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THE MEMPHIS DEPOT
TENNESSEE

ADMINISTRATIVE RECORD
COVER SHEET

AR File Number 794

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Memphis Depot

Main Installation

Final Remedial Design

Defense Distribution Center (Memphis)

July 2004 — Rev. 1

CH2MHILL

U.S. Army Engineering
and Support Center, Huntsville

U.S. Army Engineering and Support Center, Huntsville
Contract No. DACA94-02-D-0009
Task Order No. 13

E052003014ATL

DEFENSE LOGISTICS AGENCY
DEFENSE DISTRIBUTION CENTER
2001 MISSION DRIVE
NEW CUMBERLAND, PA 17070-5000

IN REPLY REFER TO DDC J-3/J-4E

July 26, 2004

MEMORANDUM FOR TURPIN BALLARD (USEPA – Region 4) and
JAMES MORRISON (TDEC)

SUBJECT: Revision 1 Main Installation Final Remedial Design

Revision 1 Final Remedial Design for the Main Installation of the former Memphis Depot is attached. This document is for your review and approval. According to the Main Installation Master schedule, there is a fifteen (15) day review cycle for this submittal.

For more information, please don't hesitate in contacting David D. Nelson Project Manager for CH2MHILL at (770) 604-9182 (ext394) or me at (717) 770-6950.

MICHAEL A. DOBBS
Environmental Program Manager

Attachment on CD ROM:
Final Main Installation Remedial Design
Distribution:
- DDC (Memphis) (2 copies)
- U.S. EPA (3 copies)
- TDEC (3 copies)
- DDC (New Cumberland) (3 copies)
- USAESCH (3 copies)
- AFCEE (3 copies)

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Acronyms and Abbreviations

AFCEE	Air Force Center for Environmental Excellence
ARAR	Applicable or relevant and appropriate requirement
BCT	BRAC Cleanup Team
bgs	Below ground surface
BRAC	Base Realignment and Closure
BCT	BRAC Cleanup Team
CF	Chloroform (trichloromethane)
CFR	Code of Federal Regulations
COC	Chemical of concern
CT	Carbon tetrachloride
cy	cubic yard (27 cubic feet)
DCE	Dichloroethene
DLA	Defense Logistics Agency
DO	Dissolved oxygen
DOC	Dissolved organic carbon
DoD	Department of Defense
DOI/NPS	Department of Interior/National Park Service
DP	Decision point
DQO	Data Quality Objective
DRC	Depot Redevelopment Corporation
EBT	Enhanced Bioremediation Treatment
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
ft	Feet
ft^2	square feet
FR	Federal Regulation
FU	Functional unit
HHRA	Human health risk assessment
HI	Hazard index
IRA	Interim remedial action
K	Hydraulic conductivity
LTOA	Long-Term Operational Area
LTM	Long-term monitoring
LUCIP	Land use controls implementation plan
MCL	Maximum contaminant level
mg/kg	Milligram per kilogram
MI	Main Installation
MNA	Monitored natural attenuation
MSCHD	Memphis-Shelby County Health Department
MW	Monitoring well
µg/L	Micrograms per liter
NCP	National Oil and Hazardous Pollution Contingency Plan

NPL	National Priorities List
O&M	Operation and maintenance
ORP	Oxidation reduction potential
OU	Operable unit
P&ID	Process and Instrumentation Diagram
PAHs	Polynuclear aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
PCE	Tetrachloroethene
PCP	Pentachlorophenol
PDB	Polyethylene diffusion bag
POL	Petroleum, oil, and lubricants
ppm	Parts per million
psi	per square inch
PVC	Polyvinyl chloride
QA/QC	Quality assurance and quality control
RA	Remedial action
RA-C	Remedial action construction
RA-O	Remedial action operation
RAO	Remedial action objective
RC	Response complete
RCRA	Resource Conservation and Recovery Act
RD	Remedial design
RI/FS	Remedial investigation/feasibility study
RIP	Remedy in place
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SVOCs	Semi-volatile organic compounds
TA	Treatment Area
TCA	Trichloroethane
TCE	Trichloroethene
TDEC	Tennessee Department of Environment and Conservation
TTA	Target Treatment Area
USAESCH	United States Army Engineering and Support Center, Huntsville
VOC	Volatile organic compound

1.0 Introduction

This Final Remedial Design (RD) report is for the Main Installation (MI) of the Defense Distribution Center (Memphis) in Memphis, Shelby County, Tennessee, commonly referred to as the Depot. The Depot has an EPA Identification Number listed as TN4210020570. This report was prepared for the U.S. Army Corps of Engineers (USACE) - Huntsville Center as part of Task Order 13 under contract number DACA87-94-D-0009. This document is in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and to the extent applicable, the National Oil and Hazardous Pollution Contingency Plan (NCP). This report is consistent with the Record of Decision (ROD) for the MI issued on September 7, 2001 (CH2M HILL, 2001).

This document complies with CERCLA guidance on preparing an RD and has been submitted to satisfy the requirements outlined by the Base Realignment and Closure (BRAC) Act, as well as requirements set forth by the BRAC Cleanup Team (BCT) for the Depot. The BCT is composed of representatives of the Defense Logistics Agency (DLA), Tennessee Department of Environment and Conservation (TDEC), and the U.S. Environmental Protection Agency (EPA), and it reviews all documents prior to issuance. The Memphis Depot is operated by DLA and is a former military supply base located in the southwestern portion of Memphis, Tennessee. From 1995 through 2000, a remedial investigation/feasibility study (RI/FS) under EPA, TDEC, and DLA oversight was conducted at the Memphis Depot. The RI workplans were prepared in 1995 (and amended in 1998), and the RI report was finalized in January 2000. Separate FS reports were prepared for the soils and groundwater on the MI. Both FS reports were finalized in July 2000.

The MI ROD was issued on September 7, 2001 and presented the selected alternative for contaminated soil and groundwater. As stated in the ROD, Enhanced Bioremediation is the selected remedy for groundwater. As part of the remedy, a pilot test was conducted to determine how best to implement the remedy. The enhanced bioremediation treatment (EBT) Treatability Study (TS) was conducted from May 2002 to August 2003. The report summarizing the EBT study is included as Appendix A of this document. Groundwater monitoring and land-use controls are also part of the selected remedy. The long-term groundwater monitoring plan is included as Appendix B. The land-use control implementation plan is included as Appendix C.

2.0 Site Description

2.1 Site Name, Location, and Description

The Depot is a former military supply facility that closed in September 1997 under the BRAC Act. The facility is located in southwestern Memphis, Tennessee (Figure 2-1), approximately 5 miles east of the Mississippi River and just northeast of Interstate 240. The Depot includes two components: the MI, which is the focus of this document, and Dunn Field. For the purposes of completing the RI and FS, while complying with BRAC requirements, the term "Functional Unit" (FU) was established to identify groups of sites on the MI based on operational history, expected use, location, and generally uniform human health exposure. The FUs are a refinement of the "Operable Unit" (OU) designation and are based on common past and anticipated future use of the land on the MI. The MI is divided into six FUs for soil and groundwater is FU 7. The FUs are defined in Table 2-1 and shown graphically on Figure 2-2. The lead agency for site activities and Federal decisions at Depot is the DLA. DLA is responsible for implementing the selected response actions and will incur all associated costs. The regulatory oversight agencies are EPA and TDEC.

2.2 Site History and Enforcement Activities

Starting in the 1940s, the Depot received, warehoused, and distributed supplies common to all U.S. military services and some civilian agencies. Industrial activities at the Depot (e.g., sandblasting of lead-based paints, application of pesticides, use of hazardous materials) resulted in release of metals, pesticides, and other less frequently detected chemicals to surface soil, surface water, sediment and groundwater above background concentrations.

Important dates for the Depot as part of the cleanup process for these chemicals are shown in the following table. For additional information see Section 2 of the MI ROD (CH2M HILL, September, 2001).

Dates	Activity
1989 through 1990	The Depot conducts RI at Memphis Depot
September 28, 1990	The Depot was issued a Resource Conservation and Recovery Act (RCRA) Part B permit (No. TN4 210-020-570) by EPA Region 4 and TDEC.
October 14, 1992	EPA added the Depot to the National Priorities List (NPL) by publication in the *Federal Register* (FR), 57 FR 47180 No. 199
March 6, 1995	A Federal Facilities Agreement (FFA) under CERCLA, Section 120, and RCRA, Sections 3008(h), and 3004(u) and (v), was reached by EPA, TDEC, and the Depot.
July 1995	The Depot was identified for closure under the BRAC process. The Depot undertook compliance with requirements for property transfer under Public Law 101-510 of Title XXIX, Defense Base Closure and Realignment.
1995 through 2000	The Depot conducted an RI/FS under EPA, TDEC, and DLA oversight.

Several interim remedial actions (IRAs) were conducted at the MI. IRAs that have been performed at the MI are detailed below.

- Approximately 602 cubic yards (cy) of surface and subsurface soil was removed from the pentachlorophenol (PCP) dip vat area in Functional Unit (FU) 4 (Building 737) because of elevated levels of PCP (completed in 1985).
- Approximately 5,000 tons (3,700 cy) of surface soil in the Housing Area of FU6 was removed because of the presence of dieldrin (began in June 1998; completed in October 1998). The soil was disposed at a RCRA-permitted Subtitle D landfill. The Housing Area is an exception to the overall industrial land use for MI and is acceptable for residential reuse.
- Approximately 530 tons or 400 cy of surface soil surrounding the cafeteria (Building 274) in FU6 was removed because of elevated levels of polychlorinated biphenyls (PCBs) (began in October 1998; completed in November 1998). The soil was disposed at a Resource Conservation and Recovery Act (RCRA)-permitted Subtitle D landfill.
- Approximately 980 cy of surface and subsurface soil from near Buildings 1084, 1085, 1087, 1088, 1089 and 1090 was removed because of elevated levels of metals and poly-aromatic hydrocarbons (PAHs) (began in May 2000; completed in August 2000). The soil was disposed at an off-site, RCRA-permitted Subtitle D landfill.

In addition to these IRAs, one other remedial action (RA) was accomplished in July and August 2001. Approximately 300 cy of surface soil was excavated near Building 949 in FU4 because of elevated levels of lead. To accomplish the removal, the DLA exercised its removal authority under CERCLA Section 104, as delegated in Executive Order 12580. Both EPA and TDEC agreed that the action was an appropriate part of a final, protective remedy. This RA is documented in the final *Remediation Report, Removal Action at Building 949*, dated February 15, 2002.

2.3 Planned Response Actions at the MI

The ROD detailed several response actions to achieve acceptable residual risk levels and allow for the planned industrial and recreational land use for the MI. These include:

- Restrict the following: (1) future residential land use or development (except for the existing Housing Area in FU6) in FUs 1 through 6; (2) child-occupied facilities, including day care operations in FUs 1 through 6; and (3) casual access to FU2 from adjacent offsite residents through land use controls.
- Prevent future groundwater use on the MI while concentrations of chemicals of concern (COCs) are above maximum contaminant levels (MCLs).
- Reduce to MCLs the concentrations of COCs in groundwater within the entire plume within the perimeter of the MI and, in groundwater migrating away from the MI, as necessary. Currently, there is no evidence of offsite migration of COCs from the MI.
- Conduct 5-year reviews of the RA according to Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(C) if there are any hazardous substances, pollutants, or contaminants

remaining at the site above levels that would allow for unlimited use and unrestricted exposure. The review will be conducted no less often than every 5 years after the initiation of the RA, to assure that human health and the environment are being protected.

In addition to these response actions, the ROD also called for development of a long-term monitoring (LTM) plan for groundwater and land use controls at the MI. The LTM plan for groundwater is provided in Appendix B. The LUCIP is provided in Appendix C.

2.4 RD/RA Objectives

Remedial action objectives (RAOs) are medium-specific goals that the response actions are expected to accomplish to protect human health and the environment. RAOs have been developed to reflect the anticipated future land use for the MI in accordance with EPA policy set forth in *Land Use in the CERCLA Remedy Selection Process (OSWER Directive No. 9355.7-04)*. The groundwater RAOs are expected to prevent ingestion of water contaminated with volatile organic compounds (VOCs) in excess of MCLs from potential future onsite wells; to restore groundwater to levels at or less than MCLs; and to prevent horizontal and vertical offsite migration of groundwater contaminants in excess of MCLs. The MCLs for tetrachloroethene (PCE) (5 μg/L), trichloroethene (TCE) (5 micrograms per liter [μg/L]), *cis*-1,2-dichloroethene (*cis*-1,2-DCE) (70 μg/L), vinyl chloride (VC) (2 μg/L), carbon tetrachloride (CT) (5 μg/L) and chloroform (CF) (80 μg/L total trihalomethanes) are the applicable or relevant and appropriate requirements (ARARs) for groundwater beneath the MI.

Industrial-based cleanup criteria for soil apply throughout the MI, except for Parcels 1 and 2 in FU6. The surface soil RAO for Parcels 1 and 2 in FU6 will protect future onsite residents from direct contact/ingestion of surface soils contaminated with dieldrin and arsenic in excess of human health risk assessment (HHRA) criteria. The RAO will also protect residential children from direct contact/ingestion of surface soils contaminated with lead in excess of risk-based criteria. Section 2.7.1 of the MI ROD presents further discussion of the HHRA criteria.

Compliance with facility-wide RAOs will reduce the excess lifetime cancer risk and hazard index associated with exposure to lead in soil to acceptable levels for future workers and will prevent future residential development in parts of the MI. This will be achieved by reducing the exposure concentration of lead to the target cleanup level of 1,536 mg/kg and by imposing land use restrictions. As discussed in Section 2.2, the target cleanup level has already been accomplished by soil excavation and removal from the Building 949 area.

2.5 Remedies Selected for the MI

The selected surface soil and groundwater remedies as identified in the final ROD for the MI are discussed below.

2.5.1 Surface Soil

Land Use Controls

The remedial actions will leave contaminated surface soil in place but deed and lease restrictions, in addition to the existing land use controls, will assure protectiveness of future users of the MI. Deed and lease restrictions will restrict residential land use in FU1 through FU6 (exclusive of Parcels 1 and 2 in FU6, which are available for unrestricted use) where dieldrin, arsenic, and/or lead in the surface soil pose an unacceptable risk for such use. Residential use controls will include preventing child-occupied facilities, including day care operations in all FUs. In addition, a boundary fence surrounding FU2 will be maintained to preclude casual access by adjacent offsite residents.

Deed and lease restrictions and site controls will be coordinated with the Depot reuse implementation plans, and will be included in all deeds and leases. As described in the LUCIP, the restrictions are most likely in place in perpetuity. Further information is provided in Appendix C. The deed and lease restrictions and site controls, in addition to the existing land use controls, to be applied are as follows:

FU	Deed and Lease Restrictions Preventing Residential Land Use[a]	Site Controls
1	X	
2	X	X[b]
3	X	
4	X	
5	X	
6	X[c]	

[a] Includes day care restriction.

[b] Maintaining a boundary fence surrounding FU2 to preclude casual access by adjacent offsite residents.

[c] Deed restrictions do not apply to Parcels 1 and 2 of FU6.

Land use controls selected in the ROD (excluding Parcels 1 and 2 of FU6) will:

- Prevent future residential land use in FUs 1 through 6, thus eliminating the risks associated with that land use scenario.
- Prevent casual access by adjacent offsite residents through maintenance of a boundary fence surrounding FU2.
- Prevent development of child-occupied facilities, including day care operations in FUs1 through 6.

Applying land use controls will result in the following (excluding Parcels 1 and 2 of FU6):

- FUs 1, 3, 4, 5, and 6 are acceptable for industrial use. Land use controls to prevent residential development are the only RA needed to address unacceptable risk in surface soils at FUs 1, 3, 4, 5, and 6.

- FU2 is acceptable for recreational use. With land use controls in place to prevent future residential development, and to prevent casual access by adjacent offsite residents through maintenance of a boundary fence, FU2 can be used for recreational purposes. In addition, according to Section 24 of the Memphis and Shelby County zoning regulations, single-family and multi-family residential uses are prohibited. Also, under the Federal Property Management Regulations, FU2 is slated for transfer from the Department of Defense (DoD), specifically the Army, to the Department of Interior/National Park Service (DOI/NPS). It will then be transferred by public benefit conveyance to the City of Memphis for use as a park. According to 41 CFR 101-47.308-7, property for use as a public park or recreational area must be used and maintained for the purpose for which it was conveyed in perpetuity, or be returned to the United States (24 CFR 51D).

Land use controls are a critical part of the selected remedy for soils at the MI, and will be implemented through the LUCIP. Further discussion of the land use controls and site controls are presented in Appendix C.

Excavation and Offsite Disposal

As described in Section 2.2, the RA for the removal of surface soils contaminated with lead was accomplished in 2002. More information on the stipulations made as part of the removal action can be found in Section 2.11.2 of the MI ROD.

2.5.2 Groundwater

The selected remedy for groundwater at the MI includes enhanced bioremediation through injection of nutrients at specific treatment areas, monitoring of natural attenuation processes outside of the treatment areas, and land use controls to prohibit interaction with and use of the fluvial aquifer beneath the MI. This section presents additional discussion of each component of the remedy.

Enhanced Bioremediation

This Final RD report describes the methods and materials for injection of nutrients (electron donor) to enhance the natural attenuation processes. The RA will accelerate biodegradation in the most contaminated parts of the groundwater plumes at the MI. Treatment zones will be established within the interpreted 100 µg/L isoconcentration contour for VOC constituents. Sodium lactate solution will be injected into wells screened into the fluvial aquifer using a trailer-mounted injection system. The lactate solution will be pumped manually from a portable tank into each injection well. Additional information on the treatment system specifications is presented within Section 4 of this document.

Groundwater Monitoring

Periodic groundwater sampling and analysis will occur in the treatment areas and within the plume outside of the treatment areas to monitor the effects of both enhanced and natural attenuation processes. Groundwater monitoring will occur until groundwater in the fluvial aquifer achieves the RAOs. The details of the monitoring are provided in Appendix B.

Maintenance of monitoring wells (cleaning, wellhead repairs) will be performed as needed. Annual summaries of monitoring data will be produced to document the site conditions and effectiveness of the remedy. To demonstrate compliance with the RAOs, groundwater concentrations must be at or below MCLs for four consecutive monitoring events, each performed at least 3 months apart. The sampling schedule may be changed with the approval of EPA and TDEC in response to observed trends and variability.

Land Use Controls

As specified in the ROD, the groundwater remedy also includes land use controls. Deed and lease restrictions will, until cleanup levels are achieved, prohibit both: (1) the installation and use of commercial and domestic wells, and (2) drilling into aquifers below the fluvial aquifer. These restrictions will also guarantee access to RA areas, including all injection and monitoring wells, for the life of the remedy. These land use controls may be removed at the completion of the remedy. Evaluations of the site will be conducted periodically in accordance with the LUCIP (Appendix C) to verify that land use controls, and deed and lease restrictions are in effect. The evaluation will also ensure that land use changes that may pose an unacceptable risk to the users have not occurred.

2.6 Hydrogeologic Setting

The following sections are a compilation of investigations that have been performed at the Memphis Depot. Information developed during the EBT Treatability Study is provided in Appendix A. A thorough discussion of the regional and local geologic characteristics of Memphis and Memphis Depot areas is presented in Section 2 of the MI RI report (CH2M HILL, July 2000).

2.6.1 Geology

The principal geologic units beneath the Depot and of most importance are (from oldest to youngest): Memphis Sand, Claiborne Group-the Cockfield and Cook Mountain Formations; the Jackson Formation; the Pliocene/Pleistocene fluvial deposits, and the Pleistocene loess deposits. Monitoring wells drilled for the RI at the MI penetrate all formations down to and including the top of the Memphis Sand. A clay-rich unit typically occurs near the base of the fluvial deposits beneath most of the MI. This upper clay of the Jackson Formation/Upper Claiborne Group does not appear to be present at the base of the fluvial deposits in the northwestern part of the MI and in the southwestern part of Dunn Field. The MI RI report concluded that clay-rich units (clay or clayey sand) occur in the Jackson Formation/Upper Claiborne Group at variable elevations, and also are highly variable in thickness.

The addition of the Long-Term Operational Area (LTOA) monitoring wells MW97, 98, 99, 100, 101, and 102 in late 2001 changed the conceptual site model for the top-of-clay in the southwestern corner of the MI (Figure 2-3). Beginning at MW100 and 101, the top-of-clay forms a trough with a gradual decrease in elevation to the northeast towards MW108. MW108 appears to have been placed within the deepest portion of the trough. Cross-sectional views of this trough can be seen in Figures 5 and 7 of the LTOA Technical Memorandum - Appendix A of the MI RD workplan (CH2M HILL, 2002). The trough does not appear to affect groundwater flow in the fluvial aquifer underlying the southwest corner of the MI.

2.6.2 Hydrogeology

The fluvial aquifer occurs in fluvial deposits under unconfined conditions at an average depth of 87 feet below ground surface (bgs) (CH2M HILL, January 2000). Aquifer thickness ranges from less than 1 foot in the northwest portion of the MI to 57 feet in the west-central portion of the MI.

The fluvial aquifer is typically underlain by a clay-rich unit that occurs beneath most of the MI. This upper clay of the Jackson Formation/Upper Claiborne Group does not occur in the northwestern part of MI and in the southwestern part of Dunn Field (Figure 2-3). The clay-rich units (clay or clayey sand) occur in the Jackson Formation/Upper Claiborne Group at variable elevations, and also are highly variable in thickness. The Memphis Sand aquifer is typically separated from the overlying fluvial aquifer by units of the Jackson Formation/Upper Claiborne Group, but in some locations in Shelby County, the Memphis Sand is directly overlain by the fluvial deposits. The Memphis Sand aquifer is the source of water supply for the City of Memphis.

Fluvial Aquifer

Slug tests were performed in the fluvial aquifer during the MI EBT Treatability Study (Appendix A). Slug test results (Table 2-2) indicate that hydraulic conductivity (K) values for the fluvial aquifer range from 1.17 to 64.35 feet/day for Study Area 1 (southwestern MI) and 0.43 to 31.75 feet/day for Study Area 2 (southeastern MI). Slug test data presented in the MI RI report from wells MW21 (near Study Area 1) and MW26 (near Study Area 2) indicated K values of 48.19 feet/day and 7.65 feet/day, respectively. Assuming an effective porosity of 30 percent, flow velocities across the study areas average 0.6 foot per day in both areas.

TABLE 2-2
Study Areas 1 and 2, Estimated Groundwater Flow Velocities
MI Final RD, Memphis Depot

Study Area	Hydraulic Conductivity (feet/day)	Assumed Porosity (%)	Gradient (feet/feet)	Groundwater Velocity (feet/day)
Area 1 (low range)	1.17	30	(MW21 to -100B) 0.0056	0.022
Area 1 (high range)	64.35	30	(MW21 to -100B) 0.0056	1.2
Area 2 (low range)	0.43	30	(MW105 to -26) 0.011	0.016
Area 2 (high range)	31.75	30	(MW105 to -26) 0.011	1.2

CH2M HILL completed an aquifer test in January 2004 on monitoring well MW-120, located in the southwestern corner of the MI. The test included a background potentiometric observation study, a brief step-drawdown test, a 72-hour pump test, and a recovery phase. Nine monitoring wells were used as observation wells and two other monitoring wells were used as background observation points. Transmissivity values range from 19.81 to 2,930.23

feet^2/day, with a geometric average of 459.53 ft^2/day. The specific capacity calculated for the pumping well was 1 gpm/ft of drawdown. Additional information on aquifer testing is provided in Appendix A.

Water Levels and Groundwater Flow

The hydrogeological properties of the two study areas of the MI EBT TS are summarized in Table 2-3. Figure 2-4 presents the July 2003 interpretation of the potentiometric surface underlying the MI. The average depths to groundwater at Area 1 and Area 2 are 92.5 feet bgs and 96.5 feet bgs, respectively.

2.6.3 Nature and Extent of Contamination

The nature and extent of contamination in groundwater were assessed based on the March 2002 sampling event. The results of this event are presented in Attachment I to Appendix A. As shown in Figure 2-5, seven PCE plumes occur in the fluvial aquifer. Figure 2-6 shows seven TCE plumes underlying the MI and one TCE plume just beyond the southeastern MI boundary. Not shown on these figures are a plume of *cis*-1,2-DCE and vinyl chloride in the northeast area of the MI. There is also a small carbon tetrachloride plume in the southeast corner of the MI.

Table 2-1
Description of Functional Units at the MI
Rev. 1 Final MI RD

FU No.	Name	Size (acres)	Common Past Land Use	Description
1	Twenty Typical Warehouses	89	Transportation to and storage in closed warehouses	Located in the northeastern area of the MI, consisting of about 20 large warehouses, with interspersed roadways and railroad tracks.
2	Southeast Golf Course/ Recreational Area	53	Golf, other recreation	Located in the southeastern corner of the MI1, consisting of golf course (Parcel 3). This FU also includes a baseball field and a small playground in the southeastern corner. This FU includes two constructed ponds and two concrete-lined drainage ditches from the ponds leading to the off-site area.
3	Southwest Open Area	92	Transportation to and storage in open-sided warehouses, painting and sandblasting, open storage	Located in the southwestern corner of the MI, consisting of varied type of parcels and sites.
4	Northern and Open Areas	193	Open storage, and transportation to and storage in closed warehouses	Located in the north-central to northwest area of the MI, covering a large area.
5	Newer Warehouses	109	Transportation to and storage in closed warehouses	Located in the south-central area of the MI and includes 10 large warehouse buildings.
6	Administrative and Residential Areas	33	Offices, equipment storage and maintenance, on-base housing	Located along the property boundary of the Depot along the Airways Boulevard. This FU includes the old Residential Unit Area, parking lots, and other asphalt-paved areas.

TABLE 2-3
Summary of Hydrogeological Properties within Study Areas 1 and 2
Rev. 1 Final MI RD

Identification	Ground Elevation (feet MSL)	TOC Elevation (feet MSL)	Clay Elevation (feet MSL)	Depth to Clay (feet bgs)	Average Depth to Water (feet BTOC)	Average Fluvial Aquifer Thickness (feet)	Location within Each Study Area	Screen Interval Within Aquifer
AREA 1								
IW-5	292.43	292.12	179.43	113.00	93.3	19.4	Injection Point	Lower
IW-6	292.27	291.94	183.27	109.00	93.2	15.5	Injection Point	Lower
IW-7	292.26	292.00	182.76	109.50	93.2	16.0	Injection Point	Lower
MW-21	295.21	295.00	NA	NA	94.5	NA	Upgradient	Upper
MW-100B	291.50	290.90	164.10	127.40	92.3	34.5	Downgradient	Entire
MW-115	291.92	291.67	NA	NA	92.6	NA	Downgradient	Upper
MW-116	291.92	291.67	183.42	108.50	92.6	15.6	Downgradient	Lower
MW-117	291.57	291.38	182.57	109.00	92.5	16.3	Downgradient	Lower
MW-118	291.58	291.17	NA	NA	92.2	NA	Downgradient	Upper
MW-119	291.74	291.50	NA	NA	92.4	NA	Downgradient	Upper
MW-120	291.72	291.56	183.72	108.00	92.5	15.3	Downgradient	Lower
MW-121	291.83	291.63	NA	NA	92.6	NA	Downgradient	Upper
MW-122	291.76	291.62	183.26	108.50	92.6	15.8	Downgradient	Lower
MW-123	291.36	291.09	NA	NA	92.3	NA	Downgradient	Upper
MW-124	291.58	291.39	NA	NA	92.4	NA	Downgradient	Upper
MW-125	291.47	291.35	182.47	109.00	92.4	16.5	Downgradient	Lower
AREA 2								
IW-1	304.29	304.03	205.29	99.00	95.8	3.0	Injection Point	Entire
IW-2	304.49	304.21	199.49	105.00	95.8	9.0	Injection Point	Entire
IW-3	304.47	304.21	201.47	103.00	96.1	6.7	Injection Point	Entire
IW-4	304.66	304.53	199.66	105.00	96.3	8.5	Injection Point	Entire
MW-86	304.76	304.29	187.89	116.87	96.5	19.9	Downgradient	Entire
MW-88	305.47	305.15	208.47	97.00	80.0	16.7	Upgradient	Entire
MW-105	304.42	304.25	205.42	99.00	96.1	2.8	Downgradient	Entire
MW-106	304.65	304.44	197.65	107.00	96.2	10.6	Downgradient	Entire
MW-109	304.75	304.57	201.75	103.00	96.5	6.3	Downgradient	Entire
MW-110	304.82	304.64	202.82	102.00	96.6	5.2	Downgradient	Entire
MW-111	304.87	304.66	205.87	99.00	96.9	1.9	Downgradient	Entire
MW-112	304.77	304.57	204.77	100.00	96.6	3.2	Downgradient	Entire
MW-113	304.92	304.81	199.92	105.00	97.2	7.7	Downgradient	Entire
MW-114	304.84	304.66	202.84	102.00	96.7	5.1	Downgradient	Entire

Notes:
NA : Not Available.
MSL : Mean Sea Level
BTOC : below top of casing

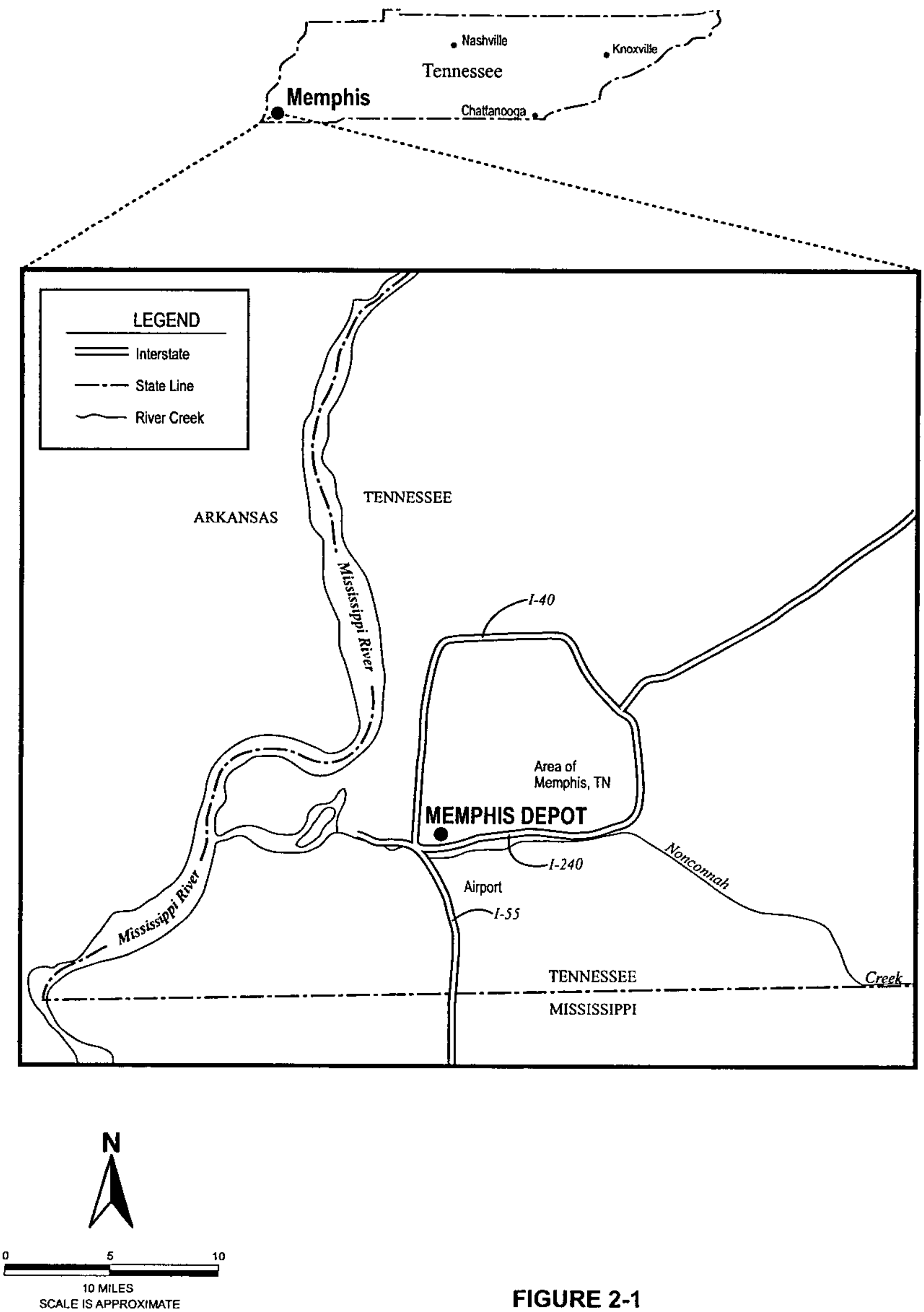

FIGURE 2-1
MEMPHIS DEPOT LOCATION IN THE MEMPHIS METROPOLITAN AREA
REV. 0 MEMPHIS DEPOT MAIN INSTALLATION RD

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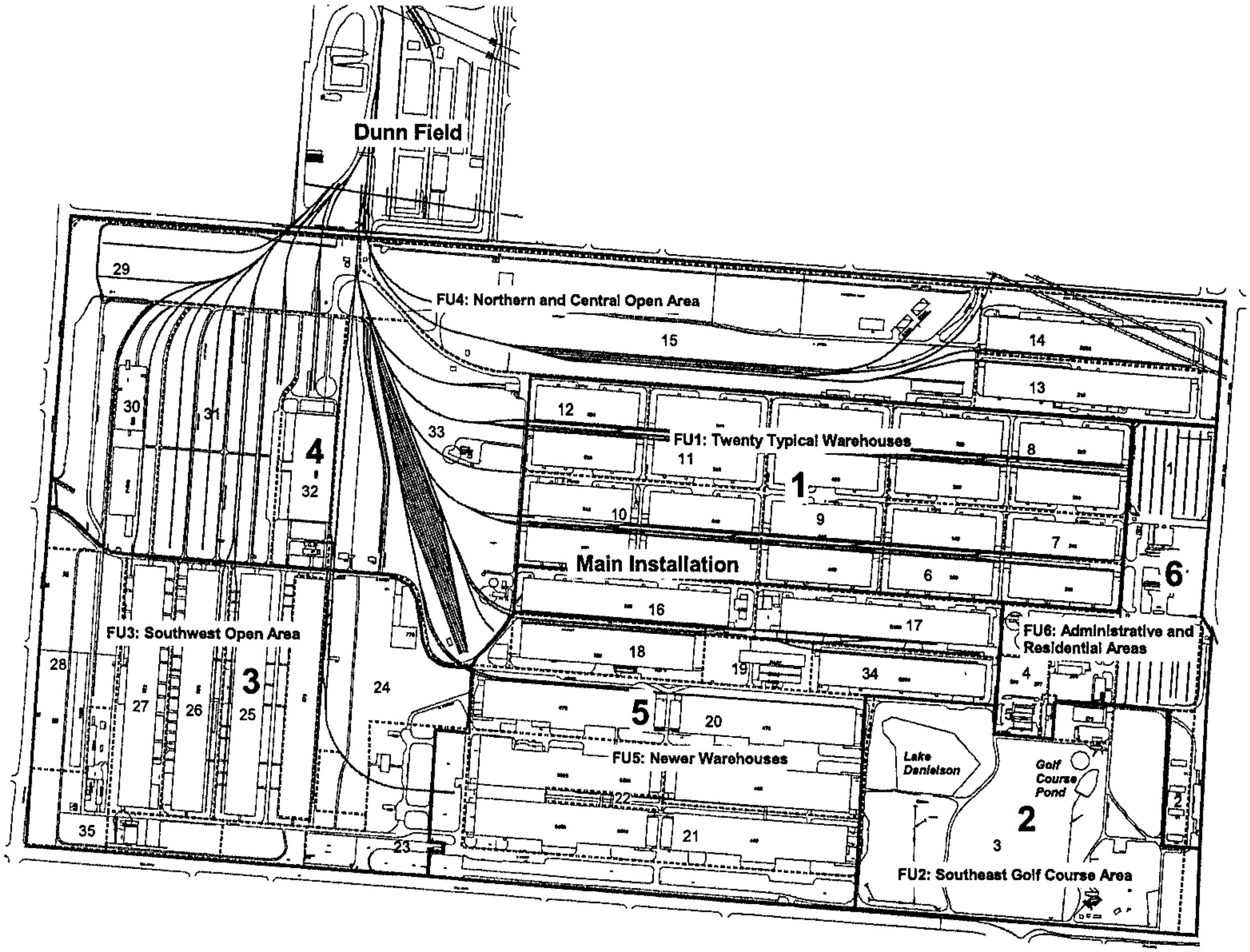

Legend
3 Functional Unit Number
26 BRAC Parcel Number
BRAC Parcel Boundary
Functional Unit Boundary

Note: Functional Unit 7 - Groundwater at the Main Installation

0 300 600 Feet
SCALE IS APPROXIMATE

FIGURE 2-2
Functional Units at Main Installation
Memphis Depot Main Installation RD

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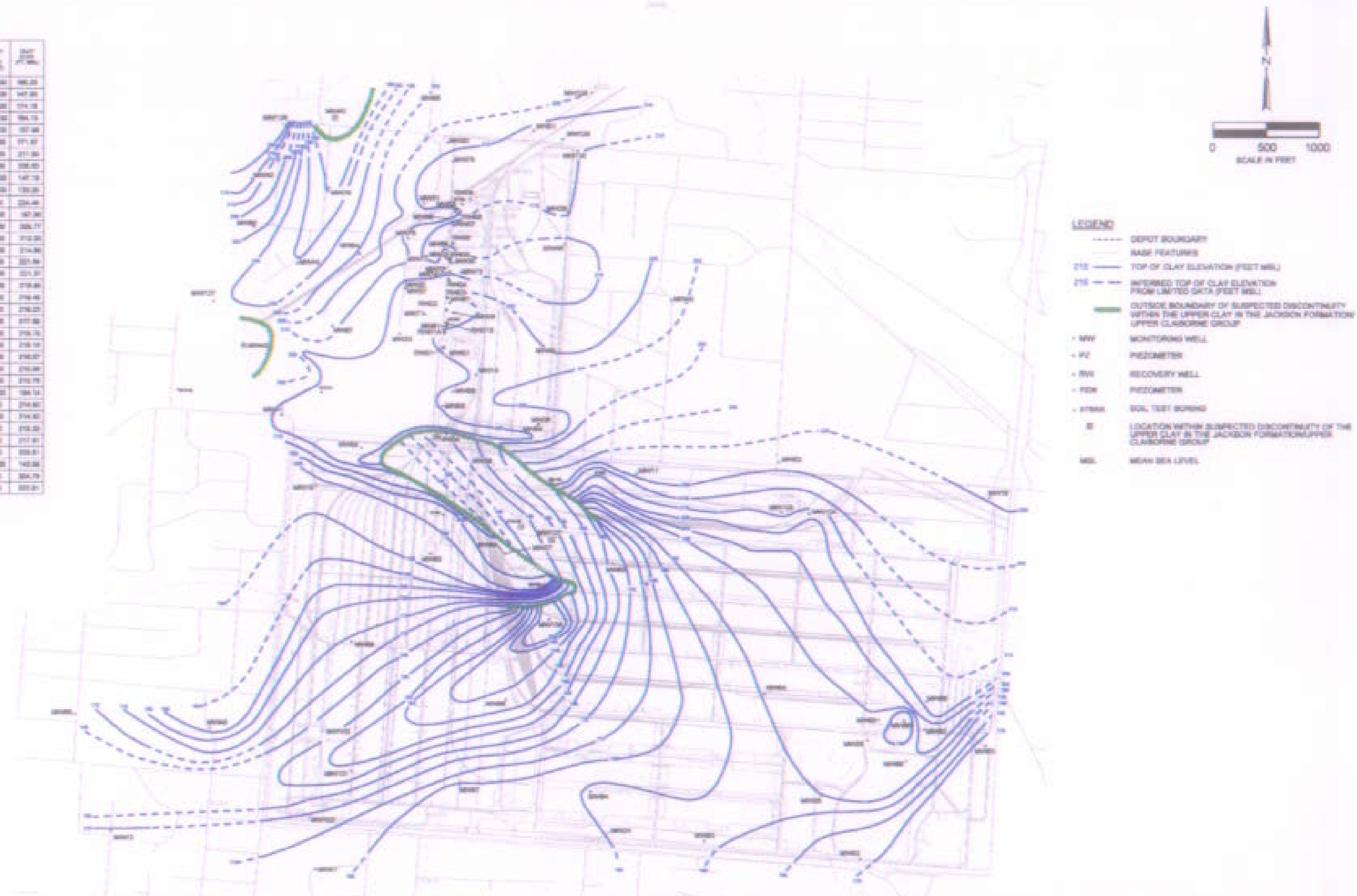

FIGURE 2-3
ESTIMATED TOP OF UPPERMOST CLAY IN THE JACKSON FORMATION/UPPER CLAIBORNE GROUP
MEMPHIS DEPOT, MAIN INSTALLATION REMEDIAL DESIGN

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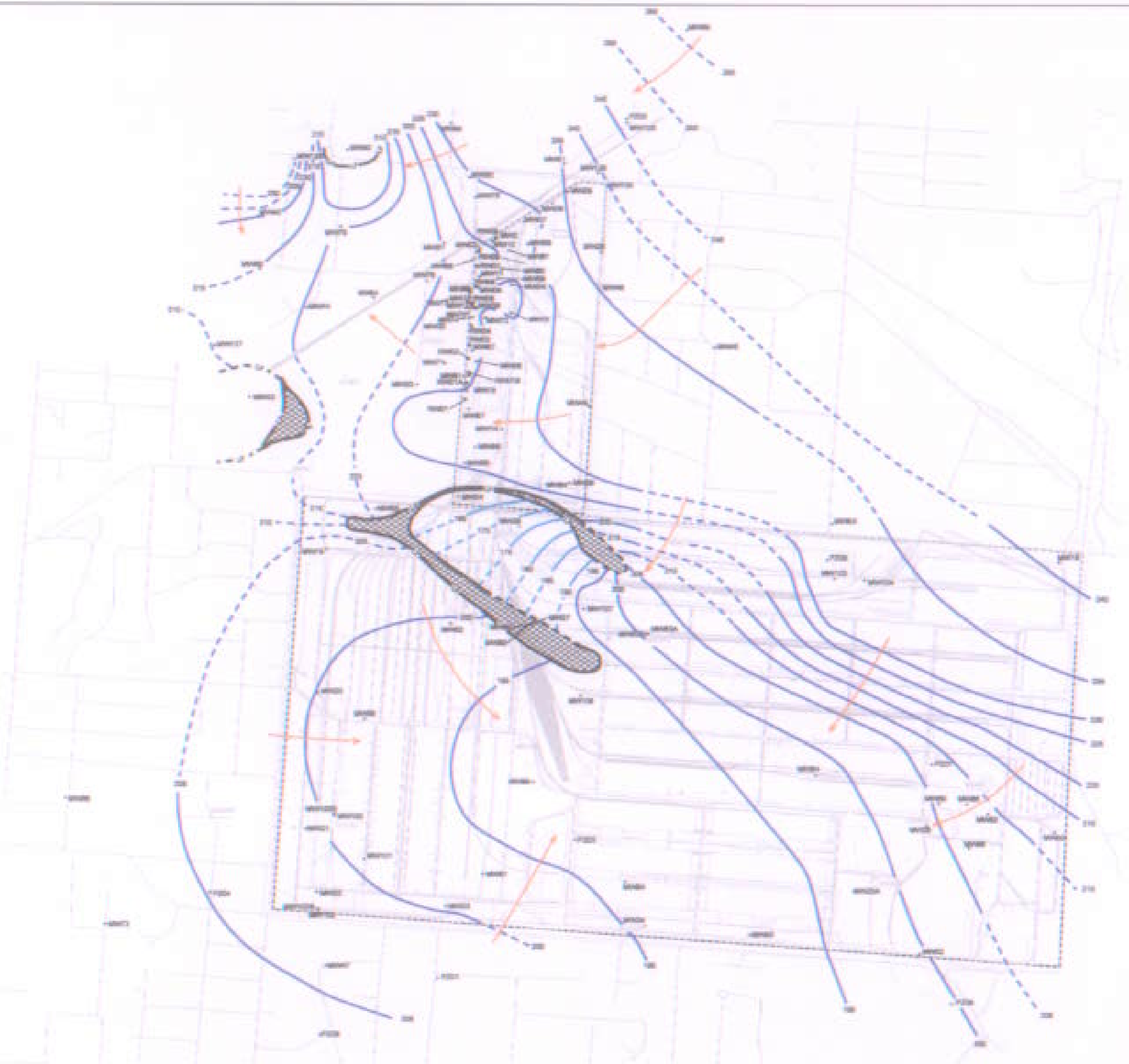
ATLANTA/CAD1/PROJECTS/148071 DDMT/DUNNFIELD_RD 2003 27-OCT-2003

794 21

Well ID	Water Level Elevation (feet MSL)
MW-02	234.74
MW-03	223.95
MW-04	224.84
MW-05	DRY
MW-06	224.99
MW-07	Not measured
MW-08	231.58
MW-09	229.05
MW-10	225.84
MW-11	224.36
MW-12	224.8
MW-13	224.81
MW-14	227.98
MW-15	235.2
MW-16	243.04
MW-17	Abandoned
MW-18	174.831
MW-19	202.98
MW-20	200.046
MW-21	200.995
MW-22	201.239
MW-23	198.909
MW-24	193.183
MW-25	Abandoned
MW-25A	198.15
MW-26	204.321
MW-27	DRY
MW-28	237.48
MW-29	236.25
MW-30	229.22
MW-31	220.59
MW-32	221.91
MW-33	224.88
MW-34	181.83
MW-35	224.62
MW-36	198.16
MW-37	155.88
MW-38	174.785
MW-39	Not measured
MW-40	179.85
MW-41	Abandoned
MW-42	230.79
MW-43	157.51
MW-44	215.15
MW-45	236.88
MW-46	230.34
MW-47	204.18
MW-48	Abandoned
MW-49	232.58
MW-50	213.788
MW-51	238.27
MW-52	199.908
MW-53	233.82
MW-54	215.89
MW-55	221.09
MW-56	229.8
MW-57	228.21
MW-58	227.31
MW-59	235.8
MW-60	226.33
MW-61	227.14
MW-62	199.716
MW-63	Abandoned
MW-63A	201.1
MW-63B	201.03
MW-64	195.843
MW-65	255.55
MW-66	207.34
MW-67	198.39
MW-68	223.55
MW-69	223.74
MW-70	224.06
MW-71	224.11
MW-72	208.13
MW-73	225.28

Well ID	Water Level Elevation (feet MSL)
MW-74	224.49
MW-75	224.33
MW-76	218.82
MW-77	222.51
MW-78	227.82
MW-79	214.59
MW-80	216.26
MW-81	159.849
MW-82	198.281
MW-83	181.298
MW-84	228.48
MW-85	208.68
MW-86	208.24
MW-87	224.73
MW-88	225.41
MW-89	187.295
MW-90	187.42
MW-91	224.42
MW-92	209.34
MW-93	193.25
MW-94	192.59
MW-95	232.47
MW-96	207.5
MW-97	197.80
MW-98	194.29
MW-99	198.79
MW-100	199.31
MW-100B	199.4
MW-101	199.53
MW-102	201.89
MW-102B	201.87
MW-103	232.89
MW-104	233.71
MW-105	208.891
MW-106	208.91
MW-107	195.13
MW-108	192.75
MW-109	208.07
MW-110	208.89
MW-111	208.31
MW-112	208.6
MW-113	207.93
MW-114	208.45
MW-115	199.87
MW-116	199.82
MW-117	199.87
MW-118	199.83
MW-119	199.86
MW-120	199.85
MW-121	199.91
MW-122	199.86
MW-123	199.84
MW-124	199.87
MW-125	199.86
MW-126	234.49
MW-127	210.57
MW-128	248.22
MW-129	239.38
MW-130	240.8
PZ-01	233.24
PZ-02	248.46
PZ-03	193.48
PZ-04	205.12
PZ-05	199.48
PZ-06	231.22
PZ-07	206.194
PZ-08	206.3



0 500 1000
SCALE IN FEET

LEGEND

- DEPOT BOUNDARY
- BASE FEATURES
- WATER TABLE ELEVATION IN THE FLUVIAL AQUIFER (FEET MSL)
- INFERRED WATER TABLE ELEVATION IN THE FLUVIAL AQUIFER FROM LIMITED DATA (FEET MSL)
- WATER TABLE ELEVATION IN THE INTERMEDIATE AQUIFER (FEET MSL)
- INFERRED WATER TABLE ELEVATION IN THE INTERMEDIATE AQUIFER FROM LIMITED DATA (FEET MSL)
- LIMITED TO NO FLOW BOUNDARY (SEE NOTE)
- INFERRED LIMITED TO NO FLOW BOUNDARY (SEE NOTE)
- MONITORING WELL
- PIEZOMETER
- GROUNDWATER FLOW DIRECTION
- CLAY ELEVATION EXCEEDS GROUNDWATER ELEVATION

NOTES

- THE "LIMITED TO NO FLOW BOUNDARY" BOUNDS AN AREA WHERE THE WATER LEVEL IN THE FLUVIAL AQUIFER INTERSECTS THE CLAY DIRECTLY UNDERLYING THE FLUVIAL DEPOSITS, LEAVING FLUVIAL DEPOSITS UNSATURATED.
- MW18, 34, 36, 37, 38, 40, 43, 81, 82, 83, 89, AND 90 ARE WELLS SCREENED WITHIN THE INTERMEDIATE AQUIFER.
- MW107 AND 108 ARE LOCATED IN A TRANSITION ZONE BETWEEN THE FLUVIAL AQUIFER AND THE INTERMEDIATE AQUIFER.
- MW18, 36, 37, 81, 82, 83, 89, 90, 100 AND 120 ARE NOT INCLUDED IN THIS POTENTIOMETRIC SURFACE MAP.
- MW87 IS SCREENED IN THE MEMPHIS AQUIFER AND THEREFORE NOT INCLUDED IN THIS POTENTIOMETRIC SURFACE MAP.
- NO MEASURABLE WATER LEVELS WERE RECORDED IN MW5 AND 27.
- DEPTH TO WATER MEASUREMENTS WERE NOT COLLECTED IN MW39.
- MW17, 25, 41, 48 AND 63 WERE ABANDONED.
- EXCLUDED MW-98 GROUNDWATER ELEVATION DATA.

