards and Reagents

2.3.6.1 Standards are obtained from certified gas mixtures or prepared from stock mixtures of neat reagent grade compounds. Stock mixtures are prepared by adding a measured aliquot of each compound to be analyzed to a preweighed septum sealed vial. The actual mass of each compound added is determined by weighing the vial. An aliquot volume of the final mixture is then weighed to establish density (weight/volume). Weighing is done on a 0.1 mg Mettler balance calibrated according to manufacturers guidelines with weights traceable to NBS standards. Certified mixtures include vinyl chloride in nitrogen, and methane in nitrogen purchased from Matheson Gas Products, Cucamonga, California.

2.3.6.2 A spiking solution containing two compounds to be used as internal standards are prepared as described in Section 2.3.6.1. The internal standards are selected such that they do not interfere with the compounds of interest. Typical compounds used as internal standards are fluorobenzene, 2-bromo-1-chloropropane, bromochloromethane, 1-

chloro-2-bromobutane, and 4-bromo-fluorobenzene. The internal standard is added to the calibration standards or samples and carried through the analytical procedure. The amount of internal standard is selected such that its concentration is 3 to 5 times greater than the expected range of concentrations found in the actual samples.

2.3.6.3. VOC-free water used in purging soil samples is prepared from distilled water degassed by boiling >1 hour.

2.3.6.4 Purge and Trap or HPLC grade methanol is used when analyzing soil samples.

2.4 Calibration

2.4.1. Calibration

2.4.1.1 For daily soil gas calibration standards, a measured volume of the standard mixture is injected into a nitrogen-filled 1-liter glass, gas bottle through a septum side port. After heating the bottle to achieve volatilization and mixing of the standards, measured volumes are extracted with a gas syringe and injected into a 200 ml/min helium gas stream leading to a carbon packed sorption cartridge. Internal standards, if utilized, will also be injected at this time. After 2 minutes,

this cartridge is inserted into the thermal desorber and analyzed exactly as the samples.

2.4.1.2 Standards used for soil and water analysis are prepared by injecting an aliquot of the stock mixture into methanol. An aliquot of the methanol solution will be injected into a 10.0 ml volume of water and purged in the same manner as soil or water samples. The aliquot of stock standard and methanol solution will depend on concentrations anticipated in the samples.

The amount of the standard stock solution used are dependent upon the required mass of analyte.

The standard will be injected at least three times at the beginning of the day to verify the instrument response. If the response varies by greater than ±20% appropriate measures will be taken to correct the circumstances causing the variability. Continuing calibration checks are performed after every tenth sample.

2.4.1.3 standard Spectra Physics calculates response factors when the external method is used as follows.

$$RF = A/C$$

where A = area of analyte to be measured

C = concentration of analyte, μg/l

Varian 3400 calculation of RF

$$RF = C/A \times 10000$$

2.4.1.4 The Spectra Physics calculates response factors when internal standards are used as follows.

$$RF_S = \frac{C_S}{A_S} x \frac{A_{IS}}{C_{IS}}$$

where RF_S = response factor of components

A_S = area of components peak

C_S = amount of component used in the calibration sample, μg

A_{IS} = Area of the internal standard peak

C_{IS} = amount of internal standard used in the calibration sample, μg

2.4.1.5 Acceptable retention time window is ±0.10 minutes from the average retention time derived from the daily calibration analyses.

2.5 Quality Control

2.5.1 System Bank

A randomly selected sampling cartridge is analyzed daily to detail interferences from cartridges or the analytical system. If interference is found at unacceptable levels, an unpacked cartridge is analyzed to determine whether the interference is due to the cartridge or to the analytical system. Appropriate measures are taken to eliminate such interferences.

2.5.2 Reagent Blanks

At the beginning of each day that soil or water samples will be analyzed, the chemist fills a sampling container with reagent water/methanol and proceeds to handle it as an actual sample is handled in order to demonstrate that the system, methanol, and water are interference-free. If VOC's are detected, a water blank will be analyzed to determine if the interferences are in the water or the methanol. Appropriate measures will be taken to eliminate the interferences.

2.5.3 Field Blanks

2.5.3.1 Soil Gas

Prior to each day's soil gas or atmospheric sampling, field blanks of the entire sampling apparatus are taken and analyzed to check background contamination in the sampling system and cartridges. Sampling cartridges are attached to both the inlet and outlet end of a sampling probe. The sample collected in the discharge end cartridge is representative of sampling train contamination only while the intake cartridge provides a measure of the atmospheric concentrations. Additional field blanks are collected prior to any reuse of recleaned sampling equipment.

2.5.3.2 Water

A sampling container will be filled with interference-free water in the field in the same manner as water samples are collected. This sample, now designated as a field blank, is returned to the laboratory for analysis. If VOC's are detected, sample collection procedure will be reviewed. If necessary, sampling equipment will be thoroughly decontaminated. One field blank will be collected and analyzed on each day that water samples are collected.

2.5.3.3 Soil

Collection of field blank soil samples is not feasible due to the nature of the matrix and because interference-free soil is ordinarily not available.

2.5.4 Duplicate Samples

Duplicate soil gas, atmospheric, or shallow groundwater samples are collected from each sampling location. Duplicate analyses are performed on at least 10% of the samples collected. Duplicate analyses are not performed on soil samples because it would require homogenization of the sample, tend to release volatiles from the sample, and therefore, limit the accuracy of the results.

2.5.5 Trip Blanks

2.5.5.1 Soil Gas

An unused sample cartridge is transported into the field with the sampling equipment. The trip blank cartridge is handled in the same manner as a sample, but a sample is not collected through this cartridge. The trip blank is returned to the lab with the other samples and

analyzed. If VOC's are detected, sample handling and transport procedures are subsequently reviewed.

2.5.5.2 Water

A sampling container is filled with water determined to be interference-free and taken into the field. The trip blank container is handled in the same manner as other water samples. The trip blank is then returned to the laboratory for analysis with the other samples. If VOC's are detected, sample handling and transport procedures are reviewed and sampling equipment is decontaminated as necessary.

2.5.5.3 Soil

Trip blanks for soil sampling are not used because uncontaminated soils without background levels of organics are not available and the trip blank procedures are not feasible.

2.5.6 Matrix Spike Duplicate

2.5.6.1 Soil Gas

During each standard calibration procedure for soil gas analysis, the activated carbon in the sample collection cartridges is directly spiked and thermally desorbed.

2.5.6.2. Water

Once a day a duplicate field sample is spiked with a calibration standard of known concentration. This spiked sample is then processed and analyzed in the same manner as all samples. The difference between the reported concentration per compound and the concentration of the spike are then compared to the previous analysis of the unspiked sample duplicate.

2.5.6.3. Soil

Soil sample spikes are provided on purged soil samples by injecting a compound of known concentration directly into the vessel containing methanol extract of the soil. The soil sample is then purged and trapped onto the carbon cartridges for thermal desorption analysis to evaluate purging efficiencies.