FIGURE 2-4
Potentiometric Surface
Map of the Fluvial Aquifer,
Including Intermediate Aquifer
July 23, 2003
REV. 0 MEMPHIS DEPOT, MAIN INSTALLATION REMEDIAL DESIGN

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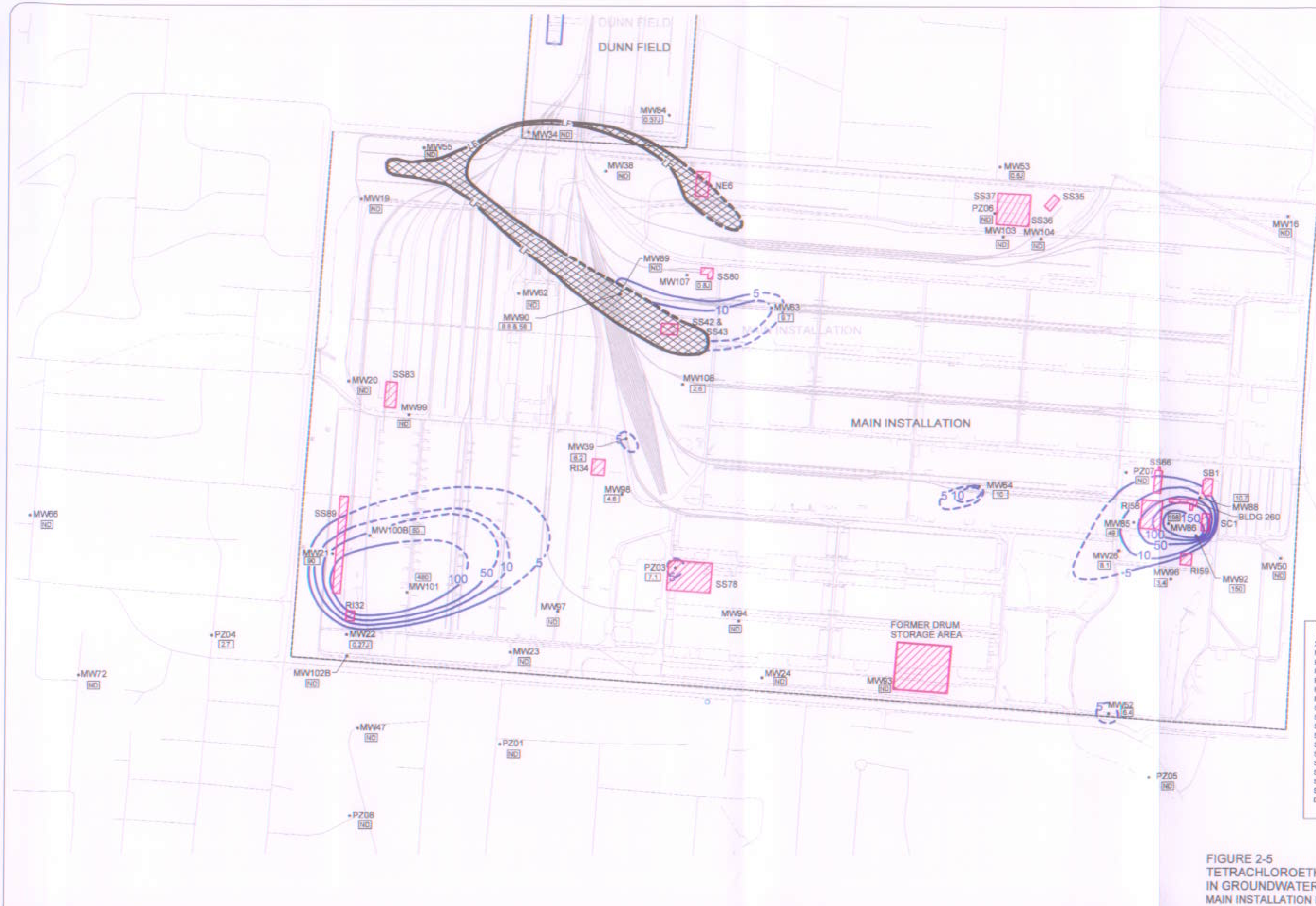


0 250 500
APPROXIMATE SCALE

LEGEND

10 ISOCONCENTRATION LINE (IN ug/L)
10 INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
DEPOT BOUNDARY
BASE FEATURES
• MW88 MONITORING WELL
• PZ06 PIEZOMETER
ND NOT DETECTED ABOVE LABORATORY REPORTING LIMIT
7.8 CONCENTRATIONS IN ug/L
ug/L MICROGRAMS PER LITER
J ESTIMATED CONCENTRATION
CLAY ELEVATION EXCEEDS GROUNDWATER ELEVATION
LONG TERM OPERATIONAL AREAS (LTOA)

NOTE:

(1) ALL UNITS ARE IN ug/L.

(2) MONITORING WELLS 85,86,88,92,93,94,96,97, 98,99,100B,101,102B,103,104,107 AND 108 WERE SAMPLED IN NOVEMBER AND DECEMBER 2001. CONCENTRATIONS DETECTED IN THESE WELLS ARE AVERAGED PER WELL, EXCEPT MW-108.

(3) ALL OTHER AVAILABLE MONITORING WELLS WERE SAMPLED DURING THE MARCH 2002 SAMPLING EVENT.

(4) 5 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD.

(5) MONITORING WELLS MW-89 AND MW-90 WERE SAMPLED AT TWO DIFFERENT INTERVALS WITHIN EACH WELL. CONCENTRATIONS ARE INDICATED FOR BOTH INTERVALS.

(6) THE "LIMITED TO NO FLOW BOUNDARY" BOUNDS AN AREA WHERE THE WATER LEVEL IN THE FLUVIAL AQUIFER INTERSECTS THE CLAY DIRECTLY UNDERLYING THE FLUVIAL DEPOSITS, LEAVING FLUVIAL DEPOSITS UNSATURATED.

SITE DESCRIPTIONS

260:	GARAGE AND PAINT SHOP
NE6:	PAINT SHOP
RI27:	OLD RECOUPMENT AREA
RI32:	PAINT/SANDBLASTING/SS31-33
RI34:	MAINTENANCE SHOP AND UST
RI58:	PAD 257, OLD PESTICIDE SHOP
RI59:	PESTICIDE MIXING AREA, B-273
SB1:	AUTO MAINTENANCE AND REPAIR SHOP
SC1:	AUTO MAINTENANCE AND REPAIR SHOP
SS35:	DRMO STORAGE
SS42:	PCP DIP VAT / PCP UST
SS43:	PCP DIP VAT / PCP UST
SS66:	VEHICLE MAINTENANCE SHOP
SS78:	BUILDING 678
SS80:	FUEL AND CLEANER DISPENSER, B-720
SS83:	DRIED PAINT / POL DISPOSAL AREA
SS89:	PAINT, SOLVENT, ACID SPILLS AREA
DRUM STORAGE AREA	

FIGURE 2-5
TETRACHLOROETHENE (PCE) CONCENTRATION IN GROUNDWATER - MARCH 2002
MAIN INSTALLATION PRE-FINAL REMEDIAL DESIGN

CH2MHILL

ATLANTA/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RD_2004 26-FEB-2004 80718g2-5.dgn

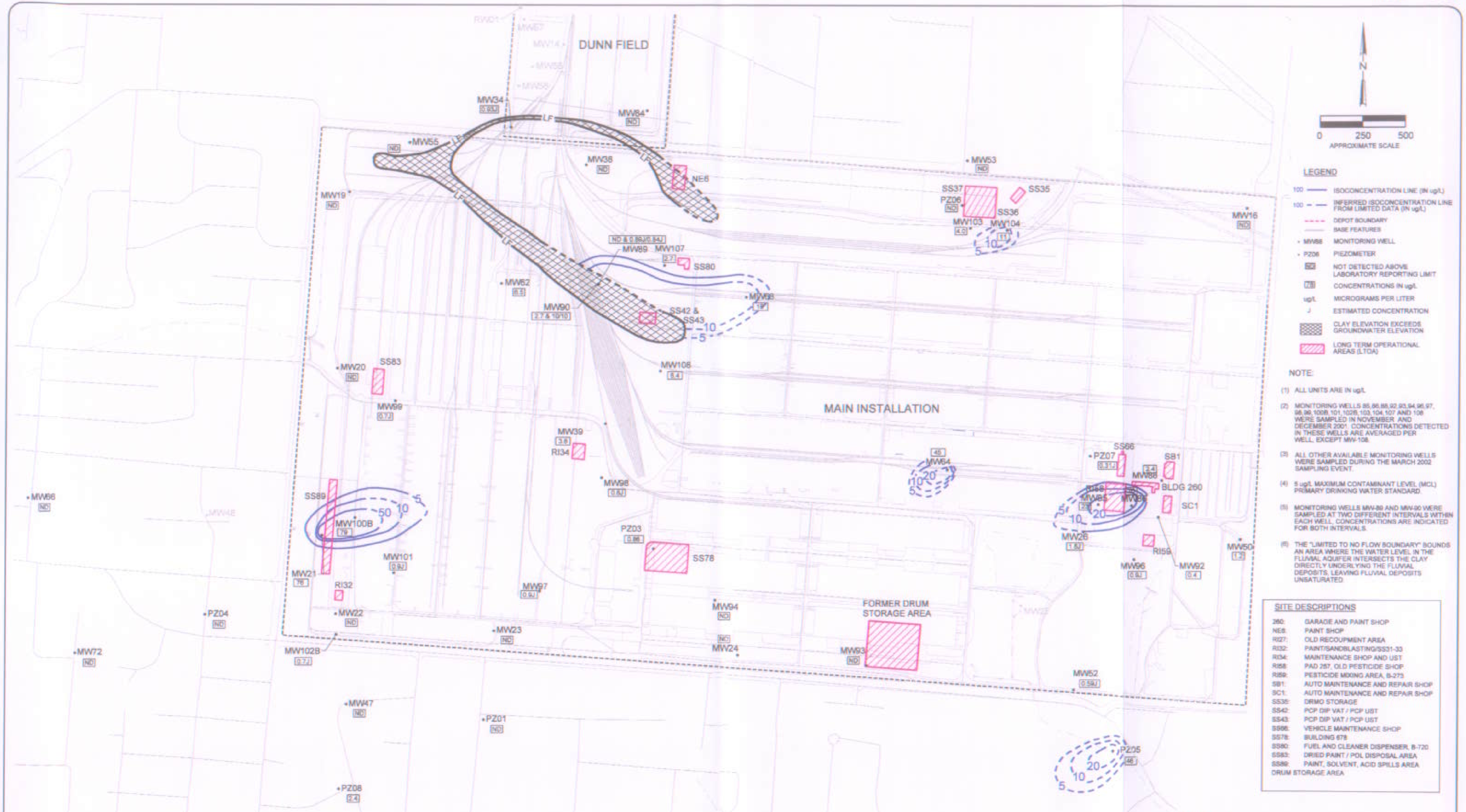


FIGURE 2-6
TRICHLOROETHENE (TCE) CONCENTRATION
IN GROUNDWATER-MARCH 2002
MAIN INSTALLATION PRE-FINAL REMEDIAL DESIGN

CH2MHILL

ATLANTA/CAD1/PROJECTS/148071/DDMT/DUNN FIELD RD 2004 26-FEB-2004 80711fg2-6.dgn

3.0 Implementation Plan

This section provides information on the tasks to be performed during the Final Design stage and a schedule for implementation of the RA.

3.1 Implementation Tasks

3.1.1 MI LUCIP

The MI LUCIP was presented as a Final Rev. 1 version within the Intermediate RD as a result of approval by the Memphis Depot stakeholders. The implementation and maintenance of land use controls has already begun and future efforts will be structured according to the final MI LUCIP.

3.1.2 MI EBT Treatability Study

The pilot study for development of EBT at the MI was conducted from May 2002 to August 2003 (Appendix A). The results of this study are the primary basis for this design. The version within the Pre-final RD document received no comments and is presented as Final within this RD document.

3.1.3 Conceptual Remedial Design

The conceptual remedial design was presented within the Intermediate RD report. In December 2003, the BCT met and, among other issues, discussed a technical memorandum developed by CH2M HILL entitled *An Overview of Sodium Lactate Delivery Alternatives – Memphis Depot, Main Installation* (Appendix D). This document defined two areas (referred to as target treatment areas 1 and 2) that will be the focus of active remediation (see Figures 3-1 and 3-2). The recommended approach includes delivery of a 2 percent sodium lactate solution from a mobile injection system that is dynamic and flexible. The sodium lactate will be injected into the more contaminated portions of the MI plumes within the 100 μg/L contour and any contamination outside will be allowed to attenuate naturally. The target treatment areas (TTAs) are further defined within Section 4.5.3.

The recommended approach also included conducting a design-related investigation to define the treatment areas. The objective of the investigation is to delineate the areas of PCE and TCE contamination in TTA1 and TTA2. The RA contractor has developed a workplan and installed approximately 21 new monitoring wells in the fluvial aquifer. These wells will also be available for monitoring to evaluate remediation performance. As of the writing of this document, the investigation is currently underway. Revision 0 of the Remedial Action Work Plan (RAWP) will incorporate all data resulting from this effort.

3.1.4 Basis of Design

The Basis of Design for the MI groundwater remedy was refined at the December 2003 BCT meeting. This report addresses the remediation system and includes estimates of the number of injection and monitoring wells, quantity of electron donor to be injected to achieve remedial action objectives, reference engineering standards used for general criteria, lists of specific USACE standards, and target treatment standards.

3.1.5 Survey of Site Features

The two TTAs have been surveyed and the data are available for production in computer aided design. Additional surveys will be required to locate the design-related investigation wells and performance monitoring wells, as described in Section 4. Permanent survey benchmarks are positioned across the Depot.

3.1.6 Aquifer Testing

Aquifer testing was completed prior to preparing this report (see Section 2.6 above). Additional information on the testing, analysis procedures, and results are provided in Appendix B.

3.1.7 Notification to Property Owners/Leasee

The Defense Distribution Center (Memphis) is currently known as the Memphis Depot Business Park and is operated by the Depot Redevelopment Corporation (DRC). The current owner of the property is the Army, who has an agreement with leaseholders and the DRC for access rights to the MI for work associated with environmental restoration. All deeds and leases developed by the DRC for property use incorporate the land use controls specified in the LUCIP and the right-of-access agreement for the Army and DLA and, consequently, all contractors working for the property owner.

3.1.8 Final RA Cost Estimate

Section 5 contains an estimate of the costs required to construct and to manage the remedial implementation and operations. The stakeholders will review the estimate to determine the feasibility and schedule for funding the construction effort.

3.1.9 Final Design

The Final Design includes refinement of the design according to comments made on the Pre-final Design and completion of the design specifications, cost estimate, and schedule for implementation. This document represents the Final Design submittal. The Depot stakeholders will review and approve this Final Design before implementation. The Final Design will be used by the RA contractor, under contract to DLA through the Air Force Center for Environmental Excellence (AFCEE), to implement the remedy.

3.1.10 Remedial Action Contracts

Several key milestones occur during the RA operations (RA-O) stage of the project. These include the MI RA Workplan, the MI RA Construction (RA-C), the MI Remedy in Place (RIP), and the MI RA Operating Properly and Successfully (OPS) stage. The RA contractor, currently MACTEC, has and will have opportunities to review the RD documents to prepare for these RA actions. Each of the RA-O tasks has a schedule for implementation, as shown in Figure 3-3.

3.1.11 Long-Term Monitoring

According to Figure 3-3, which is based on the MI Master Schedule dated April 22, 2004, LTM will begin in April 2004. However, LTM is also part of the MI RA-C phase, and monitoring began before that date. The LTM plan for the MI is presented in Appendix B.

3.1.12 Engineering During Construction

The RA contractor will provide construction inspections necessary to certify that the remedial option has been implemented in accordance with approved standards. In addition, the RA Contractor will prepare "as-built" drawings at the end of the construction phase.

3.1.13 Final Inspection

After the remedy has been installed, the construction will be reviewed for acceptance. Reviews will also take place throughout the construction phase as certain areas are completed and require final review. In addition, this phase will include completion and review of an "as-built" survey.

3.2 Five-Year Reviews

CERCLA, Section 121(c) provides for review of an RA where hazardous, substances, pollutants, or contaminants remain at the site, no less often than each 5 years after initiation of the RA. The goal of the 5-year review is to evaluate the RA for:

- Continuing protectiveness of public health and the environment
- Functioning as designed
- Degree to which RAOs have been/are being achieved
- O&M being performed, as necessary

Since the expected duration of the Depot restoration process is greater than 5 years, the five-year review process is triggered by the start of the first RA. The Dunn IRA has already triggered the five-year review schedule, and the next Five-Year Review is due (final) in January, 2008. Five-Year Reviews may be discontinued only if levels of contaminants allow for unrestricted use and unlimited exposure, and appropriate documentation and notification are provided. Therefore, five-year reviews will be needed indefinitely. For the MI, the five-year review will also include review of the effectiveness of the RA (i.e., EBT), institutional controls, and the LTM program. Information on the material typically included in a Five-Year Review document and guidance on conducting a Five-Year Review can be found at: http://www.epa.gov/superfund/resources/5year/guidance.pdf

3.3 Performance Metrics and Contingency Planning

The planned response actions and RAOs for the MI are defined in Sections 2.3 and 2.4. The remedial action proposes injection of sodium lactate periodically over a two-year period in the more contaminated portions of the MI plumes. The remainder of the plume will be allowed to attenuate naturally to MCLs. Until RAOs are achieved, maintenance of land use controls will restrict groundwater development. The RAOs for the remedial action are described in Table 3-1. Table 3-2 provides a list of essential indicators of anaerobic aquifer conditions that will be used to determine that lactate treatments are working. The table also lists other indicators of reductive dechlorination that can be used to measure progress toward achieving RAOs.

Some degree of uncertainty exists within all environmental restoration projects. The recognition and planning for these uncertainties are key to maintaining the project schedule and remaining within budget. Using the current conceptual model, expected conditions and potential deviations have been identified for the MI RA. "Expected condition" is defined as any physical, chemical, technical or regulatory condition that reasonably might be encountered during the RA. Tables 3-3 and 3-4 present the expected conditions and reasonable, potential contingencies to the planned RA. The objective of contingency planning is to ensure that there is a process for identifying deviations from expected conditions and for modifying the RA (with EPA and TDEC concurrence) to account for the deviation. The level of pre-response contingency planning for each of the potential contingencies will need to be determined by the Memphis Depot BCT.

One contingency has been identified by the Memphis Depot as already occurring, which is the presence of site contaminants of concern within three (i.e., MW34, MW89, and MW90) of the designated sentinel wells. Since the RI data were collected, this condition has been identified. The Memphis Depot BCT has agreed to investigate the area and develop stratigraphic and hydrogeologic information. This activity will be further discussed within the RAWP. Any other contingency plans contained in the RAWP will include a description of the necessary design modifications and actions required to manage the deviation.

Table 3-1
Performance Metrics for MI RA Components
Rev. 1 Memphis Depot Final MI RD

Response Objectives	Type of Data Required	Sample Locations	Sample Frequency	Target Parameter Thresholds	Duration	Applied Statistical Algorithims	Subject to Optimization?
Enhanced bioremediation of chlorinated volatile organic compounds (CVOCs) in the most contaminated parts of the plume.	VOCs, MNA parameters	Remediation (performance) monitoring wells	Use Sampling Frequency Decision Tree (Figure 5-1 of Appendix B) and decision rules	Use of key indicators presented in Table 3-2 to indicate anaerobic conditions and attenuation; Reduction of VOCs along recognized reductive dechlorination pathway and sample results indicate a "declining trend" in COC levels	Refer to decision rules in Appendix B; Sampling within treatment areas begins with injections; Four consecutive events below MCLs equals termination	MAROS[1]; Mann-Kendall	Yes; Refer to Section 9 of Appendix B
Long-term groundwater monitoring to document changes in plume concentrations and to detect potential plume migration to off-sie areas or into deeper aquifers.	VOCs, MNA parameters	Wells designated for plume monitoring in LTM plan, Appendix B. See Figure 5-2.	Use Sampling Frequency Decision Tree (Figure 5-1 of Appendix B) and decision rules	Use of key indicators presented in Table 3-2 to indicate aerobic conditions and attenuation; MCLs	Refer to decision rules in Appendix B; Four consecutive events below MCLs equals termination	MAROS[1]; Mann-Kendall	Yes; Refer to Section 9 of Appendix B
Land Use Controls (LUC) through deed restrictions and site controls	Monitoring and Verification	MI except for Parcels 1 and 2 of FU6	Annual monitoring and 5 Year LUC verification	—	In perpetuity*	—	No, unless site conditions change

*Site conditions may change, initiating re-evaluation of LUCs
VOC = volatile organic compounds
MNA = monitored natural attenuation
MCLs = maximum contaminant levels
MI = Main Installation
GW = groundwater
LTM = long-term monitoring
[1]Aziz, J.J, Newell, C.J., Rifai, H.S., Ling, M., and Gonzales, J R. 2000. *Monitoring and Remediation Optimization System (MAROS) Software User's Guide*. Developed for the Air Force Center for Environmental Excellence (AFCEE), Brooks Air Force Base, TX. Use lastest version of software.

Table 3-2
Indicators for Anaerobic Aquifer Conditions (Suitable for Reductive Dechlorination)
Rev. 0 Memphis Depot Final MI RD

Analyte	Concentration in Most Contaminated Zone	Interpretation
Essential Indicators (Performance Criteria for Treatment Zones)		
DO	0.0 to 0.75 mg/L	Optimum suppresses the reductive pathway; however, at higher DO levels VC may be oxidized aerobically
ORP	0 to -500 mV	Reductive pathway likely; note that levels less than -250 may be conducive to methanogenesis
pH	5<pH<9* 5>pH>9*	Optimal range for reductive pathway Outside optimal range for reductive pathway
TOC	20 to 2,500 mg/L	Carbon & energy source (electron donors); drives dechlorination; can be natural or anthropogenic
Other Indicators of Conditions Suitable for Reductive Dechlorination		
Nitrate	<1 mg/L*	At higher concentrations may compete with reductive pathway
Iron (II)	7 to 20 mg/L	Reductive pathway highly likely; VC may be oxidized under Fe(III)- reducing conditions
Sulfate	0.5 to 7mg/L	At higher concentrations may compete with reductive pathway
Sulfide	>1 mg/L*	Reductive pathway possible
Methane	0.05 to 1 mg/L	Ultimate reductive daughter product, VC accumulates
Temperature	>20°C	At >20°C biochemical process is accelerated
CO_2	>2x Background* or 200 to 1000 mg/L	Ultimate oxidative daughter product
Alkalinity	200 to 18,000 mg/L	Results from interaction between CO_2 and aquifer minerals
Chloride	>2x Background*	Daughter product of organic chlorine
Hydrogen	>1 nM (nm/L) <1 nM	Reductive pathway possible, VC may accumulate VC oxidized

Notes

* after Barden, M. and Wiedemeier, T., 2001. *Natural Attenuation for Remediation of Contaminated Sites.* National Ground Water Association Conference, May 7-9, 2001, Nashville, Tennessee.

mg/L - milligrams per liter

ug/L = micrograms per liter

C = celsius

Table 3-3
Contingency Planning - Enhanced Biodegradation and Natural Attenuation
Rev. 1 Memphis Depot Final MI RD

Expected Conditions	Potential Contingencies	Factors Influencing Contingency	Contingency Plan Responses
Levels of contamination in more concentrated areas of plume (within 100 ug/L contour) show signifiicant reduction	Zone of influence is less than expected or anaerobic conditions not developed.	The MI EBT study showed that introduction of lactate electron donor resulted in signficant reduction of levels of contamination	Increase injection points or electron donor concentration or volume
Levels of contamination in more concentrated areas of plume (within 100 ug/L contour) show signifiicant reduction	Larger than expected zone of influence in treatment areas	The expected extent of influence of electron donor solution is approximately 40 feet	Reduce injection volume or concentration; Adjust injection frequency downwards; Reduce number of injection points
Contaminants will reduce through time without significant migration towards the geologic window in the northwest corner of the MI	Contaminants of concern appear in sentinel wells*	Flow pathways are towards middle and NW corner of MI	Develop plans for additional stratigraphic and hydrogeologic investigation of areas surrounding the geologic "window" in the northwest corner of the MI
Levels of contamination in areas designated for natural attenuation show degradation	Contaminants in areas designated for natural attenuation show persistent levels	Without a continuing source presence, contaminant levels will naturally through time	Consider more aggressive remedy for the site, possibly through in-situ chemical oxidation. Evaluate the data for best approach
Concentration of contaminants outside of treatment area reduce through natural attenuation to MCLs	Migration of plume from off-site source	Off-site plumes appeared to have contributed to GW plumes at MI previously	Adjust the design accordingly through development of technical memroandum or during annual monitoring reports; Develop additonal PRP for site by working with regulatory agencies; Characterize impact through installation of monitoring wells
No rebound occurs in treatment areas after treatment completed in 2 years	Rebound of VOCs above MCLs within treatment zones	MI EBT study displayed rebound however these tests were conducted in center of plumes. Source material in GW will be sufficiently reduced through enhanced bioremediation	Design modifications through investigation of rebound areas, source removal, restarting or expansion of treatment areas
No other source areas found within MI perimeter	Detection of another onsite source zone within GW	Potential source zones in soil and GW have been reviewed and analyzed. Groundwater data for entire site not indicative of additional on-site sources	Adjust the design accordingly through additional characterization, potential source removal or expand the injection areas

Table 3-3
Contingency Planning - Enhanced Biodegradation and Natural Attenuation
Rev. 1 Memphis Depot Final MI RD

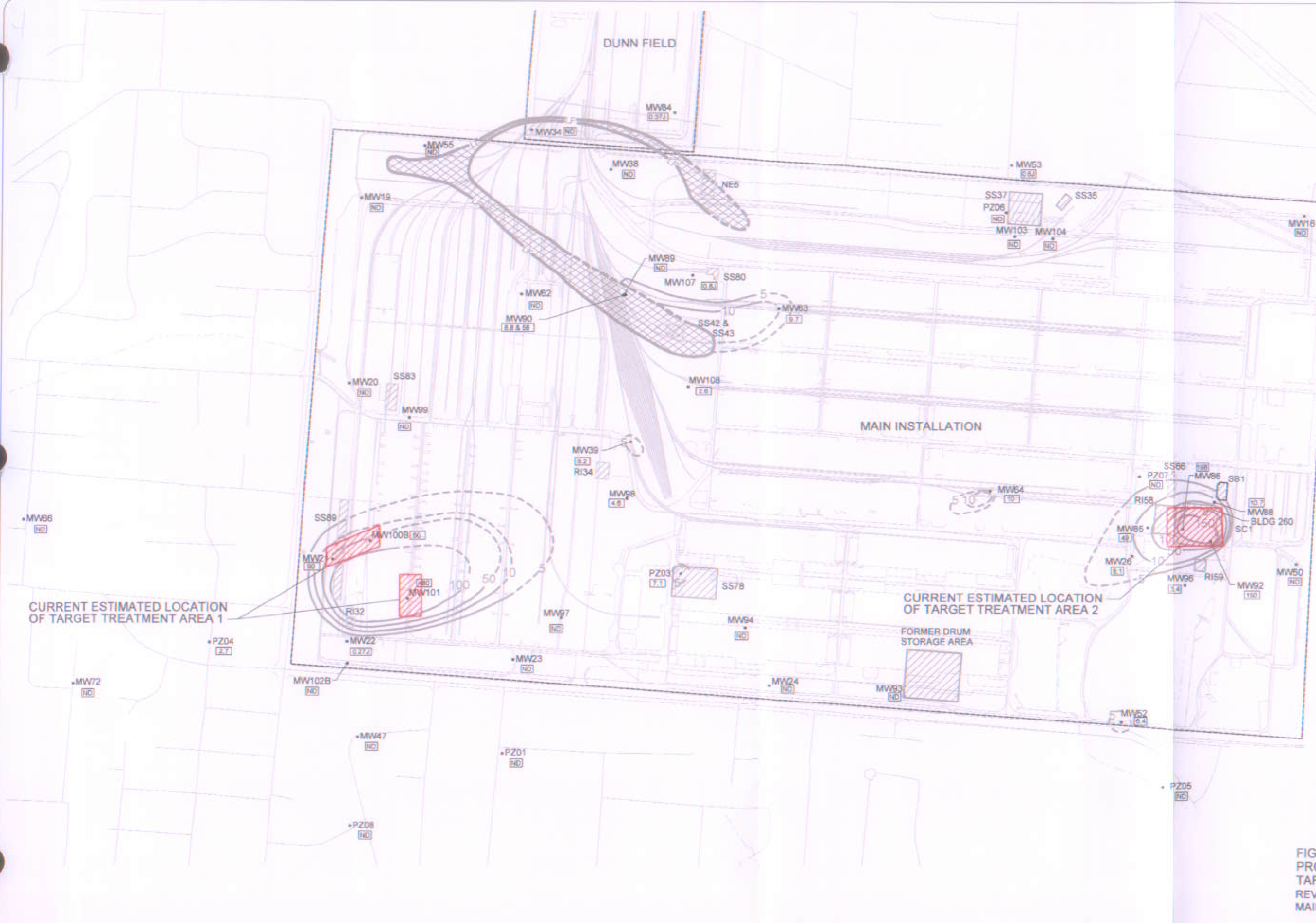
Expected Conditions	Potential Contingencies	Factors Influencing Contingency	Contingency Plan Responses
Cis-1,2-DCE and vinyl chloride (VC), if ever present, levels, decrease over period of remedial action	Cis-1,2-DCE levels do not decrease below MCLs and do not show "declining trends" within aquifer	Degradation of cis-1,2-DCE build-up within a year following the injection of an electron donor at the nearby (within 1 mile) TANG site has been demonstrated (SAIC, 2003).	Consider more aggressive remedy for the site; reduce the electron donor concentration so that the aquifer becomes more aerobic; consider bioaugmentation as an enhancement to the selected remedy
Cis-1,2-DCE and vinyl chloride (VC), if ever present, levels, decrease over period of remedial action	Vinyl chloride will increase in plumes as remedy progresses.	With enhanced bioremediation of source zones, contaminant levels should not increase in these wells.	Consider in-situ chemical oxidation as an alternative to the electron donor injection or reduce the electron donor concentration per injection
No regulatory changes occur	Regulatory change in laws regarding environmental cleanup policies or MCLs	Regulatory framework may change for former industrial sites. MCLs may change with additional information discovery.	Consideration of framework of regulatory change and implications to site will have to be made.

VOCs = volatile organic compounds
MI = Main Installation
RA = remedial action
RA-O = Remedial Action Operations
LTM = long-term monitoring
PRP = potentially responsible party
TANG = Tennessee Air National Guard Site, Memphis International Airport
GW = groundwater
MCL = maximum contaminant level
* Since the RI data were collected, this condition has been identified. The Memphis Depot BCT has agreed to investigate the area and develop stratigraphic and hydrogeologic information

Table 3-4
Contingency Planning - Land Use Controls
Rev. 1 Memphis Depot Final MI RD

Expected Conditions	Potential Contingencies	Factors Influencing Contingency	Contingency Plan Responses
Contamination in soil is reduced to levels less than HHRA goals as specified in the MI ROD.	Contamination in surface soil is reduced to levels that allow for unlimited exposure and unrestricted use	Soil levels may be reduced through reworking or removal of soil	Design modifications not required. Document change for reduction of requirements and application to those.
Contamination in groundwater is reduced to levels less than MCLs throughout entire plume.	Contamination in groundwater is not reduced to levels less than MCLs throughout entire plume.	Remedial action is expected to reduce contaminant levels in treatment areas and areas outside of these to below MCLs	After 2 year treatment period expires, and sustained concentrations of PCE and TCE are determined by compliance monitoring to be greater than MCLs, then design modifications may be required including more aggressive treatment remedies, such a in-situ chemical oxidation
No regulatory changes occur	Regulatory change initiating revision to Risk-Based levels	Regulatory changes for soil levels not common. May be contaminant specific	Design modifications not required. Document change for reduction of requirements and application to those.

794 32



LEGEND

- TETRACHLOROETHENE (PCE) ISOCONCENTRATION LINE (IN ug/L)
- INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- DEPOT BOUNDARY
- BASE FEATURES
- MW88 MONITORING WELL
- PZ06 PIEZOMETER
- ND NOT DETECTED ABOVE LABORATORY REPORTING LIMIT
- 78 CONCENTRATIONS IN ug/L
- ug/L MICROGRAMS PER LITER
- J ESTIMATED CONCENTRATION
- CLAY ELEVATION EXCEEDS GROUNDWATER ELEVATION
- LONG TERM OPERATIONAL AREAS (LTOA)
- CURRENT ESTIMATED LOCATION OF TARGET TREATMENT AREA

NOTE:

(1) ALL UNITS ARE IN ug/L.

(2) MONITORING WELLS 85,86,88,92,93,94,96,97, 98,99,100B,101,102B,103,104,107 AND 108 WERE SAMPLED IN NOVEMBER AND DECEMBER 2001. CONCENTRATIONS DETECTED IN THESE WELLS ARE AVERAGED PER WELL, EXCEPT MW-108.

(3) ALL OTHER AVAILABLE MONITORING WELLS WERE SAMPLED DURING THE MARCH 2002 SAMPLING EVENT.

(4) 5 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD.

(5) MONITORING WELLS MW-89 AND MW-90 WERE SAMPLED AT TWO DIFFERENT INTERVALS WITHIN EACH WELL. CONCENTRATIONS ARE INDICATED FOR BOTH INTERVALS.

(6) THE "LIMITED TO NO FLOW BOUNDARY" BOUNDS AN AREA WHERE THE WATER LEVEL IN THE FLUVIAL AQUIFER INTERSECTS THE CLAY DIRECTLY UNDERLYING THE FLUVIAL DEPOSITS, LEAVING FLUVIAL DEPOSITS UNSATURATED.

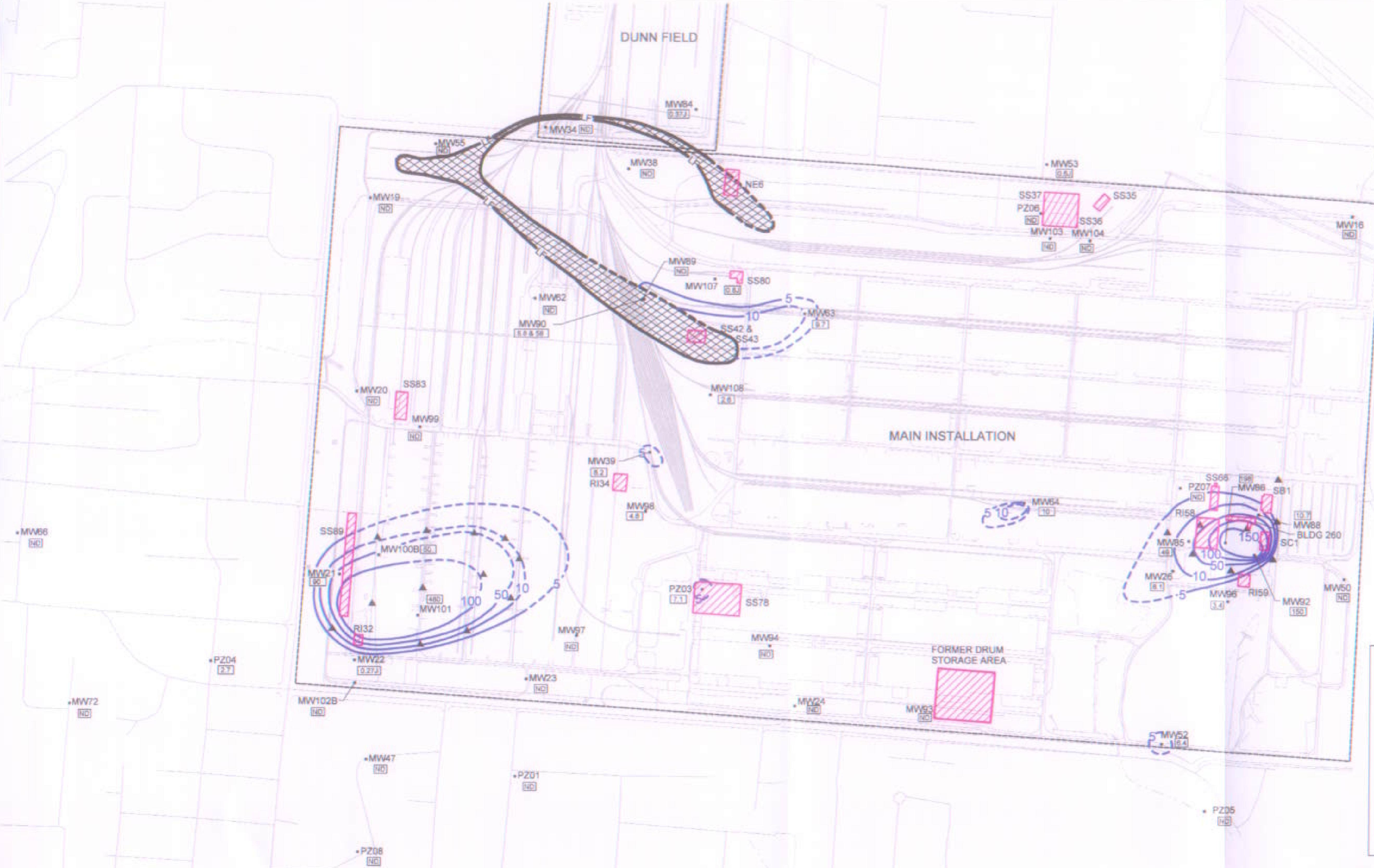
SITE DESCRIPTIONS

260:	GARAGE AND PAINT SHOP
NE6:	PAINT SHOP
RI27:	OLD RECOUPMENT AREA
RI32:	PAINT/SANDBLASTING/SS31-33
RI34:	MAINTENANCE SHOP AND UST
RI58:	PAD 257, OLD PESTICIDE SHOP
RI59:	PESTICIDE MIXING AREA, B-273
SB1:	AUTO MAINTENANCE AND REPAIR SHOP
SC1:	AUTO MAINTENANCE AND REPAIR SHOP
SS35:	DRMO STORAGE
SS42:	PCP DIP VAT / PCP UST
SS43:	PCP DIP VAT / PCP UST
SS66:	VEHICLE MAINTENANCE SHOP
SS78:	BUILDING 678
SS80:	FUEL AND CLEANER DISPENSER, B-720
SS83:	DRIED PAINT / POL DISPOSAL AREA
SS89:	PAINT, SOLVENT, ACID SPILLS AREA
DRUM STORAGE AREA	

FIGURE 3-1
PROPOSED LOCATIONS OF TARGET TREATMENT AREAS
REV.1 FINAL REMEDIAL DESIGN
MAIN INSTALLATION, MEMPHIS DEPOT

CH2MHILL

ATLANTA/CAD1/PROJECTS/148071 DDMT/DUNN FIELD RD_2004 22-JUL-2004 8071fig3-1.dgn



0 250 500
APPROXIMATE SCALE

LEGEND

10 TETRACHLOROETHENE (PCE) ISOCONCENTRATION LINE (IN ug/L)
10 INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
DEPOT BOUNDARY
BASE FEATURES
• MW86 MONITORING WELL
• PZ06 PIEZOMETER
ND NOT DETECTED ABOVE LABORATORY REPORTING LIMIT
75 CONCENTRATIONS IN ug/L
ug/L MICROGRAMS PER LITER
J ESTIMATED CONCENTRATION
CLAY ELEVATION EXCEEDS GROUNDWATER ELEVATION
LONG TERM OPERATIONAL AREAS (LTOA)
PROPOSED ADDITIONAL MONITORING WELL LOCATIONS

NOTE:

(1) ALL UNITS ARE IN ug/L

(2) MONITORING WELLS 85,86,88,92,93,94,96,97, 98,99,100B,101,102B,103,104,107 AND 108 WERE SAMPLED IN NOVEMBER AND DECEMBER 2001. CONCENTRATIONS DETECTED IN THESE WELLS ARE AVERAGED PER WELL, EXCEPT MW-108.

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(4) 5 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

(5) MONITORING WELLS MW-89 AND MW-90 WERE SAMPLED AT TWO DIFFERENT INTERVALS WITHIN EACH WELL, CONCENTRATIONS ARE INDICATED FOR BOTH INTERVALS.

(6) THE "LIMITED TO NO FLOW BOUNDARY" BOUNDS AN AREA WHERE THE WATER LEVEL IN THE FLUVIAL AQUIFER INTERSECTS THE CLAY DIRECTLY UNDERLYING THE FLUVIAL DEPOSITS, LEAVING FLUVIAL DEPOSITS UNSATURATED.

SITE DESCRIPTIONS

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SS42:	PCP DIP VAT / PCP UST
SS43:	PCP DIP VAT / PCP UST
SS66:	VEHICLE MAINTENANCE SHOP
SS78:	BUILDING 678
SS80:	FUEL AND CLEANER DISPENSER, B-720
SS83:	DRIED PAINT / POL DISPOSAL AREA
SS89:	PAINT, SOLVENT, ACID SPILLS AREA
DRUM STORAGE AREA	

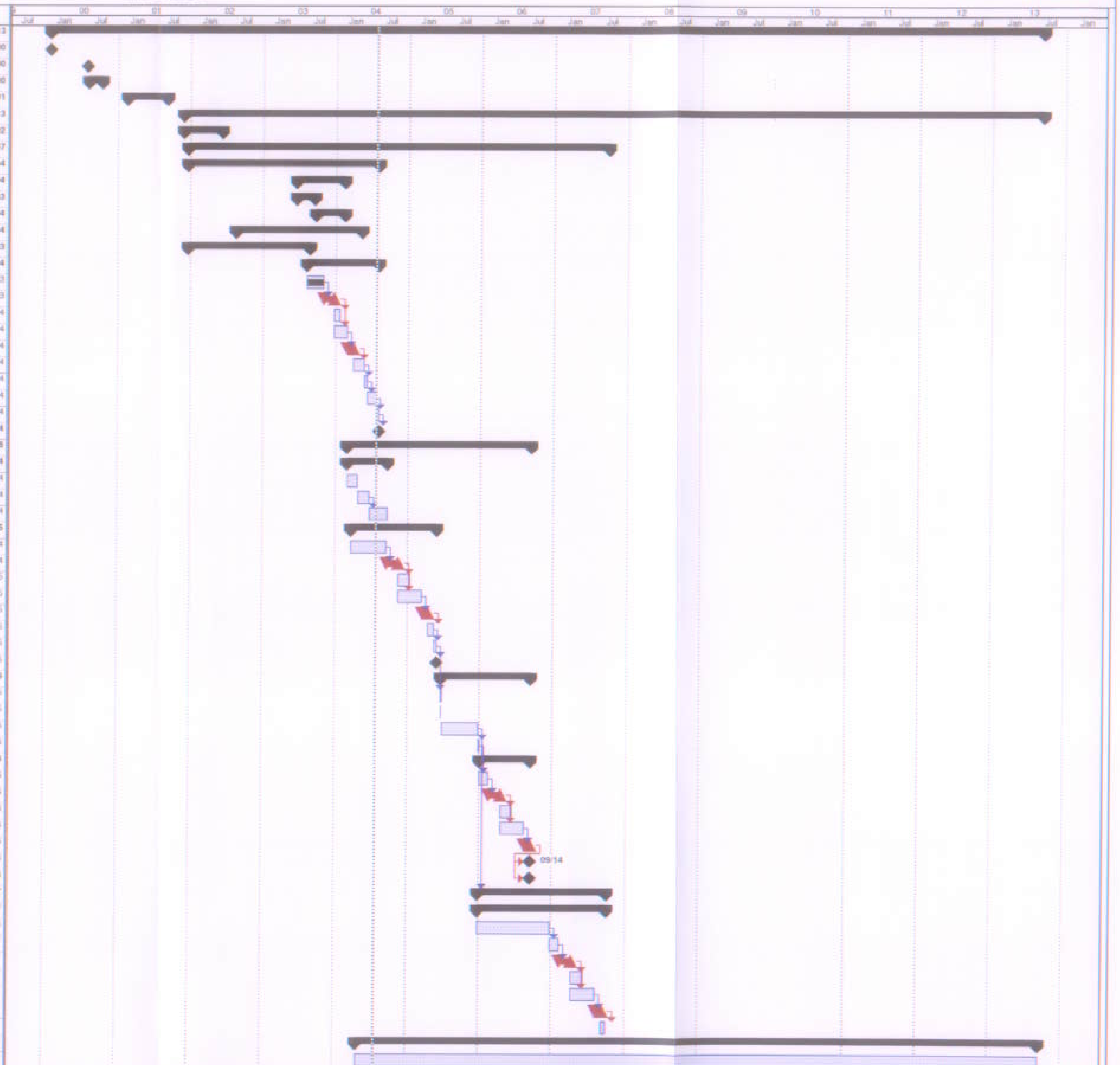
FIGURE 3-2
PROPOSED LOCATIONS FOR DESIGN-RELATED INVESTIGATION
REV.1 FINAL REMEDIAL DESIGN
MAIN INSTALLATION, MEMPHIS DEPOT

CH2MHILL

ATLANTA/CAD1/PROJECTS/148071 DDMT/DUNN FIELD RD_2004 22-JULY-2004 8071fig3-2.dgn

Figure 3-3
MI Remedial Design and Remedial Action Schedule
Rev. 1 MI Final RD

ID	BCT Item	% complete	Task Name	Duration	Start	Finish
1		16%	**MAIN INSTALLATION**	4886 days?	Fri 01/28/00	Thu 09/12/13
2		100%	**Main Installation (MI) Remedial Investigation**	0 days	Fri 01/28/00	Fri 01/28/00
4		100%	**Main Installation Feasibility Study**	0 days	Mon 07/31/00	Mon 07/31/00
7		100%	**Main Installation Proposed Remedial Action Plan (Proposed Plan)**	68 days	Mon 08/07/00	Fri 10/13/00
11		100%	**Main Installation Record of Decision**	203 days	Fri 02/16/01	Thu 09/06/01
16		15%	**Main Installation Post ROD Activities**	4307 days?	Wed 11/28/01	Thu 09/12/13
17		100%	**Main Installation Remedial Design (RD) Work Plan**	195 days	Wed 11/28/01	Mon 06/10/02
26		25%	**Main Installation Remedial Design (RD)/Remedial Action Construction (RA-C)**	2109 days?	Thu 12/20/01	Fri 09/28/07
27		55%	**Main Installation (MI) Remedial Design (RD)**	962 days	Thu 12/20/01	Sat 08/07/04
28		46%	**MI Pre-Design Sampling at Sites 42/43 (Former PCP Dip Vat/UST Area)**	244 days	Wed 06/18/03	Mon 02/16/04
29		100%	**Pre-Design Investigation Work Plan (Sites 42/43 [PCP Dip Vat])**	91 days	Wed 06/18/03	Tue 09/16/03
37		11%	**Pre-Design Investigation (Sites 42/43 [PCP Dip Vat])**	148 days	Mon 09/22/03	Mon 02/16/04
46		63%	**MI Land Use Control Implementation Plan (LUCIP)**	633 days	Mon 08/19/02	Wed 05/12/04
61		100%	**MI Enhanced Bioremediation Treatment (EBT) Pilot Test**	611 days	Thu 12/20/01	Fri 08/22/03
96		21%	**MI Remedial Design (RD) Package**	366 days	Fri 08/08/03	Sat 08/07/04
97		100%	Prepare & Submit Rev. 0 (60%) MI RD Report	84 days	Fri 08/08/03	Thu 10/30/03
98	BCT	0%	BCT Review & Submit Comments on Rev. 0 (60%) MI RD Report	54 days	Fri 10/31/03	Tue 12/23/03
99		0%	Respond to BCT Comments on Rev. 0 (60%) MI RD Report	30 days	Wed 12/24/03	Thu 01/22/04
100		0%	Prepare & Submit Rev. 0 (90%) MI RD Report	66 days	Wed 12/24/03	Fri 02/27/04
101	BCT	0%	BCT Review of Rev. 0 (90%) MI RD Report	31 days	Sat 02/28/04	Mon 03/29/04
102		0%	Prepare & Submit Rev. 0 Final (100%) MI RD Report	56 days	Tue 03/30/04	Mon 05/24/04
103		0%	BCT Review of Rev. 0 Final (100%) MI RD Report	15 days	Tue 05/25/04	Tue 06/08/04
104		0%	Respond to BCT Comments, Prepare & Submit Rev. 1 Final MI RD Report	45 days	Wed 06/09/04	Fri 07/23/04
105		0%	BCT Approval of Rev. 1 Final (100%) MI RD Report	15 days	Sat 07/24/04	Sat 08/07/04
106		0%	Rev. 1 Final (100%) MI RD Report	0 days	Sat 08/07/04	Sat 08/07/04
107		0%	**Main Installation (MI) Remedial Action (RA)**	928 days	Mon 03/01/04	Thu 09/14/06
108		0%	**Installation of LTM & Treatment Area Wells**	205 days	Mon 03/01/04	Tue 09/21/04
109		0%	Prepare & Submit Workplan	54 days	Mon 03/01/04	Fri 04/23/04
110		0%	Well Installation and LTM Groundwater Sampling Event 1	57 days	Mon 04/26/04	Mon 06/21/04
111		0%	Prepare and Submit Rev. 0 Tech Memo	92 days	Tue 06/22/04	Tue 09/21/04
112		0%	**MI Remedial Action (RA) Work Plan**	435 days	Sun 03/21/04	Sun 05/29/05
113		0%	Prepare & Submit Rev. 0 MI RA Work Plan to BCT	180 days	Sun 03/21/04	Thu 09/16/04
114	BCT	0%	BCT Review & Submit Comments on Rev. 0 MI RA Work Plan	60 days	Fri 09/17/04	Mon 11/15/04
115		0%	Respond to BCT Comments on Rev. 0 MI RA Work Plan	60 days	Tue 11/16/04	Fri 01/14/05
116		0%	Prepare & Submit Rev. 1 MI RA Work Plan	120 days	Tue 11/16/04	Tue 03/15/05
117	BCT	0%	BCT Review of Rev. 1 RA Work Plan	30 days	Wed 03/16/05	Thu 04/14/05
118		0%	Prepare & Submit Rev. 2 MI RA Work Plan	30 days	Fri 04/15/05	Sat 05/14/05
119		0%	BCT Approval of the Rev. 2 (Final) MI RA Work Plan	15 days	Sun 05/15/05	Sun 05/29/05
120		0%	Rev. 2 (Final) MI RA Work Plan	0 days	Sun 05/29/05	Sun 05/29/05
121		0%	**Main Installation Remedial Action (RA) Construction**	452 days	Mon 06/20/05	Thu 09/14/06
122		0%	Mobilization	7 days	Mon 06/20/05	Sun 06/26/05
123		0%	Notice of Remedial Action Implementation	1 day	Tue 06/21/05	Tue 06/21/05
124		0%	MI RA Construction (RA-C)	183 days	Mon 06/27/05	Mon 12/26/05
125		0%	Demobilization	7 days	Tue 12/27/05	Mon 01/02/06
126		0%	**MI RA Interim Completion Report**	255 days	Tue 01/03/06	Thu 09/14/06
127		0%	Prepare & Submit Rev. 0 MI RA Completion Report to BCT	45 days	Tue 01/03/06	Thu 02/16/06
128	BCT	0%	BCT Review & Submit Comments on Rev. 0 MI RA Completion Report	60 days	Fri 02/17/06	Mon 04/17/06
129		0%	Respond to BCT Comments on Rev. 0 MI RA Completion Report	60 days	Tue 04/18/06	Fri 06/16/06
130		0%	Prepare & Submit Rev. 1 MI RA Completion Report	120 days	Tue 04/18/06	Tue 08/15/06
131	BCT	0%	BCT Review of Rev. 1 MI RA Completion Report w/ Concurrence	30 days	Wed 08/16/06	Thu 09/14/06
132		0%	BCT Approval of the MI Interim RA Completion Report	0 days	Thu 09/14/06	Thu 09/14/06
133		0%	**MI Remedy In Place (RIP)**	0 days	Thu 09/14/06	Thu 09/14/06
134		0%	**MI RA Operations (RA-O)**	641 days?	Tue 12/27/05	Fri 09/28/07
135		0%	**MI RA Operating Properly and Successfully (OPS)**	641 days?	Tue 12/27/05	Fri 09/28/07
136		0%	4 Quarters to OPS	365 days?	Tue 12/27/05	Tue 12/26/06
137		0%	Prepare & Submit Rev. 0 OPS Determination to BCT	45 days	Wed 12/27/06	Fri 02/09/07
138	BCT	0%	BCT Review & Submit Comments on Rev. 0 OPS Determination	60 days	Sat 02/10/07	Tue 04/10/07
139		0%	Respond to BCT Comments on Rev. 0 OPS Determination	60 days	Wed 04/11/07	Sat 06/09/07
140		0%	Prepare & Submit Rev. 1 OPS Determination	120 days	Wed 04/11/07	Wed 08/08/07
141	BCT	0%	BCT Review of Rev. 1 OPS Determination w/ Concurrence	30 days	Thu 08/09/07	Fri 09/07/07
142		0%	EPA/Regional Administrator Approval of OPS Determination	21 days	Sat 09/08/07	Fri 09/28/07
143		0%	**Main Installation Long-Term Groundwater Monitoring (LTM)**	3427 days	Mon 04/26/04	Thu 09/12/13
144		0%	Conduct Long-Term Groundwater Monitoring (5-years)	3427 days	Mon 04/26/04	Thu 09/12/13



Project: Memphis Depot Main Installation Master Schedule
Date: 22-July-2004
Updated: 22-July-2004

Task | Progress | Milestone | Summary | Project Summary | BCT Review | External Milestone | Deadline

4.0 Basis of Design

4.1 Background Information

The MI ROD selected enhanced bioremediation as the remedy for groundwater. In a technical memorandum (TM), dated December 2, 2003, CH2M HILL evaluated two delivery options for the electron donor: frequent or continuous injection and recirculation. Periodic injection involving using portable equipment was selected by the BCT. Sodium lactate will be added to a storage tank secured on a trailer, mixed with water to obtain the appropriate concentration, and subsequently pumped under low pressure into the injection wells. The wells will be located within target treatment areas (TTAs) defined by the design-related groundwater investigation. This RD addresses establishment and maintenance of anaerobic conditions within the TTAs, and recommends both the location and number of injection wells within the TTAs. The recommendations are subject to adjustment based on the results of the design-related groundwater investigation. Actual location and number of injection wells and monitoring wells within the TTAs will be defined by the RA Work Plan, prepared by MACTEC.

This section summarizes the EBT study, outlines the critical elements used in the design, and provides information concerning the injection strategy, performance metrics, and contingency alternatives, if required. A long term monitoring (LTM) program is an essential part of the RA and will be implemented across the site. The LTM program is described in Appendix B.

4.2 Treatability Study Design Related Information

In the EBT report, CH2M HILL (October, 2004) concluded that the "apparent" rates of biodegradation of PCE, TCE, and carbon tetrachloride (CT) could be enhanced by lactate injections into the contaminant plume. Table 4-1 shows the enhanced degradation rates achieved by lactate injections into the fluvial aquifer treatment zones at the MI and at the nearby (within 1 mile) Tennessee Air National Guard (TANG) site at the Memphis International Airport. The rates for the TANG site were derived from results reported by SAIC (2003), based on their full-scale remedial action on a TCE plume in the fluvial aquifer. The degradation rates from TANG are considered representative of the MI because the principal contaminant is TCE, the hydrogeological conditions are very similar, and the SAIC treatment methods (lactate injections) are similar.

TABLE 4-1
Comparison of Lactate - Enhanced Degradation Rates (numbers are ranges of λ, yr^{-1})
MI Pre-final RD, Memphis Depot

Site	PCE	TCE	*cis*-1,2-DCE	VC
Memphis Depot – MI	4.4 - 11	2.3 - 7.7	--	NA
TANG	1.6 - 8.5	5.1 - 11.1	2.8 - 6.1	NA

NA - No accumulation

There is no MI enhanced rate for cis-1,2-DCE because the EBT pilot test did not show degradation of *cis*-1,2-DCE. This is most likely due to the short duration of the pilot test. The TANG results showed degradation of *cis*-1,2-DCE only after at least one year of periodic lactate injections.

Based on the effectiveness of lactate injections, CH2M HILL recommended an in situ biostimulation system consisting of periodic injections of sodium lactate into multiple wells. The effect of the periodic injections would be to sustain reducing conditions in the fluvial aquifer treatment zones suitable for reductive dechlorination. The implications of the enhanced rates for plume cleanup are that relatively small plume "source" areas need to be treated for only 2 years, with residual VOC levels in the fluvial aquifer declining to MCLs through natural attenuation. Calculations using first order degradation rates show that VOC levels within the treatment areas should meet the ROD cleanup goals (MCLs) within 2 years and untreated plume areas should achieve ROD goals in 20+ years. These predictions are discussed in more detail below.

The current design for groundwater treatment at MI targets two areas, TTA1 and TTA2. These areas are currently defined (bounded) by the interpreted 100 µg/L isoconcentration contour for parent compounds PCE and TCE. The enhanced degradation rates from Table 4-1 can be used to predict the effect of 2 years of lactate injections. The predicted concentrations use the formula:

$C_{(final)}/C_{(initial)} = e^{[-\lambda t]}$, where λ is the 1st order decay rate and t is time in years.

Table 4-2 summarizes the calculations using the highest reported levels of PCE, TCE, *cis*-1,2-DCE, VC, CT, and CF within the TTAs.

These calculations indicate that, after 2 years of periodic lactate injections, the MCL should be achieved within the TTAs for PCE, TCE, *cis*-1,2-DCE, CT, and CF. The calculations also predict that there will be an accumulation of VC (above the MCL) within the TTAs. Wiedemeier and others (1999) discuss the observed slow degradation of VC under anaerobic conditions, and rapid degradation under aerobic conditions. The fluvial aquifer outside the treatment areas is aerobic, so that any VC that migrates outside a TTA will be degraded quickly (see calculations below). As discussed in Section 4.4.4, monitoring will indicate when the lactate injections have created anaerobic conditions within a TTA.

TABLE 4-2
Summary of Predicted Treatment Effects at TTA1 and TTA2.
MI Pre-final RD, Memphis Depot

Contaminant	Maximum Concentration in TTA (μg/L)	Yield Factor*	Total Concentration to Degrade (μg/L)	Enhanced Degradation Rate, 1/yr**	MCL (μg/L)	Estimated Concentration (μg/L)	
						Year 1	Year 2
PCE	500	0.79	500	4.4	5	6	0
TCE	80	0.74	475	2.3	5	48	0
cis-1,2-DCE	100	0.64	452	2.8	70	***	28
VC	25		314	1	2	***	115
CT	90	0.78	90	3.5	5	3	0
CF	85		155	1.6	80 (THM)	31	1

Notes

* - Assumes complete degradation of parent to daughter products:
PCE → TCE → *cis*-1,2-DCE → VC, and CT → CF. The Yield Factor is the ratio of daughter/parent molecular weights.

** - PCE, TCE, CT, CF degradation rates from EBT study (CH2M HILL, October 2003). DCE degradation rate from TANG data (SAIC, 2003). VC is average field rate from Table 6.6 in Wiedemeier and others (1999).

*** - Assumes no degradation of *cis*-1,2-DCE during first year of treatment.

THM – sum of all trihalomethanes

The RA relies on natural attenuation to achieve the ROD goals for plumes outside each TTA. Calculations presented in Table 4-3 show the predicted contaminant levels in the untreated MI plumes after 10 and 20 years. The calculations use the same equation as in Table 4-2, except that the starting concentrations and degradation rates are different. Note that in Table 4-3, the "maximum" levels of *cis*-1,2-DCE and VC are the residual levels from each TTA (compare to Table 4-2). Although currently the maximum level of both *cis*-1,2-DCE and VC outside the TTAs is 20 ug/L, it is best to be conservative and assume that natural attenuation must start with the higher concentrations.

TABLE 4-3
Summary of Predicted Natural Attenuation of Plumes Outside Target Treatment Areas
MI Pre-final RD, Memphis Depot

Contaminant	Starting Concentration (μg/L)	Yield Factor*	Total Concentration to Degrade (μg/L)	Degradation Rate, 1/yr**	MCL (μg/L)	Estimated Concentration (μg/L)	
						Year 10	Year 20
PCE	60	0.79	60	0.095	5	23	9
TCE	50	0.74	97.4	0.289	5	9	3
cis-1,2-DCE	30	0.64	102	0.2	70	12	3
VC	120		185	4	2	0	0
CT	5	0.78	5	0.06	5	3	2
CF	5		9	0.6	80 (THM)	0	1

Notes

* - Assumes complete degradation of parent to daughter products:
PCE → TCE → *cis*-1,2-DCE → VC, and CT → CF. The Yield Factor is the ratio of daughter/parent molecular weights.

** - Estimated degradation rates under aerobic (natural) conditions within Fluvial aquifer. Data from EBT study (CH2M HILL, 2003) and Wiedemeier and others (1999, Section 6).

The calculations suggest that 20+ years of natural attenuation processes will be needed to achieve the RAOs. It is important to recognize that the plumes within MI are stable without treatment. Whether natural attenuation requires 10 years or 20 years to achieve the RAOs, the plumes are not expected to increase in length (size) after treatment stops.

4.3 Design Elements

This RD details three distinct components: the injection wells, the trailer-mounted injection system, and the chemical storage and transfer facility. Operational procedures and equipment used in each component are summarized in the following sections.

4.3.1 Injection Wells

Location and Spacing

Injection wells will be installed in areas where concentrations of parent VOCs (such as PCE and TCE) exceed 100 µg/L. The recommended injection well layout, presented as Figures 4-1 and 4-2, is based on groundwater monitoring performed for the EBT treatability study. The recommended injection well spacing should not exceed 40 feet in the downgradient direction. This spacing is based on the EBT pilot study that showed a maximum lactate influence of 38 feet downgradient of the injection well. Figures 4-1 and 4-2 show 13 new and 3 existing wells to be used in TTA 1 and 9 new wells to be used in TTA 2. The layout in TTA 1 focuses on the region surrounding wells MW21, MW100B, and MW101. Wells IW5, IW6, and IW7 (used during the EBT Treatability Study) could be used for injections during the RA, provided they are re-developed to clear the wells of emulsified vegetable oil. The injection wells at TTA 2 are within an area bounded by Buildings 261, 265, and 270. The recommended layouts are subject to modification based on the design-related groundwater investigation currently underway. As indicated in Figures 4-1 and 4-2, the injection wells should be placed along a line "perpendicular" to local groundwater flow direction. Final placement of injection wells must also avoid underground and overhead utilities, and other site obstructions.

Method and Construction

Mud-rotary drilling techniques[1] with a minimum borehole diameter of 10 inches are recommended to install the injection wells. Injection wells will be screened across the entire thickness of the fluvial aquifer; however, individual wells will be limited to a screens less than 15 feet long. Where the fluvial aquifer exceeds this thickness, multiple wells will be nested to span the aquifer. The RA contractor will determine the termination depth and screen interval during well installation. Note that the RD cost estimate (see Section 4.4.2) assumes an average thickness of the fluvial aquifer of 20 feet in TTA 1 (assumes a two well cluster each with 10-ft screen) and 10 feet in TTA 2.

Each injection well will be four-inch diameter, SCH 80 PVC, 0.04-inch slotted screen. The well casing and screen will be constructed using flush-fitting, internally-threaded joints. The filter pack will be washed and bagged sand with a grain-size distribution curve that meets the 4-20 gradation specification. The filter pack should extend below the bottom of the

[1] Alternative drilling techniques may be selected by the RA Contractor.

screen and at least one foot above the top of the screen. A minimum two-foot thick seal of hydrated bentonite will be placed above the filter pack to protect the screen during grouting. Each injection well head will be fitted with a 2-inch male cam-lock fitting and an air relief valve. A drilling specification and a wellhead detail are provided in Appendix E.

4.3.2 Trailer-Mounted Injection System

A trailer-mounted injection system will be used to pump sodium lactate into the injection wells. The specification for the portable injection system is presented in Appendix F. The system will consist of the following:

Storage tank - A 500-gallon polypropylene tank fitted with two injection ports (for sodium lactate concentrate and potable water) will be used for mixing and temporarily storing the dilute lactate solution. The storage tank will have a top-mounted blind flange to support a mixer, a top-mounted air vent, and a side-mounted discharge port. The tank will have volumetric gradations prominently displayed on the outside. The contents will be mixed during filling activities, or may be mechanically mixed using an agitator. Float controls are not required because filling will be manually controlled.

Tank mixer - Note that below temperatures of 40°F, the viscosity of the sodium lactate concentrate increases dramatically: the nominal viscosity is approximately 0.3 centipoise (cP), but viscosity increases to 0.9 cP at 30°F. Thus, the substrate/water solution may require mechanical mixing when ambient temperatures are below 40°F. An electrically-powered mixer will be permanently mounted on top of the storage tank. The mixer has been sized to blend the tank contents within 5 minutes.

Injection pump - A centrifugal pump rated for 20 gallons per minute (gpm) at 50 pounds per square inch (psi) output pressure will be mounted to the trailer. The pump will be connected to the storage tank with 2-inch PVC pipe and valving.

Trailer - A trailer will be specified to house the storage tank, piping, instrumentation, and injection pump. The trailer will be designed with a load capacity to transport 500-gallons of substrate solution, both on-road and off-road (grassy areas).

Generator - The trailer will have a gasoline-powered generator capable of supplying power to either the injection pump or tank mixer for four hours. The generator will be trailer-mounted and permanently wired to the pump and mixer. Generator output will be manually switched.

Delivery hose - The trailer will carry approximately 50 ft of flexible hose to deliver sodium lactate solution to one injection well at a time. The hose will be 2-inch diameter Teflon hose with stainless steel braided cover. The injection hose and supporting appurtenances will be rated for a maximum pressure of >100 psi. The hose will connect to each injection well head through a cam-lock fitting.

Instrumentation -A pressure gauge and flow meter will be installed at the pump discharge to measure injection pressure and flow volume. The operator will use polyvinyl chloride (PVC) ball valve(s) to regulate the injection volume. During injections the operator will record pressure and flow data in the field logbook.

4.3.3 Chemical Storage and Transfer Facility

A chemical storage and transfer facility will be located in Building 309. The transfer equipment will consist of containers of sodium lactate concentrate, a concentrate transfer system, and a potable water metering system. A layout depicting the storage and transfer equipment is provided in Appendix G.

Containers of Sodium Lactate Concentrate - Concentrated sodium lactate (60% by weight) will be delivered in 260-gallon (2,850 pounds) intermediate bulk containers (IBCs). The IBCs will be stored within a secondary containment curb constructed in the southwestern part of Building 309.

Concentrate Transfer System - Concentrate will be transferred from the IBCs to the trailer-mounted storage tank through a ¾-inch diameter hose. The operator will manage the transfer using a drum pump and batch controller. The drum pump can deliver up to 35 gpm of concentrate at viscosity in excess of 850 cP. The pump motor will operate on 115 volts, 50/60 Hz, single-phase power through a 15-foot cord and plug. This system provides the operator wide flexibility in the amount of concentrate transferred to the storage tank. The operator will record in the field notebook the volume of concentrate transferred.

Potable Water Metering System - Potable water will be added to the storage tank to dilute the sodium lactate concentrate. The water will be provided from a supply line maintained by the City of Memphis. A valve on the supply service to Building 309 is approximately 60 feet west of the building; the actual tie-in location will be coordinated with the City of Memphis. A backflow preventor and flow meter will be installed at the tie-in connection. The water-supply line will be trenched from the tie-in connection to Building 309. Water at 50-60 psi will be fed into the storage tank using a 1.5-inch flexible hose fitted to a connection inside the building. A meter and manual control valve will be placed in the same area as the controls for the concentrate transfer system. The operator will record in the field notebook both the total flow from the meter in the building and the liquid level in the storage tank.

4.4 Performance Metrics

4.4.1 Injection Strategy

The injection strategy involves using a combination of substrate concentration, injection volumes, and injection schedule [frequency and location(s)] to maintain subsurface conditions suitable for enhanced biodegradation. The injection strategy will be dynamic: concentrations, volumes, and/or schedule will be adjusted based on results of primary (laboratory) and secondary (field) performance monitoring. This design assumes a two-year injection schedule with an initial aggressive strategy to develop anaerobic conditions. After anaerobic conditions are established the strategy will be adjusted to sustain the conditions at "minimal" cost for labor and materials. Anaerobic conditions will be verified during the entire injection period by routine performance monitoring (see Section 4.4.4).

4.4.2 Recommended Initial Injection Strategy

The goals of the initial injection strategy are to develop and to sustain anaerobic conditions suitable for reductive dechlorination, and to provide adequate substrate distribution in the fluvial aquifer. Table 4.4 presents the recommended initial concentration (2%) and injection volumes of sodium lactate for TTA 1 and TTA 2. The recommended initial injection schedule is biweekly for the first year and monthly for the second year. The injection frequency and mass of lactate (injection volume times concentration) is recommended to assure aquifer conditions suitable for reductive dechlorination will be created quickly. As discussed in Appendix A, a more concentrated lactate solution (up to 40%) was used during the EBT treatability study. But these high lactate concentrations promoted substantial methane production. To decrease the competition between the methanogens and the dechlorinators, a low lactate concentration is recommended. The recommended 2% lactate solution is similar to the 1% lactate solution used successfully at the nearby TANG site at the Memphis International Airport (SAIC, 2003). The recommended injection strategy (includes lactate concentration, injection volume, and injection schedule) will likely be changed based on results of performance monitoring (see Sections 3.3 and 4.4.4).

It is important to note that the injection volumes in Table 4-4 are listed according to the thickness of the fluvial aquifer at the injection well. As indicated in the table, the minimum injection volume for each TTA is based on a 10-ft aquifer thickness. It is recommended that actual aquifer thickness be rounded up to the nearest 10 ft when planning the injection volume at each well (location). For calculation purposes, the total injection volume is assumed to occur at an injection "well" that may actually be a well cluster. For example, at a "well" in TTA 1, the fluvial aquifer may be 28 ft thick. At that location three wells each with a 10-ft screen would span the fluvial aquifer. The recommended total volume of dilute solution (540 gal) would be injected in equal portions into each well (180 gal/well).

The injection volumes in Table 4-4 were calculated from lactate demand using concentrations of electron acceptors and VOCs that were determined during the EBT Treatability Study (Appendix A). A summary of the lactate demand calculations for TTA 1 and TTA 2 are provided in Tables 4-5 and 4-6, respectively. Note that an engineering safety factor (SF) of 4 was used in the tables to determine the lactate mass per injection well. The 60% concentration referenced in the tables is the commercially available form of lactate concentrate solution. The 60% lactate solution is available in both 55-gallon drums and 260-gallon IBCs.

Based on performance monitoring results, the RA contractor may decide to inject other mixtures. We have calculated dilutions of the 60% concentrate for multiple safety factors (SF). Tables 4-7 and 4-8 show the dilution calculations for TTA 1 and TTA 2, respectively, using SF of 1 (none), 2, 3, and 4. These tables also show volumetric calculations for biweekly and monthly injection schedules on a per well basis. These calculated volumes may be compared to an arbitrary, elevated lactate concentration of 1,000 mg/L which is approximately 73.6% greater than the calculated demand (264 mg/L) in TTA 1 (SF = 4), and approximately 83% greater than the calculated demand (175 mg/L) in TTA 2 (SF = 4). Lastly, the tables provide the estimated cost to follow the recommended injection strategy. Note that the estimated costs are based on the following assumptions:

- There are 16 injection wells at TTA 1 and 9 injection wells at TTA 2.
- Injection fluid is 2% lactate for both TTA 1 and TTA 2.

- For each event, injection volumes are 360 gal/location in TTA 1 (assumes 20-ft fluvial aquifer) and 120 gal/location in TTA 2 (assumes 10-ft fluvial aquifer).
- Labor estimates include time for injections performed at 10 gpm rounded up to the nearest 30-minute increment. Labor estimates also include 1 hour for each filling of the transfer tank, as often as required to complete one event.

4.4.3 Target Treatment Areas

Each TTA (Figures 4-1 and 4-2) was defined using data from the March 2002 Baseline Sampling event and the baseline sampling for the EBT treatability study. Each TTA will be further refined based on the data collected during the design-related groundwater investigation that was started in April 2004.

4.4.4 Performance Monitoring

Performance monitoring will include collection of water samples for field and laboratory analysis and measurement of water levels in wells. The chemical results and water levels will provide the periodic data necessary to determine how well the in situ treatments are working, and to modify to the injection strategy. The performance monitoring will provide primary (laboratory) and secondary (field) data as discussed below. Sampling specifications and requirements for groundwater monitoring are outlined in Appendix B.

Primary Performance Monitoring Data

During performance monitoring, samples from wells within each TTA and immediately outside the injection zone will be analyzed in the laboratory for VOCs, dissolved gases, volatile fatty acids (VFAs), total organic carbon (TOC), dissolved organic carbon (DOC), and other geochemical parameters (see Table 3-2). These primary data will be used to evaluate the overall effectiveness of the treatments. Pre-injection data will provide a baseline for measuring changes in VOC concentration as the injections proceed. Sampling will occur for pre-injection and then every quarter, starting 3 months after the initial injection and continuing throughout the 2-year injection schedule.

Secondary Performance Monitoring Data

Performance monitoring using field parameters will be performed biweekly, starting one month after the initial injection event. Dissolved oxygen (DO), oxygen-reduction potential (ORP), temperature, pH, conductivity will be measured in samples from monitoring wells for a six-month period after the initial injections and will follow sampling methods described in Appendix B. These parameters were selected because they are commonly used to evaluate anaerobic conditions and can be obtained from direct-reading field instruments. These secondary data will be used to determine that anaerobic conditions suitable for reductive dechlorination are sustained within the injection areas. A revised monitoring schedule may be developed at the consent of EPA and TDEC once the fluvial aquifer reaches suitably anaerobic conditions (see Section 4.4.5).

The secondary results will be used to evaluate (1) the degree of reducing conditions achieved in the aquifer, (2) the need to modify the injection strategy (should be coupled with primary results), and (3) the frequency of additional secondary performance monitoring events. Adjustments to the injection strategy should considered, if in the event, anaerobic conditions are not maintained, or are achieved more quickly and with less lactate injection than that presented in this RD. Potential adjustments in the injection strategy include changing injection frequency and location(s), changing lactate concentration, and changing injection volume. Because aquifer conditions may not stabilize "immediately" in all parts of the injection areas, it is recommended that no changes be made to the injection strategy during the first quarter of injections.

Specific performance criteria used to evaluate sustained anaerobic conditions are provided in Table 3-2. The paragraphs below discuss indicator conditions used for optimizing the injection strategy.

Dissolved Oxygen

Anaerobic bacteria can not function at DO concentrations greater than 0.5 mg/L and as a result, reductive dechlorination will not occur (USEPA, 1998). Prior to the EBT treatability study, baseline DO readings ranged from 1.9 to 5.4 mg/L in Study Area 1 and from 3 to 5 mg/L in Study Area 2. Monitoring wells influenced by the sodium lactate injection in Study Area 2 observed sustained DO measurements less than 1 mg/L (CH2M HILL, October 2003).

As a result of the findings from the EBT treatability study, it is recommended that the DO be sustained less than 1 mg/L, with a concentration greater than 0.5 mg/L used to begin considering alternative injection strategies. An average concentration can be used, but sustained readings above 0.5 mg/L in one or two performance monitoring wells may indicate a need to change the injection strategy.

Oxidation-Reduction Potential

An ORP of less than -50 millivolts (mV) indicates conditions conducive to reductive dechlorination (USEPA, 1998). ORP readings greater than -50 mV indicate groundwater conditions that will likely hinder reductive dechlorination. ORP levels less than -100 mV are ideal for reductive dechlorination. ORP readings greater than -100 mV but less than -50mV were measured in monitoring wells impacted by the oil emulsion in Study Area 1 during the EBT treatability study. During the sodium lactate injection in Study Area 2, minimum ORP measurements were less than -400mV in some wells immediately following substrate injection. However, these very low ORP levels could not be sustained longer than three months following lactate injection (CH2M HILL, October 2003).

When evaluating ORP levels there is a desired range for a sustained anaerobic aquifer while limiting methanogenesis. During methanogenesis, carbon dioxide is used as an electron acceptor and is converted into methane. At ORP conditions of less than -250 mV, methane production was observed in the monitoring wells in Study Area 2 (CH2M HILL, October 2003). As a result of the findings from the EBT treatability study, it is recommended that the ORP be sustained within a range of -200 mV to -50 mV to promote conditions favorable for reductive dechlorination, and less favorable for methanogenesis. ORP greater than -50 mV should be used to begin evaluating alternative injection strategies. An average concentration can be used, but sustained readings above -50 mV in one or two performance monitoring wells may indicate a need to change the injection strategy.

pH

Baseline measurements of pH prior to the EBT treatability study ranged from 5.9 to 6.3 s.u. (standard units) in Study Area 1 and from 5.3 to 7 s.u. in Study Area 2. Following injection in Study Area 1, pH fluctuated slightly, with some wells reporting values of less than 5 s.u. Sodium lactate injection at Study Area 2 had little effect on pH (CH2M HILL, October 2003). Microorganisms capable of degrading chlorinated solvents prefer a pH between 6 and 8 s.u. (USEPA, 1998). As a result, it is recommended that pH values remain in this range during the 2-year injection period.

4.4.5 RAO Compliance for Groundwater Plumes

Since there are multiple contaminant plumes in the fluvial aquifer beneath the MI, a strategy has been developed for demonstrating compliance with the RAOs for all plumes. This strategy will use the existing monitoring well network within each plume for sample collection and to provide the required data. There are three parts to the strategy and each is defined as follows:

1. No later than 18 months after initial electron donor injections are started, the RA contractor will identify in a technical memorandum a subset of monitoring wells for each plume that are representative of the entire plume at that time, both in area and concentration. The subset should include wells that define the down-gradient boundary of the plume (i.e., clean wells), wells within the treatment areas, and wells within the areas subject to natural attenuation. Once approved by EPA and TDEC, this subset of wells for each plume will be considered the compliance well network (CWN) for purposes of demonstrating compliance with the RAOs.
2. When for any individual plume, the LTM results indicate that the plume is at or close to MCLs in all locations, compliance monitoring will be initiated in the CWN.
3. Four consecutive rounds with all samples from CWN wells revealing contaminants at or less than MCLs will be deemed as demonstrating compliance with the ROD for that plume. Groundwater monitoring in that plume may cease, and wells unique to the plume's LTM network, including the CWN wells, may be proposed for abandonment, with approval from EPA and TDEC.

Additional details on the strategy for final compliance monitoring and development of the CWNs may be presented within the RAWP.

4.5 Performance Monitoring Wells

It is recommended that the wells installed for the design-related groundwater investigation be used as performance monitoring wells. Twenty-one 2-inch diameter monitoring wells are recommended downgradient of the injection wells to monitor performance. Figures 4-1 and 4-2 present the recommended monitoring wells in TTA1 and TTA2, respectively. Based on an estimated seepage rate of 0.6 ft/day, additional performance monitoring wells should be installed approximately 30 feet down-gradient of the injection well layout.

4.6 Operation and Maintenance

Operation of the injection system begins with filling the 500-gallon polyethylene tank on the trailer with dilute sodium lactate. Dilution of 10 gallons of 60% sodium lactate concentrate with 290 gallons of potable water will create 300 gallons of 2% lactate solution. A digital batch controller will be used to deliver proper volumes of concentrate and water to obtain the desired volume of 2% mix. The tank-mounted mixer may be used to blend the contents prior to injection. The dilute mix will be transported in the mixing tank to each injection well. A reinforced Teflon hose will be connected to each injection well using a cam-lock fitting. A flow meter with totalizer will be used to record the volume of substrate delivered. Until performance data are generated and evaluated, it is recommended that an equal volume of substrate be delivered into each injection well during the first three monthly events.

The RA Contractor will prepare an operation and maintenance (O&M) manual to include in the RAWP. The O&M manual will define all system maintenance requirements and operating procedures. The O&M manual should contain the following information:

- Treatment System Operation and Emergency Information - description of all equipment; system operational overview; normal and emergency operating conditions; safety instructions; emergency contact information; and required sample collection and laboratory analyses.
- Preventive and Corrective Maintenance - preventive maintenance practices and protocols including scheduled equipment inspections; corrective maintenance procedures to be implemented as a result of system malfunctions.
- Product and Manufacturers' Data - equipment data, recommended operation conditions, recommended maintenance procedures, and warranties.
- As-Built Drawings - drawings that detail the initial system configuration, and any modifications made.

During injection events, the operator should perform daily equipment inspections of the trailer-mounted system, and storage and transfer facility (Building 309). Each piece of equipment should be inspected to verify that it is operating properly, and each associated gauge or meter is within "normal" operating conditions, as specified in the O&M manual. Equipment and material will be visually inspected for damage and leaks (hoses and IBCs used to store sodium lactate), normal pump operation, excessive system pressures, and unusual sounds.

Routine maintenance activities should follow the schedule provided in the O&M manual. At a minimum, daily measurements of all flow rates, pressure readings, and amperage draws for electric motors should be recorded during injections. Scheduled equipment tests should include tests of every electrically operated valve; "fail-safe" mechanism; component activation switch at the control panel; and circuit breaker in the control panel. During scheduled equipment inspections, equipment adjustments should be completed and preventative maintenance should be performed as described in the O&M Manual

TABLE 4-4
ESTIMATED INJECTION VOLUMES OF SODIUM LACTATE
Rev. 1 Memphis Depot Final MI RD

	Estimated Mass of Lactate Concentrate (60%) per Injection Well per Event[a]				Estimated Volume of Dilute Lactate Solution (2%) per Injection Well per Event			
	TTA 1		TTA 2		TTA 1		TTA 2	
Screen Interval (feet)	Mass[b] (lbs.)	Volume[c] (gal.)	Mass[b] (lbs.)	Volume[c] (gal.)	Dilution Water (gal.)	Total Volume[d] (gal.)	Dilution Water (gal.)	Total Volume[d] (gal.)
10	66	6	44	4	174	180	116	120
20	132	12	87	8	348	360	232	240
30	198	18	NA		522	540	NA	
40	264	24	NA		696	720	NA	
50	330	30	NA		870	900	NA	
60	396	36	NA		1044	1080	NA	

Notes:
[a] See Tables 4-5 and 4-6 for calculations.
[b] Mass of concentrate from Tables 4-5 and 4-6 (safety factor of 4).
[c] Density of lactate concentrate is 11 lbs/gal.
[d] Total volume of lactate concentrate plus dilution water.
NA - Not Applicable

TABLE 4-5
SODIUM LACTATE DEMAND ESTIMATE - PER INJECTION WELL - Target Treatment Area 1
Rev 1 Memphis Depot Final MI RD

Parameter[1]	Concentration (mg/L)	Molecular Weight (g/mol)	(mmol/L)	Initial Oxidation state	Final Oxidation state	Number of electrons transferred/mol	Milliequivalents
DO (O_2)	8.15	32	0 255	0	-2	4	1.02
Sulfate (SO_4^{2-})*	12 13	96	0 126	6	-2	8	1.01
Nitrate (NO^{3-})*	3 6	62	0.058	5	0	5	0.29
Ferrous Iron (Fe^{2+})*	0.44	55.9	0.008	3	2	1	0.01
Manganese (Mn^{2+})*	0.105	54.9	0.002	4	2	2	0.00
PCE (C_2Cl_4)	0.48	165 8	0.003			8	0.02
TCE (C_2HCl_3)	0 0009	131	0.000			6	0.00
cis-1,2-DCE ($C_2H_2Cl_2$)	0 0003	97	0.000			4	0.00
trans-1,2-DCE ($C_2H_2Cl_2$)	0.00025	97	0 000			4	0.00
1,1-DCE ($C_2H_2Cl_2$)	0.00025	97	0 000			4	0.00
1,2-DCA ($C_2H_4Cl_2$)	0 00025	99	0 000			4	0.00
1,1,2,2-PCA ($C_2H_2Cl_4$)	0.0005	167.9	0 000			8	0.00
Chloroform ($CHCl_3$)	0.0006	119	0 000			6	0.00
Carbon Tetrachloride (CCl_4)	0.00025	154	0.000			8	0.00
						Total mequivs	2.35

Sodium Lactate Molecular Weight (g/mol) = 112.1
Mass of Lactate Required (mg/L water) = 66 00
Desired Final Lactate Concentration (4X demand) = 264 mg/L (at 100% conc)

60% Sodium Lactate Density = 11.0 lbs/gal

Treatment Area/Volume	Imperial	SI
Length	40 ft	12 m
Width	20 ft	6 m
Area[2]	800 ft^2	74 m^2
Depth (Saturated Thickness)	10 ft	3.0 m^3
Treatment Zone Volume (including solids)	8,000 ft^3	227 m^3
Treatment Zone Volume (corrected for 0.3 porosity)	2,400 ft^3	68 m^3
	17,952 gals	68,013 liters
Number of Injection Well Pairs =	1	
Treatment Zone per injection well	2,400 ft^3	68 m^3
	17,952 gals	68,013 liters
Lactate mass per injection well	39 lbs	18.0 kg
Total Lactate Mass	39 lbs	18.0 kg
Mass of Lactate Concentrate (at 60%) per injection well	66 lbs	30 kg
	6 gals	
Total Mass of Lactate Concentrate (at 60%)	66 lbs	30 kg
	6 gals	

Notes
[1] Unless otherwise stated all concentrations used in the lactate demand calculations are from the pre-EBT sample collection event (March 2002) from monitoring well MW101
Reported concentrations of 0 00025 mg/L are half the established laboratory reportable limit of 0.0005 mg/L.
* Average concentration of sample results from 16 MWs/IWs in TTA 1 from pre-EBT sampling events March/May 2002
[2] Area assumes two rows of 8 injection wells spaced on 40-ft centers with each row having an assumed downgradient influence of approximately 40 ft.

TABLE 4-6
SODIUM LACTATE DEMAND ESTIMATE - PER INJECTION WELL - Target Treatment Area 2
Rev 1 Memphis Depot Final MI RD

Parameter	Concentration (mg/L)	Molecular Weight (g/mol)	(mmol/L)	Initial Oxidation state	Final Oxidation state	Number of electrons transferred/mol	Milliequivalents
DO (O_2)*	5.3	32	0.166	0	-2	4	0 66
Sulfate (SO_4^{2-})*	8.6	96	0.090	6	-2	8	0.72
Nitrate (NO^{3-})*	1.91	62	0 031	5	0	5	0 15
Ferrous Iron (Fe^{2+})*	0 4	55 9	0 007	3	2	1	0.01
Manganese (Mn^{2+})*	0.229	54 9	0 004	4	2	2	0.01
PCE (C_2Cl_4)	0.1288	165.8	0 001			8	0.01
TCE (C_2HCl_3)	0.021	131	0.000			6	0.00
cis-1,2-DCE ($C_2H_2Cl_2$)	0.0484	97	0.000			4	0 00
trans-1,2-DCE ($C_2H_2Cl_2$)	0.00028	97	0.000			4	0 00
1,1-DCE ($C_2H_2Cl_2$)	0 00025	97	0.000			4	0.00
1,2-DCA ($C_2H_4Cl_2$)	0.00138	99	0.000			4	0.00
1,1,2,2-PCA ($C_2H_2Cl_4$)	0.00025	167.9	0 000			8	0.00
Chloroform ($CHCl_3$)	0.0665	119	0.001			6	0.00
Carbon Tetrachloride (CCl_4)	0 059	154	0.000			8	0 00
Total Electron Donor Demand =						Total mequivs	1.56

Sodium Lactate Molecular Weight (g/mol) = 112.1
Mass of Lactate Required (mg/L water) = 43.84
Desired Final Lactate Concentration (4X demand) = 175 mg/L (at 100% conc)

60% Sodium Lactate Density = 11.0 lbs/gal

Treatment Area/Volume	Imperial	SI
Length	40 ft	12 m
Width	20 ft	6 m
Area[2]	800 ft^2	74 m^2
Depth (Saturated Thickness)	10 ft	3.0 m^3
Treatment Zone Volume (including solids)	8,000 ft^3	227 m^3
Treatment Zone Volume (corrected for 0 3 porosity)	2,400 ft^3	68 m^3
	17,952 gals	68,013 liters
Number of Injection Wells =	1	
Treatment Zone per injection well	2,400 ft^3	68 m^3
	17,952 gals	68,013 liters
Lactate Mass per injection well	26 lbs	11.9 kg
Total Lactate Mass	26 lbs	11 9 kg
Mass of Lactate Concentrate (at 60%) per injection well	44 lbs	20 kg
	4 gals	
Total Mass of Lactate Concentrate (at 60%)	44 lbs	20 kg
	4 gals	

Notes

[1] Unless otherwise stated all concentrations used in the lactate demand calculations are an average of 14 MWs/IWs from the pre-EBT sample collection event (May 2002). Data from the November 2001 sampling event were used for wells MW86 and MW88. Reported concentrations of 0.00025 mg/L are half the established laboratory reportable limit of 0.0005 mg/L.

* Average concentration of sample results from 14 MWs/IWs in TTA 2 from pre-EBT sampling events March/May 2002.

[2] Area assumes two rows of 4 injection wells spaced on 40-ft centers with each row having an assumed downgradient influence of approximately 40 ft.

TABLE 4-7
ESTIMATED SUBSTRATE INJECTION COSTS PER YEAR - Target Treatment Area 1
Rev 1 Final Memphis Depot MI Remedial Design

Well Influence Volume[a]	
Pore Volume	4,800 ft^3
(40ftx20ftx20ftx0.3)	35,904 gal

Mass of Lactate Concentrate (60%) Injected Per Well Per Year

Lactate Demand[a]	Concentration mg/L	Per Injection Well lbs.	Per Injection Well gals.[b]	26 Inj/Well/Yr lbs.	26 Inj/Well/Yr gals.[b]	12 Inj/Well/Yr lbs.	12 Inj/Well/Yr gals.[b]	4 Inj/Well/Yr lbs.	4 Inj/Well/Yr gals.[b]
No SF	66	33	3	857	78	395	36		
SF = 2	132	66	6	1,714	156	791	72		
SF = 3	198	99	9	2,571	234	1,186	108		
SF = 4	264	132	12	3,427	312	1,582	144		
Comparison Concentration	1,000	499	45					1,997	182

Volume of Dilute Lactate Solution Injected Per Event and Total Time per Event

	Lactate Concentration: 10% gals.	10% Hours[c]	5% gals.	5% Hours[c]	3% gals.	3% Hours[c]	2% gals.	2% Hours[c]	1% gals.	1% Hours[c]
66 mg/L (No SF)										
Water	15		33		57		87		177	
Total Volume/Well	18	9	36	9	60	9	90	9	180	9
132 mg/L (SF = 2)										
Water	30		66		114		174		354	
Total Volume/Well	36	10	72	9	120	9	180	9	360	17
198 mg/L (SF = 3)										
Water	45		99		171		261		531	
Total Volume/Well	54	10	108	9	180	9	270	9	540	17
264 mg/L (SF = 4)										
Water	60		132		228		348		708	
Total Volume/Well	72	11	144	9	240	9	360	17	720	25
1,000 mg/L										
Water	409		862		1,468		2,224		4,494	
Total Volume/Well	454	18	908	36	1,513	56	2,270	82	4,539	134

Lactate Injection Cost Estimate Based on 2% Concentration Per Event Per Year

Concentration	Sodium Lactate Purchase Unit Rate	Unit	Quantity[e]	Cost	Sodium Lactate Shipping Unit Rate	Unit	Quantity	Cost	Labor - 2 Technicians[d] Unit Rate	Unit	Quantity	Cost	TOTAL COST
66 mg/L (No SF)													
26/Yr (biweekly)	$1.15	lb.	1,040	$1,196	$1,200	LOAD	1	$1,200	$60.00	HR	468	$28,080	$30,476
12/Yr (monthly)	$1.15	lb.	520	$598	$1,000	LOAD	1	$1,000	$60.00	HR	216	$12,960	$14,558
132 mg/L (SF = 2)													
26/Yr (biweekly)	$1.04	lb	1,820	$1,884	$1,000	LOAD	2	$2,000	$60.00	HR	468	$28,080	$31,964
12/Yr (monthly)	$1.15	lb	1,040	$1,196	$1,000	LOAD	1	$1,000	$60.00	HR	216	$12,960	$15,156
198 mg/L (SF = 3)													
26/Yr (biweekly)	$1.04	lb.	2,600	$2,691	$1,200	LOAD	2	$2,400	$60.00	HR	936	$56,160	$61,251
12/Yr (monthly)	$1.04	lb.	1,300	$1,346	$1,200	LOAD	1	$1,200	$60 00	HR	432	$25,920	$28,466
264 mg/L (SF = 4)													
26/Yr (biweekly)	$1.04	lb.	3,640	$3,767	$1,200	LOAD	3	$3,600	$60.00	HR	1,456	$87,360	$94,727
12/Yr (monthly)	$1.04	lb.	1,820	$1,884	$1,000	LOAD	1	$1,000	$60.00	HR	672	$40,320	$43,204
1,000 mg/L													
Quarterly	$1.04	lb.	2,080	$2,153	$1,200	LOAD	1	$1,200	$60.00	HR	656	$39,360	$42,713

Notes:
[a] - See Tables 4-5 and 4-6 for calculations In TTA 1 assumes an average 20 ft thick fluvial aquifer.
[b] - Density of lactate concentrate is 11 lbs/gal
[c] - Time estimate based on 16 wells with a 10 gpm injection rate rounded up to nearest 30 minute increment per well.
Time includes 1 hour for each filling of the 500-gallon transfer tank, as required to complete injections.
[d] - Labor rate assumes a two-man crew at a minimum daily billing time of 10 hours per day.
[e] - Adjusted quantity based delivery of 260-gallon intermediate storage containers.
SF - Applied safety factor to calculated lactate concentration.