2.5.7 Chromatographic Information

2.5.7.1 System Parameters

On the first page of each day's chromatograms, the following system parameters are noted:

A) Gas flows for H_2, He, N_2, and air

B) Tank pressures for H_2, He, N_2, and air

C) Temperatures

1. Injector
2. Columns
3. Detector
4. Thermal desorber oven
5. Thermal desorber transfer lines
6. Thermal desorber desorption temperature and duration

D) Integrator parameters

1. Attenuation
2. Peak markers
3. Baseline offset

E) Column(s)

1. Type
2. Length and diameter
3. Packing material
4. Temperature

F) Operator

G) Date

If any system parameters change, the changes shall be noted.

2.5.8 Internal Quality Control

All chromatograms are reviewed internally by a chemist other than the chemist performing the analysis.

2.5.9 Outside Quality Control Audits

Samples are periodically sent to independent laboratories for analysis as a quality assurance check.

2.5.10 Sample Chain of Custody

All samples are labeled with the following information:

1) Sample identification number
2) Date and time of sample collection
3) Name of sampler

In addition to labeling the samples, a field data/chain of custody form is completed for each sample (Figure 6). At the time of sample collection, the field sampler signs the custody form and records the date, time and sampling conditions. The sample is then transferred to the laboratory, where the individual receiving the sample for analysis signs the original custody form and records the date and time. This Soil Gas

Field Data Sheet (Chain of Custody Form) is then filed in a notebook with the hard copy of the analytical results and eventually becomes part of the final report.

2.6 Procedures

2.6.1 Typical chromatographic equations are summarized in Section 2.7.

2.6.2 The system is calibrated daily as described in Section 2.4.1.

2.6.3 Soil Water Samples

A representative fraction, typically 20 ml of each cooled soil water sample will be transferred to a tared 40.0 ml VOC vial. The remaining volume is stored at less than 4°C. If less than 20 ml of the soil water sample is used, the volume will be brought to 25 ml with VOC-free reagent water prior to purging. Any surrogate or spiking

HYDRO GEO CHEM, INC.

Sample #_____ Date/Time_____ Data Base File____

Location Description_____

Sampler's Signature_____Soil____Water____Soil Gas____

Weather_____Air Temp.(°F)_____ Soil Temp.(°F)_____

Wind Direction & Speed_____Surface Conditions_____

Cartridge # A=_____ B=_____Sample Size (ml) A=_____ B=_____

Adapter #_____Probe Depth_____Probe Volume (ml)_____

Purge Rate_____Purge Time_____Minutes Purge Vacuum_____"Hg

Sample Flow Rate_____ml/min Sample Vacuum ("Hg) A=_____ B=_____

Notes_____

Lab Receipt: Signature_____Date/Time_____

Compound	Concentration (µg/L) A	Concentration (µg/L) B	Notes

Figure 6

mixture will then be introduced by piercing the septum and injecting the mixture below the water surface. Following any additions, needle sparging will be carried out for 15 minutes under ambient lab temperatures using a purge gas flow rate of 200 ml/minute. The purged volatile compounds will then be trapped on a packed cartridge which is held at 40°C to minimize carry-over of water.

2.6.4 Soil Samples

Five grams of each soil will be transferred to a 40 ml VOC vial. Immediately following, five milliliters of HPLC-grade methanol will be added and the vial sealed. Any surrogate or spiking mixture will then be added by piercing the septum and injecting the mixture below the methanol surface. Following any additions, the soil/methanol mixture will be agitated to fully wet the soil with the extracting solution. After allowing the soil/methanol mixture to settle so that a particulate free layer forms, a measured aliquot will be transferred to a second 40.0 ml VOC vial containing 25 ml of VOC-free reagent grade water. The second vial will then be needle sparged for 15 minutes under ambient laboratory temperatures using a purge gas flow rate of 200 ml/minute. The purged volatile compounds will then be trapped on a packed cartridge which will be held at 40°C to minimize carry-over of water.

2.6.5 Gas Samples

The thermal desorption tubes on which the samples are collected are placed in the thermal desorber and heated to 380 ±4°C with a helium flow of 20 ml/min. at the same time that the GC temperature program is initiated and data acquisition started. The trapped materials are desorbed and carried through the heated transfer lines to the GC columns where separation occurs (Figure 4).

2.7 Calculations

2.7.1 Each analyte in the sample chromatogram is identified by comparing the retention time of the suspect peak to retention times generated by the calibration standards on the appropriate detector. When applicable, the relative response of the alternate detector to the analyte is determined. The relative response should agree to within 20% of the relative response determined from the standards.

2.7.2 Quantitation is usually performed on the detector which exhibits the greater response if all detectors respond to an analyte. In cases where greater specificity or precision would result, the analyst uses his/her professional judgement in determining the alternate detector.

2.7.3 The concentration of the unknowns is determined by using the calibration curve or by comparing the peak height or area of the unknowns to the peak height or area of the standards as follows for external standards:

External Standards:

$$C = (A/RF)(1/SA)$$

or $$C = (A \times RF/10000)(1/SA)$$

where C = concentration of the analyte in sample in μg/L

SA = sample amount in L or kg

RF = relative response factor

Internal Standards:

$$C_{\mu g/l} = \left(\frac{IS}{SA}\right)\left(\frac{RF_S A_S}{RF_{IS} A_{IS}}\right)$$

where C μg/L = concentration of the component of interest present in the sample

SA = sample volume or mass (L or kg)

IS = the amount of the internal standard added to the samples

RF_S = response factor of component's determined by calibration

A_S = area count of the components in the sample analysis

RF_{IS} = response factor of the internal standard is

1 by definition

A_{IS} = the area of the internal standard in the sample analysis run

2.7.4 The results for the unknown samples are reported in μg/L. The results are rounded off to the nearest 0.01 μg/L or 2 significant figures.