TABLE 4-8

ESTIMATED SUBSTRATE INJECTION COSTS PER YEAR - Target Treatment Area 2

Rev. 1 Final Memphis Depot MI Remedial Design

Well Influence Volume[a]									
Pore Volume	2,400 ft^3								
(40ftx20ftx10ftx0.3)	17,954 gal	**Mass of Lactate Concentrate (60%) Injected per Well Per Year**							
	Concentration	**Per Injection Well**		**26 Inj/Well/Yr**		**12 Inj/Well/Yr**		**4 Inj/Well/Yr**	
Lactate Demand[a]	mg/L	lbs.	gals.[b]	lbs.	gals.[b]	lbs.	gals.[b]	lbs.	gals.[b]
No SF	44	11	1	286	26	132	12		
SF = 2	88	22	2	571	52	264	24		
SF = 3	132	33	3	857	78	396	36		
SF = 4	176	44	4	1,143	104	527	48		
Comparison Concentration	1,000	250	23					999	91

Volume of Dilute Lactate Solution Injected per Event and Total Time per Event

	Lactate Concentration:									
	10%		**5%**		**3%**		**2%**		**1%**	
	gals.	Hours[c]	gals.	Hours[c]	gals.	Hours[c]	gals.	Hours[c]	gals.	Hours[c]
44 mg/L (No SF)										
Water	5		11		19		29		59	
Total Volume/Well	6	5.5	12	5.5	20	5.5	30	5.5	60	5.5
88 mg/L (SF = 2)										
Water	10		22		38		58		118	
Total Volume/Well	12	5.5	24	5.5	40	5.5	60	5.5	120	5.5
132 mg/L (SF = 3)										
Water	15		33		57		87		177	
Total Volume/Well	18	5.5	36	5.5	60	5.5	90	5.5	180	5.5
175 mg/L (SF = 4)										
Water	20		44		76		116		236	
Total Volume/Well	24	5.5	48	5.5	80	5.5	120	5.5	240	5.5
1,000 mg/L										
Water	204		431		734		1,112		2,247	
Total Volume/Well	227	8.0	454	14.0	757	22.0	1,135	30.0	2,270	58.0

Lactate Injection Cost Estimate Based on 2% Concentration Per Event Per Year

	Sodium Lactate Purchase				**Sodium Lactate Shipping**				**Labor - 2 Technicians**[d]				**TOTAL**
Concentration	Unit Rate	Unit	Quantity[e]	Cost	Unit Rate	Unit	Quantity	Cost	Unit Rate	Unit	Quantity	Cost	**COST**
44 mg/L (No SF)													
26/Yr (biweekly)	$1.15	lb.	520	$598	$1,200	LOAD	1	$1,200	$60.00	HR	286	$17,160	$18,958
12/Yr (monthly)	$1.15	lb.	260	$299	$1,000	LOAD	1	$1,000	$60.00	HR	132	$7,920	$9,219
88 mg/L (SF = 2)													
26/Yr (biweekly)	$1.04	lb.	780	$807	$1,000	LOAD	1	$1,000	$60.00	HR	286	$17,160	$18,967
12/Yr (monthly)	$1.15	lb.	520	$598	$1,000	LOAD	1	$1,000	$60.00	HR	132	$7,920	$9,518
132 mg/L (SF = 3)													
26/Yr (biweekly)	$1.04	lb.	1,040	$1,076	$1,200	LOAD	1	$1,200	$60.00	HR	936	$56,160	$58,436
12/Yr (monthly)	$1.04	lb.	520	$538	$1,200	LOAD	1	$1,200	$60.00	HR	432	$25,920	$27,658
175 mg/L (SF = 4)													
26/Yr (biweekly)	$1.04	lb.	1,300	$1,346	$1,200	LOAD	1	$1,200	$60.00	HR	1,352	$81,120	$83,666
12/Yr (monthly)	$1.04	lb.	780	$807	$1,000	LOAD	1	$1,000	$60.00	HR	624	$37,440	$39,247
1,000 mg/L													
Quarterly	$1.04	lb.	1,040	$1,076	$1,200	LOAD	1	$1,200	$60.00	HR	624	$37,440	$39,716

Notes:

[a] - See Tables 4-5 and 4-6 for calculations. In TTA 2 assumes an average 10 ft thick fluvial aquifer.

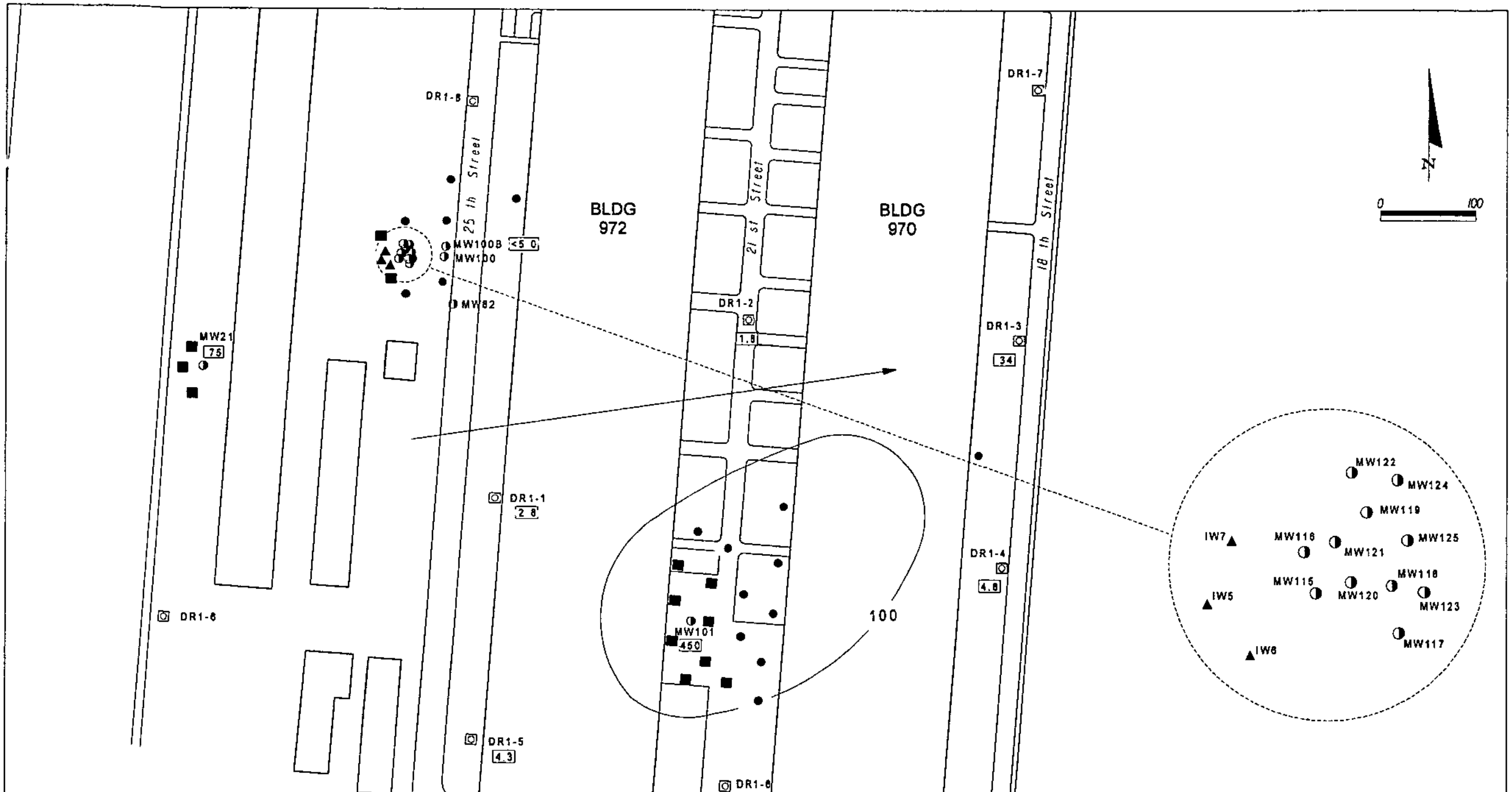
[b] - Density of lactate concentrate is 11 lbs/gal.

[c] - Time estimate based on 9 wells with a 10 gpm injection rate rounded up to nearest 30 minute increment per well. Time includes 1 hour for each filling of the 500-gallon transfer tank, as required to complete injections.

[d] - Labor rate assumes a two-man crew at a minimum daily billing time of 10 hours per day.

[e] - Adjusted quantity based on delivery of 260-gallon intermediate storage containers.

SF - Applied safety factor to calculated lactate concentration.



LEGEND:

◐	EXISTING MONITORING WELL
▲	EXISTING INJECTION WELL
▭	BUILDING
90	TETRACHROROETHENE (PCE) CONCENTRATION (ug/L)
100 ———	ISOCONCENTRATION LINE (ug/L)
●	PROPOSED PERFORMANCE MONITORING WELL
■	PROPOSED INJECTION WELL
◙	DESIGN RELATED GROUNDWATER INVESTIGATION WELL
———►	INTERPRETED DIRECTION OF GROUNDWATER FLOW

FIGURE 4-1
TARGET TREATMENT AREA 1
DESIGN INJECTION WELL LAYOUT
Remedial Design - Enhnced In Situ Anaerobic Biodegradation
Memphis Depot Main Installation

CH2MHILL

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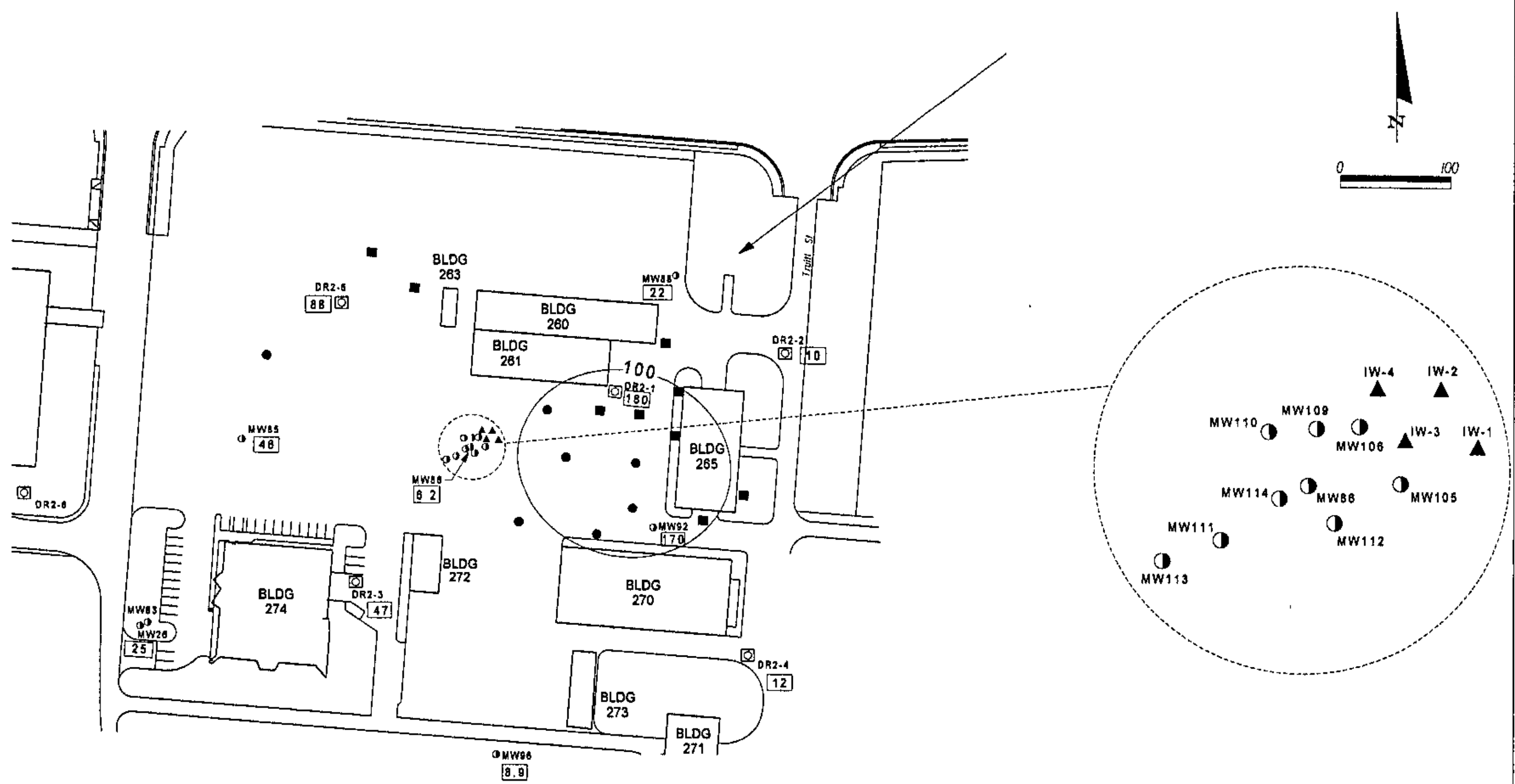

LEGEND:

- ◑ EXISTING MONITORING WELL
- ▲ EXISTING INJECTION WELL
- ▭ BUILDING
- 49 TETRACHROROETHENE (PCE) CONCENTRATION (ug/L)
- 100 —— ISOCONCENTRATION LINE (ug/L)
- ● PROPOSED PERFORMANCE MONITORING WELL
- ■ PROPOSED INJECTION WELL
- ◙ DESIGN RELATED GROUNDWATER INVESTIGATION WELL
- ——► INTERPRETED DIRECTION OF GROUNDWATER FLOW

FIGURE 4-2
TARGET TREATMENT AREA 2
DESIGN INJECTION WELL LAYOUT
Remedial Design - Enhnced In Situ Anaerobic Biodegradation
Memphis Depot Main Installation

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ORLANDO/TRANSPOR/CADPROJ/160492.RD.03/4-Y.DGN 2-July-2004

5.0 Remedial Design Cost Estimates

Table 5-1 presents the estimated cost to implement EBT at the MI. The estimate includes labor costs associated with project management and construction oversight. The estimate also provides labor and analytical costs associated with performance and long-term monitoring. The estimate is based on a 10-year completion schedule as presented in the MI ROD. While more than 10 years may be required to achieve the groundwater RAOs, this estimate does not extend beyond 10 years because of the uncertainty associated with long-term monitoring and potential use of contingency remedies.

Table 5-2 presents the estimated cost to implement a contingency remedy, if required. These remedies include one additional year of sodium lactate injection using a monthly injection frequency and one-time injection of potassium permanganate. Both of these remedies assume a very localized region of treatment (4 injection wells or well pairs). The contingency estimates in Table 5-2 assume no additional injection or performance monitoring wells will be required. The estimates also assume that no additional monitoring will be required, and that the injection trailer designed for lactate delivery would be used to deliver the potassium permanganate.

Table 5-1

TOTAL COST OF REMEDIAL ALTERNATIVE
Source Control - Groundwater
Enhanced In Situ Anaerobic Biodegradation using $C_3H_5NaO_3$

Site:	Memphis Depot - Main Installation
Location:	Memphis, TN
Phase:	Remedial Design
Base Year:	2004

	Manual Substrate Injection System TTA 1 and TTA 2
Total Project Duration (Years)	10
Capital Cost	\$1,379,500
O&M Costs	\$1,838,500 (Year 1 - 10)
Total Present Worth of Solution	\$3,120,000

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude cost estimate that is expected to be within -30 to +50 percent of the actual project costs

Table 5-1 - Enhanced In Situ Anaerobic Biodegradation using $C_3H_5NaO_3$ Manual Substrate Injection System TTAs 1 and 2

COST ESTIMATE SUMMARY

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

Description: Manual substrate injection of sodium lactate in the fluvial aquifer

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Baseline Groundwater Sample Collection Event	1	EA	$56,100	$56,100	49 Monitoring Locations
Mobilization and Prep Work					
Security Fencing, Signs, Traffic Control, and Utility Location	1	LS	$3,500	$3,500	
Survey	1	LS	$2,000	$2,000	
Manual $C_3H_5NaO_3$ Injection Systems					TTA 1 and TTA 2
INJECTION WELLS					
Injection Well Installation	1	EA	$537,800	$537,800	TTA 1 - 13 Well Pairs TTA 2 - 9 Wells
Monitoring Well Installation	1	EA	$399,700	$399,700	TTA 1 - 16 Well Pairs TTA 2 - 7 Wells
TRAILER MOUNTED INJECTION SYSTEM	1	EA	$17,500	$17,500	500-Gallon Polyethylene Storage Tank, Tank Mixer, Chemical Injection Pump, Piping, Valves, Gas-Powered Generator, Trailer
STORAGE AND TRANSFER FACILITY - BUILDING 309					
Equipment and Material					
Sodium Lactate	97,240	LB	$1.04	$101,130	Two Year Injection in TTA 1 and 2
Shipping - Sodium Lactate	3	LOAD	$1,200	$3,600	39,900 lbs./load
Potassium Bromide Tracer	4,628	LB	$3.05	$14,106	200 g/100 gal solution
Drum Pump	1	EA	$1,000	$1,000	
Flow Control Systems Batch Controllers	1	EA	$4,830	$4,830	
Supply Hose (Sodium Lactate and H_2O) Hose Racks, PVC Piping Backflow Preventor Flow Meters, Solenoid Valves Cam-Lock Fittings	1	LS	$11,155	$11,155	

Table 5-1 - Enhanced In Situ Anaerobic Biodegradation using $C_3H_5NaO_3$ Manual Substrate Injection System TTAs 1 and 2

COST ESTIMATE SUMMARY

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

Description: Manual substrate injection of sodium lactate in the fluvial aquifer.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Work					
Connection to Existing Water Main - Trenching	1	LS	$4,830	$4,830	Labor and Material Gate Valve and PVC Piping
Construction of Concrete Curb for Sodium Lactate Storage	1	LS	$3,950	$3,950	Ready Mix Concrete 4,000 psi Rated
Drill Hole In Wall - Water Pipe	1	LS	$210	$210	Labor and Material
Electrical Subcontractor	1	EA	$4,700	$4,700	Install Electrical Service, Conduit, Wiring, and System Connections
Site Restoration	1	EA	$500	$500	Includes Labor and Materials
SUBTOTAL				**$1,166,611**	

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Project Management	3%	of	$1,166,611	$34,998	
Remedial Design	2%	of	$1,166,611	$23,332	
Construction Management	2%	of	$1,166,611	$23,332	
Subcontractor General Requirements	0.5%	of	$1,166,611	$5,833	
SUBTOTAL				**$1,254,106**	
Contingency	10%	of	$1,254,106	$125,411	
TOTAL CAPITAL COST				**$1,379,500**	

Table 5-1 - Enhanced In Situ Anaerobic Biodegradation using $C_3H_5NaO_3$ Manual Substrate Injection System TTAs 1 and 2

COST ESTIMATE SUMMARY

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

Description: Manual substrate injection of sodium lactate in the fluvial aquifer.

OPERATIONS AND MAINTENANCE COST - SYSTEM PERFORMANCE (Years 1 and 2)

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Manual $C_3H_5NaO_3$ Injection Systems					
Electrical Costs	1	LS	700	$700	Electricity and Electrician
Miscellaneous Equipment Parts and Materials/Supplies	1	LS	$2,000	$2,000	
Labor - O&M Technician	4,104	HR	$60	$246,240	2 Technicians
Performance Monitoring					
					TTAs 1 and 2
Lab Sampling Events	4	EA	$56,100	$224,400	49 Monitoring Wells
Field Monitoring Events	6	EA	$23,200	$139,200	Monthly First Quarter
SUBTOTAL				**$612,540**	
Annual Performance Report					
Labor - Project Manager	24	HR	$125	$3,000	
Labor - Engineer/Hydrogeologist	80	HR	$100	$8,000	
Labor - Editor	12	HR	$65	$780	
Labor - CAD Technician	24	HR	$65	$1,560	
SUBTOTAL - Annual Report				**$13,340**	
TOTAL ANNUAL O&M COST				**$626,000**	

OPERATIONS AND MAINTENANCE COST - MONITORING AND REPORTING (Years 1 - 10)

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Annual Monitoring					
Year 1	1	LS	$257,102	**$257,102**	Second Year of Injection
Year 2	1	LS	$31,587	**$31,587**	
Years 3, 5, 7, and 9	1	LS	$9,430	**$9,430**	
Years 4, 6, 8 and 10	1	LS	$21,257	**$21,257**	
Well Abandonment - Injection and Monitoring Wells					
Driller	6,485	LF	$15	$97,275	40 Injection 21 Monitoring
Labor - Oversight Engineer/Hydrogeologist	244	HR	$100	$24,400	64 Wells at 4 Hrs/Well
SUBTOTAL - Abandonment				**$121,675**	
Five-Year Review (Years 5 and 10)					
Labor - Engineer/Hydrogeologist	60	HR	$100	**$6,000**	
Annual Land Use Control Review (Years 1 - 10)					
Labor - Engineer/Hydrogeologist	32	HR	$75	**$2,400**	

Table 5-1 - Enhanced In Situ Anaerobic Biodegradation using $C_3H_5NaO_3$ Manual Substrate Injection System TTAs 1 and 2 — **COST ESTIMATE SUMMARY**

Site:	Memphis Depot - Main Installation	**Description:**	Manual substrate injection of sodium lactate in the fluvial aquifer.
Location:	Memphis, TN		
Phase:	Remedial Design		
Base Year:	2004		

Table 5-1 - Enhanced In Situ Anaerobic Biodegradation using $C_3H_5NaO_3$ Manual Substrate Injection System TTAs 1 and 2

COST ESTIMATE SUMMARY

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

Description: Manual substrate injection of sodium lactate in the fluvial aquifer.

OPERATIONS AND MAINTENANCE COST - MONITORING AND REPORTING (Years 1 -10)

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Annual Groundwater Monitoring Report					Years 1 through 5
Labor - Project Manager	2	HR	$125	$250	
Labor - Engineer/Hydrogeologist	60	HR	$100	$6,000	
Labor - Editor	12	HR	$65	$780	
Labor - CAD Technician	24	HR	$65	$1,560	
SUBTOTAL				**$8,590**	
Quarterly Groundwater Monitoring Report					4 Reports/Year for Years 1 and 2
Labor - Project Manager	2	HR	$125	$250	
Labor - Engineer/Hydrogeologist	36	HR	$100	$3,600	
Labor - Editor	8	HR	$65	$520	
Labor - CAD Technician	16	HR	$65	$1,040	
SUBTOTAL				**$5,410**	
TOTAL ANNUAL REPORTING COST				**$14,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 3.2%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	TOTAL PRESENT VALUE	NOTES
	FIRST YEAR CAPITAL COST	$1,379,500	$1,379,500	$1,379,500	
1	ANNUAL O&M COST (Year 1)	$899,502	$899,502		
2	ANNUAL O&M COST (Year 2)	$673,987	$673,987		
3	ANNUAL O&M COST (Year 3)	$20,420	$20,420		
4	ANNUAL O&M COST (Year 4)	$32,247	$32,247	$1,740,836	
5	ANNUAL O&M COST (Year 5)	$26,420	$26,420		
6 and 8	ANNUAL O&M COST (Years 6 and 8)	$23,657	$23,657		
7 and 9	ANNUAL O&M COST (Years 7 and 9)	$11,830	$11,830		
10	ANNUAL O&M COST (Year 10)	$151,332	$151,332		
				$3,120,336	
	TOTAL PRESENT WORTH OF ALTERNATIVE			**$3,120,000**	

SOURCE INFORMATION

Table 5-1
Element: **Injection Well Installation**

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

WORK STATEMENT

Injection well installation for the manual substrate injection systems in TTAs 1 and 2

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
TTA 1					
Injection Well Installation - Mud Rotary Drilling with Revert	2,730	LF	$30.00	$81,900	
Injection Well Screen and Riser Installation (4-inch, SCH 80 PVC, 0.04-inch slot)	2,730	LF	$33.00	$90,090	Prosonic 13 wells @ 100 ft bls & 13 wells at 110 ft bls
Injection Well Vault and Concrete Pad (2 ft by 2 ft)	26	EA	$350	$9,100	
Injection Well Head Pressure Relief Valve and Cam-Lock Fitting for 2-Inch Hose	26	EA	$250	$6,500	
TTA 2					
Injection Well Installation - Mud Rotary Drilling with Revert	945	LF	$30.00	$28,350	
Injection Well Screen and Riser Installation (4-inch, SCH 80 PVC, 0.04-inch slot)	945	LF	$33.00	$31,185	Prosonic 9 wells @ 105 ft bls
Injection Vault and Concrete Pad (2 ft by 2 ft)	9	EA	$350	$3,150	
Injection Well Head Pressure Relief Valve and Cam-Lock Fitting for 2-Inch Hose	9	EA	$250	$2,250	
Mobilization/Demobilization	1	EA	$5,800	$5,800	Prosonic
Per Diem	70	DAY	$260	$18,200	Prosonic
Well Development Labor	160	HR	$145.00	$23,200	Prosonic
Decontamination Pad	2	EA	$863	$1,726	Prosonic
Decontamination - Drill Rig	40	EA	$250	$10,000	Prosonic
IDW Management	40	EA	$375	$15,000	Prosonic
Backhoe Rental	4	MON	$1,725	$6,900	Prosonic
55-Gallon Drums for Drill Cuttings	765	EA	$52	$39,589	
Dispose Well Cuttings	765	DRUM	$29	$21,994	Assumes Non-Hazardous Waste
Transportation of Well Cuttings	10	LOAD	$460	$4,600	80 Drums/Load
Frac Tank for Development H_2O	3	EA	$5,280	$15,840	17,000 gal/3 month rental @ $1,760/month
Transport and Dispose Development Water	42,000	GAL	$0.30	$12,600	Assumes Non-Hazardous Waste
Waste Characterization Well Cuttings	7	EA	$518	$3,623	TCLP - VOCs and Metals
Waste Characterization Well Development Water	2	EA	$1,300	$2,600	TCLP, Ignitability, Reactivity, Corrosivity
PPE and PID Rental	3	MON	$1,000	$3,000	
SUBTOTAL				**$437,196**	

794 62

Table 5-1
Element: **Injection Well Installation**

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

WORK STATEMENT

Injection well installation for the manual substrate injection systems in TTAs 1 and 2

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Project Management	5%	of	$437,196	$21,860	
Technical Support	5%	of	$437,196	$21,860	
Construction Management	10%	of	$437,196	$43,720	
Subcontractor General Requirements	3%	of	$437,196	$13,116	
SUBTOTAL				**$537,751**	
TOTAL UNIT COST				**$537,800**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
TOTAL ANNUAL O&M COST				**$0**	

Source of Cost Data

1. Sources are as noted in cost table.

Table 5-1

Element: **Monitoring Well Installation**

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

WORK STATEMENT

Monitoring well installation to evaluate performance of enhanced in situ biodegradation alternative.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
TTA 1					
Monitoring Well Installation - Rotasonic Drilling	3,520	LF	$31.05	$109,296	Prosonic
Monitoring Well Screen and Riser Installation (2-inch, SCH 40 PVC, 0.01-inch slot)	3,520	LF	$13.80	$48,576	Performance Monitoring - 16 Well Pairs All @ 110 ft bls
TTA 2					
Monitoring Well Installation - Rotasonic Drilling	735	LF	$31.05	$22,822	Prosonic
Monitoring Well Screen and Riser Installation (2-inch, SCH 40 PVC, 0.01-inch slot)	735	LF	$13.80	$10,143	Performance Monitoring - 7 Wells All @ 105 ft bls
Mobilization/Demobilization	1	EA	$2,000	$2,000	Prosonic
Per Diem	90	DAY	$260	$23,400	Prosonic
Well Development Labor	117	HR	$143.75	$16,819	Prosonic
Decontamination Pad	2	EA	$863	$1,726	Prosonic
Decontamination - Drill Rig	39	EA	$230	$8,970	Prosonic
IDW Management	39	EA	$230	$8,970	Prosonic
Backhoe Rental	3	MON	$1,725	$5,175	Prosonic
Roll-Off Containers for Drill Cuttings (Rental 15 yd^3 container)	9	EA	$3,300	$29,700	3 month rental $1,100/month each
Frac Tank for Development H_2O	3	EA	$5,280	$15,840	17,000 gal/3 month rental @ $1,760/month
Transport and Dispose Development Water	35,100	GAL	$0.30	$10,530	Assumes Non-Hazardous Waste
Dispose Well Cuttings	161	TON	$35	$5,629	Assumes Non-Hazardous Waste
Waste Characterization Well Cuttings	2	EA	$518	$1,035	TCLP - VOCs and Metals
Waste Characterization Well Development Water	1	EA	$1,300	$1,300	TCLP, Ignitability, Reactivity, Corrosivity
PPE and PID Rental	3	MON	$1,000	$3,000	
SUBTOTAL				**$324,930**	

Table 5-1

Element: **Monitoring Well Installation**

Project Management	5%	of	$324,930	$16,247
Technical Support	5%	of	$324,930	$16,247
Construction Management	10%	of	$324,930	$32,493
Subcontractor General Requirements	3%	of	$324,930	$9,748
SUBTOTAL				**$399,664**
TOTAL UNIT COST				**$399,700**

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
TOTAL ANNUAL O&M COST				**$0**	

Source of Cost Data

1. Sources are as noted in cost table.

Table 5-1

Element: **Electrical - Building 309 - Storage and Transfer Facility**

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

Prepared By:
Date:

Checked By:
Date:

WORK STATEMENT

Install Control Panel and Electrical Service Connection for Dispensing Potable Water and Sodium Lactate to Trailer-Mounted Transfer Tank.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Electricity Installation					
Electrical Wire and Connections	1	LS	$1,200	$1,200	Labor and Material
Electrical Conduit - 3/4-Inch PVC	785	LF	$3.75	$2,944	20 amp Ground Fault Interrupt, Hangers, Channels, Junction Box, and NEMA 12 Wiring Boxes
Miscellaneous Electrical Equipment	1	LS	$600	$600	
SUBTOTAL				$4,744	
TOTAL UNIT COST				**$4,700**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Annual O&M Costs					
Electricity	600	kWh	$0 10	$60	
Electrician	4	HR	$150	$600	
SUBTOTAL				**$660**	
TOTAL ANNUAL O&M COST				**$700**	

Source of Cost Data

Table 5-1

Element: **Sample Collection and Laboratory Costs - Evaluation of System Performance**

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

WORK STATEMENT

Costs associated with water sample collection from monitoring wells only, shipment and analysis on a per event and per well basis to evaluate enhanced anaerobic biodegradation. Includes design-related groundwater investigation wells.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Equipment & Labor per Event					
Sample Analysis					
VOCs - SW8260 - Level III	55	SAMPLE	$100	$5,500	
Methane, Ethane, Ethene					
AM19A	49	SAMPLE	$115	$5,635	
Carbon Dioxide - Hach Kit	49	SAMPLE	$10	$490	
Nitrate/Nitrite - SW9056	49	SAMPLE	$25	$1,225	TTA 1
Sulfate - SW9056	49	SAMPLE	$20	$980	37 MWs
Sulfide - E376 or 300	49	SAMPLE	$20	$980	(16 Pairs - 5 Existing)
Manganese - SW6010B	49	SAMPLE	$20	$980	
Potassium	49	SAMPLE	$20	$980	TTA 2
Bromide	49	SAMPLE	$20	$980	12 MWs
Alkalinity - E310	49	SAMPLE	$15	$735	
Chloride - SW9056	49	SAMPLE	$20	$980	6 QA/QC samples
Iron II - SM3500 - Fe	49	SAMPLE	$20	$980	(VOCs Only)
Iron III (calculated)	49	SAMPLE	$0	$0	
Volatile Fatty Acids	49	SAMPLE	$80	$3,920	
Total Organic Carbon - SW9060	49	SAMPLE	$25	$1,225	
Dissolved Organic Carbon - SW9060	49	SAMPLE	$25	$1,225	
Chemical Oxygen Demand - E410.4	49	SAMPLE	$25	$1,225	
Dissolved Hydrogen	49	SAMPLE	$100	$4,900	
Dehalococcoides Ethenogenes	0	SAMPLE	$350	$0	Microbial Insights Est
Equipment & Labor					
Sampling Supplies	1	EA	$750	$750	
Groundwater Sampling					Includes YSI 6500 and
Equipment Rental	3	WK	$600	$1,800	Bladder Pump
Sample Shipment	1	EA	$400	$400	CH2M HILL Estimate
Labor - Technicians	147	HR	$80	$11,760	3 hrs/well, 2 people
SUBTOTAL				**$47,650**	
Data Validation	16	HR	$100	$1,600	
Data Management	16	HR	$100	$1,600	
Project Management	5%	of	$47,650	$2,383	
Technical Support	3%	of	$47,650	$1,430	
Construction Management	0%	of	$47,650	$0	
Subcontractor General Requirements	3%	of	$47,650	$1,430	
SUBTOTAL				**$56,092**	
TOTAL UNIT COST				**$56,100**	

Element: **Sample Collection and Laboratory Costs - Evaluation of System Performance**

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

WORK STATEMENT

Costs associated with water sample collection from monitoring wells only, shipment and analysis on a per event and per well basis to evaluate enhanced anaerobic biodegradation. Includes design-related groundwater investigation wells.

OPERATION AND MAINTENANCE COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Sampling Event	4	EA	$56,100	$224,400	Quarterly Performance Monitoring
TOTAL O&M COST				**$224,400**	

Source of Cost Data

Table 5-2

Element: **Field Monitoring**

Site:	Memphis Depot - Main Installation
Location:	Memphis, TN
Phase:	Remedial Design
Base Year:	2004

WORK STATEMENT

Costs associated with field monitoring on a per event basis to evaluate enhanced anaerobic bioremediation performance.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Equipment & Labor per Event					
Dissolved Oxygen	87	SAMPLE	$0	$0	TTA 1 29 IWs
Temperature	87	SAMPLE	$0	$0	(13 Pairs - 3 Existing)
pH	87	SAMPLE	$0	$0	37 MWs
Eh or ORP	87	SAMPLE	$0	$0	(16 Pairs - 5 Existing) TTA 2
Turbidity	87	SAMPLE	$0	$0	9 IWs
Conductivity	87	SAMPLE	$0	$0	12 MWs
Equipment & Labor					
Sampling Supplies	1	EA	$750	$750	
Groundwater Sampling Equipment Rental	2	WK	$600	$1,200	Includes YSI 6500 and Bladder Pump
Sample Shipment	1	EA	$400	$400	CH2M HILL Estimate
Labor - Technicians	261	HR	$80	$20,880	3 hrs/well, 2 people
SUBTOTAL				**$23,230**	
Project Management	0%	of	$23,230	$0	
Technical Support	0%	of	$23,230	$0	
Construction Management	0%	of	$23,230	$0	
Subcontractor General Requirements	0%	of	$23,230	$0	
SUBTOTAL				**$23,230**	
TOTAL UNIT COST				**$23,200**	

OPERATION AND MAINTENANCE COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Field Monitoring Event - 1st Year	6	EA	$23,200	$139,200	Monthly First Quarter Quarterly Thereafter
Field Monitoring Event - 2nd Year	4	EA	$23,200	$92,800	Quarterly
TOTAL O&M COST				**$232,000**	

Source of Cost Data

Table 5-1

Element: **Sample Collection and Laboratory Costs - Main Installation Monitoring - Years 1 - 10**

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

WORK STATEMENT

Costs associated with water sample collection from monitoring wells only, shipment and analysis on a per event and per well basis to monitor plume migration throughout the Main Installation

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Sample Analysis Costs					
VOCs - SW8260 - Level III	1	SAMPLE	$100	$100	
Methane, Ethane, Ethene					
AM19A	1	SAMPLE	$115	$115	
Carbon Dioxide - Hach Kit	1	SAMPLE	$10	$10	
Nitrate/Nitrite - SW9056	1	SAMPLE	$25	$25	
Sulfate - SW9056	1	SAMPLE	$20	$20	
Sulfide - E376 or 300	1	SAMPLE	$20	$20	
Manganese - SW6010B	1	SAMPLE	$20	$20	
Potassium	1	SAMPLE	$20	$20	
Bromide	1	SAMPLE	$20	$20	
Alkalinity - E310	1	SAMPLE	$15	$15	
Chloride - SW9056	1	SAMPLE	$20	$20	
Iron II - SM3500 - Fe	1	SAMPLE	$20	$20	
Iron III (calculated)	1	SAMPLE	$0	$0	
Volatile Fatty Acids	1	SAMPLE	$80	$80	
Total Organic Carbon - SW9060	1	SAMPLE	$25	$25	
Dissolved Organic Carbon - SW9060	1	SAMPLE	$25	$25	
Chemical Oxygen Demand - E410.4	1	SAMPLE	$25	$25	
Dissolved Hydrogen	1	SAMPLE	$100	$100	
SUBTOTAL				$660	
Quarterly Event					
Analytical Costs - VOCs Only	49	Well	$100	$4,900	
Analytical Costs - MNA Parameters	49	Well	$280	$13,720	Two of the Four Events
Dehalococcoides Ethenogenes	0	SAMPLE	$350	$0	Microbial Insights Est
QA/QC Samples - VOCs Only	6	SAMPLE	$132	$792	
Equipment & Labor					
Sampling Supplies	1	EA	$750	$750	
Groundwater Sampling					Includes YSI 6500 and
Equipment Rental	3	WK	$600	$1,800	Bladder Pump
Sample Shipment	1	EA	$400	$400	CH2M HILL Estimate
Labor - Technicians	147	HR	$80	$11,760	3 hrs/well, 2 people
SUBTOTAL				$34,122	
Data Validation	16	HR	$100	$1,600	
Data Management	16	HR	$100	$1,600	
Project Management	5%	of	$34,122	$1,706	
Technical Support	3%	of	$34,122	$1,024	
Construction Management	0%	of	$34,122	$0	
Subcontractor General Requirements	3%	of	$34,122	$1,024	
TOTAL				$41,075	
Semiannual Event					
Analytical Costs - VOCs Only	16	Well	$100	$1,600	
Analytical Costs - MNA Parameters	16	Well	$280	$4,480	One of the Two Events
Dehalococcoides Ethenogenes	0	SAMPLE	$350	$0	Microbial Insights Est
QA/QC Samples - VOCs Only	3	SAMPLE	$132	$396	
Equipment & Labor					
Sampling Supplies	1	EA	$750	$750	
Groundwater Sampling					Includes YSI 6500 and
Equipment Rental	1	WK	$600	$600	Bladder Pump
Sample Shipment	1	EA	$400	$400	CH2M HILL Estimate
Labor - Technicians	48	HR	$80	$3,840	3 hrs/well, 2 people
SUBTOTAL				$12,066	
Data Validation	12	HR	$100	$1,200	
Data Management	12	HR	$100	$1,200	
Project Management	5%	of	$12,066	$603	
Technical Support	3%	of	$12,066	$362	
Construction Management	0%	of	$12,066	$0	
Subcontractor General Requirements	3%	of	$12,066	$362	
TOTAL				$15,793	

Element: **Sample Collection and Laboratory Costs - Main Installation Monitoring - Years 1 - 10**

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

WORK STATEMENT

Costs associated with water sample collection from monitoring wells only, shipment and analysis on a per event and per well basis to monitor plume migration throughout the Main Installation.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Annual Event					
Analytical Costs	6	Well	$660	$3,960	
Dehalococcoides Ethenogenes	0	SAMPLE	$350	$0	Microbial Insights Est
QA/QC Samples - VOCs Only	2	SAMPLE	$132	$264	
Equipment & Labor					
Sampling Supplies	1	EA	$750	$750	
Groundwater Sampling					Includes YSI 6500 and
Equipment Rental	1	WK	$600	$600	Bladder Pump
Sample Shipment	1	EA	$400	$400	CH2M HILL Estimate
Labor - Technicians	18	HR	$80	$1,440	3 hrs/well, 2 people
SUBTOTAL				$7,414	
Data Validation	6	HR	$100	$600	
Data Management	6	HR	$100	$600	
Project Management	5%	of	$7,414	$371	
Technical Support	3%	of	$7,414	$222	
Construction Management	0%	of	$7,414	$0	
Subcontractor General Requirements	3%	of	$7,414	$222	
TOTAL				$9,430	
Biannual Event					
Analytical Costs	8	Well	$660	$5,280	
Dehalococcoides Ethenogenes	0	SAMPLE	$350	$0	Microbial Insights Est
QA/QC Samples - VOCs Only	2	SAMPLE	$132	$264	
Equipment & Labor					
Sampling Supplies	1	EA	$750	$750	
Groundwater Sampling					Includes YSI 6500 and
Equipment Rental	1	WK	$600	$600	Bladder Pump
Sample Shipment	1	EA	$400	$400	CH2M HILL Estimate
Labor - Technicians	24	HR	$80	$1,920	3 hrs/well, 2 people
SUBTOTAL				$9,214	
Data Validation	8	HR	$100	$800	
Data Management	8	HR	$100	$800	
Project Management	5%	of	$9,214	$461	
Technical Support	3%	of	$9,214	$276	
Construction Management	0%	of	$9,214	$0	
Subcontractor General Requirements	3%	of	$9,214	$276	
TOTAL				$11,828	

OPERATION AND MAINTENANCE COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Annual Sampling Costs (Year 1)					
Quarterly Sampling Event	4	EA	$41,075	$164,302	
Annual Sampling Costs (Year 2)					
Semi-Annual Sampling Event	2	EA	$15,793	$31,587	
Annual Sampling Costs (Years 3, 5, 7, 9)					
Annual Sampling Event	1	EA	$9,430	$9,430	
Annual Sampling Costs (Years 4, 6, 8, 10)					
Annual Sampling Event	1	EA	$9,430	$9,430	
Biannual Sampling Event	1	EA	$11,828	$11,828	
SUBTOTAL				$21,257	

Source of Cost Data

Table 5-1

Element: **Present Worth Analysis**

Alternative: **Enhanced In Situ Anaerobic Biodegradation using $C_3H_5NaO_3$**
Manual Substrate Injection System TTAs 1 and 2

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

WORK STATEMENT

Calculation of alternative present worth. Assumes total present value earns interest for an entire year (12 months), compound annually.

Discount Rate 3.2%

Present Worth Analysis

Elapsed Time	Year	Discount Factor at 3.2%	Capital Cost	O&M Cost	Total Cost	Total PV Capital Costs at 3.2%	Total PV O&M Costs at 3.2%	Total PV Costs at 3.2%	Balance of Interest Bearing Account at 3.2%
0	2004	1 000	$ 1,379,500		$ 1,379,500	$ 1,379,500	$ -	$ 1,379,500	$ 1,796,542
1	2005	0.969		$ 899,502	$ 899,502	$ -	$ 871,610	$ 871,610	$ 897,041
2	2006	0.939		$ 673,987	$ 673,987	$ -	$ 632,837	$ 632,837	$ 223,054
3	2007	0.910		$ 20,420	$ 20,420	$ -	$ 18,578	$ 18,578	$ 202,635
4	2008	0.882		$ 32,247	$ 32,247	$ -	$ 28,430	$ 28,430	$ 170,388
5	2009	0.854		$ 26,420	$ 26,420	$ -	$ 22,570	$ 22,570	$ 143,968
6	2010	0.828		$ 23,657	$ 23,657	$ -	$ 19,583	$ 19,583	$ 120,311
7	2011	0.802		$ 11,830	$ 11,830	$ -	$ 9,489	$ 9,489	$ 108,481
8	2012	0.777		$ 23,657	$ 23,657	$ -	$ 18,388	$ 18,388	$ 84,824
9	2013	0.753		$ 11,830	$ 11,830	$ -	$ 8,909	$ 8,909	$ 72,995
10	2014	0.730		$ 151,332	$ 151,332	$ -	$ 110,442	$ 110,442	$ (78,337)
Total Alternative			$ 1,379,500	$ 1,874,880	$ 3,254,380	$ 1,379,500	$ 1,740,836	$ 3,120,336	

TABLE 5-2 COST COMPARISON OF CONTINGENCY REMEDIES
Source Control Alternatives

Site:	Memphis Depot - Main Installation
Location:	Memphis, TN
Phase:	Remedial Design
Base Year:	2004

	Enhanced In Situ Anaerobic Biodegradation Using $C_3H_5NaO_3$ Manual Substrate Injection System Localized Injection	**In Situ Chemical Oxidation Using $KMnO_4$ Manual Oxidant Injection System Localized Injection**
Total Project Duration (Years)	1	One Time Event
Capital Cost	$26,000	$15,000
O&M Costs	$44,000 (Year 1)	Not Applicable
Total Present Worth of Solution	$70,000	$15,000

Disclaimer. The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude cost estimate that is expected to be within -30 to +50 percent of the actual project costs.

TABLE 5-2 Enhanced In Situ Anaerobic Biodegradation using $C_3H_5NaO_3$ Manual Substrate Injection System - Contingency Remedy

COST ESTIMATE SUMMARY

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

Description: Manual substrate injection of sodium lactate in the fluvial aquifer. Localized region within the TTA.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Baseline Groundwater Sample Collection Event	0	EA	$44,300	$0	38 Monitoring Locations
Mobilization and Prep Work					
Security Fencing, Signs, Traffic Control, and Utility Location	0	LS	$3,500	$0	
Survey	0	LS	$2,000	$0	
Manual $C_3H_5NaO_3$ Injection Systems					
INJECTION WELLS					
Injection Well Installation	0	EA	$595,500	$0	
Monitoring Well Installation	0	EA	$283,000	$0	
TRAILER MOUNTED INJECTION SYSTEM	0	EA	$17,500	$0	500-Gallon Polyethylene Storage Tank, Tank Mixer, Chemical Injection Pump, Piping, Valves, Gas-Powered Generator, Trailer
STORAGE AND TRANSFER FACILITY - BUILDING 309					
Equipment and Material					
Sodium Lactate	20,020	LB	$1.04	$20,821	Localized Injection in 4 Well or Well Pairs
Shipping - Sodium Lactate	1	LOAD	$1,200	$1,200	39,900 lbs./load
Potassium Bromide Tracer	0	LB	$3.05	$0	200 g/100 gal solution
Drum Pump	0	EA	$1,000	$0	
Flow Control Systems					
Batch Controllers	0	EA	$4,830	$0	
Supply Hose (Sodium Lactate and H_2O) Hose Racks, PVC Piping Backflow Preventor Flow Meters, Solenoid Valves Cam-Lock Fittings	0	LS	$11,155	$0	

TABLE 5-2 Enhanced In Situ Anaerobic Biodegradation using $C_3H_5NaO_3$ Manual Substrate Injection System - Contingency Remedy

COST ESTIMATE SUMMARY

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

Description: Manual substrate injection of sodium lactate in the fluvial aquifer. Localized region within the TTA.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Work					
Connection to Existing Water Main - Trenching	0	LS	$4,830	$0	Labor and Material Gate Valve and PVC Piping
Construction of Concrete Curb for Sodium Lactate Storage	0	LS	$3,950	$0	Ready Mix Concrete 4,000 psi Rated
Drill Hole In Wall - Water Pipe	0	LS	$210	$0	Labor and Material
Electrical Subcontractor	0	EA	$4,700	$0	Install Electrical Service, Conduit, Wiring, and System Connections
Site Restoration	0	EA	$500	$0	Includes Labor and Materials
SUBTOTAL				**$22,021**	

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Project Management	3%	of	$22,021	$661	
Remedial Design	2%	of	$22,021	$440	
Construction Management	2%	of	$22,021	$440	
Subcontractor General Requirements	0.5%	of	$22,021	$110	
SUBTOTAL				**$23,672**	
Contingency	10%	of	$23,672	$2,367	
TOTAL CAPITAL COST				**$26,000**	

TABLE 5-2 Enhanced In Situ Anaerobic Biodegradation using $C_3H_5NaO_3$ Manual Substrate Injection System - Contingency Remedy

COST ESTIMATE SUMMARY

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

Description: Manual substrate injection of sodium lactate in the fluvial aquifer. Localized region within the TTA.

OPERATIONS AND MAINTENANCE COST - SYSTEM PERFORMANCE (Year 1)

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Manual $C_3H_5NaO_3$ Injection Systems					
Electrical Costs	0	LS	$700	$0	Electricity and Electrician
Miscellaneous Equipment Parts and Materials/Supplies	0.25	LS	$2,000	$500	
Labor - O&M Technician	720	HR	$60	$43,200	2 Technicians
Performance Monitoring					TTAs 1 and 2
Lab Sampling Events	0	EA	$44,300	$0	38 Monitoring Wells
Field Monitoring Events	0	EA	$10,500	$0	Monthly First Quarter
SUBTOTAL				**$43,700**	
Annual Performance Report					
Labor - Project Manager	0	HR	$125	$0	
Labor - Engineer/Hydrogeologist	0	HR	$100	$0	
Labor - Editor	0	HR	$65	$0	
Labor - CAD Technician	0	HR	$65	$0	
SUBTOTAL - Annual Report				**$0**	
TOTAL ANNUAL O&M COST				**$44,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 3.2%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	TOTAL PRESENT VALUE	NOTES
	FIRST YEAR CAPITAL COST	$26,000	$26,000	$26,000	
1	ANNUAL O&M COST (Year 1)	$44,000	$44,000	$44,000	
				$70,000	
	TOTAL COST OF CONTINGENCY ALTERNATIVE			**$70,000**	

SOURCE INFORMATION

TABLE 5-2 In Situ Chemical Oxidation Using MnO_4
Manual Oxidant Injection System - Contingency Remedy

COST ESTIMATE SUMMARY

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

Description: One time manual oxidant injection of $KMnO_4$ in the fluvial aquifer. Localized region within the TTA.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Baseline Groundwater Sample Collection Event	0	EA	$44,300	$0	38 Monitoring Locations
Mobilization and Prep Work					
Security Fencing, Signs, Traffic Control, and Utility Location	0	LS	$3,500	$0	
Survey	0	LS	$2,000	$0	
Manual $KMnO_4$ Injection System					
INJECTION WELLS					
Injection Well Installation	0	EA	$595,500	$0	
Monitoring Well Installation	0	EA	$283,000	$0	
TRAILER MOUNTED INJECTION SYSTEM	0	EA	$17,500	$0	500-Gallon Polyethylene Storage Tank, Tank Mixer, Chemical Injection Pump, Piping, Valves, Gas-Powered Generator, Trailer
STORAGE AND TRANSFER FACILITY - BUILDING 309					
Equipment and Material					
Potassium Permanganate	3,142	LB	$1.35	$4,242	Assume 14,000 gallons of 3% $KMnO_4$ injected solution (3,142 pounds)
Shipping - Sodium Lactate	1	LOAD	$1,000	$1,000	331 pounds per drum
Potassium Bromide Tracer	0	LB	$3.05	$0	200 g/100 gal solution
Drum Pump	0	EA	$1,000	$0	
Flow Control Systems					
Batch Controllers	0	EA	$4,830	$0	
Supply Hose (Sodium Lactate and H_2O) Hose Racks, PVC Piping Backflow Preventor Flow Meters, Solenoid Valves Cam-Lock Fittings	0	LS	$11,155	$0	

794 77

TABLE 5-2 In Situ Chemical Oxidation Using MnO_4
Manual Oxidant Injection System - Contingency Remedy

COST ESTIMATE SUMMARY

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

Description: One time manual oxidant injection of $KMnO_4$ in the fluvial aquifer. Localized region within the TTA.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Work					
Connection to Existing Water Main - Trenching	0	LS	$4,830	$0	Labor and Material Gate Valve and PVC Piping
Construction of Concrete Curb for Sodium Lactate Storage	0	LS	$3,950	$0	Ready Mix Concrete 4,000 psi Rated
Drill Hole In Wall - Water Pipe	0	LS	$210	$0	Labor and Material
Electrical Subcontractor	0	EA	$4,700	$0	Install Electrical Service, Conduit, Wiring, and System Connections
Site Restoration	0	EA	$500	$0	Includes Labor and Materials
SUBTOTAL				**$5,242**	

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Project Management	3%	of	$5,242	$157	
Remedial Design	2%	of	$5,242	$105	
Construction Management	2%	of	$5,242	$105	
Subcontractor General Requirements	0.5%	of	$5,242	$26	
SUBTOTAL				**$5,635**	
Contingency	10%	of	$5,635	$563	
TOTAL CAPITAL COST				**$6,200**	

TABLE 5-2 In Situ Chemical Oxidation Using MnO_4
Manual Oxidant Injection System - Contingency Remedy

COST ESTIMATE SUMMARY

Site: Memphis Depot - Main Installation
Location: Memphis, TN
Phase: Remedial Design
Base Year: 2004

Description: One time manual oxidant injection of $KMnO_4$ in the fluvial aquifer. Localized region within the TTA.

OPERATIONS AND MAINTENANCE COST - SYSTEM PERFORMANCE (Year 1)

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Manual $C_3H_5NaO_3$ Injection Systems					
Electrical Costs	0	LS	$700	$0	Electricity and Electrician
Miscellaneous Equipment Parts and Materials/Supplies	0.25	LS	$2,000	$500	
Labor - O&M Technician	140	HR	$60	$8,400	2 Technicians 28 - 500 gal deliveries and injection - 4 gpm delivery
Performance Monitoring					
Lab Sampling Events	0	EA	$44,300	$0	TTAs 1 and 2 38 Monitoring Wells
Field Monitoring Events	0	EA	$10,500	$0	Monthly First Quarter
SUBTOTAL				**$8,900**	
Annual Performance Report					
Labor - Project Manager	0	HR	$125	$0	
Labor - Engineer/Hydrogeologist	0	HR	$100	$0	
Labor - Editor	0	HR	$65	$0	
Labor - CAD Technician	0	HR	$65	$0	
SUBTOTAL - Annual Report				**$0**	
TOTAL ANNUAL O&M COST				**$9,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 3.2%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	TOTAL PRESENT VALUE	NOTES
	FIRST YEAR CAPITAL COST	$6,200	$6,200	$6,200	
1	ANNUAL O&M COST (Year 1)	$9,000	$9,000	$9,000	
				$15,200	
	TOTAL COST OF CONTINGENCY ALTERNATIVE			**$15,000**	

SOURCE INFORMATION

APPENDIX A

Treatability Pilot Study of Enhanced Bioremediation Treatment (EBT)

794 80

Memphis Depot

Main Installation

Treatability Pilot Study of Enhanced Bioremediation Treatment (EBT)

Defense Distribution Center (Memphis)

February 2004 — Rev. 1

U.S. Army Engineering and Support Center, Huntsville

CH2MHILL

U.S. Army Engineering and Support Center, Huntsville
Contract No. DACA87-02-D-0006
Task Order No. 01

E052003014ATL

Defense Distribution Center (Memphis)
Main Installation

Treatability Pilot Study of Enhanced Bioremediation Treatment (EBT)

Rev. 1

PREPARED FOR

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PREPARED BY

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Executive Summary

This report of the Treatability Pilot Study of Enhanced Bioremediation Treatment (EBT) was prepared for the U.S. Army Corps of Engineers - Huntsville Center. The study was part of the Remedial Design (RD) for remediation of groundwater at the Main Installation (MI) of the Defense Distribution Center (Memphis), commonly referred to as the Memphis Depot. Contaminant plumes beneath the MI contain chlorinated volatile organic compounds (CVOCs), primarily tetrachloroethene (PCE), trichloroethene (TCE), carbon tetrachloride (CT), and chloroform. The study began in June 2002 and included use of two electron donors (vegetable oil and sodium lactate) injected into two separate study areas to develop design parameters and a suitable donor during full-scale implementation. The objectives of the EBT treatability study were as follows:

- Obtain additional information on the geology of the aquifer.
- Define the effect of the injection pressure on the aquifer.
- Estimate the radius of influence of electron donors.
- Evaluate transport of electron donors within the aquifer.
- Identify preferential pathways for CVOC migration or retention.
- Define the electron donor depletion period in the aquifer.
- Ascertain the effectiveness of electron donor addition as a remedial treatment.
- Estimate time for aquifer remediation.

A vegetable oil emulsion (food grade soybean oil mixed with lecithin, commercially known as *Centromix BR*™) was injected into the fluvial aquifer beneath Study Area 1. A 15 to 40 percent solution of sodium lactate was injected into the aquifer beneath Study Area 2. Both study areas included multiple observation/monitoring wells and 3 to 4 injection wells. Drilling to prepare for the pilot studies indicated the soil lithology and fluvial aquifer within the study areas were representative of the MI.

At Study Area 1, a total of 11,592 gallons of vegetable oil emulsion with bromide tracer were injected. The electron donor was detected almost immediately within a zone up to 63 feet downgradient of the injection wells. At Study Area 2, an initial injection of 9,705 gallons lactate and bromide solution was made, with an affected zone up to 38 feet downgradient of the injection wells. Subsequent lactate injections of 2,995, 3,375, and 3,338 gallons were made in February, April and May 2003, respectively, into Area 2. Injection pressures had no measurable effect on water levels in wells greater than 20 feet from the injection well.

Following injection activities, groundwater samples were collected on a monthly basis at both areas until August 2003. Samples were analyzed for dissolved organic carbon (DOC), CVOCs), bromide, dissolved gases (methane, ethane, and ethene), geochemical indicator parameters, and volatile fatty acids.

Both electron donors persisted for more than 6 months in the aquifer. After one year the oil emulsion was still detectable near the injection zone. The lactate was substantially depleted within 7 months of the initial injection, and the subsequent injections were made to sustain the reducing conditions necessary for reductive dechlorination.

Comparison of the levels of bromide and DOC in downgradient wells indicated the lactate was transported in groundwater at approximately an equal rate as the tracer. DOC from the oil emulsion also traveled downgradient at a rate approximately the same as the tracer. The DOC from both substrates was degradable and levels were substantially depleted within a few hundred feet downgradient of the injection zone. Variations in bromide and DOC within the study areas indicated potential aquifer heterogeneities or preferential pathways for migration. At both test sites, an area near the injection wells showed very little effect from the (initial) injection, suggesting a local zone of lower permeability. This has implications to full-scale implementation because a uniform radius of influence cannot be assumed. Multiple injections may be required to assure all areas within the target area are treated.

Both pilot tests showed that EBT can be effective in reducing CVOCs at the MI. Post-injection sampling revealed that almost immediately both donors created changes in geochemical conditions favorable for reductive dechlorination. Dissolved oxygen, nitrate, sulfate, and oxidation reduction potential levels declined, while iron and manganese, DOC, alkalinity, carbon dioxide, chloride, and dissolved gases (especially methane) increased. Changes were more dramatic with the lactate injections indicating that substrate was more available to stimulate microbial activity. During the study, water samples were tested for iron related and sulfate-reducing bacteria. Both types were identified repeatedly at reasonably high population levels suggesting the electron donors were sustaining conditions suitable for reductive dechlorination. Tests for a particular bacterium, *Dehalococcoides ethenogenes*, known to be effective at completely transforming PCE and TCE to ethane, were negative (less than 500 cells per gram).

During the one year period of the study, PCE and TCE levels declined in Study Area 1. Some transformation to cis-1,2-DCE was noted and overall attenuation rates for PCE and TCE were up to 100 times the natural attenuation rates. However, some of the attenuation was apparently due to absorption of PCE and TCE into the vegetable oil, not transformation. Within 3 months of the initial lactate injection in Study Area 2, PCE, TCE, CT and its daughter products were degrading in areas affected by the electron donor. The reductive dechlorination reaction appeared to slow somewhat as the lactate became depleted, but subsequent injections were very effective in removing these contaminants from nearly all of the study area. Unfortunately, after one year of biostimulation with lactate, the indigenous microbial communities did not transform the cis-1,2-DCE to vinyl chloride and then to ethane. This suggests that full-scale implementation may require longer treatment periods, or injection of special bacterial strains (bioaugmentation) to complete the transformation. Ongoing remedial actions at the nearby Memphis Airport suggest that a more continuous lactate injection might stimulate effective treatment of cis-1,2-DCE over time. Buildup of cis-1,2-DCE was not noted at Study Area 1 but the slow rate of cis-1,2-DCE generation indicates the EBT rates for the vegetable oil are slower than the lactate.

Overall, the lactate showed better promise for EBT within the fluvial aquifer. Since short-term biostimulation with lactate does not cause complete transformation of the chlorinated ethenes, the design for full-scale implementation should be based on multiple injections to sustain lactate in the aquifer for a period of a year. As an alternative approach, EBT with lactate could be used to attenuate PCE/TCE to cis-1,2-DCE, with subsequent attenuation of the cis-1,2-DCE via aerobic oxidation in downgradient portions of the site (outside the active treatment zone). This approach would have to be shown effective via fate and transport modeling, or by results of continued monitoring of these pilot study sites. If continual EBT with lactate was to be used, the time for complete treatment of the "hottest" plume areas is estimated to be at least 2 to 3 years. If limited EBT treatment creates cis-1,2-DCE that will attenuate via aerobic oxidation, the active treatment time would be about 1 year, with overall cleanup time of the "hottest" plume areas possibly in 2 to 5 years.

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Attachments

Acronyms

BCT	Base Cleanup Team
bgs	below ground surface
BRAG	Base Realignment and Closure
cfu/mL	colony-forming units per milliliter
cis-1,2-DCE	cis-1,2-dichloroethene
CO_2	carbon dioxide
COCS	Constituents of concern
CT	carbon tetrachloride
CVOC	chlorinated volatile organic compound
DCE	Dichloroethene
DLA	Defense Logistics Agency
DO	dissolved oxygen
DOC	dissolved organic carbon
DQE	data quality evaluation
DQOs	data quality objectives
EBT	Enhanced Bioremediation Treatment
EISOPQAM	Environmental Investigations Standard Operating Procedures Quality Assurance Manual of the USEPA
EPA	Environmental Protection Agency
ERD	enhanced reductive dechlorination
Fe(II)	Ferrous iron
Fe(III)	Ferric iron
gpm	gallons per minute
H_2	Hydrogen
HRC®	Hydrogen Release Compound®
ID	inner diameter
IRB	iron-related bacteria
LTOA	Long-Term Operational Area
MCL	Maximum Contaminant Level
MI	Main Installation
µg/kg	micrograms per kilogram
mg/kg	milligrams per kilogram
µg/L	micrograms per liter

mg/L	milligrams per liter
Mn(II)	Manganese (II)
MNA	Monitored Natural Attenuation
MV	Millivolt
ORP	oxidation reduction potential
OVA-FID	organic vapor analyzer-flame ionization detector
PCE	Tetrachloroethene
PCR	polymerase chain reaction
PDB	polyethylene diffusion bag
POL	petroleum/oil/lubricants
ppm	part per million
psi	pounds per square inch
QA	quality assurance
RAB	Restoration Advisory Board
RI	Remediation Investigation
ROD	Record of Decision
RPO	Remedial Process Optimization
SRB	sulfate-reducing bacteria
SU	standard units for measurement of pH
TCE	Trichloroethene
TDEC	Tennessee Department of Environment and Conservation
TOC	total organic carbon
VC	vinyl chloride
VFAs	volatile fatty acids
VOC	volatile organic compound

1.0 Introduction

This report of the Treatability Pilot Study of Enhanced Bioremediation Treatment (EBT) was prepared for the U.S. Army Corps of Engineers - Huntsville Center. The work was done as part of the Remedial Design to clean up groundwater at the Main Installation (MI) within the former Memphis Depot, Memphis, Tennessee (Figure 1.1). The Defense Logistics Agency (DLA) is the lead agency for site activities at the former Memphis Depot; the supporting regulatory agencies are the U.S. Environmental Protection Agency (EPA) and the Tennessee Department of Environment and Conservation (TDEC). Together, DLA, EPA, and TDEC compose the Base Realignment and Closure (BRAC) Base Cleanup Team (BCT) for the Memphis Depot.

Groundwater beneath the MI is contaminated with chlorinated volatile organic compounds (CVOC). The cleanup goals for the MI for the groundwater as indicated in Table 1.1.

TABLE 1.1
Groundwater Cleanup Goals
Main Installation, Memphis Depot

Compound	Units	Cleanup Goal	Maximum Reported Concentration
Tetrachlorethene (PCE)	µg/L	5	480
Trichloroethene (TCE)	µg/L	5	179
Cis-1,2-Dichloroethylene	µg/L	70	53
Trans-1,2-Dichloroethylene	µg/L	100	164
Vinyl chloride	µg/L	2	0.2
Carbon Tetrachloride	µg/L	5	122
Chloroform	µg/L	80*	77
1,2-Dichloroethane	µg/L	5	21

* the MCL for trihalomethanes
µg/L micrograms per liter

Research has shown that in situ biological processes including reductive dechlorination can remove CVOCs from groundwater. The Record of Decision (ROD) for the MI selected enhanced bioremediation as the technology to clean up the most contaminated parts of the groundwater plumes. Enhanced bioremediation involves adding nutrient amendments (electron donors) to the groundwater to stimulate or enhance geochemical conditions for anaerobic reductive dechlorination of CVOCs. In order to determine the design parameters and to select a suitable electron donor, CH2M HILL began in June 2002 a pilot-scale study of EBT at two MI sites. The pilot study tested two electron donors (sodium lactate and vegetable oil) that are common, commercially available materials proven at other sites to enhance reductive dechlorination.

This report presents the objectives, methods, field and laboratory results, and findings of the pilot study.

1.1 Objectives of the Pilot Study

The objectives of the pilot study were discussed in detail in the Enhanced Bioremediation Treatment Treatability Study Workplan (CH2M HILL, 2002) and are as follows:

- **Obtain additional information on the geology of the aquifer.**
  Borings for all injection and monitoring wells were logged, and hydraulic (slug) tests were conducted to measure aquifer properties.

- **Define the effect of the injection pressure on the aquifer.**
  During the initial injection at both study areas and additional injections at Study Area 2, water levels were measured to assess the radius of hydraulic influence.

- **Estimate the radius of influence of electron donors.**
  Monitoring wells were installed downgradient of the injection wells. Groundwater samples were collected for dissolved total organic carbon (TOC) and bromide (a conservative tracer) to indicate the radius of influence of the electron donor.

- **Evaluate transport of electron donors within the aquifer.**
  Groundwater samples were collected for geochemical parameters (i.e., oxidation reduction potential [ORP], dissolved oxygen, sulfate, nitrate, carbon dioxide, etc.), dissolved TOC, and bromide.

- **Identify preferential pathways for CVOC migration or retention.**
  Bromide was analyzed in groundwater samples to provide estimates of groundwater velocity and local flow paths. Wells upgradient and within the test area were analyzed for CVOC to detect changes in concentration.

- **Define the electron donor depletion period in the aquifer.**
  Fourteen monitoring events were conducted after the initial injections in July 2002. Results from Area 2 revealed the lactate was expended by January 2003; additional lactate was injected in February 2003, April 2003, and May 2003.

- **Ascertain the effectiveness of electron donor addition as a remedial treatment.**
  Groundwater samples were analyzed for CVOC and daughter products, as well as geochemical parameters associated with biodegradation (carbon dioxide [CO_2}; pH; ethane; methane; and ethene).

- **Estimate time for aquifer remediation.**
  CVOC results were used to estimate biodegradation rates associated with each substrate. These rates were used to estimate treatment times for the most concentrated parts of the MI plumes.

1.2 Bioremediation Concepts

Biodegradation of CVOC in groundwater commonly occurs through cometabolic processes, reductive dechlorination, and/or oxidation. The oxygen content of the groundwater has a strong effect on the prevalent biological process. At most sites the predominant mechanism for CVOC biodegradation is reductive dechlorination, an anaerobic (oxygen-depleted groundwater) process. Cometabolic transformation of CVOC has been reported in both aerobic and anaerobic environments (McCarty, 1994). Oxidation of CVOC has also been reported in both aerobic and anaerobic environments (Bradley and Chapelle, 1996). Within the MI plumes, all three mechanisms might occur (CH2M HILL, 2002).

Subsurface microorganisms create energy for life processes by oxidizing organic matter. Oxidizing something causes something else to be reduced, hence the term: redox reaction. Only those redox reactions that yield energy are facilitated by microorganisms. Inside the microorganism, the oxidation of an electron donor (e.g., native organic carbon, fuel hydrocarbons, other fermentable organics) combined with the reduction of a terminal electron acceptor (e.g., oxygen, nitrate, manganese, ferric iron, sulfate, carbon dioxide, and CVOC) yields energy for use. The microbes use a food source, such as lactate, as an electron donor and undergo respiration by oxidizing an organic molecule to carbon dioxide using a terminal electron acceptor. Dissolved oxygen (DO) yields the most energy and is used first. After DO is consumed, anaerobic microorganisms typically use native electron acceptors (as available) in the following order of preference: nitrate, ferric iron oxyhydroxide, sulfate, and CVOC (USEPA, 1998). Figure 1.2 summarizes these geochemical processes in groundwater.

Reductive dechlorination is a destructive chemical reaction that occurs when microorganisms respire CVOC (the electron acceptor). The microorganism gains energy when a hydrogen atom replaces a chlorine atom on the CVOC. The ultimate source for the hydrogen and electrons in this reaction is the hydrogen (H_2) released during fermentation of simple organic substrates (ITRC, 1998). Reductive dechlorination usually occurs as a series of sequential reactions. For PCE, the following sequence occurs: PCE -> TCE -> DCE -> VC -> ethene. For carbon tetrachloride, the following sequence occurs: Carbon tetrachloride -> chloroform -> methylene chloride -> chloromethane -> methane. Figure 1.3 presents common dechlorination pathways for CVOC contaminants at the MI. Each step in the reductive pathway requires a lower reduction/oxidation (redox) potential than the previous one. PCE degradation occurs in a wide range of reducing conditions, whereas VC is reduced to ethene only under sulfate reducing and methanogenic conditions. It has also been shown that VC can be oxidized in aerobic environments (McCarty, 1994).

Specific conditions required to sustain a microbial population capable of bioremediation includes a source of carbon (electron donor) and terminal electron acceptor(s); appropriate level of nutrients (e.g., phosphorus and nitrogen); a suitable temperature range; and pH and ORP in the optimal range. Plume conditions that will not sustain the microbial population can inhibit CVOC biodegradation. One purpose of this pilot study was to manipulate the plume conditions to create a sustaining environment for the indigenous microbial populations to thrive.

During contaminant bioremediation studies, several parameters are used to evaluate terminal electron-accepting processes. Table 1.2 presents these parameters and explains the significance to the pilot study.

1.3 Substrate Selection

Selection factors included the following:

- substrates used successfully at other sites
- contaminant concentrations at the pilot study sites relative to other sites
- viscosity of the substrate and the ability to be injected into the aquifer
- equipment required for substrate injections
- overall substrate effectiveness as reported at other sites

Potential substrates evaluated included lactate, vegetable oil, butyric acid, ethanol, molasses, HRC®, and hydrogen gas. Hydrogen sparging was eliminated due to the complexity of delivering the gas to the aquifer. Due to the treatment depth and potential injection problems into a silty sand aquifer, high viscosity substrates such as HRC® and molasses were also eliminated. Although butyric acid and ethanol were reportedly effective at some sites, more consistent results were reported with the lactate. Based on data reported from other EBT sites, a 60 percent sodium lactate solution, supplied by JRW Technologies of Lenexa, Kansas, was used as a substrate.

The DLA, as part of the Remedial Process Optimization (RPO) evaluation, recommended that vegetable oil be used as one of the substrates, based on the positive results reported by Parsons Engineering Science, Inc. (Parsons) (June, 2001). Parsons reported successful enhancement of reductive dechlorination by vegetable oil at multiple sites contaminated by CVOCs (personal communication, 2002). CH2M HILL had also used vegetable oil as a substrate at several sites but had found little to moderate reduction in contaminant levels. In order to overcome the low aqueous solubility of pure vegetable oil, CH2M HILL decided to inject an emulsion of the oil. An emulsion of food-grade soybean oil mixed with lecithin (commercially known as *Centromix BR*™), as supplied by Central Soya Company of Fort Wayne, Indiana, was used as the second substrate.

1.4 Report Organization

This Treatability Study Report is organized into the following sections and appendices:

Section 1.0 **Introduction** includes the objectives of the Treatability Study and a brief overview of bioremediation concepts and injection material selection.

Section 2.0 **Site History and Setting** provides background information for the Main Installation and a brief description of the Study Areas.

Section 3.0 **Activities and Methodology of the EBT Treatability Study** describes the activities and methods used during the Treatability Study to gather data needed to answer the objectives.

Section 4.0 **Results** summaries and discusses all data collected during the Study.

Section 5.0 Summary and Conclusions presents the findings of the pilot study and how the results may be used to develop the remedial design.

Section 6.0 References.

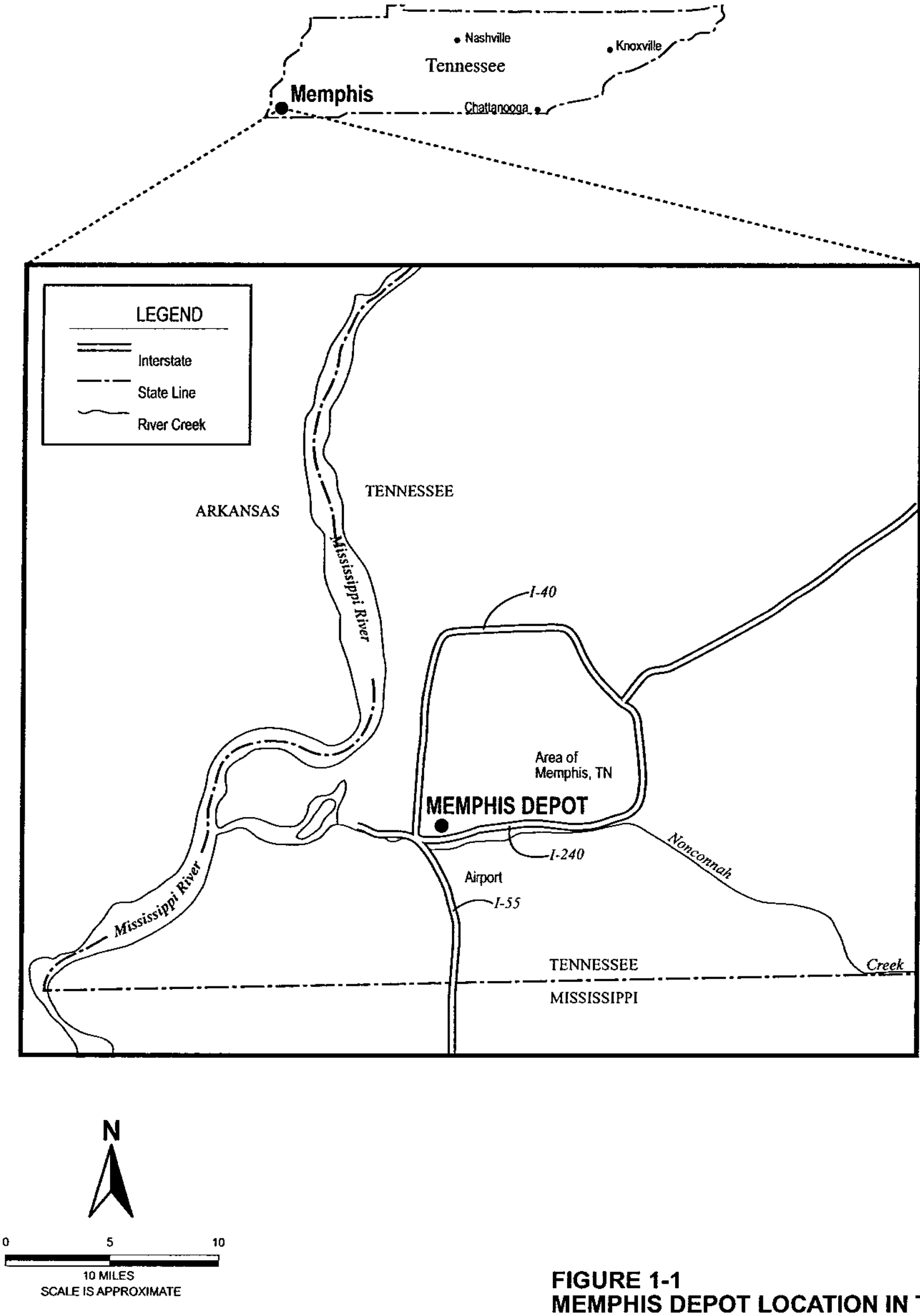

FIGURE 1-1
MEMPHIS DEPOT LOCATION IN THE MEMPHIS METROPOLITAN AREA
EBT Treatability Study (Rev. 0)
Memphis Depot

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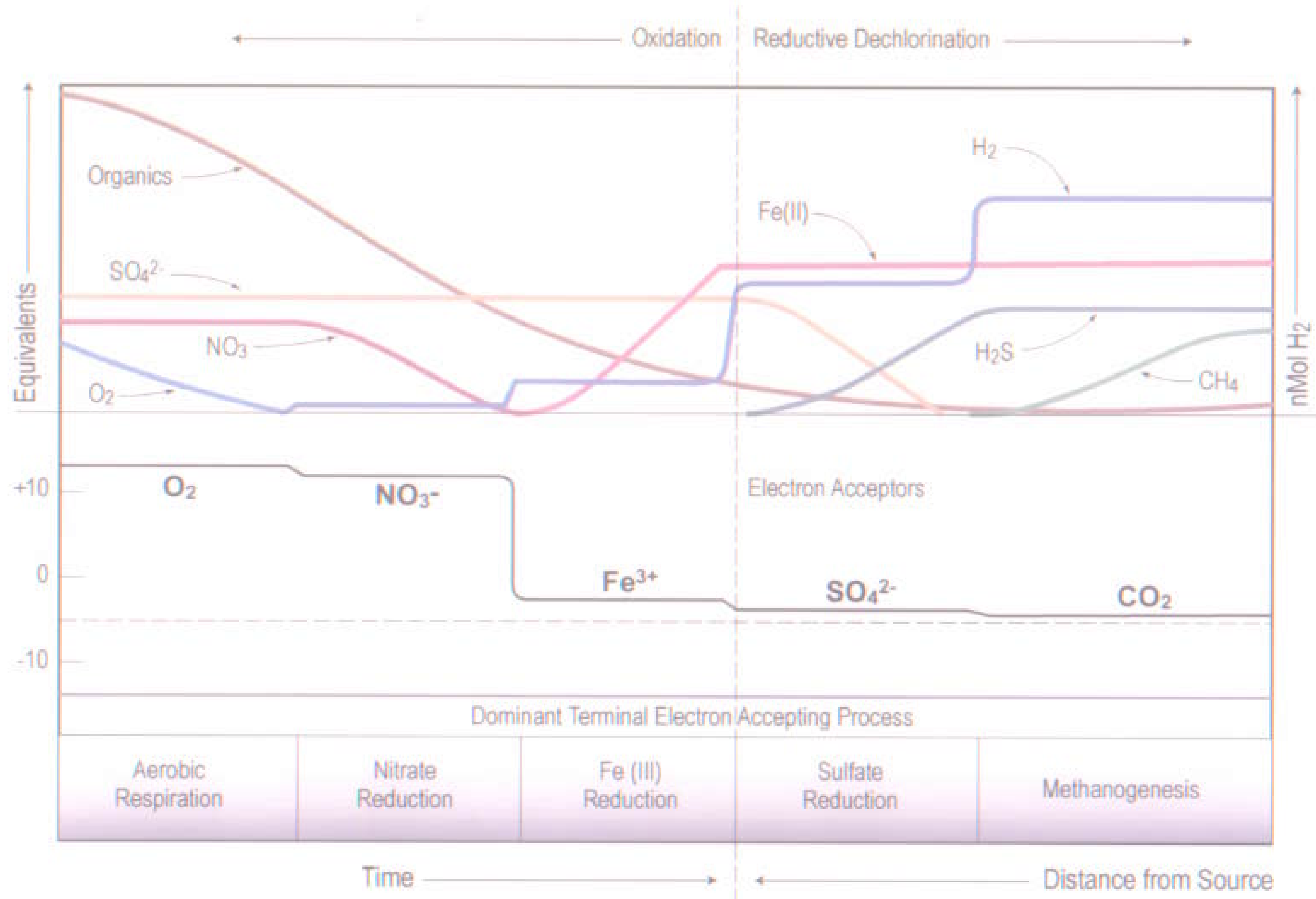
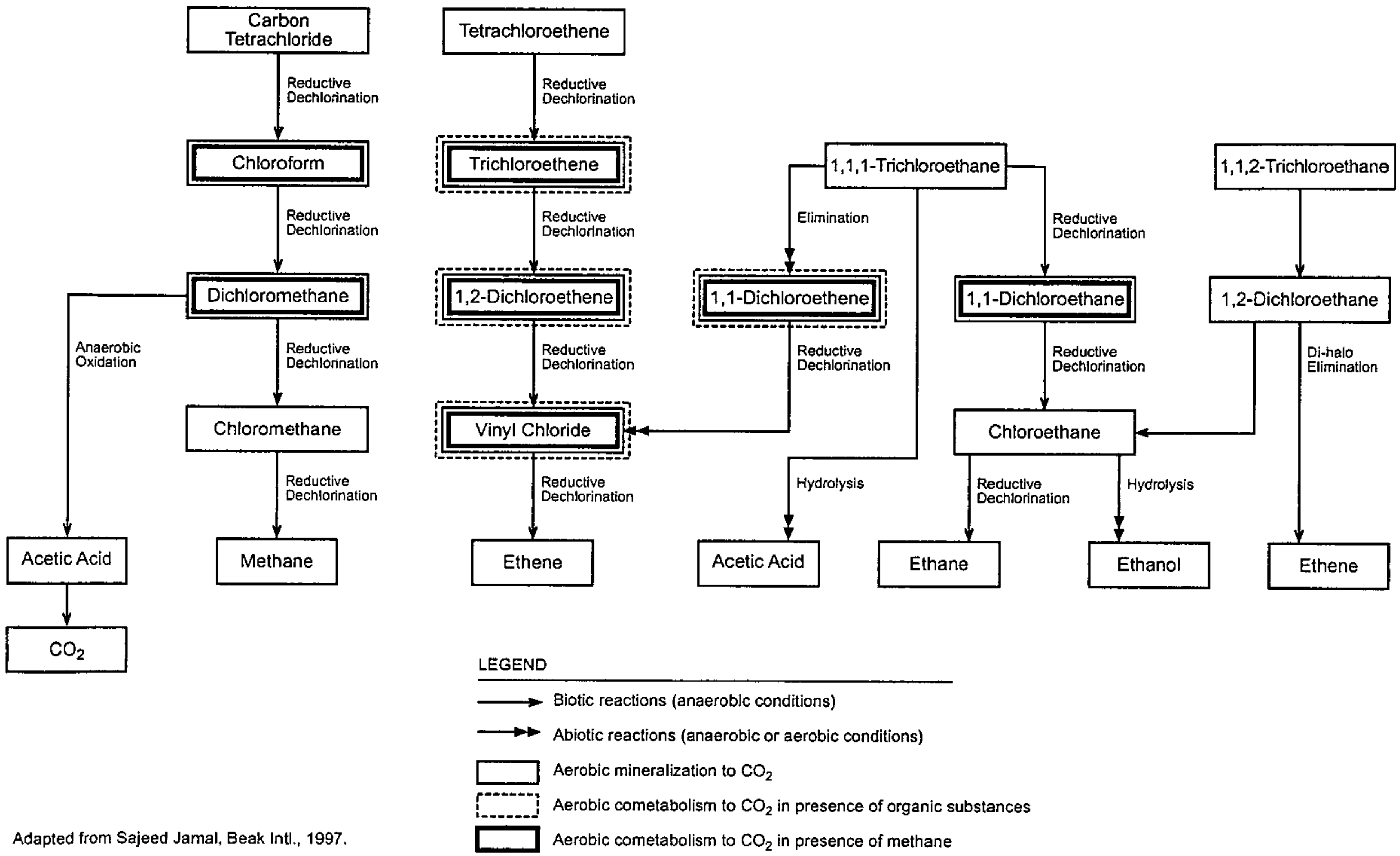


after Wiedemeier (2001)

Figure 1.2
Geochemical Processes in Groundwater
EBT Treatability Study (Rev. 0)
Memphis Depot



Adapted from Sajeed Jamal, Beak Intl., 1997.

Figure 1.3
Common CVOC Biodegradation Pathways
EBT Treatability Study (Rev. 0)
Memphis Depot

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Table 1.2
Analytical Parameters for Detection of Bioremediation
Main Installation, Memphis Depot

Analyte	Data Use
Dissolved Oxygen	Favored electron acceptor used by microbes for the biodegradation of many forms of organic carbon. Strictly anaerobic bacteria generally cannot function at dissolved oxygen concentrations greater than about 0.5 mg/L. Highly chlorinated compounds, such as PCE, TCE, and TCA are biologically recalcitrant under aerobic conditions. Low levels of DO will indicate favorable conditions for reductive dechlorination.
Nitrate	After DO has been depleted, nitrate may be used as an electron acceptor for anaerobic biodegradation of organic carbon via denitrification. Nitrate concentrations below background in areas with high organic carbon concentrations and low DO are indicative of denitrification. If nitrate concentrations exceed 1 mg/L, then microorganisms may use nitrate instead of CVOCs to produce energy (Wiedemeier et al., 1999).
Manganese (II)	Level of Mn(II) much above background indicates Mn(IV) reduction during microbial degradation of organic compounds in the absence of dissolved oxygen and nitrate.
Iron (II)	The reduction of ferric iron results in the formation of ferrous iron (Fe(II)). Elevated concentrations of ferrous iron are often found in anaerobic groundwater systems. Typically, Fe(II) concentrations greater than 1 mg/L indicate the potential for an anaerobic pathway (Wiedemeier et al., 1999).
Sulfate/Sulfide	Under more reducing conditions, sulfate may be used as an electron acceptor during microbial degradation of organic carbon. This is commonly called sulfate reduction (Grbic-Galic, 1990). Sulfate is reduced to sulfide during the oxidation of natural or anthropogenic carbon. Wiedemeier et al. (1999) reports that sulfate may compete with CVOCs as an electron acceptor and possibly preferred by microorganisms when sulfate concentrations exceed 20 mg/L.
Methane	During methanogenesis, acetate is split to form carbon dioxide and methane, or carbon dioxide is used as an electron acceptor and is reduced to methane. Methanogenesis generally occurs after oxygen, nitrate, and sulfate have been depleted. The presence of methane in groundwater is indicative of strongly reducing conditions. Methane concentrations greater than 0.5 mg/L supports reductive dechlorination (Wiedemeier et al., 1999).
Chloride	Chloride is removed from CVOCs during reductive dechlorination and enters solution. A strong indicator of chlorinated solvent degradation is the increase in chloride concentrations of at least two times greater than background levels (Wiedemeier et al., 1999).
Oxidation-Reduction Potential	The ORP of groundwater is a measure of electron activity and is an indicator of the relative tendency of solutes to transfer electrons. ORP reactions in groundwater containing organic compounds (natural or anthropogenic) are usually biologically mediated, and therefore, influences the rates of biodegradation. Typically, redox potential below 50 millivolts (mV) enhances the potential for reductive dechlorination (Wiedemeier et al., 1999).
Alkalinity	Carbon dioxide (CO2) is produced during the biodegradation of native organic compounds. In solution carbon dioxide forms carbonic acid, thus increasing the alkalinity of the groundwater. Alkalinity is a measure of the ability of groundwater to buffer changes in pH. Increasing CO2 levels are indicative of bioremediation.
Dissolved Hydrogen	Dissolved hydrogen (H2) is continuously produced in anoxic groundwater systems by fermentative microorganisms that decompose natural and anthropogenic organic matter. The H2 is then consumed by respiratory microorganisms that use nitrate, ferric iron, sulfate, carbon dioxide, or CVOC as terminal electron acceptors. The microorganisms exhibit different efficiencies in utilizing H2. Nitrate reducers are highly efficient H2 utilizers, maintaining very low H2 concentrations. Ferric iron reducers are significantly less efficient, and thus maintain higher H2 concentrations, and sulfate reducers are even less efficient. Because each terminal electron-accepting process is associated with a characteristic H2 concentration, H2 concentrations can be indicators of predominant redox processes. Note: H2 was not analyzed during the pilot study.

2.0 Site History and Setting

2.1 MI Site History

The Defense Distribution Center (also referred to as the Memphis Depot) is a former military supply base located in the southwestern portion of Memphis, Tennessee. The Memphis Depot received, stored, and warehoused military and civilian goods from inception in 1942 until closure under the BRAC program in 1997. Activities at the MI included storing and shipping various materials (e.g., food, clothing, medical supplies) and industrial supplies (e.g., hazardous materials). Several commonly used hazardous materials were also used for facility maintenance. Hazardous materials that were used or stored at the Depot during its operational period include: flammables, solvents, paints, pesticides, herbicides, petroleum/oil/lubricants (POL), wood treating products, oxidizers, corrosives, and reactives.

Hazardous materials were released into the relatively highly oxygenated fluvial aquifer that underlies this facility. The contaminants present in groundwater today consist mainly of CVOCs, principally PCE and TCE, but also carbon tetrachloride and chloroform.

Memphis Depot, which is now known as the Memphis Depot Business Park, covers 642 acres of land and is separated into two distinct areas (Figure 2.1). The MI comprises 574 acres and Dunn Field, to the north of the MI, comprises the balance. Additional details on the site history of the MI can be located in the January 2000 *MI Remedial Investigation (RI).*

2.2 MI Record of Decision

The *MI RI* and *FSs* has been conducted and the final reports are part of the Administrative Record. The results are discussed in the January 2000 *Memphis Depot Main Installation Remedial Investigation Report*, the July 2000 *Memphis Depot Main Installation Groundwater Feasibility Study Report* and *Memphis Depot Main Installation Soil Feasibility Study Report*. The July 2000 *Memphis Depot Main Installation Proposed Plan* was presented to the public in August 2000 and the *Memphis Depot Main Installation Record of Decision* was completed and signed by DLA and TDEC in February 2001. EPA signed the *MI ROD* in September 2001. The July 2002 *Memphis Depot Main Installation Remedial Design Workplan* has been approved by EPA and TDEC.

The primary components of the selected remedy for groundwater on the MI are in part as follows:

> *Alternative GW3 uses injection of nutrients to enhance the natural biodegradation processes. The remedy will accelerate biodegradation in the most contaminated parts of the plume. Untreated parts of the plume will degrade under natural attenuation processes (as described in Alternative GW2, Land Use Controls with Long-Term Monitoring). In the absence of pilot test data, a conservative assumption was made that the nutrients will triple the biodegradation rate within the aquifer, and the duration of the remedial action was assumed*

to be 10 years. Therefore, enhanced bioremediation must also include land use controls and groundwater monitoring.

Preliminary design components will include the following:

- *Nutrient injection into the fluvial aquifer will be conducted via borings or wells. Treatment zones will be established in the most contaminated parts of the plume within the MI. Pilot tests will be required to determine injection volumes, spacing, and depth. Nutrient re-injection will occur at intervals determined by pilot tests and monitoring results.*

The final *MI RD*, of which the results of this pilot study are included, will be completed in 2004.

2.3 MI Hydrogeology

The fluvial aquifer beneath the Memphis Depot occurs under unconfined conditions in fluvial deposits at an average depth of 87 feet below ground surface (CH2M HILL, January 2000). Aquifer thickness in the fluvial deposits ranges from <1 foot in the northwest portion of the MI to as high as 57 feet in the west central portion of the MI. Groundwater flow in this aquifer is variable but is primarily southwest, south, and southeast. Figure 2.2 presents the most recent interpretation of the potentiometric surface underlying the MI.

The fluvial aquifer is typically underlain by a clay-rich unit that occurs beneath most of the MI. This upper clay of the Jackson Formation/Upper Claiborne Group does not appear to be present at the base of the fluvial deposits in the northwestern part of MI and in the southwestern part of Dunn Field (the northern half of the Memphis Depot). The MI RI concluded that clay-rich units (clay or clayey sand) occur in the Jackson Formation/Upper Claiborne Group at variable elevations, and also are highly variable in thickness. The Memphis aquifer is separated from the overlying fluvial aquifer by units of the Jackson Formation/Upper Claiborne Group. The Memphis aquifer is the source of water supply for the City of Memphis. Additional information is located in the January 2000 *MI RI* and the July 2000 *MI Groundwater FS*.

2.4 Nature and Extent of Contamination within the MI

The constituents of concern (COCs) in groundwater beneath the MI are PCE, TCE, carbon tetrachloride, and chloroform. Based on findings from the January 2000 *MI RI*, the July 2001 pre-design *Long-Term Operational Area (LTOA) Investigation*, and the March 2002 *MI Baseline Groundwater Investigation*, there are two major groundwater plumes under the MI (Figures 2.3 and 2.4). The two distinct VOC groundwater plumes were delineated in the southwestern and southeastern portions of the MI. These plumes appear to have different origins and, based on recent data, do not commingle. An apparent source for this groundwater contamination has not been revealed. The areas with the highest CVOC concentrations were selected for the two Study Areas. Refer to the March 2002 *MI Baseline Sampling Technical Memorandum* (Attachment I) and June 2002 *EBT Treatability Study Workplan* for additional information about the extent of contamination within the MI.

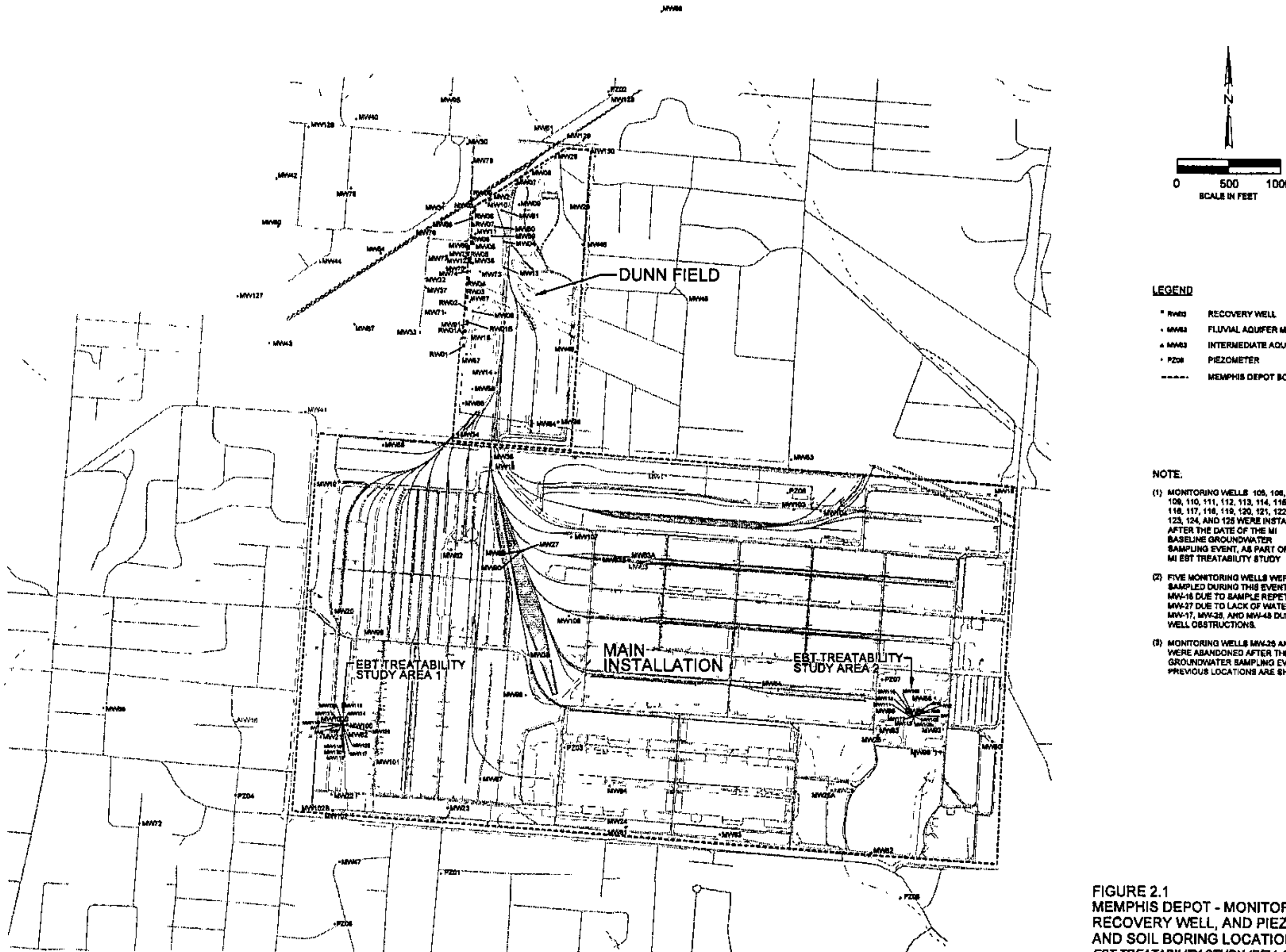
2.5 Preparation of the Study Areas 1 and 2

The locations of the Study Areas are shown in Figure 2.5. Study Area 1 is located in the southwestern corner of MI in a plume of PCE and TCE. Site preparation consisted of installation of 3 injection wells (IW-5, -6, and -7) and 13 monitoring wells (MW-21, -100B, -115, -116, -117, -118, -119, -120, -121, -122, -123, -124, and -125) (see Figure 2.6). Monitoring wells MW-21 and -100B were installed previously but were included as test wells during the pilot study. All wells are constructed of 2-inch ID polyvinyl chloride (PVC) casing and screens, with the injection wells using 0.04-inch slotted screens and the monitoring wells using 0.01-inch slotted screens. Water levels collected during the installation of the test wells (April/May 2002) indicate the thickness of the fluvial aquifer in Study Area 1 ranged from 15 to 20 feet. Monitoring wells were installed in clusters of two wells screened from either the top of the underlying clay confining layer to the center of the aquifer (MW-115, -118, -119, -121, -123, and -124) or from the center of the aquifer to the water table (MW-116, -117, -120, -122, and -125). All injection wells are screened from the top of the underlying clay confining layer to the middle of the aquifer.