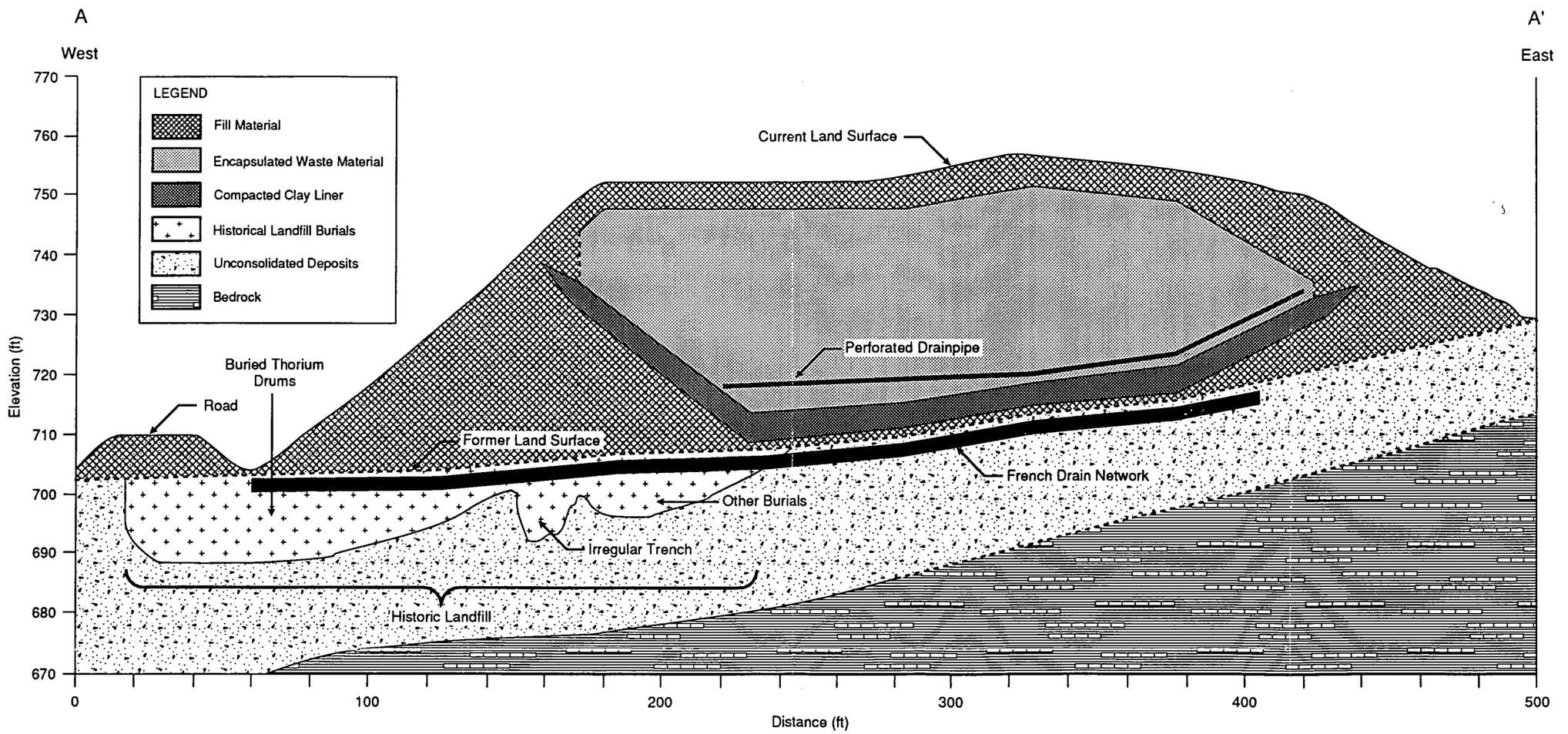
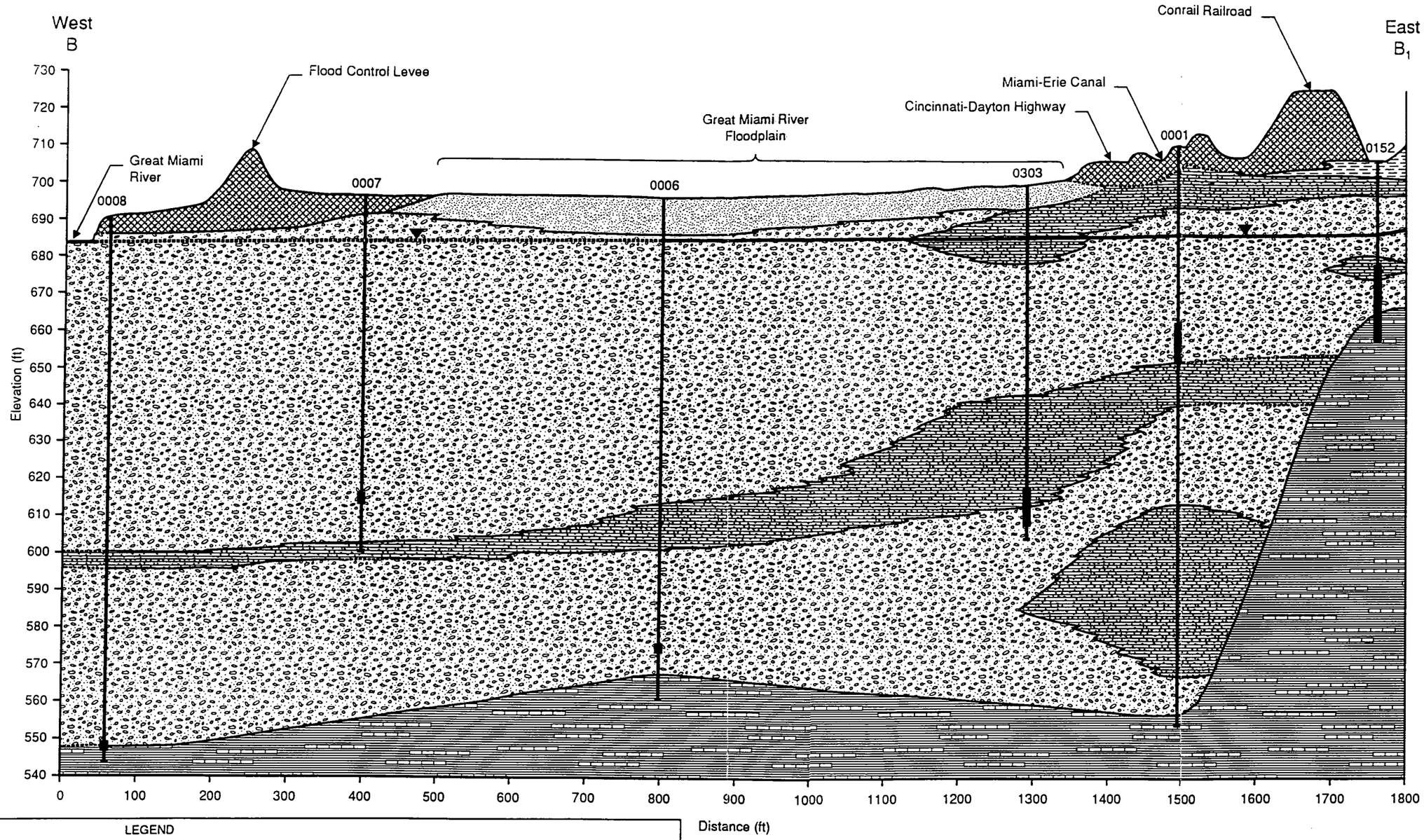


Figure 2.4. Schematic cross section A-A'