Study Area 2 in the southeastern corner of MI is in a plume of PCE, TCE, carbon tetrachloride, and chloroform. Site preparation consisted of installation of 4 injection wells (IW-1, -2, -3, and -4) and 10 monitoring wells (MW-86, -88, -105, -106, -109, -110, -111, -112, -113, and -114) (see Figure 2.7). Wells MW-86 and -88 were installed previously but were included as test wells during the pilot study. The construction of the wells is similar to Study Area 1. Water levels collected in April/May 2002 indicated the thickness of the aquifer in Study Area 2 ranged from 1.5 to 10 feet. Therefore, all injection wells and monitoring wells at Study Area 2 are screened across the entire aquifer.

Well construction details for the Study Areas are provided in Attachment A.

794 103



LEGEND

- RECOVERY WELL
- FLUVIAL AQUIFER MONITORING WELL
- INTERMEDIATE AQUIFER MONITORING WELL
- PIEZOMETER
- MEMPHIS DEPOT BOUNDARY

NOTE:

(1) MONITORING WELLS 105, 106, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, AND 125 WERE INSTALLED AFTER THE DATE OF THE MI BASELINE GROUNDWATER SAMPLING EVENT, AS PART OF THE MI EBT TREATABILITY STUDY

(2) FIVE MONITORING WELLS WERE NOT SAMPLED DURING THIS EVENT, INCLUDING: MW-16 DUE TO SAMPLE REPETITION; MW-27 DUE TO LACK OF WATER; AND, MW-17, MW-25, AND MW-48 DUE TO WELL OBSTRUCTIONS.

(3) MONITORING WELLS MW-26 AND MW-63 WERE ABANDONED AFTER THE MI BASELINE GROUNDWATER SAMPLING EVENT. THE PREVIOUS LOCATIONS ARE SHOWN.

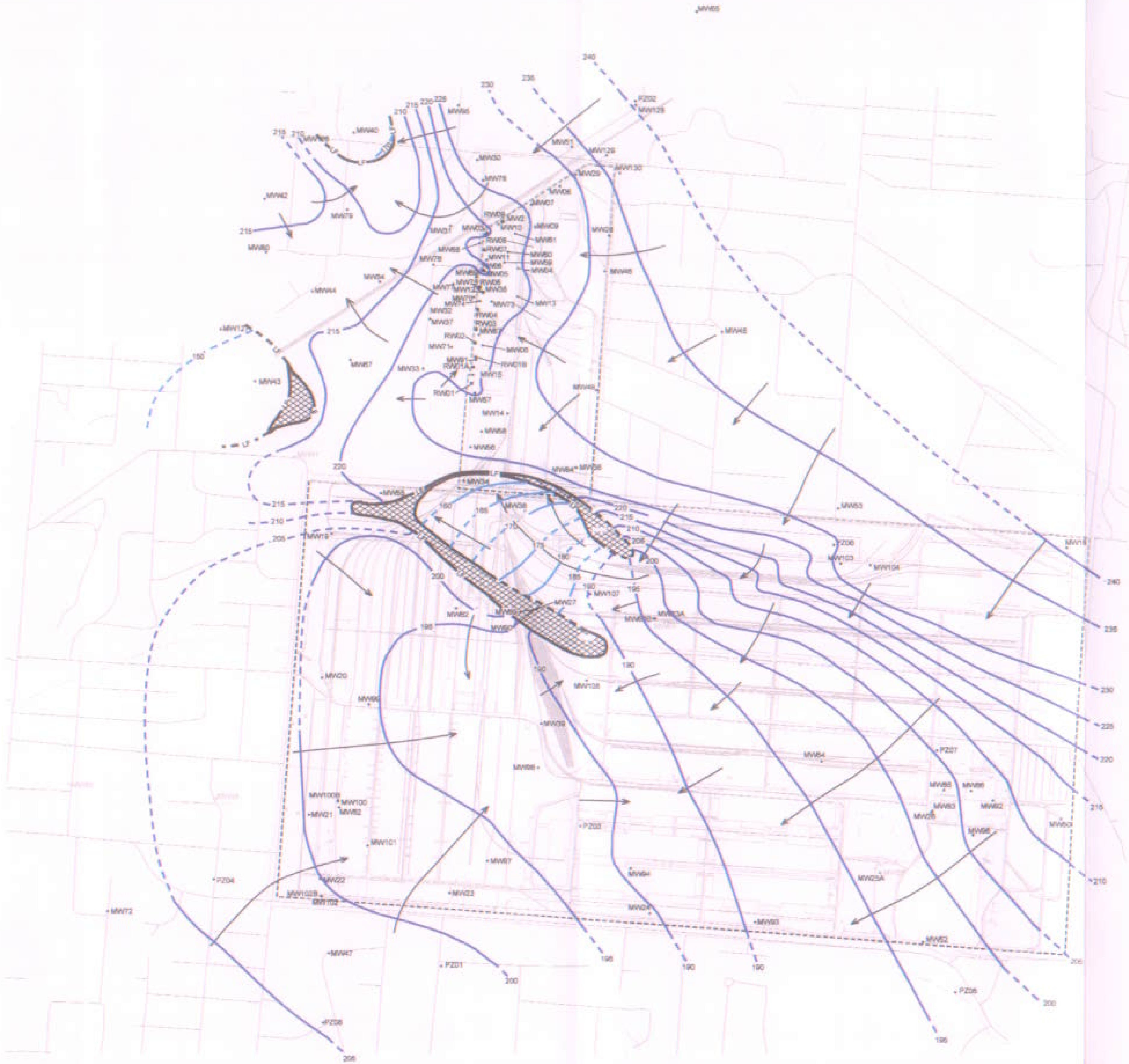
FIGURE 2.1
MEMPHIS DEPOT - MONITORING WELL, RECOVERY WELL, AND PIEZOMETE, AND SOIL BORING LOCATIONS
EBT TREATABILITY STUDY (REV. 0)
MEMPHIS DEPOT

CH2MHILL

ATLANTA/CAD1/PROJECTS/146071 DDMT/DUNNFIELD_RD 2003 06-OCT-2003 figure2.1.dgn

Well ID	Water Level Elevation (feet MSL)
MW03	221.66
MW04	224.84
MW06	224.00
MW07	226.71
MW08	228.86
MW09	226.43
MW10	223.18
MW11	222.66
MW12	224.11
MW13	224.81
MW14	227.22
MW15	224.49
MW16	241.44
MW18	175.20
MW19	200.92
MW20	199.30
MW21	199.95
MW22	200.03
MW23	198.57
MW24	190.62
MW26	203.03
MW27	DRY
MW28	233.86
MW29	233.52
MW30	226.59
MW31	218.34
MW32	221.41
MW33	224.18
MW34	156.66
MW35	222.34
MW36	151.53
MW37	151.12
MW38	169.97
MW39	191.89
MW40	171.05
MW41	217.86
MW42	217.70
MW43	152.75
MW44	212.97
MW45	236.86
MW46	232.06
MW47	203.89
MW49	230.56
MW50	212.21
MW51	234.62
MW52	197.25
MW53	232.67
MW54	213.60
MW55	221.05
MW56	225.61
MW57	224.97
MW58	226.29
MW59	223.92
MW60	224.15
MW61	224.73
MW62	199.71
MW63	197.46

Well ID	Water Level Elevation (feet MSL)
MW64	196.83
MW65	252.65
MW67	151.59
MW68	221.79
MW69	222.44
MW70	223.06
MW71	222.43
MW72	205.91
MW73	223.87
MW74	223.36
MW75	222.99
MW76	217.04
MW77	221.42
MW78	226.11
MW79	212.63
MW80	212.64
MW81	154.67
MW82	161.60
MW83	157.48
MW84	228.46
MW85	204.16
MW86	206.08
MW87	223.70
MW88	224.17
MW89	183.57
MW90	183.94
MW91	223.76
MW92	207.66
MW93	191.63
MW94	189.87
MW95	228.82
MW96	206.00
MW97	196.19
MW98	192.43
MW99	195.73
MW100	198.21
MW101	198.38
MW102	200.68
MW103	231.92
MW104	232.75
MW107	190.49
MW108	189.86
PZ01	202.74
PZ02	241.91
PZ03	191.47
PZ04	203.96
PZ05	196.54
PZ06	229.22
PZ07	205.74
PZ08	204.86
RW04	223.38
RW06	220.82
RW08	219.24
RW09	221.89
SB105	DRY
SB106	DRY



N

0 500 1000
SCALE IN FEET

LEGEND

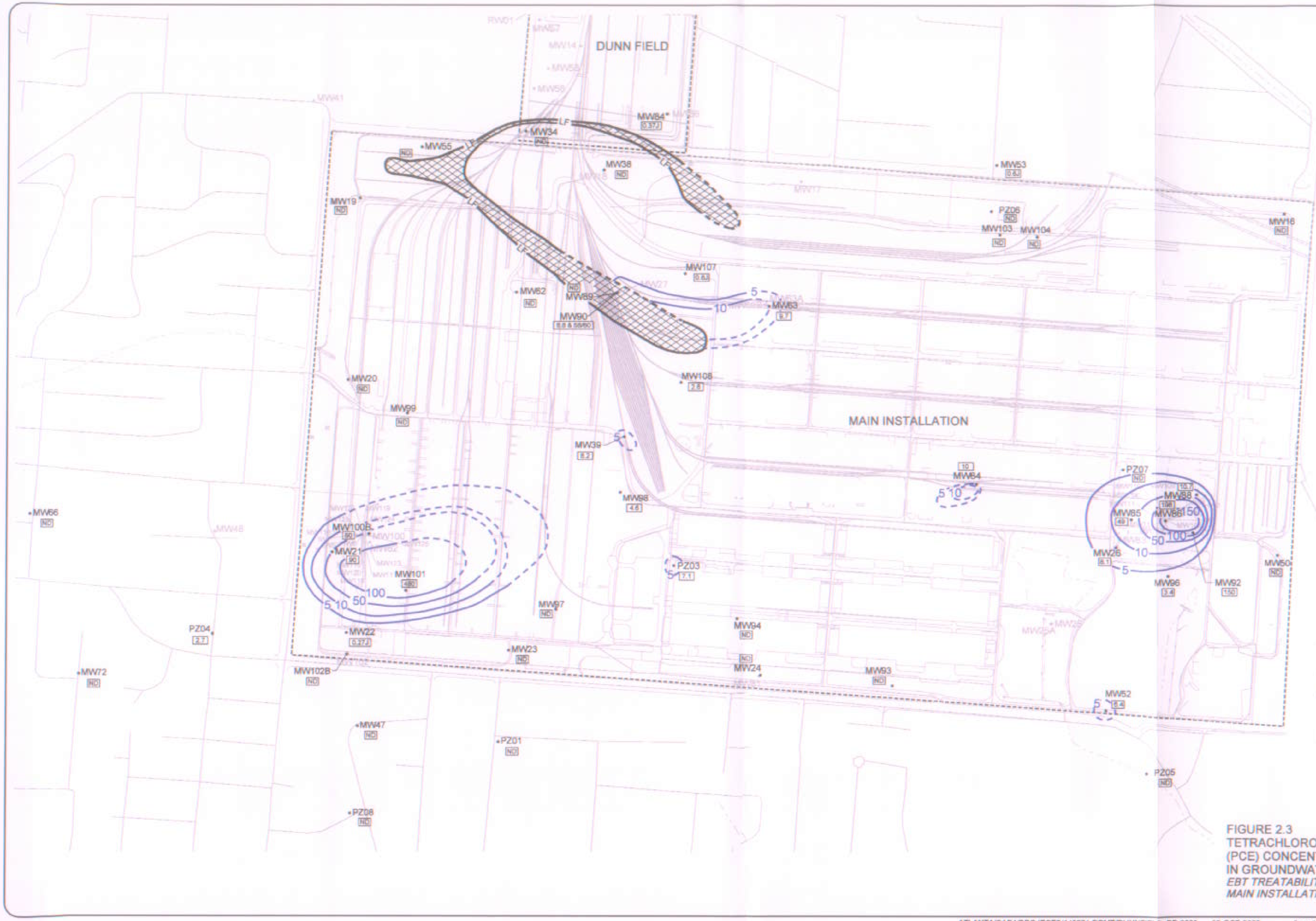
- DEPOT BOUNDARY
- BASE FEATURES
- 215 — WATER TABLE ELEVATION IN THE FLUVIAL AQUIFER (FEET MSL)
- 215 — — INFERRED WATER TABLE ELEVATION IN THE FLUVIAL AQUIFER FROM LIMITED DATA (FEET MSL)
- 185 — WATER TABLE ELEVATION IN THE INTERMEDIATE AQUIFER (FEET MSL)
- 185 — — INFERRED WATER TABLE ELEVATION IN THE INTERMEDIATE AQUIFER FROM LIMITED DATA (FEET MSL)
- —LF— LIMITED TO NO FLOW BOUNDARY (SEE NOTE)
- --LF-- INFERRED LIMITED TO NO FLOW BOUNDARY (SEE NOTE)
- • MW63 MONITORING WELL
- • PZ06 PIEZOMETER
- • SOIL BORING
- GROUNDWATER FLOW DIRECTION
- CLAY ELEVATION EXCEEDS GROUNDWATER ELEVATION

NOTES

- THE "LIMITED TO NO FLOW BOUNDARY" BOUNDS AN AREA WHERE THE WATER LEVEL IN THE FLUVIAL AQUIFER INTERSECTS THE CLAY DIRECTLY UNDERLYING THE FLUVIAL DEPOSITS, LEAVING FLUVIAL DEPOSITS UNSATURATED
- MW18, 34, 36, 37, 38, 40, 43, 81, 82, 83, 89, AND 90 ARE WELLS SCREENED WITHIN THE INTERMEDIATE AQUIFER.
- MW107 AND 108 ARE LOCATED IN A TRANSITION ZONE BETWEEN THE FLUVIAL AQUIFER AND THE INTERMEDIATE AQUIFER.
- MW18, 36, 37, 81, 82, 83, 89 AND 90 ARE NOT INCLUDED IN THIS POTENTIOMETRIC SURFACE MAP
- MW67 IS SCREENED IN THE MEMPHIS AQUIFER AND THEREFORE NOT INCLUDED IN THIS POTENTIOMETRIC SURFACE MAP.
- NO MEASUREABLE WATER LEVELS WERE RECORDED IN MW2, 5, 17, AND 27.
- DEPTH TO WATER MEASUREMENTS WERE NOT COLLECTED IN MW25, 48 AND 66.
- SB-105 AND 106 WERE MEASURED ON OCTOBER 16, 2001 AND OCTOBER 17, 2001, RESPECTIVELY
- EXCLUDES MW-68 GROUNDWATER ELEVATION DATA.

FIGURE 2.2
Potentiometric Surface
of the Fluvial Aquifer,
Including Intermediate Aquifer
EBT TREATABILITY STUDY (REV. 0)
MEMPHIS DEPOT

CH2MHILL



LEGEND

- 10 —— ISOCONCENTRATION LINE (IN ug/L)
- 10 – – INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- ---- DEPOT BOUNDARY
- —— BASE FEATURES
- • MW88 MONITORING WELL
- • PZ06 PIEZOMETER
- ND NOT DETECTED ABOVE LABORATORY REPORTING LIMIT
- 78 CONCENTRATIONS IN ug/L
- ug/L MICROGRAMS PER LITER
- J ESTIMATED CONCENTRATION
- CLAY ELEVATION EXCEEDS GROUNDWATER ELEVATION

NOTE:

(1) ALL UNITS ARE IN ug/L

(2) MONITORING WELLS 85,86,88,92,93,94,96,97, 98,99,100B,101,102B,103,104,107 AND 108 WERE SAMPLED IN NOVEMBER AND DECEMBER 2001. CONCENTRATIONS DETECTED IN THESE WELLS ARE AVERAGED PER WELL, EXCEPT MW-108

(3) ALL OTHER AVAILABLE MONITORING WELLS WERE SAMPLED DURING THE MARCH 2002 SAMPLING EVENT

(4) 5 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD.

(5) MONITORING WELLS MW-89 AND MW-90 WERE SAMPLED AT TWO DIFFERENT INTERVALS WITHIN EACH WELL. CONCENTRATIONS ARE INDICATED FOR BOTH INTERVALS.

(6) THE "LIMITED TO NO FLOW BOUNDARY" BOUNDS AN AREA WHERE THE WATER LEVEL IN THE FLUVIAL AQUIFER INTERSECTS THE CLAY DIRECTLY UNDERLYING THE FLUVIAL DEPOSITS, LEAVING FLUVIAL DEPOSITS UNSATURATED.

FIGURE 2.3
TETRACHLOROETHENE (PCE) CONCENTRATION IN GROUNDWATER-MARCH 2002
EBT TREATABILITY STUDY (REV. 0)
MAIN INSTALLATION, MEMPHIS DEPOT

CH2MHILL

ATLANTA/CAD1/PROJECTS/148071 DDMT/DUNNFIELD_RD 2003 06-OCT-2003 figure2.3.dgn

FIGURE 2.4
TRICHLOROETHENE (TCE) CONCENTRATION IN GROUNDWATER-MARCH 2002
EBT TREATABILITY STUDY (REV. 0)
MAIN INSTALLATION, MEMPHIS DEPOT

CH2MHILL

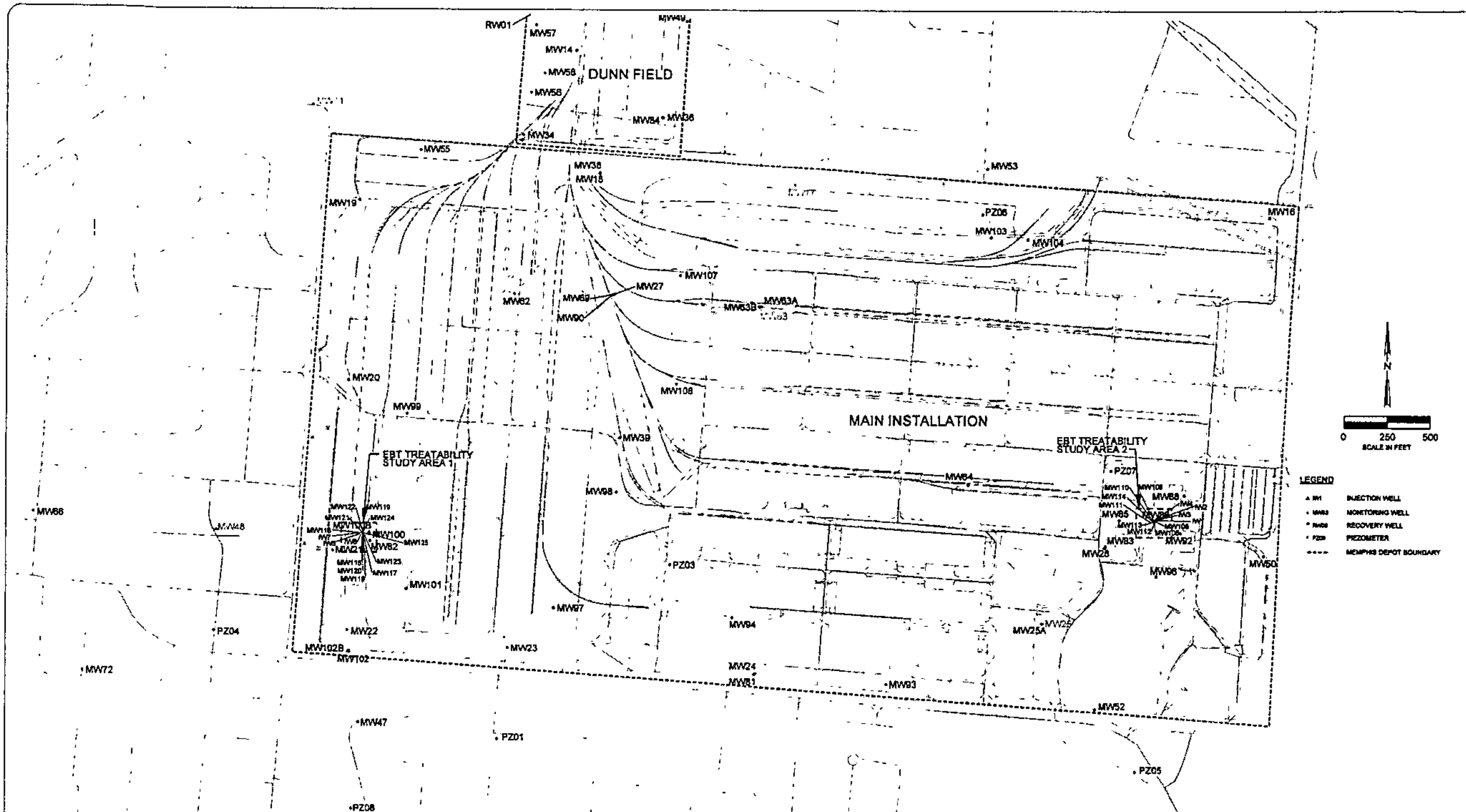


FIGURE 2 5
MEMPHIS DEPOT - MONITORING WELL RECOVERY WELL, AND PIEZOMETER LOCATIONS
EBT TREATABILITY STUDY (REV. 0)
MAIN INSTALLATION, MEMPHIS DEPOT

CH2MHILL

ATLANTA/CAD1/PROJECTS/148071 DDMT/DUNNFIELD_RD 2003 06-OCT-2003 figure2.5.dgn

794 108

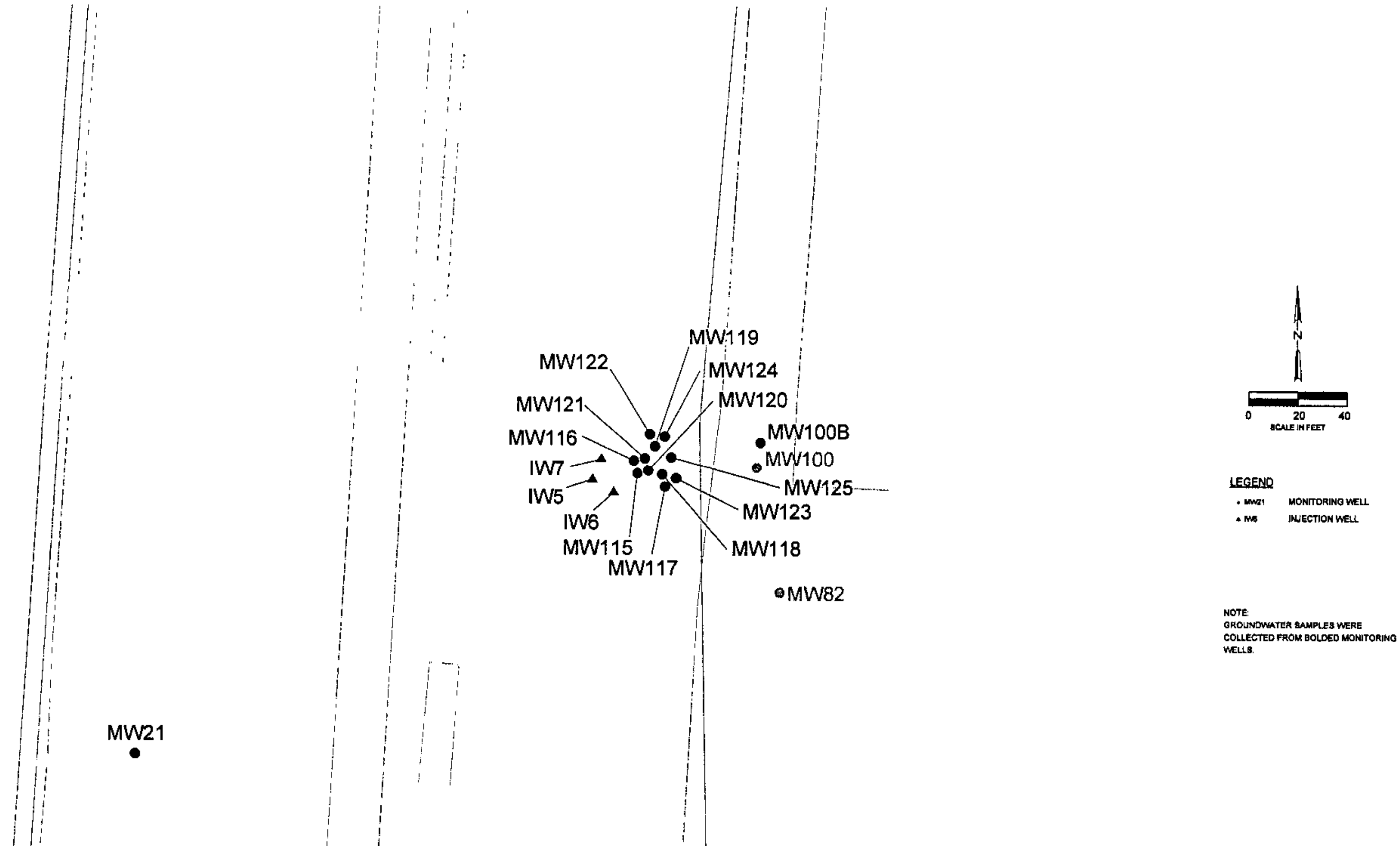


FIGURE 2.6
AREA 1 SITE MAP
EBT TREATABILITY STUDY (REV. 0)
MAIN INSTALLATION, MEMPHIS DEPOT

CH2MHILL

ATLANTA/CAD1/PROJECTS/148071 DDMT/DUNNFIELD_RD 2003 06-OCT-2003 figure2.6.dgn

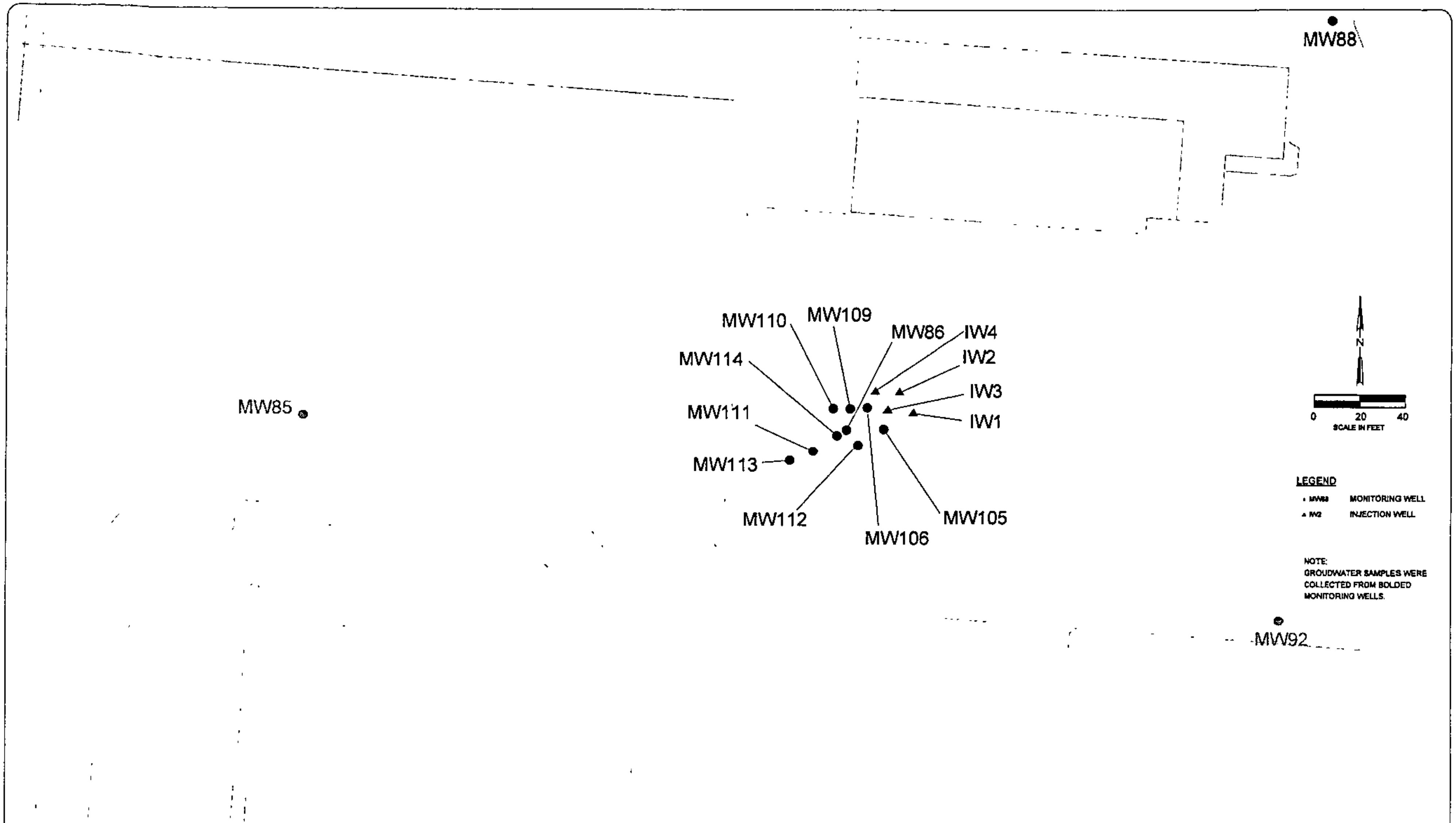


FIGURE 2.7
AREA 2 SITE MAP
EBT TREATABILITY STUDY (REV 0)
MAIN INSTALLATION, MEMPHIS DEPOT

CH2MHILL

ATLANTA/CAD1/PROJECTS/148071 DDMT/DUNNFIELD_RD 2003 08-OCT-2003 figure2.7.dgn

3.0 Activities and Methods

3.1 MI Groundwater Sampling Event

CH2M HILL completed groundwater sampling of all existing monitoring wells (except for those sampled as part of the 2001 LTOA investigation [November/December 2001]) and piezometers on- and off-site of the MI during March 2002. This work was completed to provide a comprehensive data set of groundwater conditions across the entire facility. Work was conducted according to procedures described in the sampling plan (CH2M HILL, November 2002).

3.2 Well Installation and Soil Sampling

Well were installed using rotasonic drilling techniques. Continuous sampling was conducted from land surface to termination depth. Soil boring logs are included in Attachment A. One soil sample for headspace field screening was collected from each boring at a frequency of one per every 5 feet from land surface to the groundwater interface. The headspace in each sample was analyzed using an organic vapor analyzer (OVA) equipped with a flame ionization detector (FID). Duplicate headspace samples were also collected and analyzed with an activated carbon filter to correct for methane concentrations.

One soil sample was collected every 20 feet from soil associated with the highest OVA-FID concentration greater than or equal to 20 parts per million (ppm) or wherever there appeared to be obvious staining in the soil profile. If no OVA-FID concentrations were greater than or equal to 20 ppm, no soil samples were collected for chemical analysis. A total of 3 soil samples from 26 borings was collected for VOC analyses via SW-846 Method 8260B and sent to Kemron Environmental Services in Marietta, Ohio. In addition, a portion of each sample was placed into corresponding pre-weighed 40-millilter vials preserved with sodium bisulfate and methanol, and sent to the laboratory for extraction using EPA SW-846 Method 5035. Soil samples were also collected for TOC analysis (SW-846 Method 9060) within the saturated portion of the borings.

Upon completion of a soil boring, a monitoring well or injection well was installed using 2-inch ID PVC casing and screen. Each well was completed as a flush-mount with an 8-inch ID manhole set within a 3-foot by 3-foot by 0.5-foot concrete pad. Following installation, all newly installed monitoring wells were developed in accordance with procedures presented in the *Environmental Investigations Standard Operating Procedures Quality Assurance Manual* (EISOPQAM), Section 6.8 (USEPA, November 2001).

At both study areas, the position of well screens within the fluvial aquifer for monitoring wells was critical. For Study Area 1, historical data indicated an aquifer thickness of approximately 35 feet; thus, screens were supposed to be set within the upper, middle, and lower zones of the aquifer. Because the thickness of the fluvial aquifer in Study Area 1 ranged from approximately 15 to 20 feet, wells were installed in clusters of 2 no more than

10 feet apart. The screen intervals for each well cluster were offset with a "deep" well screen of 10-foot length set at the top of the confining clay layer and a "shallow" well screen of 15-foot length set to intersect the water table. For Study Area 2, historical data indicated the fluvial aquifer thickness ranged from 13 to 19 feet. Drilling data indicated the thickness of the fluvial aquifer ranged from 1.5 to 10 feet. Therefore, clustered wells were not used and all monitoring wells were screened across the entire saturated zone in Study Area 2. Well construction details are summarized in Table 3.1.

Injection wells were installed in an off-set line perpendicular to the groundwater flow direction in each study area and upgradient of the monitoring wells. Because the fluvial aquifer was so thin in Study Area 2, typically the screen interval for each injection well was set across the entire thickness of the aquifer. Within Study Area 1, the well screens (10-foot length) were installed approximately 5 feet below the top of the water table to hinder possible "floating" of the vegetable oil emulsion.

3.3 Injection Activities

Injection activities began with mobilization and setup of equipment at each study area. Figure 3.1 shows typical injection equipment schematic. After site setup, potable water from the City of Memphis was treated through two activated-carbon canisters to remove synthetic organic compounds such as trihalomethanes and stored in an onsite mixing tank. The initial injection event for Study Areas 1 and 2 used 18,500-gallon mixing tanks equipped with three 5-horsepower mixers to prepare the injection solutions. Subsequent injection events at Study Area 2 used a 6,500-gallon tank equipped with a sump pump to mix the injection solution. In addition to the substrates, sodium bromide was added to aid in monitoring the movement of injection solutions.

Substrates were injected into the fluvial aquifer through the 2-inch-diameter injection wells. The fluids were pumped by a Watson Marlow SPX-40, high-pressure hose pump capable of producing 20 gallons per minute, down through the well casing via a 1-inch-diameter PVC pipe coupled with two rubber packers (Figure 3.1). The open end of the injection pipe was approximately 2 feet above the bottom of the well and within the screened interval. Once injection commenced, the substrate was forced into the well between the packer and the bottom of the screen. As pressure increased, the substrate was forced into the aquifer through the entire screened interval.

Gauges connected to the injection pipeline allowed the field crew to measure the injection pressure. An injection pressure of greater than 50 pounds per square inch (psi) caused the rubber packers to rise within the well casing. In one instance, this overpressuring caused injection fluid to exit the top of the well. Thereafter, no pumping pressures in excess of 40 psi were used. When 40 psi was registered, the pump was turned off and the pressure within the well was allowed to decrease. The pump was restarted after the pressure decreased below 20 psi. Injection activities continued until the prescribed quantity of substrate had been pumped into the aquifer. After the prescribed quantity had been injected, potable water that had been pretreated through carbon, was pumped into the well.

Only one injection event occurred within Study Area 1 (June 2002). Approximately 2,379 gallons of the soybean oil/lecithin mixture were combined with 9,213 gallons of water (total of 11,592 gallons), creating a solution with 20 percent oil, and was injected equally into each injection well at Area 1 (3,864 gallons each). Approximately 300 gallons of water were used to flush the oil from the injection wells and into the aquifer.

Four injections of sodium lactate occurred within Study Area 2, as shown in Table 3.2. The first injection event occurred in June 2002 and injected a solution of 15 percent sodium lactate (9,705 total gallons). Seven months after the first injection event, the BCT decided to inject lactate three more times in Study Area 2. All subsequent injection events used various volumes of a 40 percent sodium lactate solution. Injection volumes per well were calculated based on the estimated radius of influence, thickness of the fluvial aquifer, and estimated porosity. Table 3.3 summarizes the volumes of sodium lactate/potable water injected in each well.

TABLE 3.2
Treatability Study Area 2, Sodium Lactate Injections
Main Installation, Memphis Depot

	Injection Fluid					
Date of Injection	**60% Sodium Lactate Content (gallons)**	**Potable Water Content (gallons)**	**Final Solution (%)**	**40% Sodium Bromide Content (gallons)**	**Potable Water Flush (gallons)**	**Total Gallons Injected**
June 2002	2,423	7,047	15	15	220	9,705
February 2003	1,430	1,430	40	15	120	2,995
April/May 2003	1,620	1,620	40	15	120	3,375
May 2003	1,609	1,609	40	0	120	3,338

TABLE 3.3
Treatability Study Area 2, Volumes Injected
Main Installation, Memphis Depot

Date of Injection	IW-1 (gallons)	IW-2 (gallons)	IW-3 (gallons)	IW-4 (gallons)
June 2002	1,764	2,647	2,647	2,647
February 2003	348	949	749	949
April/May 2003	370	1,081	843	1,081
May 2003	372	1,066	834	1,066

3.4 Groundwater Sampling for Pilot Study

3.4.1 Baseline Sampling

Prior to the injection of the electron donors, all monitoring and injection wells within the Study Areas were sampled for VOCs and various geochemical parameters. Sampling was conducted according to procedures described in the pilot study workplan (CH2M HILL, May 2002). The samples were analyzed for the following parameters (method used in parentheses):

Laboratory

- VOCs (EPA 8260B)
- Dissolved Organic Carbon (EPA 9060)
- Volatile Fatty Acids (AM21G)
- Methane, Ethane, and Ethene (AM18)
- Alkalinity (Method 310.1)
- Nitrate/Nitrite (EPA 9056)
- Sulfate/Sulfide (EPA 9056/376.2)
- Chloride (EPA 9056)
- Dissolved Manganese (EPA 200.7)
- Arsenic (Method 6020)
- Selenium (Method 6020)
- Bromide (Method 9056)

Field

- Ferrous Iron (Hach Method 8146)
- Carbon Dioxide (Hach Method 8205)
- Sulfate Reducing Bacteria (Hach BART test)
- Iron Reducing Bacteria (Hach BART test)
- DO (Field Meter)
- pH (Field Meter)
- Temperature (Field Meter)
- Specific Conductivity (Field Meter)
- Oxidation-Reduction Potential (ORP) (Field Meter)
- Turbidity (Field Meter)

Monitoring wells were sampled for VOCs using polyethylene diffusion bag samplers (PDBs). PDB samplers allow for collection of discrete water samples and consist of polyethylene bags filled with distilled water. The VOC concentration gradient between the groundwater within the well screen and the water-filled bag results in diffusion of contaminants into the PDB. Construction, installation, and sampling of PDB samplers followed guidelines established in USGS (2001). One PDB was installed in each well and positioned in the center of the aquifer within the screened zone. PDB lengths of 1, 2, or 5 feet (a mixing ball was used in the 5 foot long bags) were used in each well depending on the thickness of the aquifer within the screened interval (Table 3.4).

The membrane in the PDB sampler is permeable only to VOCs. Therefore, a pump was used to collect samples for geochemical parameters. Pumped samples were obtained using low-flow techniques, as described in USEPA (November 2001) and Puls and Barcelona (1996). Before sampling, each well was purged using a bladder pump in order to minimize both agitation of the groundwater and sample turbidity. Field measurements of DO, ORP, turbidity, pH, temperature, and specific conductance were recorded periodically during purging. These parameters were measured using a YSI 6820 Multi-Parameter System coupled with an airtight flow-through cell. Purging continued until field measurements were stable according to the following standards: plus or minus 0.1 pH, plus or minus 10 millivolts ORP, plus or minus 3 percent for specific conductance, and plus or minus 10 percent for turbidity and DO. Field parameters were recorded in the field logbook.

All samples were preserved as required by USEPA (November 2001) and delivered to a laboratory within the appropriate holding period. Three different laboratories were used for analyses: Kemron Environmental Services in Marietta, Ohio (VOCs and geochemical parameters), Microseeps, Incorporated in Pittsburgh, Pennsylvania (methane, ethene, and ethane), and Microbial Insights, Incorporated in Rockford, Tennessee (Volatile Fatty Acids). Sample information is summarized in Attachment B.

In addition to normal groundwater samples, quality assurance/quality control (QA/QC) samples were collected . These samples included field duplicates, matrix spike/matrix spike duplicates, source blanks, equipment blanks, and trip blanks. The quantity of QA/QC samples collected at the site were in accordance with guidelines in Section 5.13.11 and 5.13.12 of the EISOPQAM (USEPA, November 2001). Data quality evaluation (DQE) reports are located in Attachment H.

3.4.2 Post-Injection Groundwater Sampling

Subsequent to the initial injections, groundwater samples were collected biweekly for the first month (July 2002) and then monthly thereafter. Sample events are summarized in Table 3.5.

TABLE 3.5
Summary of Sampling Events for Pilot Study
Main Installation, Memphis Depot

	Sample Event	
Study Area 1	July 2002	(Post-Injection #1)
	July 2002 (late)	(Post-Injection #2)
	September 2002	(Post-Injection #3)
	October 2002	(Post-Injection #4)
	November 2002	(Post-Injection #5)
	December 2002	(Post-Injection #6)
	January 2003	(Post-Injection #7)
	February 2003	(Post-Injection #8)
	March 2003	(Post-Injection #9)
	April 2003	(Post-Injection #10)
	May 2003	(Post-Injection #11)
	June 2003	(Post-Injection #12)
	July 2003	(Post-Injection #13)

TABLE 3.5
Summary of Sampling Events for Pilot Study
Main Installation, Memphis Depot

	Sample Event	
Study Area 2	July 2002	(Post-Injection #1)
	July 2002 (late)	(Post-Injection #2)
	September 2002	(Post-Injection #3)
	October 2002	(Post-Injection #4)
	November 2002	(Post-Injection #5)
	December 2002	(Post-Injection #6)
	January 2003	(Post-Injection #7)
	March 2003	(Post-Injection #9)
	April 2003	(Post-Injection #10)
	May 2003	(Post-Injection #11)
	June 2003	(Post-Injection #12)
	July 2003	(Post-Injection #13)
	August 2003	(Post-Injection #14)

All post-injection sampling events included the same laboratory and field analyses as the baseline groundwater sampling event with the exception of the following:

- Injection wells for both sites were sampled during the January 2003 sampling event only.
- Groundwater samples for arsenic and selenium analysis (Method 6020) were sampled during the January 2003 sampling event only.
- Groundwater samples for oil-in-water analysis (Method 1664) were collected from wells within Study Area 1 only.
- Groundwater samples were analyzed for iron-related and sulfate-reducing bacteria using field test kits. The test kits use BART™ biodetector technology and are sold by HACH Company, Loveland, Colorado (www.hach.com).
- Additional groundwater samples were collected during the August 2003 sampling event from MW-86, -100B, and –111 to be analyzed for bacteria that have been shown to cause complete transformation of CVOCs to ethene. Microbial Insights of Rockford, Tennessee (microbe@microbe.com) performed real time polymerase chain reaction (PCR) analyses on DNA extracted from the bacteria in the groundwater samples.

A list of the analyses performed on each sample is summarized in Attachment B.

3.4.3 Aquifer Tests

3.4.3.1 Slug Tests

Slug tests were performed to determine post-injection hydraulic characteristics of the fluvial aquifer. Slug tests were performed in wells IW-6, MW-21, MW-100B, MW-115, and MW-119 within Study Area 1 and IW-3, MW-26, MW-86, MW-88, and MW-111 within Study Area 2. All slug tests were conducted using an In-situ MiniTROLL® datalogger. Slug tests were analyzed using the Bouwer-Rice Method (Bouwer and Rice, 1976).

3.4.3.2 72-Hour Aquifer Test

A 72-hour aquifer test was performed in monitoring well MW-120 within Study Area 1 during the week of January 12 through 16, 2004. The aquifer test was conducted in three phases: pre-test, pumping test, and post-test activities. Well locations are located on Figure 2.5 and in more detail in Attachment D.

Pre-Test Activities

Pre-test activities were initiated to collect background information and perform a step-drawdown test for optimization of the 72-hour pumping test. Initial water level measurements were collected using a Solinst® water level meter in monitoring wells MW-20, -21, -22, -99, -100B, -101, -102B, MW-115 through - MW-125. Two MiniTROLL® dataloggers were set in wells MW-21 and MW-99, programmed, and started, for collection of background data prior to beginning the pumping test. Background data were collected in these two wells for the duration of the aquifer test activities.

A 2-inch Grundfos® pump was installed in well MW-120 followed by pressure transducers in monitoring wells MW-116, MW-118, and MW-120 through MW-125. Each pressure transducer was set approximately one foot from the bottom of each monitoring well and connected to a centrally located In-Situ Inc. Hermit® 3000 datalogger (Hermit). The Hermit was programmed for each pressure transducer and test type.

After the setup of equipment, a step-drawdown test was performed in the pumping well, MW-120. The test consisted of three successive steps using different flow rates with each step approximately 15 minutes in length. A maximum flow rate of 5 gallons per minute (gpm) was achieved with minimal drawdown from nearby wells. The size of the fittings and tubing connected to the pump was increased from 0.5 inch inner-diameter (ID) tubing to 0.75 inch ID tubing to increase flow rate. A brief test indicated the flow rate increased to approximately 7.7 gpm.

Water levels in all monitoring wells were allowed to return to baseline conditions and a baseline, background test was conducted using the dataloggers for approximately 13 hours.

Pumping Test

Prior to starting the 72-hour aquifer test, another round of water level measurements was collected in all test-associated monitoring wells. The Grundfos® pump was then activated and programmed to pump at its maximum capacity of approximately 7.7 gpm. Monitoring wells in the pump test network, which were not monitored by pressure transducers or MiniTROLL® dataloggers , were gauged by field personnel at the start of each hour for the duration of the 72-hour aquifer test. The pressure transducer within monitoring well MW-119 failed during the test, therefore, manual depth-to-water measurements were collected from this well.

Six groundwater samples were collected during the aquifer test for analysis of VOCs to define the quantity of VOCs removed from the aquifer. The samples were collected at the initial start of the test (0 hours) and then at hour 14, 28, 42, 56, and 72.

Post-Test Activities

Prior to ending the 72-hour aquifer test, the Hermit® was programmed to record the water level recovery event. The Grundfos® pump was then switched off and the recovery phase test started on the Hermit®. Water levels in the monitoring wells were found to have equilibrated within 1 hour. Therefore, the recovery test was stopped. A post-test round of water level measurements were collected from all test site monitoring wells.

All water removed from the aquifer was stored within one 21,000 gallon and one 17,000 gallon frac tank, which were rented from Wade Services Inc. in Ellisville, MS. A 6,000 gallon vaccuum truck was used to transfer purged groundwater from the MI to the Stiles Water Treatment Plant in western Memphis. Permission to dispose of the water at the treatment plant had been obtained earlier from Mr. Akil Al-Chokachi with the City of Memphis Utilities Department. Approximately, 31,000 gallons of water were transported to the treatment plant.

The 72-hour aquifer test was conducted in an unconfined aquifer and, therefore, the data were analyzed using the Neuman Method (Neuman, 1975), the Cooper-Jacob Time-Drawdown straight-line method (Cooper-Jacob 1946), the Cooper-Jacob Time-Drawdown straight-line method (Cooper-Jacob 1946), and the Theis and Jacob recovery method (Theis 1935). The latter three methods were performed using an unconfined aquifer correction. The Neuman method is based on the assumption of an unconfined aquifer; therefore, a correction was not required. All tests were performed using the AquiferTest® software, created by Waterloo Hydrogeologic, Inc (http://www.waterloohydrogeologic.com/software/aquifertest/aquifertest_ov.htm).

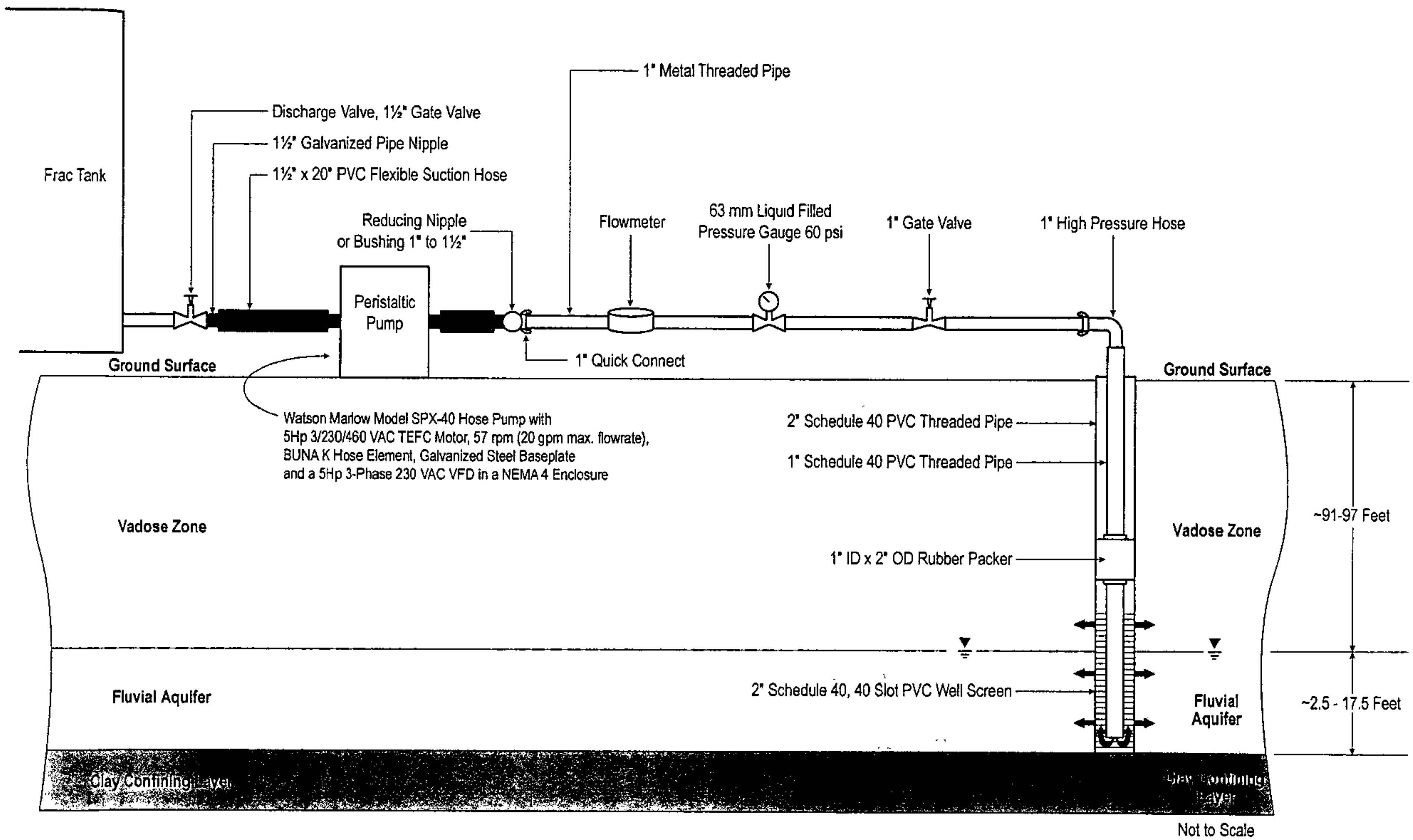


Figure 3.1
Injection Equipment Schematic
EBT Treatability Study (Rev. 0)
Main Installation, Memphis Depot

CH2MHILL
E052003014ATL/Memphis102.ai

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Table 3.1
Summary of Well Construction Details
Main Installation, Memphis Depot

Identification	Onsite or Offsite	Northing	Easting	Type	Ground Elevation (feet MSL)	TOC Elevation (feet MSL)	Well Finish	TOC vs. Ground Elevation (feet)	Length of Riser (feet)	Length of Screen (feet)	Top of Screen Elevation (feet MSL)	Bottom of Screen Elevation (feet MSL)	Depth of Boring (feet bgs)	Bottom of Boring Elevation (feet MSL)
Study Area 1														
IW-5	On	276585 57	800787.32	IW	292 43	292.12	FL	-0 31	103	10	189.1	179.1	130	162.4
IW-6	On	276580 44	800795.75	IW	292.27	291.94	FL	-0 33	99	10	192 9	182 9	115	177 3
IW-7	On	276593 69	800791.35	IW	292.26	292.00	FL	-0 26	99 5	10	192.5	182.5	115	177 3
MW-21	On	276473.39	800602.39	MW	295.21	295 00	FL	-0 21	92.1	15	202 9	187 9	109 5	185 7
MW-100B*	On	276600.65	800854.43	MW	291.60	291.06	FL	-0.54	107.5	20	183 6	163 6	132.5	159.1
MW-115	On	276588 14	800805.19	MW	291.92	291.67	FL	-0 25	89.5	10	202 2	192.2	182 2	109 8
MW-116	On	276593.32	800803 79	MW	291.92	291.67	FL	-0.25	98.5	10	193 2	183 2	173 2	118 8
MW-117	On	276582.76	800816 22	MW	291 57	291.38	FL	-0.19	99	10	192 4	182.4	172 4	119 2
MW-118	On	276587.70	800815.05	MW	291.58	291.17	FL	-0 41	90	10	201.2	191 2	181 2	110 4
MW-119	On	276599.18	800812 21	MW	291 74	291.50	FL	-0 24	90	10	201.5	191.5	181.5	110 2
MW-120	On	276589 30	800809 53	MW	291 72	291 56	FL	-0.16	98	10	193 6	183.6	173.6	118.2
MW-121	On	276594.20	800808.20	MW	291.83	291 63	FL	-0 20	92	10	199 6	189 6	179 6	112.2
MW-122	On	276604 07	800810 28	MW	291.76	291 62	FL	-0 14	98.5	10	193.1	183 1	173.1	118.6
MW-123	On	276586.10	800820 53	MW	291 36	291 09	FL	-0 27	90	15	201.1	186.1	171.1	120.3
MW-124	On	276603 07	800816 13	MW	291 58	291.39	FL	-0 19	90	15	201.4	186 4	171.4	120 2
MW-125	On	276594 62	800818 74	MW	291 47	291.35	FL	-0 12	94	15	197.4	182.4	167 4	124 1
Study Area 2														
IW-1	On	276705 58	806329.97	IW	304 29	304 03	FL	-0 26	89	10	215 0	205 0	107	197 3
IW-2	On	276714 75	806324 06	IW	304 49	304 21	FL	-0 28	90	15	214 2	199 2	105 5	199.0
IW-3	On	276706 78	806317 92	IW	304 47	304 21	FL	-0 26	88	15	216 2	201.2	105	199 5
IW-4	On	276705 54	806311 11	IW	304 66	304 53	FL	-0 13	90	15	214.5	199 5	115	189 7
MW-26	On	276508 16	805962 09	MW	303 89	303.69	FL	-0 20	97 6	10	206.1	196 1	115 0	188.9
MW-66	On	276696 65	806301 24	MW	304 89	304 35	FL	-0 54	97.5	20	206 9	186 9	118	186.9
MW-88	On	276879 05	806512.88	MW	305 47	305.15	FL	-0.32	82	15	223 2	208 2	102 5	203 0
MW-105	On	276698 44	806316 91	MW	304 42	304 25	FL	-0.17	89	10	215 3	205 3	105	199 4
MW-106	On	276708 07	806309 98	MW	304 65	304 44	FL	-0 21	97	10	207.4	197 4	110	194 7
MW-109	On	276707.71	806302 56	MW	304 75	304.57	FL	-0 18	93	10	211.6	201 6	105	199 8
MW-110	On	276707 51	806294.48	MW	304 82	304 64	FL	-0 18	92	10	212 6	202 6	105	199 8
MW-111	On	276690 51	806287.67	MW	304 87	304.66	FL	-0 21	89	10	215 7	205 7	105	199 9
MW-112	On	276690 57	806305.80	MW	304 77	304 57	FL	-0 20	90	10	214.6	204 6	105	199 8
MW-113	On	276685 34	806279 10	MW	304 92	304 81	FL	-0 11	96	10	208 8	198 8	115	189.9
MW-114	On	276695 47	806296 33	MW	304 84	304 66	FL	-0 18	92	10	212 7	202 7	105	199 8

MW = Monitoring Well
IW = Injection Well
MSL = Mean Sea Level
bgs = Below Ground Surface
TOC = Top of Casing

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Table 3.4
Sampling Details for Pilot Study Wells
Main Installation, Memphis Depot

#	Identification	Total Depth (feet BTOC)	Depth to Water 05/24/2002 (feet BTOC)	Length of Riser (feet)	Length of Screen (feet)	Depth to Bottom of Screen (feet BTOC)	Water Column Within Screened Interval (feet)	Groundwater Sample: VOCs: Sample Method	Length of Bag (feet)	Depth to Bottom of Bag (feet BTOC)	Length of Sump (feet)	Distance of Bottom of Bag Above Bottom of Well (feet)	Geochemical Parameters: Sample Method	Distance of Pump Above Bottom of Well (feet)
	AREA 1													
	Injection Wells													
1	IW-5	114.00	93.31	103	10	113	10.0	Diffusion Bag	5	110.5	1	3.0	Low Flow/Bladder Pump	6.0
2	IW-6	110.00	93.20	99	10	109	10.0	Diffusion Bag	5	106.5	1	3.0	Low Flow/Bladder Pump	6.0
3	IW-7	110.50	93.23	99.5	10	109.5	10.0	Diffusion Bag	5	107.0	1	3.0	Low Flow/Bladder Pump	6.0
	Monitoring wells													
1	MW-21	107.50	94.94	92.1	15	107.1	12.2	Diffusion Bag	5	103.5	0.5	3.5	Low Flow/Bladder Pump	6.6
2	MW-100B	127.50	92.61	107.5	20	127.5	20.0	Diffusion Bag	5	115.0	0.5	12.0	Low Flow/Bladder Pump	10.5
3	MW-115	100.50	92.98	89.5	10	99.5	6.5	Diffusion Bag	5	98.7	1	1.3	Low Flow/Bladder Pump	4.3
4	MW-116	109.50	92.97	98.5	10	108.5	10.0	Diffusion Bag	5	106.0	1	3.0	Low Flow/Bladder Pump	6.0
5	MW-117	110.00	92.74	99	10	109	10.0	Diffusion Bag	5	106.5	1	3.0	Low Flow/Bladder Pump	6.0
6	MW-118	101.00	92.52	90	10	100	7.5	Diffusion Bag	5	98.8	1	1.7	Low Flow/Bladder Pump	4.7
7	MW-119	101.00	92.83	90	10	100	7.2	Diffusion Bag	5	98.9	1	1.6	Low Flow/Bladder Pump	4.6
8	MW-120	109.00	92.86	98	10	108	10.0	Diffusion Bag	5	105.5	1	3.0	Low Flow/Bladder Pump	6.0
9	MW-121	103.00	92.95	92	10	102	9.1	Diffusion Bag	5	100.0	1	2.5	Low Flow/Bladder Pump	5.5
10	MW-122	109.50	92.97	98.5	10	108.5	10.0	Diffusion Bag	5	106.0	1	3.0	Low Flow/Bladder Pump	6.0
11	MW-123	106.00	92.47	90	15	105	12.5	Diffusion Bag	5	101.2	1	4.3	Low Flow/Bladder Pump	7.3
12	MW-124	106.00	92.74	90	15	105	12.3	Diffusion Bag	5	101.4	1	4.1	Low Flow/Bladder Pump	7.1
13	MW-125	110.00	92.72	94	15	109	15.0	Diffusion Bag	5	104.0	1	5.5	Low Flow/Bladder Pump	8.5
	AREA 2													
	Injection Wells													
1	IW-1	100.00	96.19	89	10	99	2.8	Diffusion Bag	2	98.6	1	0.9	Low Flow/Bladder Pump	2.4
2	IW-2	106.00	96.81	90	15	105	8.2	Diffusion Bag	5	103.4	1	2.1	Low Flow/Bladder Pump	5.1
3	IW-3	104.50	96.47	88	15	103.5	7.0	Diffusion Bag	2	101.0	1	3.0	Low Flow/Bladder Pump	4.5
4	IW-4	106.00	96.73	90	15	105	8.3	Diffusion Bag	5	103.4	1	2.1	Low Flow/Bladder Pump	5.1
	Monitoring wells													
1	MW-86	117.50	96.98	97.5	20	117.5	20.0	Diffusion Bag	5	105.0	0.5	12.0	Low Flow/Bladder Pump	12.0
2	MW-88	97.50	80.43	82	15	97	15.0	Diffusion Bag	5	92.0	0.5	5.0	Low Flow/Bladder Pump	8.0
3	MW-105	100.00	96.92	89	10	99	2.1	Diffusion Bag	1	98.5	1	1.0	Low Flow/Bladder Pump	2.0
4	MW-106	108.00	96.81	97	10	107	10.0	Diffusion Bag	6	104.5	1	3.0	Low Flow/Bladder Pump	6.0
5	MW-109	104.00	96.97	93	10	103	6.0	Diffusion Bag	2	101.0	1	2.5	Low Flow/Bladder Pump	4.0
6	MW-110	103.00	97.12	92	10	102	4.9	Diffusion Bag	2	100.6	1	1.9	Low Flow/Bladder Pump	3.4
7	MW-111	100.00	97.41	89	10	99	1.6	Diffusion Bag	1	98.7	1	0.8	Low Flow/Bladder Pump	1.8
8	MW-112	101.00	97.17	90	10	100	2.8	Diffusion Bag	2	99.6	1	0.9	Low Flow/Bladder Pump	2.4
9	MW-113	107.00	97.71	96	10	106	8.3	Diffusion Bag	6	104.4	1	2.1	Low Flow/Bladder Pump	5.1
10	MW-114	103.00	97.31	92	10	102	4.7	Diffusion Bag	2	100.7	1	1.8	Low Flow/Bladder Pump	3.3

IW = Injection Well
MW = Monitoring Well
BTOC = Below Top of Casing

4.0 Results

4.1 Hydrogeology

Based on soil boring logs generated from wells installed within each study area (Attachment A), the fluvial aquifer is primarily composed of gravelly sand in Study Area 1, and fine to medium sand and silty sand within Study Area 2. These aquifer materials are typical beneath the MI. Historic boring logs suggest the possibility of localized remnant stream channels filled with sand and gravel, and overbank deposits of sand, silt, and clay. These conditions will create zones within the fluvial aquifer of highly variable permeability. More description of the fluvial aquifer is provided in the MI RI report (CH2M HILL, January 2002).

The hydrogeological properties for each area are summarized in Table 4.1. Based on groundwater elevations, groundwater flow across Study Area 1 is southwest to northeast and at Study Area 2 the flow is northeast to southwest (Figures 4.1 and 4.2, respectively). The average depths to groundwater at Area 1 and Area 2 are 92.5 feet below ground surface (bgs) and 96.5 feet bgs, respectively. Water level measurements and aquifer thicknesses for both sites were consistent with the MI RI and LTOA findings and are summarized in Table C.1, Attachment C.

Slug test results indicate hydraulic conductivity (K) values range from 1.17 to 64.35 feet/day for Study Area 1 and 0.43 to 31.75 feet/day for Study Area 2 (Table 4.2). Previous slug test data generated for the *MI RI* from existing wells MW-21 (near Study Area 1) and MW-26 (near Study Area 2) indicated K values of 48.19 feet/day and 7.65 feet/day, respectively. Complete slug test data and interpretive graphs are presented in Attachment D.

The 72-hour aquifer test results indicate hydraulic conductivity of the fluvial aquifer at Study Area 1 range from 1.30 to 192.76 feet/day, with a geometric average of 39.12 feet/day; Transmissivity values range from 19.81 to 2930.23 feet^2/day, with a geometric average of 459.53 feet^2/day. In general, the Neuman method resulted in lower hydraulic conductivity and transmissivity values and the Theis and Jacob recovery method estimated higher values. The specific capacity calculated for the pumping well, MW-120, during the 72-hour pump test was 0.134 square feet per minute. Complete 72-hour aquifer test data and interpretive graphs are presented in Attachment D.

No response was observed in monitoring wells MW-21, MW-99, MW-100B, and MW-101 during the aquifer test; therefore data from these wells were not analyzed. Furthermore, usable data was not obtained from monitoring wells MW-116 and MW-118, possibly due to a faulty data probes.

Assuming an effective porosity of 30 percent, flow velocities across the study areas average 1.8 feet/day within Study Area 1 and 0.6 foot/day within Study Area 2 (Table 4.3).

TABLE 4.3
Study Areas 1 and 2, Estimated Groundwater Flow Velocities
Main Installation, Memphis Depot

Study Area	Hydraulic Conductivity (feet/day)	Assumed Porosity (%)	Gradient (feet/feet)	Groundwater Velocity (feet/day)
Area 1 (low range)	1.17	30	(MW-21 to -100B) 0.0056	0.022
Area 1 (high range)	192.76	30	(MW-21 to -100B) 0.0056	3.6
Area 2 (low range)	0.43	30	(MW-105 to -26) 0.011	0.016
Area 2 (high range)	31.75	30	(MW-105 to -26) 0.011	1.2

4.2 Summary of Chemical Results

Soil samples were collected during the drilling of soil borings to determine the native TOC and levels of VOCs. Twenty-nine soil samples were analyzed for TOC; only seven samples had concentrations above detection limits. Of those detected, concentrations ranged from 288 to 681 milligrams per kilogram (mg/kg). These relatively low TOC concentrations are the primary reason that natural biodegradation rates are low in the fluvial aquifer. TOC results are summarized in Table 4.4.

Soil samples were collected from borings IW-5 (82.5 feet bgs), MW-116 (52.5 feet bgs), and MW-120 (62.5 feet bgs) based on field screening protocol defined in the EBT Treatability Study workplan, and analyzed for VOCs. TCE was the only CVOC detected: TCE was measured in soil from IW-5, MW-120, and a duplicate of MW-120 at relatively low concentrations of 0.612 J micrograms per kilogram (µg/kg), 2.18 J µg/kg, and 2.43 J µg/kg, respectively.

The validated laboratory results for the groundwater samples collected during the pilot study are summarized in the following tables and attachments:

- Table 4.5 – Study Area 1 VOCs
- Table 4.6 – Study Area 1 Other Analytes
- Table 4.7 – Study Area 2 VOCs
- Table 4.8 – Study Area 2 Other Analytes
- Attachment G – Summary of Detected Analytes
- Attachment H – Data Quality Evaluation Reports

4.3 Radius of Influence During Injection Activities

The theoretical radius of influence can be calculated using the volume of injected fluid in each well. Assuming the injected volume fills a vertical cylinder within the aquifer centered around the injection well. The theoretical radius of influence of the vegetable oil emulsion in

Study Area 1 can be calculated by assuming a cylinder height equal to the length of the injection well screen and an aquifer porosity of 30 percent. The theoretical radius of influence of the lactate solution in Study Area 2 can be calculated by assuming a cylinder height of the thickness of the aquifer and an aquifer porosity of 30 percent. These calculations are presented in Table 4.9. The radius of influence at the time of injection can be estimated from water level changes observed in nearby monitoring wells (Table C.2, Attachment C). The changes in water levels are summarized in Table 4.10.

The post-injection radius of influence was estimated based on the detection of bromide tracer and dissolved organic carbon (DOC) in the monitoring wells. Baseline results from both study areas indicated undetectable levels of DOC and less than 0.6 mg/L of bromide within the fluvial aquifer (Tables 4.6 and 4.8). Two weeks after the injection of vegetable oil emulsion, bromide and DOC were detected in Study Area 1 monitoring wells approximately 27 feet downgradient of the closest injection well (Figure 4.3a). Therefore, the injection radius of influence is estimated to be between 27 and 63 feet. Two weeks after the first lactate injection, bromide and DOC were detected in Study Area 2 monitoring wells approximately 25 feet downgradient of the closest injection well (Figure 4.4a). Therefore, the injection radius of influence is estimated to be between 25 and 38 feet.

A comparison of these radii is summarized in Table 4.11.

TABLE 4.11
Summary of Estimates of injection Radius of Influence
Main Installation, Memphis Depot

Injection Well	Injection Date	Theoretical Radius (feet)	Water Level Effect in Nearby Well (feet from IW)	Bromide Tracer[1] (feet)	DOC[1] (feet)
Study Area 1					
IW-5	June 2002	20.2	10	27 to 63	27 to 63
IW-6	June 2002	20.2	10	27 to 63	27 to 63
IW-7	June 2002	20.2	10	27 to 63	27 to 63
Study Area 2					
IW-1	June 2002	25	Not Measured	25 to 38	25 to 38
IW-2	June 2002	17.6	10	25 to 38	25 to 38
IW-3	June 2002	20.5	10	25 to 38	25 to 38
IW-4	June 2002	18.2	11	25 to 38	25 to 38
IW-1	February 2003	10.2	Not Measured	25 to 38	38 to 48.5
IW-2	February 2003	10.3	11	25 to 38	38 to 48.5
IW-3	February 2003	10.5	11	25 to 38	38 to 48.5
IW-4	February 2003	10.6	None	25 to 38	38 to 48.5
IW-1	April 2003	11.2	Not Measured	>48.5	>48.5
IW-2	April 2003	11.2	11	>48.5	>48.5
IW-3	April 2003	11.5	10	>48.5	>48.5
IW-4	April 2003	11.5	11	>48.5	>48.5
IW-1	May 2003	11.1	Not Measured	>48.5	>48.5
IW-2	May 2003	11.1	11	>48.5	>48.5
IW-3	May 2003	11.3	17	>48.5	>48.5
IW-4	May 2003	11.4	None	>48.5	>48.5

1) Distance measured from IW-3 (Area 2) or IW-6 (Area 1) to the furthermost downgradient detection and assumed for all injection wells. Based on groundwater samples collected after the injection events.

4.4 Transport of Electron Donors

4.4.1 Study Area 1

The vegetable oil emulsion was injected into the lower part of the fluvial aquifer in late June 2002. Levels of DOC and bromide indicate breakthrough within two weeks of injection, but the effects of the emulsion were limited in the wells screened in the upper part of the fluvial aquifer (Figure 4.5a). The effects of the emulsion were much more pronounced in the wells screened in the lower part of the fluvial aquifer (Figure 4.5b). As indicated by comparison of Figures 4.3a, b, and c, the emulsion eventually reached at least 63 feet downgradient of the closest injection well. The emulsion affected both bromide and DOC levels in MW-100B approximately one month after injection (Figure 4.5b). These results are consistent with injection of the emulsion to the area between MW-125 and -100B, with groundwater transport during the month between the injection and the late July sampling event. Using average flow velocities within Study Area 1, the bromide should have completely disappeared in the 13 months following the injection. The distribution of bromide over time (Figures 4.3a and c) suggests some bromide is trapped within the emulsion and not dispersed by groundwater flow.

4.4.2 Study Area 2

The initial lactate injection occurred late June 2002. As indicated in Figures 4.4a and 4.6a, the injection pushed the electron donor approximately 30 feet from the nearest injection well. As indicated in Figure 4.6b, several downgradient wells were not affected by the initial lactate injection, and were only moderately affected by subsequent injections. These observations suggest preferential flow paths within Study Area 2 (see discussion below). One month before the second lactate injection, the bromide levels within the injection zone had depleted (Figure 4.4b) due to groundwater transport. Levels of lactate were also depleted, most likely due to microbial utilization (see discussion below). The injections in 2003 were able to distribute lactate and bromide to all of the wells in the study area (Figures 4.4c, d, and e); however, the distribution appears to be highly irregular.

4.5 Preferential Pathways Within the Aquifer

The fluvial aquifer contains remnant stream channels filled with sand and gravel, and overbank deposits of sand, silt, and clay (CH2M HILL, January 2000). These various lithologies create zones within the aquifer of highly variable permeability. Zones of high permeability are preferential pathways for migration of injected substrates.

4.5.1 Study Area 1

Figures 4.3a, b, and c suggest that preferential pathways occur within the fluvial aquifer. Two weeks after the injection, concentrations of DOC within the southern portion of the test area were 2 to 3 orders of magnitude greater than concentrations in the northern portion. Levels of bromide in the southern part were an order of magnitude higher. The DOC and bromide plumes along the northern boundary also bend around MW-119 suggesting a localized low permeability zone. After seven months, the southern portion of the DOC and bromide plumes had extended further downgradient to MW-100B while a larger area in the vicinity of MW-119 and MW-121 had no detectable concentrations. By the end of month 13, the entire study area had detectable concentrations of DOC with the southern portion still containing the higher concentrations.

Comparison of the Figures 4.5a and b suggests that injecting an emulsion had the desired effect of not allowing the vegetable oil to "float" to the top of the aquifer. The highest levels of DOC in the shallow monitoring wells was only about 20 percent of the maximum levels measured in the deeper monitoring wells. In contrast, the bromide levels in the shallow wells reached about 50 percent of the maximum levels measured in the deeper wells.

4.5.2 Study Area 2

Figures 4.4a through e indicate preferential pathways may occur in Study Area 2. The initial and second injections of lactate bypassed wells MW-110 and -113. Levels of DOC and bromide were consistently higher in the southern wells compared to the northern wells. These results could also be produced by the groundwater flow direction being more toward the south. However, the lack of detectable bromide or DOC in MW-110 strongly suggests a localized low permeability zone, because this well is only 17 feet from the nearest injection well (IW-4). Similarly the area aquifer near MW-106 must have lower permeability than at MW-109 or MW-105. MW-106 and MW-105 are approximately the same distance from IW-3 yet MW-105 showed an order of magnitude more DOC after the initial injection. This pattern was repeated by subsequent injections.

4.6 Electron Donor Depletion

4.6.1 Study Area 1

Figures 4.5a and b indicate DOC is sustained for months following the injection oil emulsion. As indicated in Table 4.6, wells MW-117, -120, and -123 showed measurable levels of oil and grease 1 year. The rate of depletion of DOC in MW-117 suggests that the vegetable oil emulsion could last for several years (Figure 4.5b).

4.6.2 Study Area 2

Figure 4.6a indicates rapid utilization of the lactate within the study area. The data for well MW-105 in Table 4.8 show DOC levels declining rapidly in the first two months after injection, but are sustained at low levels for a period of at least seven months. Much of the lactate was apparently converted to methane, as indicated by the data in Table 4.7. The rate of DOC depletion in MW-105 suggests the lactate would not persist more than one year.

4.7 Effectiveness of Electron Donor Addition

4.7.1 General Geochemical Conditions

The most important factor influencing enhanced bioremediation is the aquifer geochemical conditions. The EPA has suggested a list of geochemical parameters to establish conditions favorable to enhanced bioremediation (USEPA, 1998). The following sections discuss the geochemical parameters and their significance to enhanced bioremediation. The sections also include an analysis of the changes in these geochemical parameters observed during the pilot study. Geochemical data are summarized in Tables 4.6 and 4.8. Plots of geochemical parameters over the period of the pilot study are provided in Figures 4.7, 4.8, 4.9, and 4.10. The wells shown in Figures 4.9 and 4.10 were selected to demonstrate the effects of the electron donor injections. Graphs of geochemical data for all study area wells are provided in Attachment E.

4.7.1.1 Dissolved Oxygen (DO)

Reductive dechlorination occurs under anaerobic conditions; therefore, DO must be depleted in groundwater before reduction of CVOCs will occur. Anaerobic bacteria generally cannot function at DO concentrations greater than 0.5 milligram per liter (mg/L) and thus reductive dechlorination will not occur (USEPA, 1998).

Study Area 1

Baseline DO concentrations ranged from 1.9 to 5.4 mg/L (Table 4.6). This is indicative of an oxic aquifer. Following the vegetable oil injection, DO concentrations in the monitoring wells screened in the lower portion of the aquifer generally decreased to < 0.5 mg/L (Figure 4.9). These levels are conducive to reductive dechlorination. In contrast, the DO concentrations in the upper part of the aquifer remained elevated thereby inhibiting reductive dechlorination (Figure 4.7). The differences in DO between the lower and upper wells are summarized below.

Lower Wells					*Upper Wells*				
Well	Distance from Nearest Injection Point	DO (mg/L) Min	DO (mg/L) Max	DO (mg/L) Average	Well	Distance from Nearest Injection Point	DO (mg/L) Min	DO (mg/L) Max	DO (mg/L) Average
MW-21[1]	--	2.4	7.6	5.3	MW-21[1]	--	2.4	7.6	5.3
MW-116	12 ft	0.3	4.3	1.5	MW-115	12 ft	0.1	5.5	3.6
MW-120	15 ft	0.0	2.8	0.7	MW-121	16 ft	0.3	5.4	2.9
MW-117	20 ft	0.2	2.4	0.9	MW-118	20 ft	0.3	7.4	3.3
MW-122	22 ft	0.3	4.0	1.0	MW-123	25 ft	0.1	3.6	0.8
MW-125	26 ft	0.3	4.2	1.2	MW-119	16 ft	1.7	9.4	5.5
MW-100B	63 ft	0.3	4.9	1.0	MW-124	26 ft	0.3	3.1	2.1

1) MW-21 is the background monitoring well.

MW-123 was the only upper well that had, on average, low DO concentrations that might be conducive to reductive dechlorination. This is likely attributable to the movement of oxygen depleted groundwater from upgradient wells MW-120 and MW–117.

Study Area 2

During the first seven months of the pilot study, background (MW-88) DO concentrations ranged from 3 to 5 mg/L (Table 4.8). These concentrations are indicative of an oxic aquifer. Immediately following the lactate injection, DO concentrations in affected wells decreased to below 1 mg/L (Figure 4.10). DO levels in these wells remained very low throughout the period of the pilot study. As indicated by comparison of Figures 4.4 and 4.8, wells not affected by the lactate injection sustained background DO levels.

4.7.1.2 Oxidation-Reduction Potential

Oxidation-reduction potential (ORP) is an indicator of electron activity in groundwater. Biological processes generally occur within a prescribed ORP range (USEPA, 1998). As microbial activity depletes available electron acceptors, the ORP decreases. An ORP of less than 50 millivolts (mV) indicates conditions conducive to reductive dechlorination. ORP levels greater than 50 mV indicate groundwater conditions that will hinder reductive dechlorination; ORP levels below -100 mV are ideal for reductive dechlorination.

Study Area 1

Figure 4.11 shows ORP levels within the study area during the months after the injection of emulsion. Comparison of Figures 4.3 and 4.9 shows that ORP in wells directly affected by the injection (MW-117) is marginally below the level conducive to reductive dechlorination. Other wells that affected over time by the injection (MW-100B and MW-122) show similar marginally reducing conditions. Furthermore, ORP levels in the upper and lower part of the fluvial aquifer were not significantly affected by the oil injection. The differences between the lower and upper wells are summarized below.

Lower Wells					*Upper Wells*				
Well	Distance from Nearest Injection Point	ORP (mV) Min	Max	Average	Well	Distance from Nearest Injection Point	ORP (mV) Min	Max	Average
MW-21	--	19	516	240	MW-21	--	19	516	240
MW-116	12 ft	-42	544	123	MW-115	12 ft	-67	197	35
MW-120	15 ft	-114	225	-22	MW-121	16 ft	11	241	107
MW-117	20 ft	-71	311	77	MW-118	20 ft	-89	661	92
MW-122	22 ft	-94	179	8	MW-123	25 ft	-129	142	-27
MW-125	26 ft	-117	284	18	MW-119	16 ft	-3	433	194
MW-100B	63 ft	-95	353	35	MW-124	26 ft	-50	348	71

These facts suggest that the oil emulsion is not readily available to the microbial community as an electron donor.

Study Area 2

Figure 4.12 shows the ORP levels across the study area during the pilot test. Figure 4.10 shows ORP levels in selected monitoring wells affected by the lactate injection. As indicated in the figure, ORP levels dropped dramatically immediately after the injection. ORP levels below –400 mV suggest massive generation of hydrogen via lactate fermentation. These conditions are highly favorable for reductive dechlorination. However, the ORP change is not sustained; ORP levels increased within three months of the initial injection. This is likely due to decrease in the amount of hydrogen generation as the lactate levels decline.

4.7.1.3 Nitrate

Nitrate concentrations greater than 1.0 mg/L can inhibit natural reductive dechlorination, because the microorganisms prefer nitrate to CVOCs as an electron acceptor. However, nitrate can also facilitate the anaerobic oxidation of lesser chlorinated compounds such as cis-1,2-DCE and VC. This process is usually more prevalent at the fringes of CVOC plumes.

Study Area 1

Nitrate concentrations measured during the baseline sampling event ranged from below detection limits to 5.1 mg/L (Table 4.6). After the vegetable oil injection, nitrate concentrations dropped significantly in all downgradient wells (Figure 4.9), indicating denitrification was occurring. As indicated in Figure 4.8, some wells showed no change in nitrate levels. Nitrate concentrations remained low (<1 mg/L) in monitoring wells affected by the vegetable oil, where as nitrate concentrations returned to pre-injection levels in unaffected wells within three months.

Study Area 2

Nitrate concentrations measured during the baseline sampling event ranged from below detection limits to 1 mg/L (Table 4.8). The low initial levels in this study area make it difficult to discern any significant impact of the lactate injections.

4.7.1.4 Dissolved Organic Carbon

DOC concentrations in the aquifer are generally used to assess the amount and distribution of electron donors that microorganisms require to degrade CVOCs. The purpose of the pilot study was to stimulate reductive dechlorination by adding large amounts of DOC. The discussion in Sections 4.3, 4.4, and 4.5 present the results of increasing DOC by injections of electron donors.

4.7.1.5 Iron and Manganese

Ferrous iron (Fe[II]) is produced from the reduction of ferric iron (Fe[III]), a common constituent of soil and rock. Although less abundant than iron, manganese is also common in soil and rock: manganese (II) (Mn[II]) is produced from the reduction of Mn[IV]. Measurable levels of either of these cations in groundwater indicate a reducing environment favorable for reductive dechlorination. Reduction of Fe(III) and Mn (IV) typically occurs during anaerobic degradation of natural or anthropogenic organic carbon, but may also occur during anaerobic oxidation of VC. Fe(II) concentrations above 1 mg/L often indicate anaerobic conditions in the aquifer (Wiedemeier et al., 1999).

Study Area 1

Baseline concentrations of both Fe(II) and Mn(II) were below 1 mg/L in all monitoring wells (Table 4.6). After the vegetable oil injection, Fe(II) and Mn(II) concentrations generally increased in all affected wells. In some wells, Fe(II) levels increased to above 10 mg/L (Figure 4.9). Increases in Mn(II) were not as dramatic. As discussed above, the lower part of the fluvial was the most affected by the injection and lower ORP conditions were created. Both Fe(II) and Mn(II) levels were somewhat higher in the lower wells (Figure 4.7). The table below compares Fe(II) levels in lower and upper wells.

Lower Wells				Upper Wells			
	Distance from Nearest Injection Point	Fe(II) mg/L			Distance from Nearest Injection Point	Fe(II) mg/L	
Well		Min	Max	Well		Min	Max
MW-21	--	0.02	0.19	MW-21	--	0.02	0.19
MW-116	12 ft	0.00	3.00	MW-115	12 ft	0.60	5.90
MW-120	15 ft	0.05	10.40	MW-121	16 ft	0.24	2.71
MW-117	20 ft	0.14	5.26	MW-118	20 ft	0.29	4.66
MW-122	22 ft	0.08	10.08	MW-123	25 ft	0.25	5.28
MW-125	26 ft	0.00	4.64	MW-119	16 ft	0.00	0.21
MW-100B	63 ft	0.01	11.68	MW-124	26 ft	0.07	5.86

Study Area 2

Baseline Fe(II) and Mn(II) concentrations were below 1 mg/L and 1.5 mg/L, respectively, in all monitoring wells (Table 4.8). After the lactate injection, Fe(II) and Mn(II) concentrations increased in all affected wells following the initial injection and in some cases exceeded 20 mg/L (Figure 4.10). In some wells, the Mn(II) level exceeded the Fe(II) level, possibly due to Mn-rich sediments locally in the aquifer or reprecipitation of the Fe(II). Fe(II) and Mn(II) levels generally remained elevated in affected wells throughout the duration of the pilot study.

4.7.1.6 Sulfate and Sulfide

Sulfate reduction produces sulfide and is indicative of conditions conducive to reductive dechlorination. Sulfide is often difficult to detect in groundwater because of its tendency to precipitate with iron and other metals. Sulfate concentrations greater than 20 mg/L can reduce the potential for reductive dechlorination because the sulfate is preferred by microorganisms as an electron acceptor.

Study Area 1

Baseline sulfate concentrations ranged from about 6 to 20 mg/L (Table 4.6). During the pilot test, groundwater inflow replenished sulfate within the treated area. As long as the effects of the emulsion created reducing conditions at the wells, sulfate reduction kept the sulfate levels low in the monitoring wells (Figure 4.9). As indicated in Figure 4.7, wells unaffected by the injection (MW-121 and MW-119) showed little or no loss of sulfate during the pilot study. As expected sulfide concentrations increased in monitoring wells affected by the injection (Table 4.6). Because of the reactivity of sulfide with metals, sulfide levels were low to non-detect in all wells.

Study Area 2

Baseline sulfate concentrations ranged from about 6 to 14 mg/L (Table 4.8). Although groundwater inflow replenished sulfate within the treated area, fermentation of the lactate sustained reducing conditions and sulfate reduction kept sulfate levels low(Figure 4.8). As indicated in Figure 4.10, sulfate levels in wells strongly affected by the injection showed nearly zero levels of sulfate. As expected sulfide concentrations increased to detectable levels in monitoring wells affected by the injection (Table 4.8). Because of the reactivity of sulfide with metals, sulfide levels were low to non-detect in all wells.

4.7.1.7 Methane

During methanogenesis, carbon dioxide is used as an electron acceptor and is converted to methane. The presence of methane in the aquifer indicates strongly reducing conditions (commonly ORP is less than -250 mV). Methane-producing organisms are much better at using hydrogen than organisms causing dechlorination. Therefore, much more of the hydrogen produced from fermentation of electron donors is used to generate methane than for reductive dechlorination. In one study, Ballapragada and others (1997) found that 95 percent of the hydrogen produced by fermentation was used for methane production. However, methane can migrate in groundwater into aerobic environments and facilitate co-metabolic degradation of chlorinated solvents.

Study Area 1

Except for wells IW-5, IW-6, and MW-121, baseline methane concentrations were below laboratory detection limits in all monitoring wells (Table 4.5). Methane concentrations began increasing within 1 month after the injection in affected wells. As with other geochemical parameters, the greatest increases in methane levels were noted in the lower part of the fluvial aquifer, which received most of the electron donor. The differences between the lower and upper wells are summarized below.

Lower Wells				*Upper Wells*			
	Distance from Nearest Injection Point	Methane (mg/L)			Distance from Nearest Injection Point	Methane (mg/L)	
Well		Min	Max	Well		Min	Max
MW-21	--	ND	0.034	MW-21	--	ND	0.034
MW-116	12 ft	ND	3.6	MW-115	12 ft	ND	5.4
MW-120	15 ft	ND	18	MW-121	16 ft	ND	1.6
MW-117	20 ft	ND	19	MW-118	20 ft	ND	7.1
MW-122	22 ft	ND	7.2	MW-123	25 ft	ND	21
MW-125	26 ft	ND	15	MW-119	16 ft	ND	0.092
MW-100B	63 ft	ND	26	MW-124	26 ft	ND	1.2

Study Area 2

Except for wells MW-105 and MW-109, baseline methane concentrations were below laboratory detection limits in all monitoring wells (Table 4.7). After a slight decline in methane concentrations, levels began to increase dramatically after the initial lactate injection (Figure 4.8). By the end of the pilot study, methane levels exceeded 1 mg/L in the wells that received the most electron donor.

4.7.1.8 Alkalinity and Carbon Dioxide

Alkalinity is defined as the capacity of an aqueous solution to neutralize acid (Hem 1970). The principal contributors to alkalinity in groundwater are dissolved carbonate species. These are formed by the dissolution of carbon dioxide (CO_2). CO_2 occurs in the atmosphere and also is produced in the aquifer during the biodegradation of native organic carbon compounds. Therefore, alkalinity occurring above background concentrations might indicate microbial activity and serve as an indirect indicator of CVOC biodegradation.

Study Area 1

Baseline alkalinity concentrations ranged from 64 to 96 mg/L; baseline CO_2 concentrations ranged from 39 to 233 mg/L (Table 4.6). After the vegetable oil injection, both alkalinity and CO_2 increased in several monitoring wells affected by the emulsion. Maximum level of alkalinity was observed in MW-100B (400 mg/L) and maximum CO_2 occurred in MW-117 (1,024 mg/L). Alkalinity and CO_2 rose significantly in affected wells within three months of the injection. This indicates some organic component of the emulsion is a readily available food source to microorganisms.

Study Area 2

Baseline alkalinity concentrations ranged from 35 to 60 mg/L; baseline CO_2 concentrations ranged from 38 to 196 mg/L (Table 4.8). Reported concentrations of alkalinity below detection limits in MW-86 and MW-88 are suspect based on measurable CO_2 concentrations and therefore were not used. The microorganisms can easily ferment lactate and create large quantities of CO_2 within the treatment area. Extremely high levels of alkalinity (>10,000 mg/L) and CO_2 (>400 mg/L) were reported for multiple wells.

4.7.1.9 Chloride

Chloride is produced by all CVOC degradation processes (Figure 1.3). If sufficient CVOCs are destroyed, chloride levels in groundwater can measurably increase. Reductive dechlorination generally results in chloride concentrations greater (> 2x) than background levels in the contaminated portion of the aquifer (Wiedemeier and others, 1999). Chloride increases above background could be an indirect indication of CVOC degradation.

Study Area 1

Baseline chloride concentrations ranged from 5 to 14 mg/L (Table 4.6). After the vegetable oil injection, chloride concentrations increased slightly in wells affected by the emulsion (Figure 4.8). By the end of the pilot study, chloride concentrations had increased less than 5 mg/L.

Study Area 2

Baseline chloride concentrations ranged from 11 to 48 mg/L (Table 4.8). Chloride concentrations were highly variable in this study area; some wells showed both dramatic increases and decreases during the pilot study (Figure 4.10 and Attachment E). There is no obvious reason for these variations; possible explanations include laboratory error, contamination of injected fluids, and contamination of sampling equipment.

4.7.1.10 Temperature and pH

Temperature and pH are groundwater parameters that affect microbial activity. Microorganisms capable of degrading chlorinated solvents generally prefer a pH between 6 and 8 SU (Standard Units) (USEPA, 1998). Microbial activity tends to increase with increasing temperature up to a certain level. Below about 10°Celsius, microbial activity decreases until it is negligible at freezing temperatures.

Study Area 1

Baseline measurements indicate pH ranged from 5.9 to 6.3 SU. After the injection, pH fluctuated slightly with some wells testing below 5 SU (Table 4.6). The pH data suggest that the aquifer was usually within the optimal range during the pilot study.

The injection of the emulsion was not expected to alter groundwater temperatures. Temperatures remained within the normal range for groundwater at MI during the pilot study (Table 4.6).

Study Area 2

Baseline measurements indicate pH ranged from 5.3 to 7 SU. Injections of the lactate had very little effect on pH (Table 4.8). This is likely due to the extremely high levels of alkalinity generated by the lactate fermentation.

The lactate injections were not expected to alter groundwater temperatures. Temperatures remained within the normal range for groundwater at MI during the pilot study (Table 4.8).

4.7.1.11 Arsenic and Selenium

Arsenic (As) and selenium (Se), both relatively toxic, were targeted for analysis as risk indicators during the pilot study. Samples were collected for laboratory analysis during the May 2003 baseline event and the January 2003 sampling event from wells IW-6, IW-7, MW-121, and MW-123 within Area 1 and wells IW-1, IW-4, MW-110, and MW-114 within Area 2. Arsenic currently has a maximum contaminant level (MCL) of 0.05 mg/L for drinking water but this regulatory limit will change to 0.01 mg/L as of January 23, 2006. Selenium has a MCL of 0.05 mg/L.

Arsenic mobility was expected to be enhanced within the strongly reducing areas (ORP < -200 mV) created by electron donor injections. The principal species was assumed to be As(III) which could form insoluble sulfide species, if SO_4 was available to be reduced (Brookins, D.G., 1988; Nriagu J., 1994). Dimethyl arsenic acid (cacodylic acid) could also form, but this volatile compound was unlikely to be of concern, since the highest measured arsenic levels were less than $4x10^{-6}$ molar. Outside the immediate treatment area, more normal oxidizing conditions would prevail in the Fluvial aquifer, and the As(III) would rapidly oxidize to As(V). Because As(V) is highly adsorbed to Fe-oxyhydroxides and clay minerals, the "normal" redox conditions were expected to control arsenic concentrations to below MCLs. This is evidenced by background sampling performed within the test areas.

Selenium mobility may be enhanced by the reducing conditions produced by the electron donor injections. Under normal aquifer conditions, Se(VI) would be present as the selenate ion [$SeO4^{2-}$]. Se(VI) will reduce to Se(IV) (selenite anion) under strongly reducing conditions within treated areas (Allen and others, 1993; Brookins, D.G., 1988). Fortunately, available Se(IV) is greater than 90% adsorbed to Fe-oxyhydroxides in groundwater with a mildly acidic pH which is characteristic of the Fluvial aquifer. CH2M HILL notes that high levels of selenium measured during this pilot study were in highly-turbid water samples, supporting the claim that selenium was adsorbed, and not in solution. Outside the treatment area, the mobility of the selenate anion also was controlled by adsorption. Although less strongly adsorbing than selenite, selenate is still moderately to strongly adsorbing. Low-turbidity water samples from the Fluvial aquifer were below the MCL, as evidenced by background sampling performed within the test areas.

Study Area 1
Arsenic and selenium were not detected during the baseline sampling event (Table 4.6). After the initial injection, arsenic was detected in three of the four wells sampled, which included one concentration that exceeded the current MCL. The sample from IW-6 contained arsenic at a concentration of 0.274 mg/L. Selenium was also detected in three of the four wells sampled and exceeded the MCL in IW-6 (0.454 mg/L). It should be noted that elevated turbidity (172.9 NTUs) was measured in IW-6 at the time of the sampling and may have biased the results high for arsenic and selenium. These results indicate injection of oil emulsion may increase the solubility and mobility of toxic metals in the aquifer.

Study Area 2
Arsenic and selenium were not detected during the baseline sampling event (Table 4.8). After the initial injection, arsenic was detected in three of the four wells sampled, but did not exceed the current MCL. Selenium was also detected in three of the four wells sampled and exceeded the MCL in IW-4 (0.0689 mg/L). These results indicate injection of lactate solution may slightly increase the solubility and mobility of toxic metals in the aquifer.

4.7.1.12 Volatile Fatty Acids

Volatile fatty acids (VFAs), also called low molecular weight organic acids, are readily metabolized, highly oxidized, organic substrates. These acids are used as indicators of biodegradation in two ways.

- Natural appearance of these acids is unequivocal evidence that biodegradation (via oxidation) has occurred. However, in all but the most extreme environments (exceptions are typically landfills) concentrations of these acids is extremely low (Hutchinson, 1995).
- Secondly, concentrations of the VFAs are monitored when they are used as a carbon source, particularly to induce methanogenic conditions (Fennel et al., 1997). Upon introduction to the groundwater, lactate releases lactic acid into the groundwater. This lactic acid is then metabolized by a primary sequential path to pyruvic acid and, in turn, to acetic acid. Two additional VFAs, butyric and propionic acid are also produced through secondary reactions.

Study Area 1
Baseline concentrations of VFAs were below the detection limit in all monitoring wells, except MW-100B (lactic acid at 0.7 mg/L) (Table 4.6). After the vegetable oil injection, concentrations of VFAs increased in all affected wells. However, no significant impacts were observed in wells MW-116, -119, -121, and -124. Vegetable oil was not measured for VFA content prior to injection activities, and therefore, it is uncertain whether VFA increases are due to injection of the oil. Delayed increases were observed in MW-122 and MW-100B. VFAs have been on a decreasing trend in most monitoring wells since September 2002. As of July 2003, except for MW-117, concentrations were not much above background.

Study Area 2
Baseline VFA concentrations were below detection limits in all wells except MW-106 (formic acid at 1.7 mg/L) (Table 4.8). As expected, VFA concentrations increased dramatically following all lactate injections. The highest concentrations were observed after the injections in the spring of 2003. Detections of acetic acid at levels >3,000 mg/L further emphasize the bioavailability of lactate compared to vegetable oil emulsion.

4.7.2 Testing for Anaerobic Bacteria

4.7.2.1 Iron-related and Sulfate-reducing Bacteria

Field tests were performed during each sampling event at selected monitoring wells to determine the presence or absence of iron-related and sulfate-reducing bacteria in the study areas. To perform the test, a sample of groundwater was collected in a pretreated vial, sealed, and visually checked for microbial growth for 8 days. If bacterial growth was observed during the test period, the number of bacteria in the groundwater sample was then estimated. Table 4.12 summarizes the results from the tests for iron-related bacteria (IRB) and Table 4.13 summarizes the results for the tests for sulfate-reducing bacteria (SRB). Field observation sheets for each test are included as Attachment F.