LEGEND

Variable permeability	Artificial fill: consists of variable proportions of gravel, sand, and clay	0152	Well borehole number
Moderate permeability	Recent alluvium	----------	Inferred contact or water level
Very low permeability	Clay-bearing glacial till: clay containing trace amounts of silt and sand		Well borehole showing screened interval
Low permeability	Glacial till: clay containing variable proportions of gravel, sand and silt		Static water elevation (January 1991)
Moderate to high permeability	Glacial outwash: sand and gravel containing some silt and trace amounts of clay		
Variable fracture permeability	Bedrock: interbedded limestone and shale		

Vertical Scale in Feet: 0 – 10
Horizontal Scale in Feet: 0 – 100

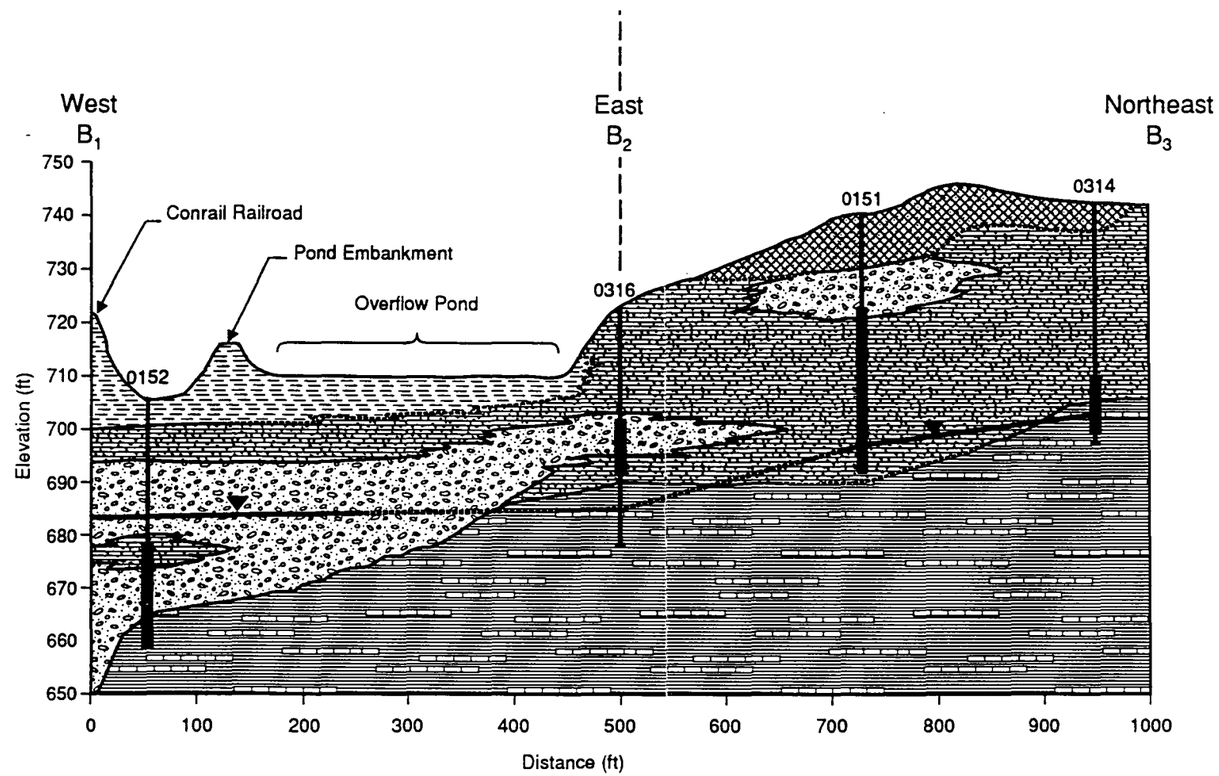
Vertical Scale Exaggerated 5 Times

Well ID	T	S	K (ft./day) I	K (ft./day) W
0152	37,360	0.1264	–	–

T - transmissivity
S - storativity
K - hydraulic conductivity
I - injection
W - withdrawal

MNDAB/XSectB-B1 6-12-91

Figure 2.18. Geologic cross section B-B_1.



LEGEND

Variable permeability	Artificial fill: consists of variable proportions of gravel, sand, and clay	0152	Well borehole number
Essentially impermeable	Clay-bearing glacial till: clay containing trace amounts of silt or sand	----------	Inferred contact or water level
Low permeability	Glacial till: clay containing variable proportions of gravel, sand, and silt		Well borehole showing screened interval
Moderate to high permeability	Glacial outwash: sand and gravel containing some silt and trace amounts of clay		Static water elevation (January 1991)
Variable fracture permeability	Bedrock: interbedded limestone and shale		

Vertical Scale in Feet 10 0

0 100 Horizontal Scale in Feet

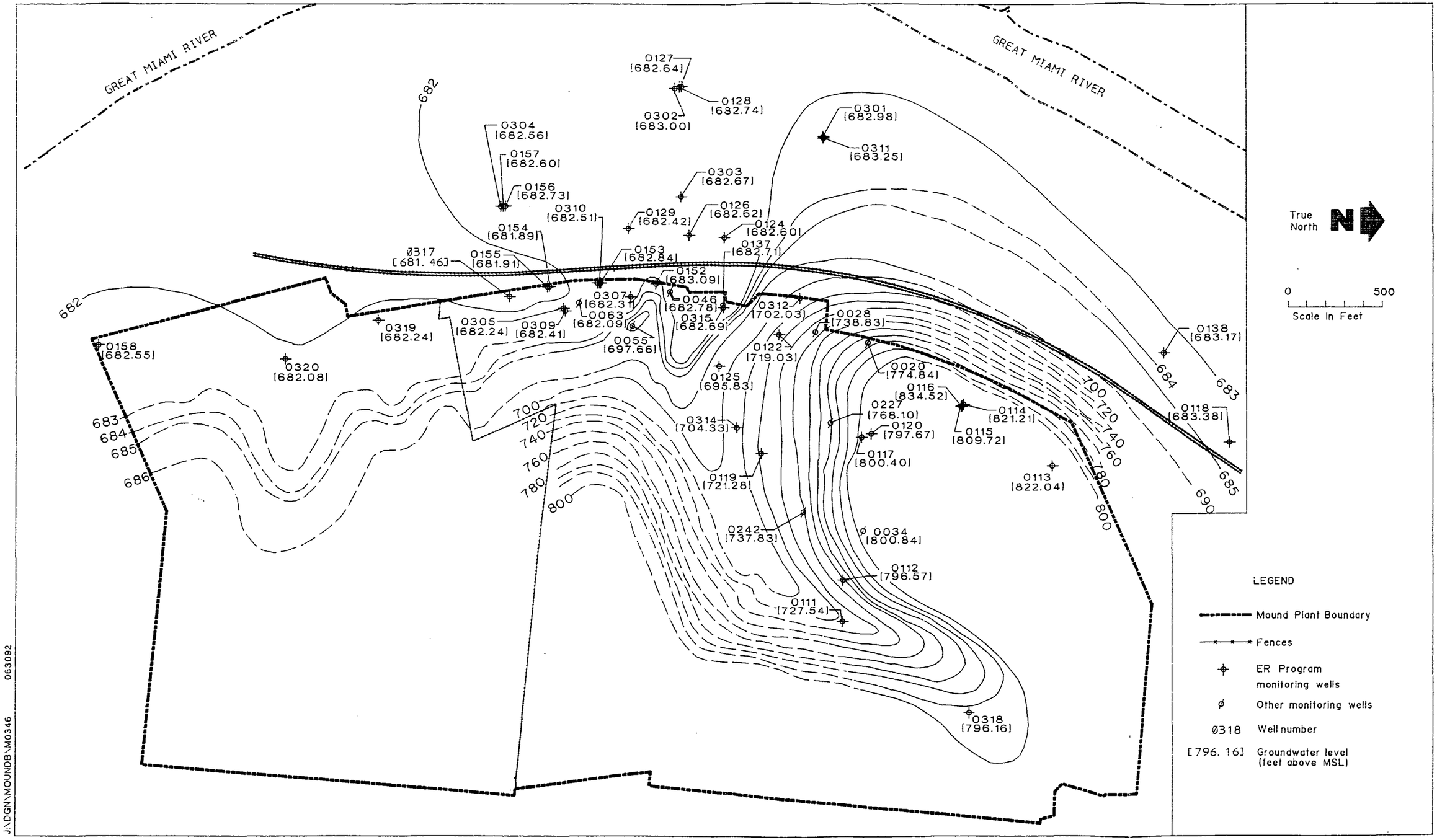
Vertical Scale Exaggerated 5 Times

Well ID	T	S	K (ft./day) I	K (ft./day) W
0152	37,360	0.1264	–	–
0314	–	–	0.6	–

T - transmissivity
S - storativity
K - hycraulic conductivity
I - injection
W - withdrawal

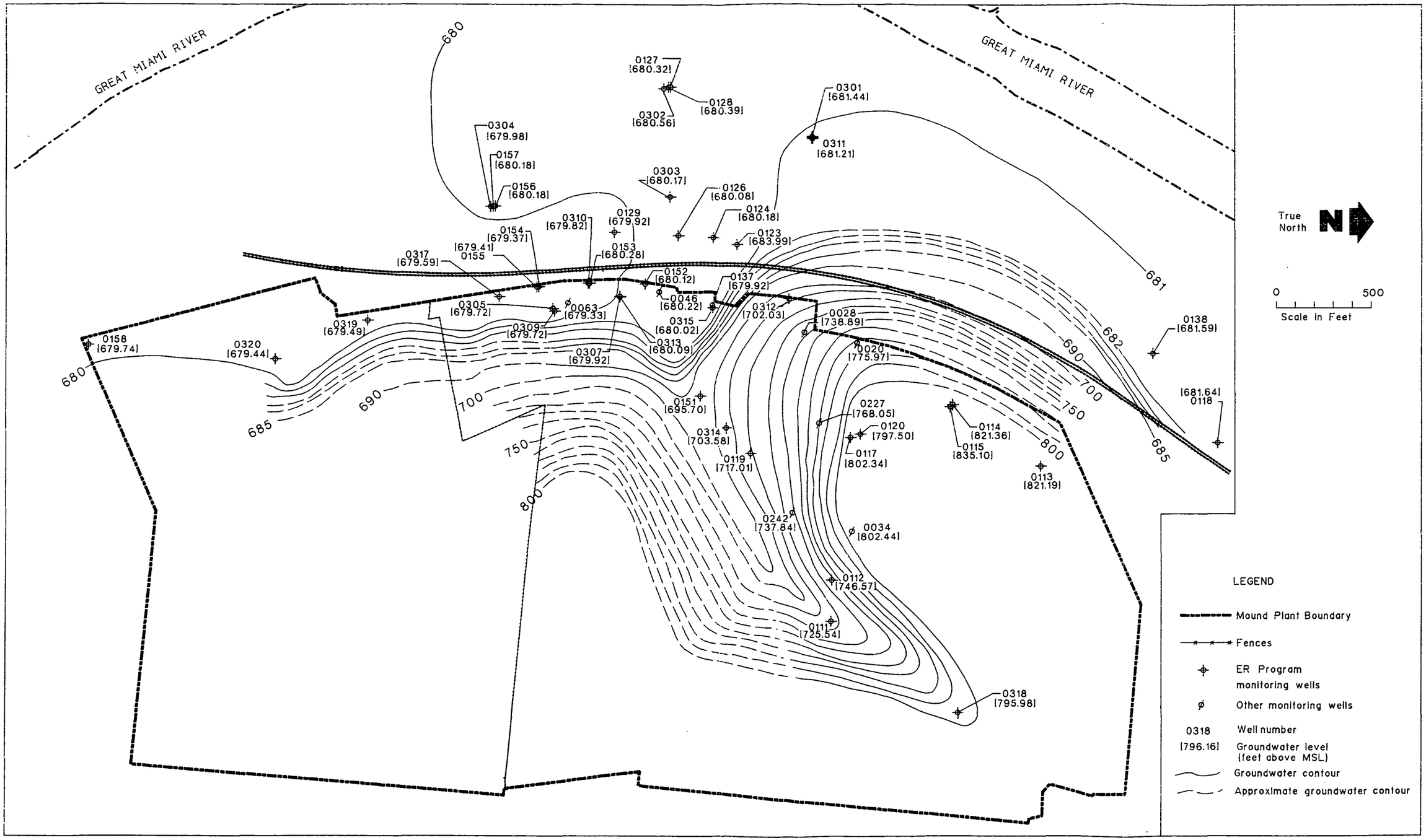
MNDAB/XSect8-B2 4/24/91

Figure 2.19. Geologic cross section B_1-B_3.



J:\DGN\MOUNDB\M0346 063092

Figure 2.20. Average localized groundwater level contour map for September, 1990, April and July, 1991.



J:\DGN\MOUNDB\M0380 063092

Figure 2.21. Localized groundwater level contour map for September, 1990.

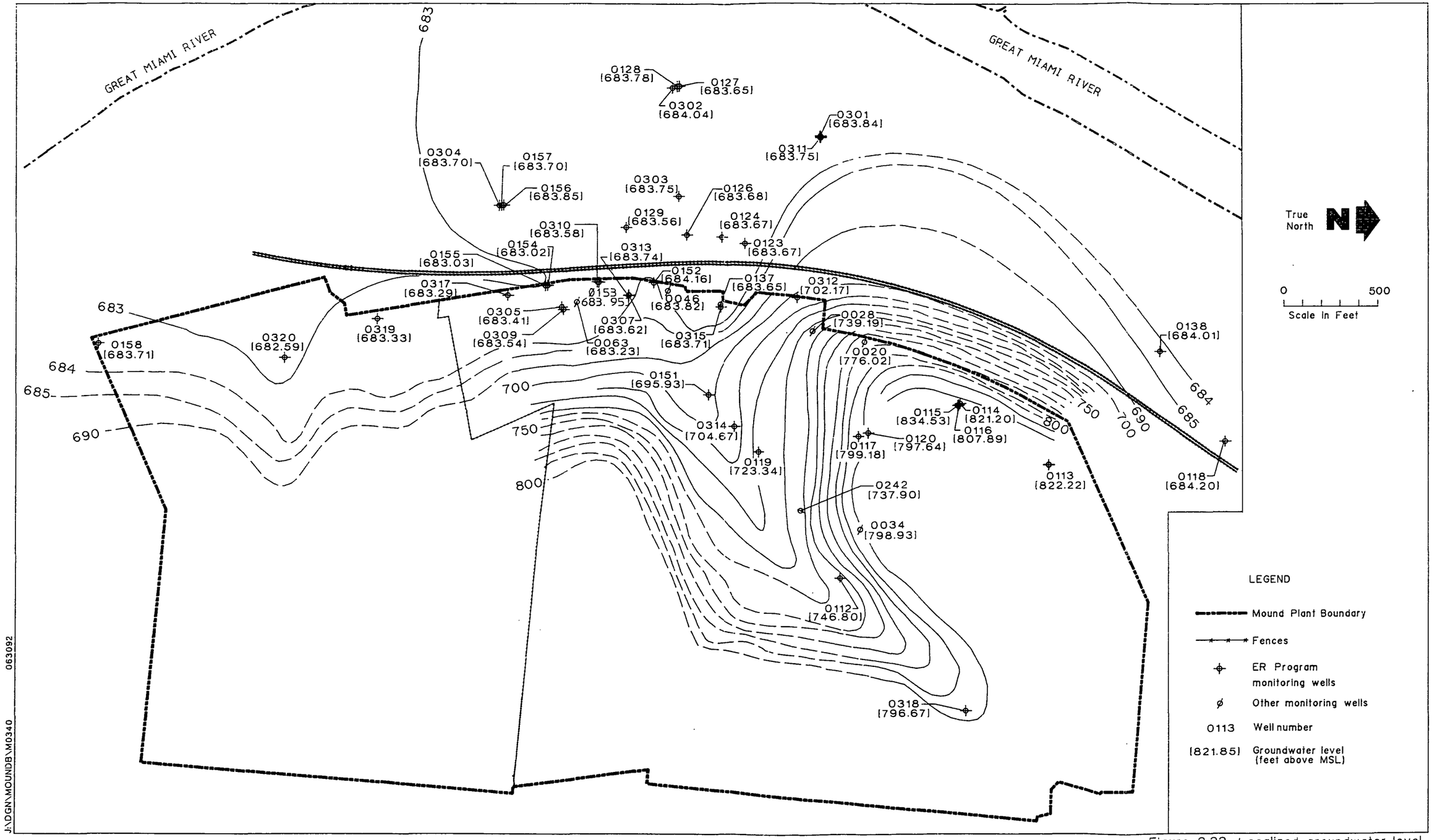
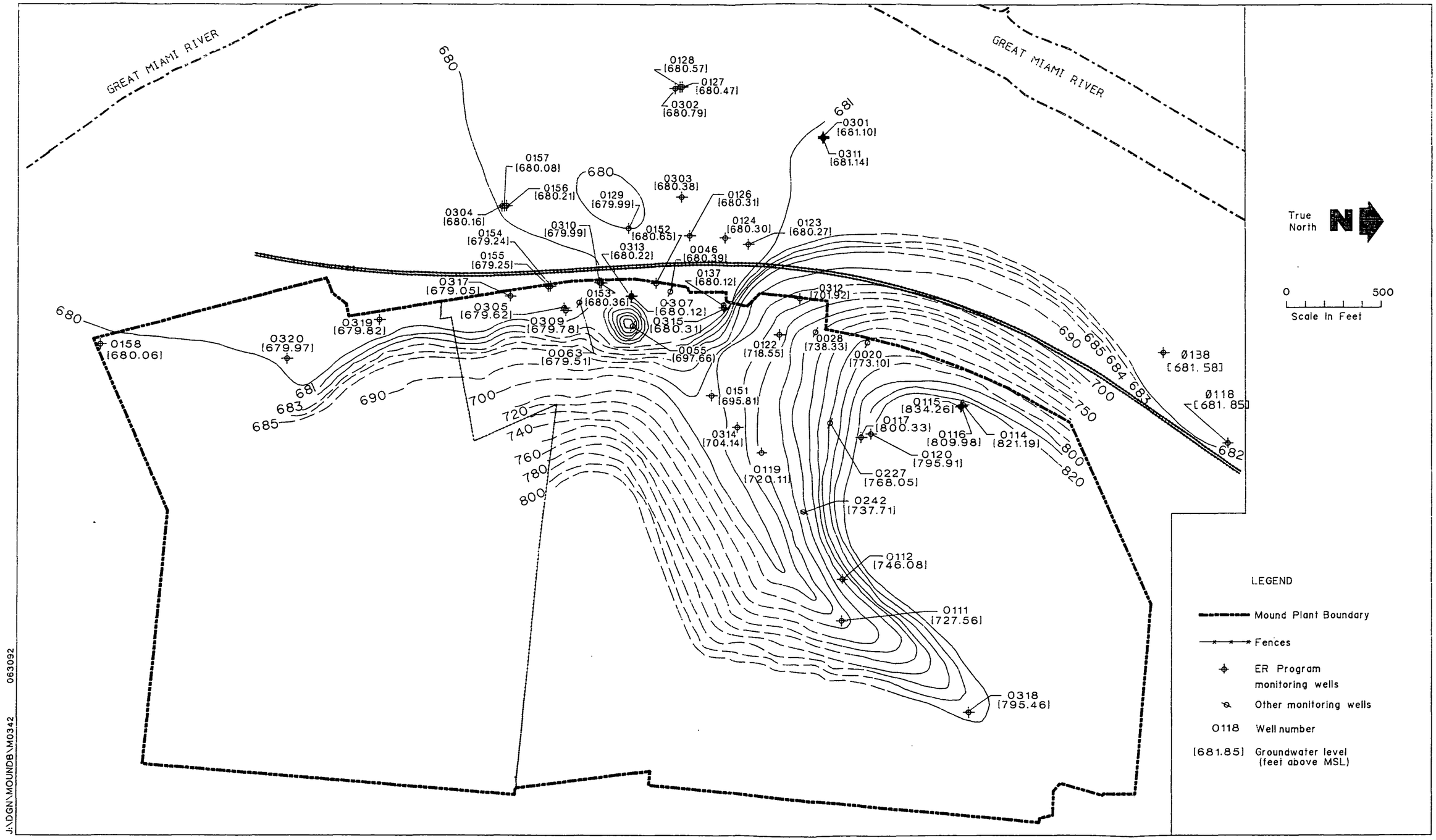


Figure 2.22. Localized groundwater level contour map for April, 1991.

063092

J:\DGN\MOUNDB\M0340



J:\DGN\MOUNDB\M0342 063092

Figure 2.23. Localized groundwater level contour map for July, 1991.

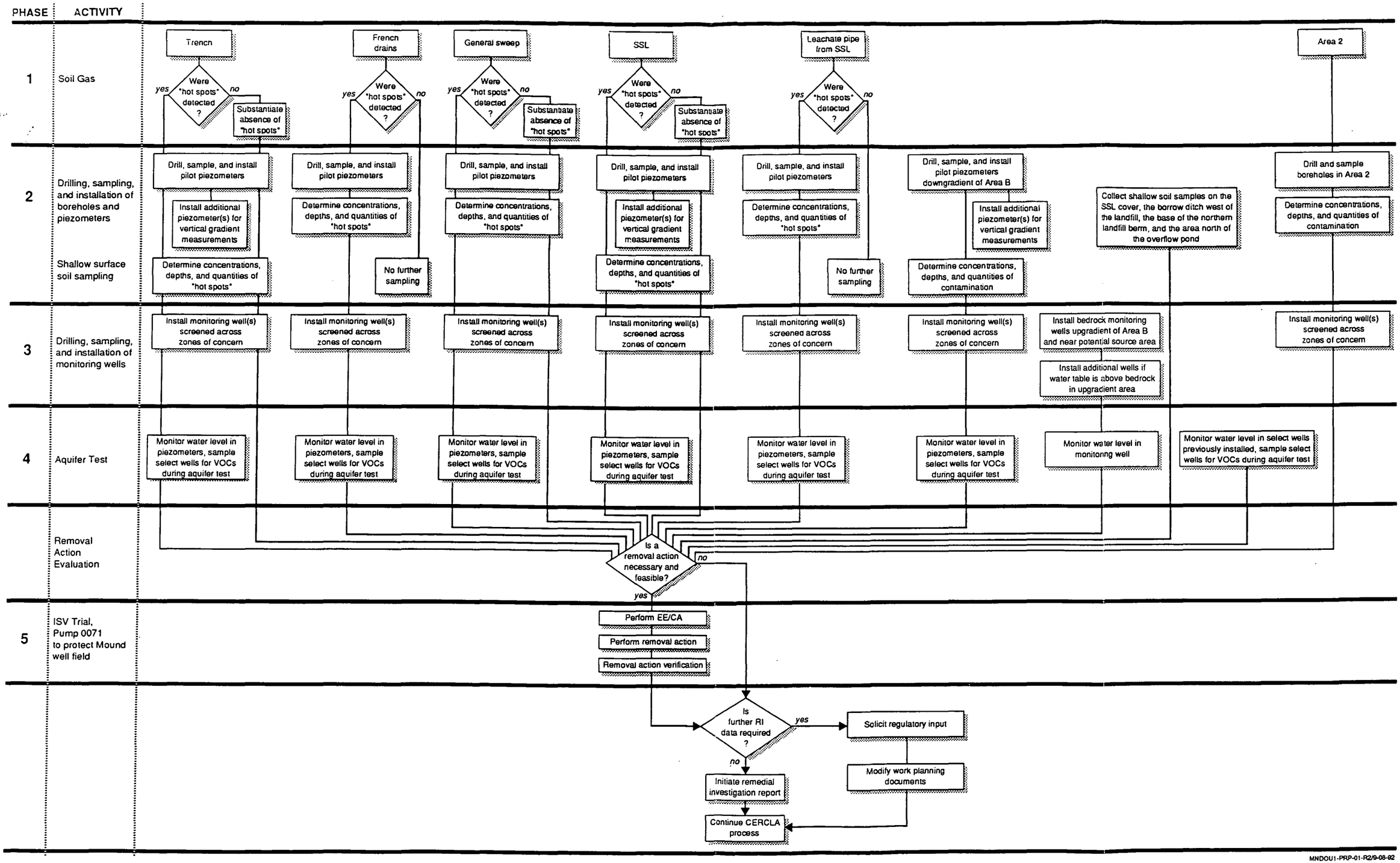


Figure 2.25. Decision tree to guide Area B additional work.

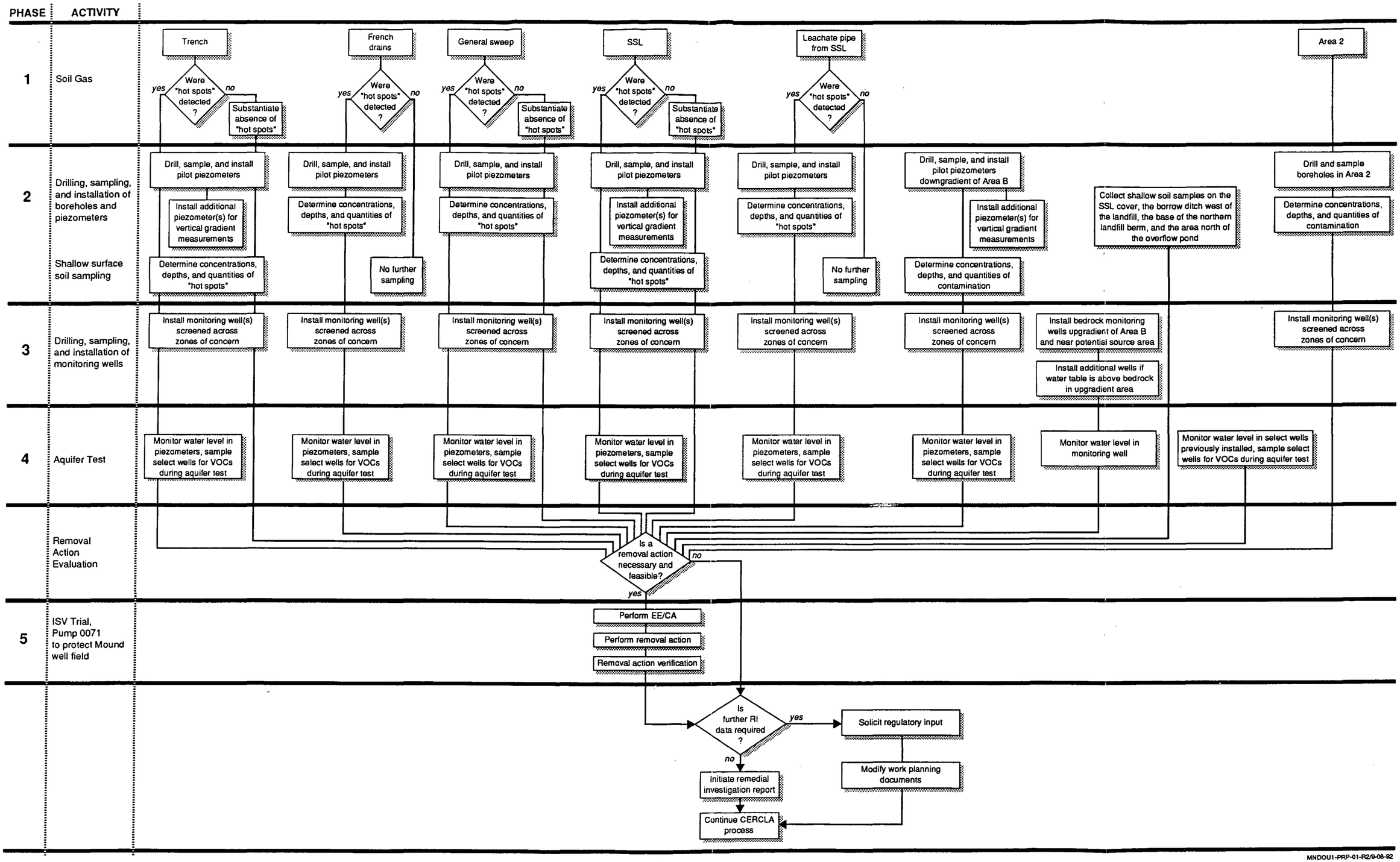
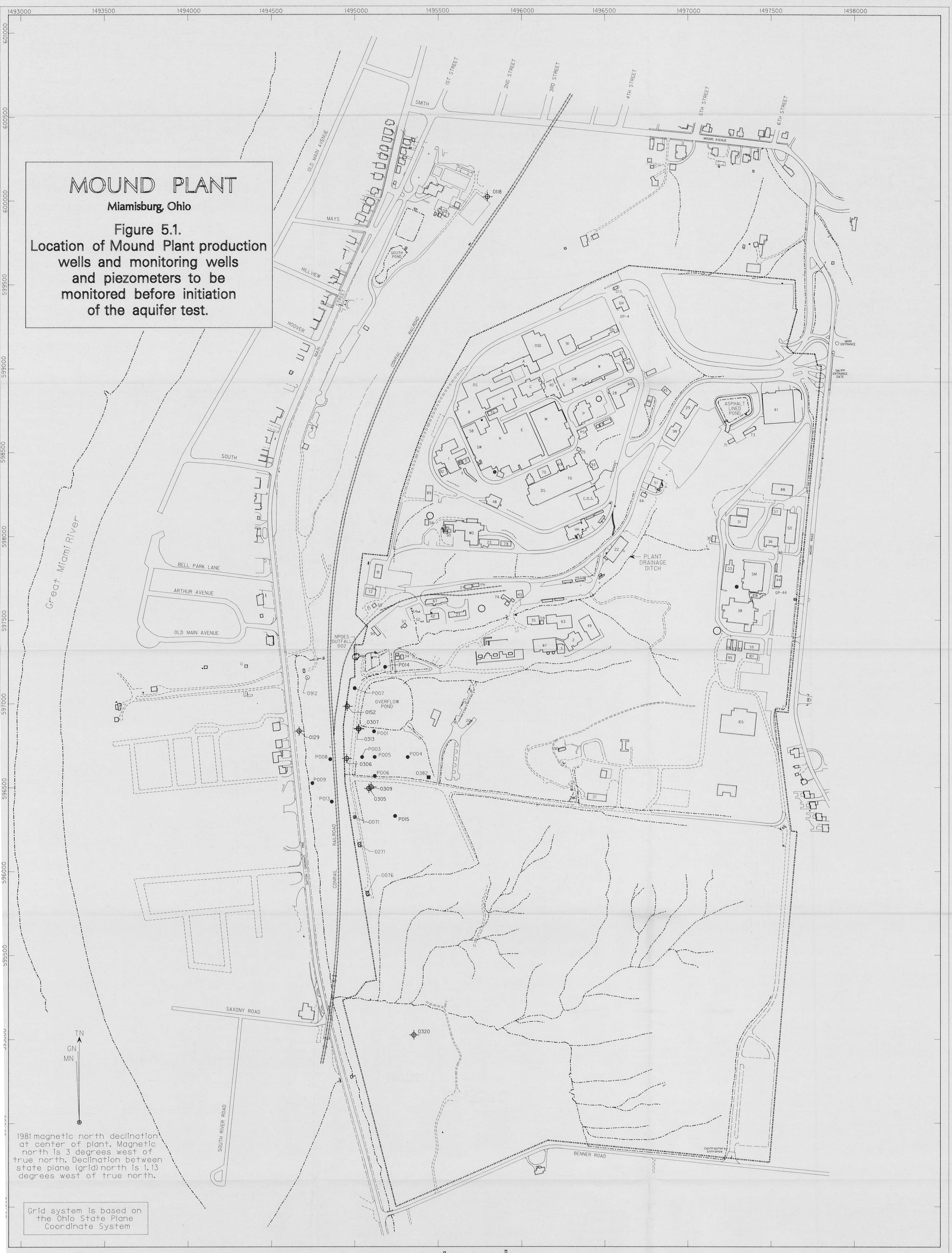


Figure 1.1. Decision tree to guide Area B additional work.

MOUND PLANT

Miamisburg, Ohio

Figure 5.1.
Location of Mound Plant production wells and monitoring wells and piezometers to be monitored before initiation of the aquifer test.



1981 magnetic north declination at center of plant. Magnetic north is 3 degrees west of true north. Declination between state plane (grid) north is 1.13 degrees west of true north.

Grid system is based on the Ohio State Plane Coordinate System

Legend

- 53 Structures
- Paved Roadway
- Unpaved Roadway
- Railroad
- Water
- Fences
- Retaining Wall
- Mound Plant Boundary
- ER Program monitoring wells
- Municipal production wells
- Municipal and Plant production wells
- Proposed new piezometer location
- Proposed new well location

NOTES:

1. The electronic base map data file was obtained by WESTON from Woolpert Consultants, Inc., Dayton, Ohio. The data were photogrammetrically compiled from aerial photography dated 12/08/85.

2. WESTON converted MOUND plant coordinates to Ohio State Plane Coordinates using an algorithm provided by Oak Ridge National Laboratory, Grand Junction Project Office.

3. Area west of Dayton-Cincinnati Pike was digitized from a hand drafted map, dated 3/12/86 from Monstanto Research Corp.

0 100 200 400 600 800 1000
Scale in Feet

WESTON
MANAGERS DESIGNERS/CONSULTANTS
6501 Americas Parkway N.E.
SUITE 800
ALBUQUERQUE, NM 87110
PHONE: (505) 884-5050

21D2020302-9407180018 #1
Box 28135