IRB were indicated in the majority of the tests. The January 2003 samples contained the least number of positive test results. When present, the majority of indicated bacteria were pseudomonads and enterics; however, general anaerobic bacteria and iron-related bacteria were also indicated. The bacterial populations ranged from 100 to 100,000 colony-forming units per milliliter (cfu/mL); the average population size was 40,000 cfu/mL.

SRB were indicated during all tests except the baseline event (June 2002). The dominant bacteria in the majority of tests was indicated to be a complex consortium with sulfate-reducers present. The bacterial populations ranged from 100 to 100,000 cfu/mL; the average population size was 32,000 cfu/mL.

The IRB and SRB test results generally corroborate the other pilot study findings. Baseline conditions within the pilot study areas were mildly to strongly oxic with small populations IRB and SRB. Following the injection of electron donors, reducing conditions were created and populations of IRB and SRB increased. Both study areas showed high populations of SRB by the end of the pilot test.

4.7.2.2 Dehalococcoides Species

Scientific research has shown that multiple microbial populations are responsible for degradation of organic compounds including denitrifiers, iron and manganese reducers, acetogenic bacterial, sulfate-reducers and methanotrophs (Brock and Madigan, 1994). At some sites, conversion of PCE to TCE to cis-1,2-DCE occurs, but further degradation does not occur, even after biostimulation (addition of electron donors and nutrients). Compelling evidence shows that halorespiring bacteria (*Dehalococcoides spp.*, particularly *D. ethanogenes*) are needed to facilitate complete reduction of cis–1,2-DCE to ethene. Testing of the native bacteria may be done at sites where buildup of cis-1,2-DCE occurs after biostimulation to determine if these specific halorespiring bacteria are present. Bioaugmentation with a microbial consortium known to degrade CVOCs has been shown to be effective at a few sites.

Three groundwater samples were collected to test for the presence of Dehalococcoides bacteria. Samples were collected in August 2003 from MW-86, and MW-111 (Study Area 2), and MW-100B (Study Area 1) using 1-liter septum-sealed bottles. Sample bottles were filled to overflowing using a bladder pump operating at a low-flow rate and capped in the field with zero headspace.

During laboratory analysis, the presence of Dehalococcoides was based on conducting an analysis of DNA subsequent to amplification by the Polymerase Chain Reaction using two primers to amplify sequences of nucleotides in the DNA. Secondly, detection of Dehalococcoides was also conducted using a probe in a TaqMan based detection/enumeration method (He, Ritalahti, Aiello, and Loeffler, 2003).

Test results for all wells showed populations (if present at all) were below the reporting limit of 500 cells per gram. These results indicate that Dehalocaccoides spp. are not present at either site at populations significant enough to completely dechlorinate CVOCs to ethene.

4.7.3 CVOCs and Daughter Compounds

The distribution of CVOCs and their daughter compounds were evaluated at each study area to assess the impact of the electron donor injections. The analytical results for Study Area 1 and 2 are presented on Tables 4.5 and 4.7. In the figures presented below, CVOC isoconcentration contours were interpolated using the software program, Surfer©. Interpolations were made by the kriging method, which is an accepted geostatistical gridding method. To represent trends in CVOC concentrations, the analytical results plotted in Figures 4.14 and 4.17 were converted to micromolar units. This type of plot allows better comparison of the analytical results because reductive dechlorination of CVOCs follows a 1:1 molecular ratio of parent to daughter products (Figure 1.3).

4.7.3.1 Study Area 1

The principal CVOCs at Study Area 1 are PCE, TCE, and cis-1,2-DCE. Figure 4.13 shows the areal distribution of PCE, TCE, and cis-1,2-DCE at different times during the pilot study. Trends in CVOC concentrations at individual wells are presented in Figure 4.14. Figure 4.15 presents plots of CVOC concentration versus distance downgradient from the injection area along the centerline of the study area.

PCE

Baseline PCE concentrations ranged from 1.3 μg/L to 53 μg/L (Table 4.5 and Figure 4.13a). Following the vegetable oil injection in June 2002, PCE concentrations decreased slightly in many site wells. During the months following the injection, the greatest impact to PCE concentrations was observed in downgradient wells located in the southeastern portion of the site. Concentrations of PCE in wells located closest to the injection wells decreased immediately after the injection, then rebounded to baseline conditions (Table 4.5). This phenomenon has been reported for other test sites using vegetable oil as an electron donor. These changes in concentrations are attributed to adsorption of the CVOC into the oil phase. Also, as indicated in Figure 4.15, about one year after injection, PCE levels in the upgradient wells had rebounded to pre-injection levels. This may be due to influx of CVOCs from upgradient (untreated areas) or gradual desorption of CVOCs from the vegetable oil, or both.

Downgradient of the zone initially impacted by the injection, microorganisms used the soluble organics from the emulsion (DOC) to facilitate reductive dechlorination. For example in well MW-122, where low levels of DOC were sustained during the study, both PCE and TCE were completely transformed to cis-1,2-DCE (Figure 4.14). As shown in the figure, concentrations of PCE decreased in nearly all wells affected by the injection. PCE levels in both MW-100B and MW-117 decreased to non-detect levels near the end of the study period. However, further inspection of the Figure shows losses of PCE in most wells are not matched with increases of TCE and cis-1,2-DCE. This suggests that processes other than reductive dechlorination are responsible for the apparent loss of PCE.

TCE

Baseline TCE concentrations ranged from 9 µg/L to 170 µg/L (Table 4.5 and Figure 4.13b). Until four months after the injection, TCE concentrations were relatively unaffected (Figure 4.13b). However, beginning in October 2002 and continuing throughout the entire study period, TCE levels decreased in nearly all of the downgradient wells. During the treatability study period, concentrations of TCE were observed to fluctuate greatly. Typically wells located in the southern part of the study area had the highest concentrations of DOC and therefore showed the greatest decrease in TCE levels. It is possible that the oil, especially in MW-117 and MW-120, absorbed some of the TCE. Inspection of Figure 4.14 shows that in several wells (MW-115, MW-118, MW-119, and MW-121) the decrease in TCE does not match the increase in cis-1,2-DCE. This suggests that processes other than reductive dechlorination are responsible for the loss of TCE.

As indicated in Figure 4.15, TCE concentrations near the center of the study area remained relatively constant while the concentrations further downgradient of the injection declined to non-detect. This pattern suggests that TCE was being "added" and degraded at about equal rates near the injection area, but TCE degradation was predominant in the downgradient areas. Addition of TCE likely occurred from degradation of PCE, influx of CVOCs in groundwater from upgradient (untreated) areas, and desorption of CVOCs from the oil.

In MW-117 and MW-124 the TCE levels increased slightly during the study period (Figure 4.14). In both cases, this is attributed to degradation of PCE causing "addition" of TCE to groundwater at the well. At MW-117 there is also the potential for desorption from the oil, since the well was immediately affected by the injection and continued to show high concentrations of oil throughout the study period (Table 4.6). However, desorption could not have contributed much TCE, because PCE only rebounded to about 25 percent of pre-injection (baseline) levels during the study period. Well MW-124 showed later, very low-level effects of the injection (Figure 4.3), and thus showed degradation of both PCE and TCE with generation of cis-1,2-DCE.

DCE

During the reductive dechlorination of TCE, three isomers of DCE may be created: 1,1-DCE, cis-1,2-DCE, and trans-1,2-DCE. Cis-1,2-DCE is the predominant isomer produced by microbial degradation of TCE. Because this compound occurs at only trace levels in manmade solvents, its presence in CVOC plumes is strong evidence of reductive dechlorination (Wiedemeier and others 1999). Table 4.5 provides analytical results for cis-1,2-DCE; analytical results for 1,1-DCE and trans-1,2-DCE are provided in Attachment G.

Baseline levels of cis-1,2-DCE ranged from below the detection limit to 1.2 µg/L (Table 4.5). Within about 4 months after the injection, cis-1,2-DCE began to appear in samples from the monitoring wells (Figure 4.13c). Levels of cis-1,2-DCE increased gradually in many wells affected by the injection, but the earliest increases were noted in wells (MW-100B, MW-125) that received low to moderate levels of DOC (Table 4.6, Figure 4.14). Two wells immediately affected by the injection (MW-117 and MW-120) showed different responses: MW-120 showed large increases in cis-1,2-DCE levels after about 9 months, while MW-117 had only minimal cis-1,2-DCE levels after one year. These delays in transforming CVOCs have been noted at other sites using vegetable oil as an electron donor (Parsons ES, oral communication). The delay is attributed to the slow rate of dissolution of the oil and release of DOC that the microorganisms can digest.

Figures 4.13c and 4.15 show the distribution of cis-1,2-DCE was very irregular within the study area. This is believed to be due to variations in distribution of indigenous bacteria, not to the irregular distribution of DOC noted in Section 4.5.

Vinyl Chloride

During the baseline event, vinyl chloride was not detected in any study area wells. During the pilot study, levels of cis-1,2-DCE were seen to rise, but vinyl chloride was only detected once in MW-100B (2.57 μg/L) (Table 4.5). Reductive dechlorination is not the only degradation process for vinyl chloride: vinyl chloride may be mineralized or cometabolized in aerobic environments (Figure 1.1). ORP measurements suggest that mildly reducing conditions were typical within areas affected by the injection (Section 4.7.1.2) so these alternative degradation processes seem unlikely or of minimal importance. The lack of detections of vinyl chloride during the pilot study indicates that complete transformation of CVOCs may not be occurring. This further suggests that biostimulation by addition of vegetable oil may not be completely effective in removing the CVOC plumes at MI.

Ethene

Ethene is the result of complete transformation of PCE and TCE. The maximum concentration of ethene detected during the baseline event was 1,000 μg/L in IW-5 (Table 4.5). Although a slight increase was observed in downgradient wells MW-100B, -117, -122, and -123 after the injection, no significant increase was observed in any site wells. The lack of increase in ethene concentrations after the injection indicates complete transformation of PCE and TCE did not occur.

4.7.3.2 Study Area 2

The CVOCs in Study Area 2 are PCE, TCE, cis-1,2-DCE, carbon tetrachloride, chloroform, and methylene chloride. Analytical data for these parameters are presented in Tables 4.7 and 4.8. Figures 4.16, 4.17 and 4.18 show areal and at well changes in CVOC concentrations during the pilot study. Figure 4.19 shows concentration versus distance plots of chlorinated ethenes and chlorinated methanes along the centerline of the study area.

PCE

Baseline PCE concentrations in study area wells ranged from 30 μg/L to 220 μg/L (Table 4.7). As shown in Figure 4.16 and 4.19, PCE concentrations declined slightly after the first injection, and declined significantly only after the second injection in February 2003. Figure 4.19 also shows that after the last injection some PCE rebound occurred due to influx of CVOCs from upgradient areas. The initial injection caused little reductive dechlorination, possibly because most of the lactate was used to generate methane. PCE concentrations were relatively stable until December 2002 when some decrease was noted at MW-86. Most of the PCE degradation occurred in the southern part of the treatment area, the area most affected by the injection (compare Figures 4.4 and 4.16). In contrast to the vegetable oil study, the lactate injection caused transformation of both PCE and TCE to cis-1,2-DCE (Figure 4.17).

TCE

Baseline TCE concentrations ranged from 13 μg/L to 29 μg/L (Table 4.7). Slight increases in TCE were observed following the initial injection (Figures 4.16b and 4.19), most likely produced from degradation of PCE. Most of the TCE reduction was observed in the downgradient areas located along the centerline and in the southern part of the treated area. By August of 2003, TCE concentrations had decreased to low levels in nearly all of the wells in the study area, indicating the lactate was effective in stimulating reductive dechlorination of both PCE and TCE.

DCE

Baseline levels of cis-1,2-DCE within the study area ranged from 26 μg/L and 64 μg/L (Table 4.7). After the first injection, cis-1,2-DCE concentrations increased slightly throughout the study area, but the greatest increases were observed after the subsequent injections (Figures 4.16c and 4.17). Wells located in the center of the treatment area showed minimal changes in cis-1,2-DCE levels until about 6 months after the initial injection (Figure 4.19). As was noted during the vegetable oil pilot study, cis-1,2-DCE appears to accumulate rather than degrade to vinyl chloride and ethene (Figure 4.17). This indicates biostimulation with lactate may not be effective in completely transforming chlorinated ethene plumes at MI.

Vinyl Chloride

Vinyl chloride was not detected in any wells during the pilot study except in July 2003, in MW-112 at 0.263J μg/L. The low levels of vinyl chloride may indicate that cis-1,2-DCE is not being transformed or that vinyl chloride is being rapidly removed by another mechanism, such as co-metabolism. The persistence of cis-1,2-DCE (Figures 4.16c and 4.17) suggests that incomplete transformation of the chlorinated ethenes is the principal reason that vinyl chloride was not detectable within the study area.

Ethene

Baseline concentrations of ethene ranged from below the detection limit to 1.3J μg /L (Table 4.7). Concentrations increased above detection limits (0.0025 μg /L) in all site wells with the greatest increase in the area around MW-86. However concentrations remained very low and close to baseline conditions, even after multiple injections of lactate. This is further evidence that chlorinated ethenes are not being fully transformed by biostimulation.

Carbon Tetrachloride

Baseline concentrations of carbon tetrachloride (CT) ranged from 30 μg/L to 91 μg/L (Table 4.7). Within two months after the first injection, CT concentrations had decreased in wells nearest to the injection wells and in the southeastern part of the study (Figures 4.16d and 4.19). After the subsequent injections, CT was removed from all areas that received moderate or higher amounts of lactate (i.e., DOC >500 mg/L) (compare Figures 4.4 and 4.16e). As shown in Figure 4.18 an increase in chloroform or methylene chloride concentration (or both) matched the decrease in CT concentration. These changes indicate the loss of CT was due to addition of the lactate that stimulated reductive dechlorination.

Chloroform

Baseline chloroform concentrations ranged from 52 µg/L to 91 µg/L (Table 4.7). Within two months following the first injection, chloroform concentrations increased in areas moderately to highly affected by the lactate (Figures 4.16e and 4.19). Wells nearest the injection zone showed reductive dechlorination of chloroform to methylene chloride for about three months after the first injection (Figure 4.18). The chloroform transformation apparently slowed (or stopped) as the lactate was depleted, and the untreated CVOC plume migrated into the study area. Chloroform levels remained stable or rose slightly in the upgradient areas during the months preceding the second lactate injection (Figures 4.16e and 4.18). The entire study area showed depletion of the chloroform and measurable accumulation of methylene chloride only after the subsequent injections.

Methylene Chloride

Baseline levels of methylene chloride ranged from below the detection limit to 1.4 µg/L (Table 4.7). Within two months after the first injection, methylene chloride concentrations began to increase in areas near the injection zone (Figures 4.16f and 4.19). After the later injections, wells in the center and the southeastern part of the study area showed the greatest concentrations of methylene chloride, and the greatest reduction of chloroform. Figure 4.18 shows that methylene chloride was degraded relatively quickly after being created by EBT. Apparently the compound was subject to both reductive chlorination and anaerobic oxidation processes in the aquifer.

Chloromethane

Chloromethane was not measured above the detection limit during the pilot study (Table 4.7). These results suggest that the disappearance of methylene chloride could be due to anaerobic oxidation, rather than reductive dechlorination.

Methane

Baseline levels of methane ranged from below the detection limit to 4.4 µg/L (Table 4.7). Concentrations of methane increased in the area nearest the injection zone almost immediately (Figure 4.18). Methane is the byproduct of reductive dechlorination of chloromethane, but chloromethane was not detected during the pilot study. It is possible that the degradation of chloromethane is almost instantaneous, and therefore chloromethane would not be detected. However, it seems more likely that the majority in methane is the result of methanogenesis following fermentation of the lactate.

4.7.4 Rates of CVOC Degradation

The rate that microbes degrade CVOCs is often calculated for the purpose of estimating cleanup times for a contaminated aquifer. The degradation rates are generally dependent on several factors:

- microbial growth rates and initial populations in the aquifer
- concentrations of electron donors (substrates) and receptors
- availability of essential nutrients
- ratio of degradation due to attached-phase versus suspended-phase microorganisms

The first-order degradation rate equation, which commonly represents the apparent degradation kinetics of chlorinated ethenes and methanes is:

$$C_t = C_0e^{-kt}$$

where:

C_t	=	Solute (e.g., PCE) concentration in mg/L at time t
C_0	=	Solute (e.g., PCE) concentration in mg/L at time "zero"
t	=	time (days)
k	=	first-order degradation rate (day^{-1})

It is important to note that this equation includes the effects of both biological and physical (i.e., dispersion, adsorption, volatilization, and dilution) degradation mechanisms.

This section discusses the calculation of CVOC degradation rates from monitoring data obtained during the pilot study. Only the data that indicated contaminant reduction were used to calculate degradation rates (i.e., data from a period of increasing contaminant levels were not used). The data were plotted arithmetically and logarithmically for each of the wells to estimate the first-order degradation rates. These rates are not intended to represent actual biodegradation rates, since the calculations are based on data that included the effects of other attenuation processes, such as advection, dispersion, volatilization, and adsorption. The calculated rates likely overestimate the actual biodegradation rates, especially in Study Area 1 where the vegetable oil was used. As discussed above, the oil appears to have absorbed PCE and TCE, thus depleting the apparent concentrations without any biodegradation. Also, since the CVOCs degrade in sequential reactions, a "net" reduction rate is estimated by these methods. Finally, it is expected that biodegradation rates vary in different parts of each site, depending on the local geochemical conditions and microbial populations.

4.7.4.1 Study Area 1

Evidence of reductive dechlorination was observed only in the data from MW-100B and MW-122. The data are summarized in Table 4.14. Plots of the data are provided in Figure 4.20.

PCE

First-order degradation rates for PCE ranged from 0.016 day^{-1} (5.8 yr^{-1}) to 0.058 day^{-1} (21 yr^{-1}) (Table 4.14). The calculated degradation rates are equal to a PCE half-life ranging of 12 to 43 days. As shown in Table 4.15, the calculated PCE degradation rates are generally consistent with other EBT studies.

PCE levels in the background well increased slightly during the pilot test study, therefore no degradation rate could be calculated for the aquifer outside the study area. Natural attenuation rates for PCE at the MI indicated a half-life ranging from 3.2 to 7.3 years (CH2M HILL, January 2000). These estimates suggest that the vegetable oil EBT attenuated PCE 60 to 100 times faster than natural processes.

TCE

First-order degradation rates for TCE ranged from 0.023 day^{-1} (8.4 yr^{-1}) to 0.039 day^{-1} (14 yr^{-1}). The calculated degradation rates are equal to a TCE half-life ranging of 18 to 30 days. As shown in Table 4.16, these TCE degradation rates are generally consistent with other EBT studies.

TABLE 4.14
PCE and TCE Degradation Rate Analysis for Area 1
Main Installation, Memphis Depot

Date	MW21 (BG Well)		MW122		MW100B	
	Distance from Injection Wells					
	–		22		63	
	PCE/TCE Concentrations (µg/L)					
12/11/01		–		–	50	79
3/20/02	90	76		–		–
5/21//02		–	53	49		–
7/9/02	110	66	20	32	49	72
7/29/02	125	53.6	25.3	51.8	1.56	22.8
9/3/02	178	38.1	30.7	52	25.3	33.1
10/7/02	152	49.2	44	66.4	14.5	11.6
11/11/02	188	37.6	46.4	68.3	1.77	2.27
12/16/02	195	38.3	55.4	84.4	2.35	2.06
1/20/03	194	32.4	71	96.5	*0.395*	*0.4*
2/24/03	200	50.7	18.9	20.4	0.53	*0.41*
3/24/03	190	38.6	0.75	*0.95*	*0.34*	<1
4/21/03	171	33.8	*0.34*	*0.32*	<0.5	<1
5/19/03	172	38.6	<0.5	*0.763*	<0.5	<1
6/23/03	159	34	<0.5	<1	<0.5	<1
7/21/03	120	33.6	<0.5	<1	<0.5	<1
First-Order Analysis						
R^2	–	–	0.95	0.82	0.73	0.96
Rate (1/d)	–	–	-0.058	-0.039	-0.016	-0.023
Half-life (d)	–	–	12	18	43	30

Period of observable PCE and/or TCE degradation is shaded black.
Italics = estimated value.

TABLE 4.15
First-Order PCE Degradation Rate Summary
Main Installation, Memphis Depot

Source	First-Order Degradation Rates			Comments
	Day^{-1}	$Year^{-1}$	Half-life (d)	
Area 1 (this study)	0.016 – 0.058	5.8 – 21	12 – 43	electron donor: vegetable oil
Area 2 (this study)	0.012 – 0.031	4.4 – 11	22 – 58	electron donor: lactate
Sheldon, 1999	0.005 – 0.011	2.0 - 3.8	66 – 128	rates decreased as HRC was depleted
Dooley, 1999	0.021	7.7	33	rate order not reported (assumed first)
Maierle, 2001	0.021 – 0.027	7.7 –9.5	26 – 33	enhanced reductive dechlorination (ERD)
EnSafe, 2002	0.009 - 0.01	3.3 – 3.7	69 – 77	carbon source: sodium acetate

For comparison, TCE concentrations at MW-21 (background well upgradient of the study area) have decreased from 76 µg/L in March 2002 to 34 µg/L in August 2003. This decrease yields a first-order degradation rate of 0.0015 day^{-1} (0.5 yr^{-1}) and a half-life of 470 days (1.3 years) with an R-squared value of 0.63. TCE degradation rates for the MI ranged from 1.9 to

4.4 years (CH2M HILL RI, January 2000). These data suggest the EBT rate is as much as 50 times the natural attenuation rate in the aquifer near the study area.

TABLE 4.16
First-Order TCE Degradation Rate Summary
Main Installation, Memphis Depot

Source	First-Order Degradation Rates			Comments
	Day^{-1}	Year^{-1}	Half-life (d)	
Enhanced In Situ Bioremediation				
Area 1 (this study)	0.023 – 0.039	8.4 – 14	18 – 30	electron donor: vegetable oil
Area 2 (this study)	0.0063 – 0.021	2.3 – 7.7	33 – 110	electron donor: lactate
Dooley, 1999	0.018	6.6	39	rate order not reported
Maierle, 2001	0.005 - 0.023	1.8 – 8.4	30 – 139	enhanced reductive dechlorination (ERD)
EnSafe, 2002	0.016 - 0.026	5.8 – 9.5	27 – 43	carbon source: sodium acetate
Natural Attenuation				
Area 1 (this study)	0.0015	0.55	470	Background monitoring well MW-21
Area 2 (this study)	0.0008	0.29	920	Background monitoring well MW-88
Cox, 1995	0.003	1.1	231	sequential anaerobic-aerobic aquifer
Wiedemeier and others, 1999	0.0001 – 0.002	0.05 – 0.9	350 - 6900	Reported in BIOCHLOR v. 1.0 manual
Lee, 1995	0.002	0.7	347	downgradient of an industrial landfill

4.7.4.2 Study Area 2

Figures 4.21a and 4.21b show the data plots for the calculations.

PCE

First-order degradation rates for PCE ranged from 0.012 day^{-1} (4.4 yr^{-1}) to 0.031 day^{-1} (11 yr^{-1}) (Table 4.17). The calculated rates are equal to a PCE half-life ranging from 22 to 58 days. As shown in Table 4.15, the calculated degradation rates are generally consistent with rates calculated by other EBT studies.

PCE concentrations at background monitoring well MW-88, which is nearly 245 feet upgradient of the Area 2 study, increased slightly during the study period therefore no degradation rate for the aquifer outside the study area could be calculated. Natural attenuation rates for PCE at the MI indicated a half-life ranging from 3.2 to 7.3 years (CH2M HILL RI, January 2000). These estimates suggest the lactate EBT rate is as much as 50 times the natural attenuation rate.

TCE

First-order degradation rates for TCE ranged from 0.0063 day^{-1} (2.3 yr^{-1}) to 0.021 day^{-1} (7.7 yr^{-1}). The calculated degradation rates are equal to a TCE half-life ranging from 33 to 110 days. As shown in Table 4.16, the TCE degradation rates are generally consistent with other EBT studies. However, the higher rate is 7 to 10 times greater than the reported literature value of natural attenuation studies at monitored natural attenuation (MNA) sites; the lower rate is 2 to 3 times greater than reported from MNA studies.

TCE concentrations at MW-88 (background well) decreased from 7.1 µg/L to 5.4 µg/L during the pilot study. This decrease equates to a first-order degradation rate of 0.0008 day-

^{1} (0.3 yr^{-1}) and a half-life of 920 days (2.5 years). Natural attenuation of TCE for the MI indicates half-life ranging from 1.9 to 4.4 years (CH2M HILL RI, January 2000). These data suggest the EBT degradation rate is 10 to 30 times the natural attenuation rate for TCE.

TABLE 4.17
PCE and TCE Degradation Rate Analysis for Area 2
Main Installation, Memphis Depot

Date	BG Well		Central Path										South Path				North Path			
	MW88		MW106		MW86		MW114		MW111		MW113		MW105		MW112		MW109		MW110	
	Distance from Injection Wells																			
	--		9 ft		19 ft		24 ft		36 ft		47 ft		6 ft		18 ft		13 ft		19 ft	
	PCE and TCE Concentrations (μg/L)																			
5/20/02*	10.7	2.40	170	25.0	198	20.0	220	29.0	170	28.0	30.0	15.0	130	19.0	74.0	18.0	160	27.0	120	28.0
7/8/02	17.0	7.10	220	28.0	160	18.0	190	24.0	100	28.0	45.0	20.0	55.0	15.0	94.0	17.0	130	23.0	200	31.0
7/30/02	17.2	7.55	162	27.9	182	21.1	258	33.0	135	30.8	59.3	26.7	131	22.7	83.0	22.2	164	30.2	181	34.9
9/3/02	21.8	7.72	232	29.9	197	22.7	290	32.5	187	33.1	112	29.4	136	23.6	63.4	19.4	148	35.1	223	34.0
10/7/02	16.1	6.90	208	28.5	205	20.7	221	31.1	201	29.1	80.4	28	133	22.6	87.6	20.4	170	34.4	169	30.2
11/11/02	23.8	7.66	207	31.0	180	25.0	270	31.3	177	30.5	97.0	31.6	163	24.2	133.0	25.3	34.1	12.3	182	33.0
12/16/02	22.2	7.41	176	27.5	21.4	10.2	268	31.2	189	31.3	96.9	32.7	167	23.5	121.0	24.4	88.6	20.8	201	33.0
1/20/03	19.8	7.24	219	31.2	5.06	3.25	240	29.7	192	33.3	91.1	30.4	203	26.9	85.0	25.3	96.8	21.3	199	33.3
3/24/03	13.4	6.49	181	28.2	2.99	2.37	38.2	30.9	145	27.9	48.7	23.3	57.7	19.5	8.11	7.19	35.4	15.6	154	31.2
4/21/03	18.2	6.65	249	32.2	14.4	7.63	7.57	6.62	188	31.8	49.4	21.1	22.0	8.69	28.7	12.9	15.3	7.30	171	31.1
5/19/03	14.5	5.34	197	26.6	28.9	16.7	6.19	9.79	113	33.9	27.5	15.3	5.39	6.48	8.86	14.1	4.97	5.10	*151*	25.8
6/23/03	19.9	5.98	241	28.5	60.4	25.8	73.2	37.8	37.8	25.0	54.5	19.7	57.7	26.5	22.0	11.0	23.9	11.9	18.5	6.88
7/21/03	21.8	6.26	103	30.0	73.4	28.7	66.5	28.5	8.46	6.83	56.1	19.3	92.3	27.6	7.22	3.39	28.3	11.7	96.7	18.8
8/18/03	21.0	5.37	43.1	12.4	89.8	26.7	6.50	4.48	6.35	6.43	63.6	18.5	9.54	4.20	1.88	0.711	4.02	2.18	122	17.6
	First-Order Analysis																			
R^2	–	–	0.99	0.70	0.90	0.88	0.94	0.60	0.97	0.87	–	–	0.95	0.89	0.80	0.63	0.69	0.66	0.66	0.75
Rate (1/d)	–	–	-0.031	-0.015	-0.029	-0.015	-0.028	-0.0091	-0.031	-0.021	–	–	-0.029	-0.012	-0.013	-0.013	-0.012	-0.0063	-0.022	-0.016
Half-life (d)	–	–	22	46	24	46	25	76	22	33	–	–	24	58	53	53	58	110	32	43

*MW-86 and MW-88 baseline samples were collected on November 30, 2001.
Period of observable PCE and/or TCE degradation is shaded black.
Italics = estimated value.

794 145

794 146

Carbon Tetrachloride

First-order rates for CT degradation ranged from 0.0072 day^{-1} (2.6 yr^{-1}) to 0.059 day^{-1} (22 yr^{-1}) (Table 4.18). The calculated degradation rates are equal to a CT half-life ranging of 12 to 96 days.

CT concentrations at MW-88 (background) increased during the period of the pilot study, and no degradation rate was calculated.

TABLE 4.18
Carbon Tetrachloride Degradation Rate Analysis for Area 2
Main Installation, Memphis Depot

	BG Well	Central Path					South Path		North Path	
	MW-88	MW-106	MW-86	MW-114	MW-111	MW-113	MW-105	MW-112	MW-109	MW-110
	Distance from Injection Wells									
	--	6 ft	19 ft	24 ft	36 ft	47 ft	6 ft	18 ft	13 ft	19 ft
Date	CT Concentrations (μg/L)									
5/20/02*	3	82	77	94	91	30	46	40	46	77
7/8/02	4.7	89	65	79	80	50	8.6	34	13	110
7/30/02	5.54	23.7	1.74	47.5	96.1	69.1	<1	*0.41*	<1	120
9/3/02	6.61	42.9	<1	11.3	111	60.7	<1	<1	<1	131
10/7/02	5.3	39.2	<1	42.9	112	64.5	<1	<1	4.45	94.1
11/11/02	5.79	42	<1	50.8	92.8	59	1.81	*0.5*	12.8	98.3
12/16/02	6.76	44.1	<1	*76.8*	*106*	69.6	4.88	*1.73*	11.6	*120*
1/20/03	6.98	42.4	<1	65.2	*108*	71.6	4.28	*3.32*	13.8	109
3/24/03	4.63	16	<1	2.04	76.5	50.8	<1	<1	<1	90.5
4/21/03	5.61	*2.16*	<1	*2.01*	*103*	53.2	<1	<1	<1	*101*
5/19/03	5.08	2.57	<1	<1	34.3	26	<1	<1	<1	*77.7*
6/23/03	6.17	*12.4*	<1	<1	<1	43.6	<1	<1	<1	14.2
7/21/03	8.17	<1	<1	<1	<1	38	<1	<1	<1	60.8
8/18/03	7.3	<1	<1	<1	10.3	42.7	<1	<1	<1	56.7
	First-Order Analysis									
R^2	–	0.86	0.80	0.79 / 0.83	0.93	0.74	0.87	0.70	0.80	–
Rate (1/d)	–	-0.026	-0.051	-0.019 / -0.039	-0.086	-0.0072	-0.059	-0.048	-0.057	–
Half-life (d)	–	27	14	37 / 18	8.1	96	12	15	12	–

*MW-86 and MW-88 baseline samples were collected on November 30, 2001.
Period of observable CT degradation is shaded black.
Italics = estimated value.

Chloroform

First-order rates for chloroform degradation ranged from 0.0027 day^{-1} (0.99 yr^{-1}) to 0.065 day^{-1} (24 yr^{-1}) (Table 4.19). The calculated degradation rates are equal to a chloroform half-life ranging of 11 to 257 days.

Chloroform levels at MW-88 increased slightly during the pilot study period, and no degradation rate was calculated.

TABLE 4.19
Chloroform Degradation Rate Analysis for Area 2
Main Installation, Memphis Depot

	BG Well	Central Path					South Path		North Path	
	MW-88	MW-106	MW-86	MW-114	MW-111	MW-113	MW105	MW-112	MW-109	MW-110
	Distance from Injection Wells									
	--	6 ft	19 ft	24 ft	36 ft	47 ft	6 ft	18 ft	13 ft	19 ft
Date	Chloroform Concentrations (μg/L)									
5/20/02*	1.1	76	77	84	85	76	52	63	91	83
7/8/02	1.9	87	57	75	85	79	90	56	90	85
7/30/02	2.10	130	88.1	129	96.8	98.0	100	127	9.26	99.9
9/3/02	1.86	71.3	94.4	137	116	90.6	73.3	94	7.83	103
10/7/02	1.81	75.7	85	112	103	83.2	56.4	18	34.1	89
11/11/02	1.89	78.7	70.1	92.6	86.3	78.2	59.5	17	53.5	78.1
12/16/02	1.88	90.3	46.8	92.3	93.4	87.6	85.4	17.8	98.7	85.4
1/20/03	1.64	95.9	19.7	75.9	98 2	93.8	97	24.7	105	84.2
3/24/03	1.23	83.7	13.1	107	79.9	70.8	41.6	16.1	55.5	71.8
4/21/03	1.43	90.1	17.1	72	82.2	81	<u>0.5</u>	47.5	69	76.3
5/19/03	1.71	83.4	11.9	95.6	120	84.4	29.7	36	17.5	86.4
6/23/03	1.93	83.9	6.72	64.2	109	89.8	48.8	46.7	4.8	91.3
7/21/03	2.08	85.8	11	64.9	106	89.7	12	11.4	6.81	78.3
8/18/03	1.93	9.72	12.1	29.4	97.5	80.4	9.72	5.47	3.69	54.8

First-Order Analysis

R^2	–	–	0.94	0.66	–	–	0.84	0.70	0.78	1.0	0.88	–
Rate (1/d)	–	–	-0.0091	-0.0027	–	–	-0.0054	-0.065	-0.021	-0.030	-0.018	–
Half-life (d)	–	–	76	257	–	–	128	11	33	23	39	–

*MW-86 and MW-88 baseline samples were collected on November 30, 2001.
Period of observable CT degradation is shaded black.
Italics = estimated value.

4.7.5 Plume Treatment

The two pilot studies showed that EBT could be effective in accelerating natural attenuation rates for the CVOCs in the fluvial aquifer. At Study Area 1 the vegetable oil emulsion attenuated PCE and TCE as much as 100 times the rate of natural attenuation. These "apparent" rates may not be indicative of reductive dechlorination since the vegetable oil may have absorbed PCE and TCE, thus lowering the concentration without biodegradation. The lactate EBT showed degradation rates up to 50 times the natural attenuation rates. The oil emulsion was persistent for at least a year after injection and was reasonably successful in depleting PCE and TCE within the areas affected by the injection. The lactate was less persistent, with substantial depletion of the electron donor within 7 months of the initial injection. Three subsequent injections were successful in removing nearly all of the PCE and TCE from within the study area in one year. The injection process produced a "radius of influence" from the injection wells in excess of 30 ft, and both substrates were transported downgradient under natural gradients at rates approximately equal to the bromide tracer. However, both studies showed local heterogeneities in the aquifer strongly affected the distribution of the injected fluids, and thereby the zones of EBT.

Neither electron donor was effective at totally transforming the PCE and TCE to vinyl chloride and ultimately to ethene. Buildup of cis-1,2-DCE was especially noticeable at Study Area 2, but Study Area 1 also showed signs that cis-1,2-DCE was not degrading. This "stalling" of the degradation process has been noted at other sites where the natural bacterial consortium is missing a key bacterial species, *Dehalococcoides ethenogenes*. Tests of groundwater samples from the study areas indicate this bacterium is not present or if present, occurs at extremely low populations. The injection of lactate was, however, successful in completely transforming the CT and daughter products. These one-year pilot studies suggest that biostimulation alone may not be successful in transforming the PCE and TCE plumes at the MI. Lactate injections into the CVOC plume at the nearby Memphis International Airport have indicated the buildup of cis-1,2-DCE; however, the data show that it may be a temporary phenomenon. After about 1 year of "continuous" lactate injections the cis-1,2-DCE is also beginning to be depleted (SAIC, September 2003).

The results of the pilot studies confirmed that EBT can be used to remove PCE, TCE, CT, and chloroform from the fluvial aquifer. The oil emulsion appears to absorb PCE and TCE rather than initiate biodegradation, but there are signs that, one year after the donor was injected, degradation is occurring. The lactate provided much quicker response from the indigenous bacteria, but also was depleted (digested) much faster. After multiple injections the lactate EBT removed nearly all of the PCE, TCE, CT and its daughter products from the area affected by the injections. Based on these results the most contaminated parts of the MI plumes could be treated by lactate EBT and show nearly complete cleanup within one year. If the results from the Memphis Airport are typical, the residual cis-1,2-DCE may require a longer, more continuous treatment of lactate. As an alternative, the plume could be injected (bioaugmented) with *Dehalococcoides ethenogenes* to complete the transformation of the chlorinated ethenes.

FIGURE 4.1
Potentiometric Surface at Study Area 1
Main installation, Memphis Depot

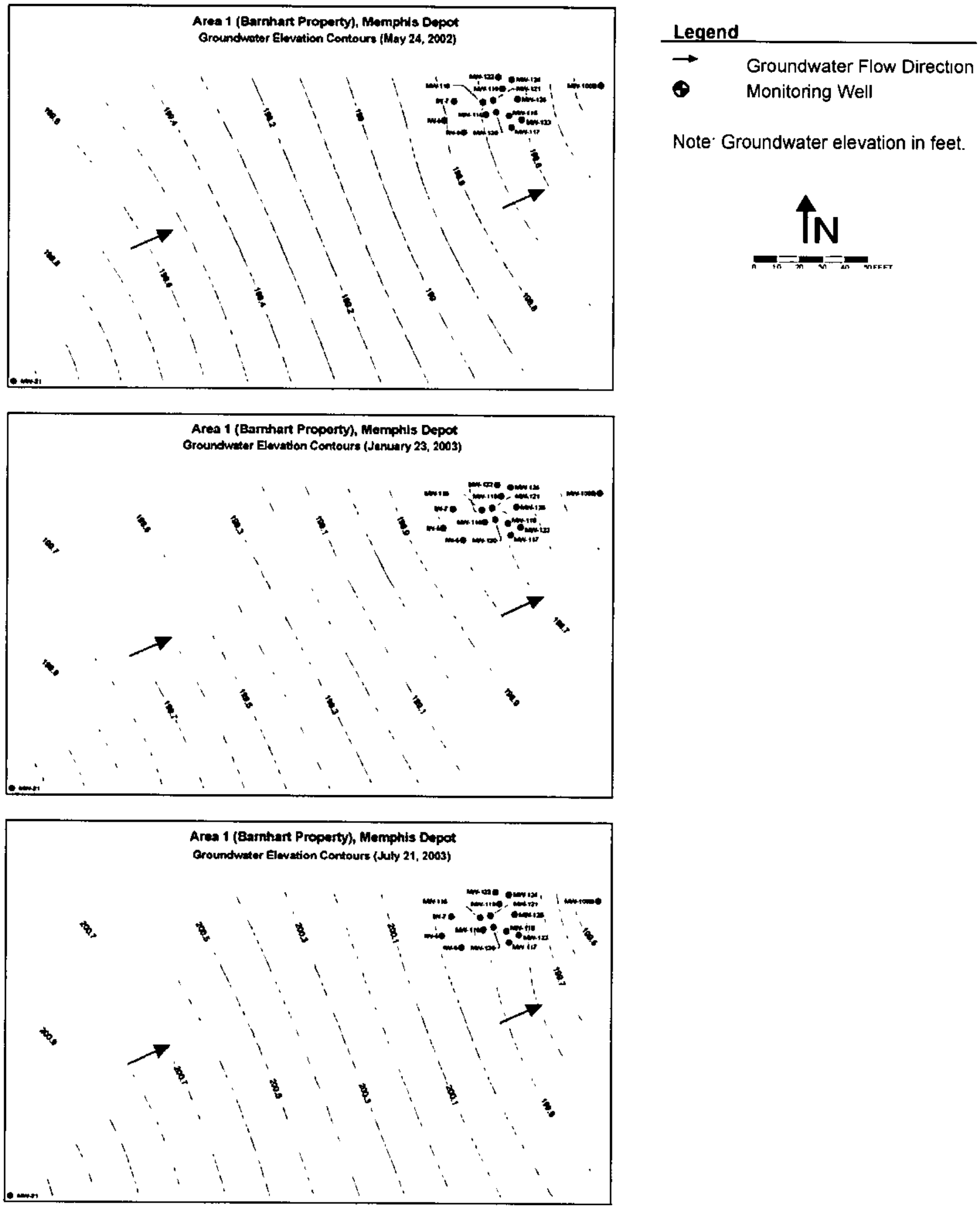
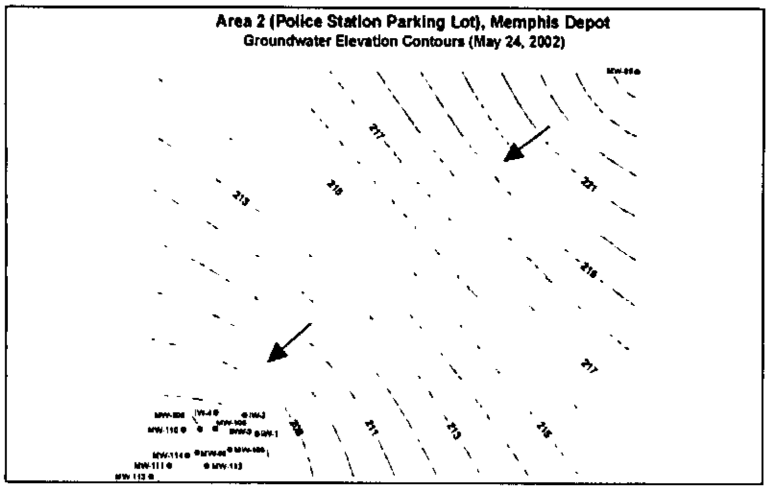
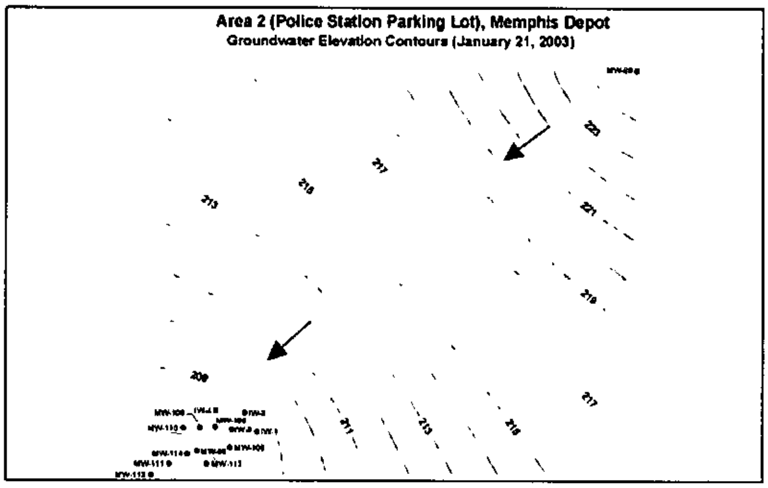
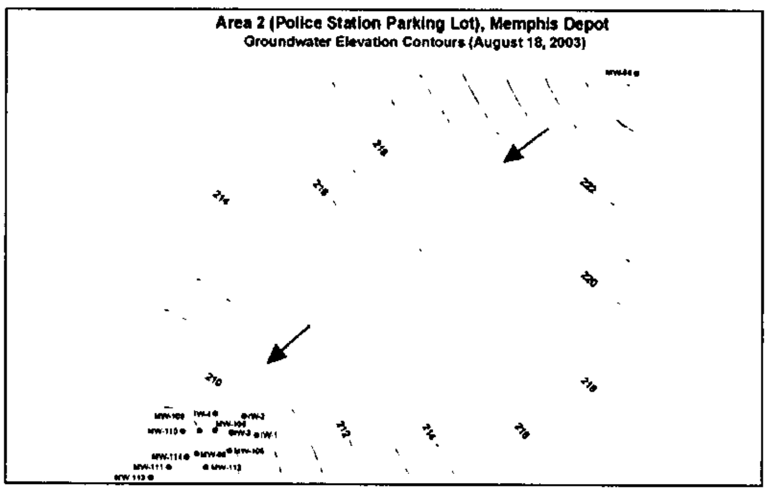


FIGURE 4.2
Potentiometric Surface at Study Area 2
Main installation, Memphis Depot



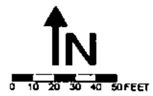




Legend

- Groundwater Flow Direction
- Monitoring Well

Note: Groundwater elevation in feet.



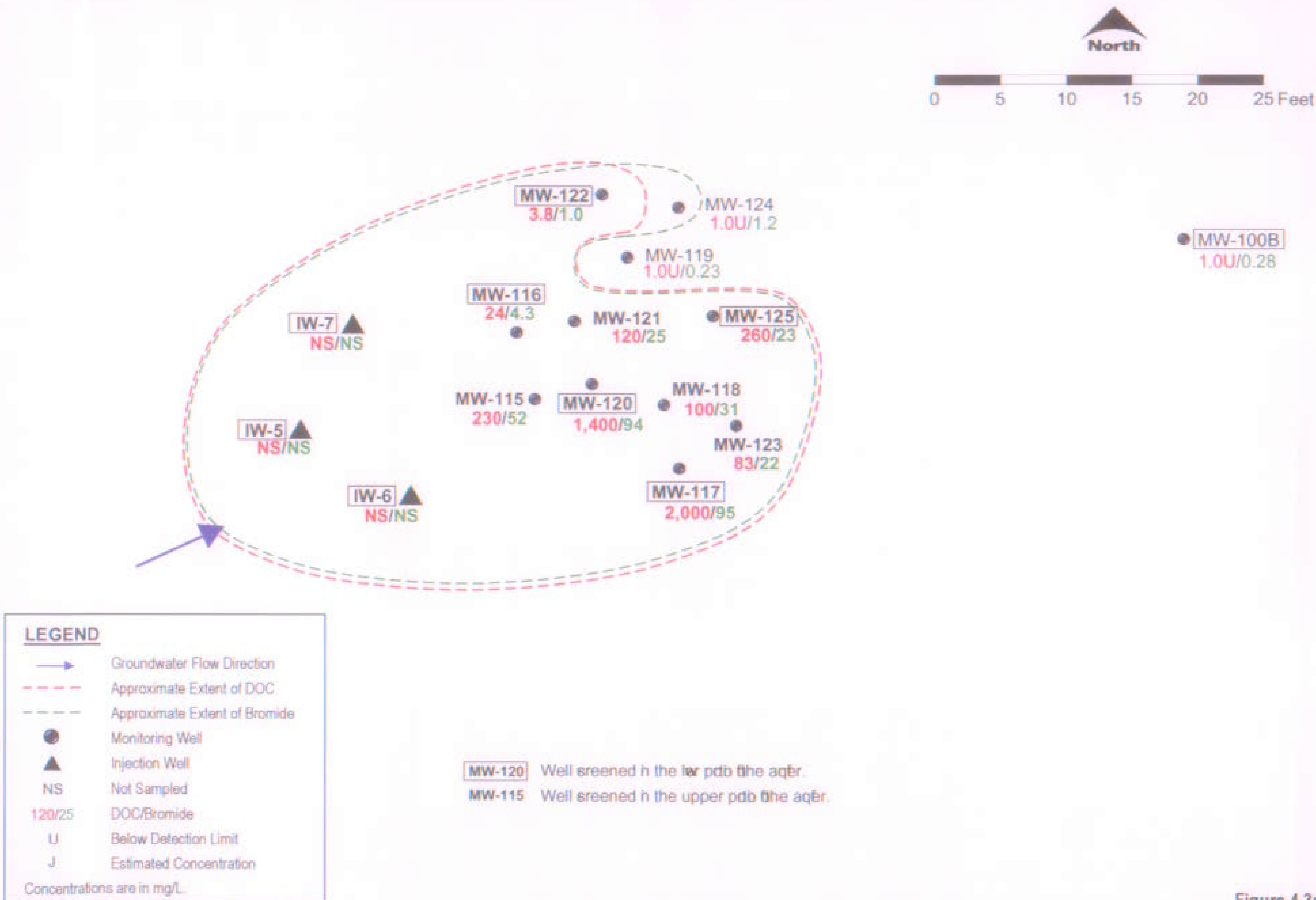


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Figure 4.3a
Bromide and Dissolved Organic Carbon (DOC) Concentrations in Groundwater, July 2002 - Post Injection #1
Study Area 1, Memphis Depot

794 151

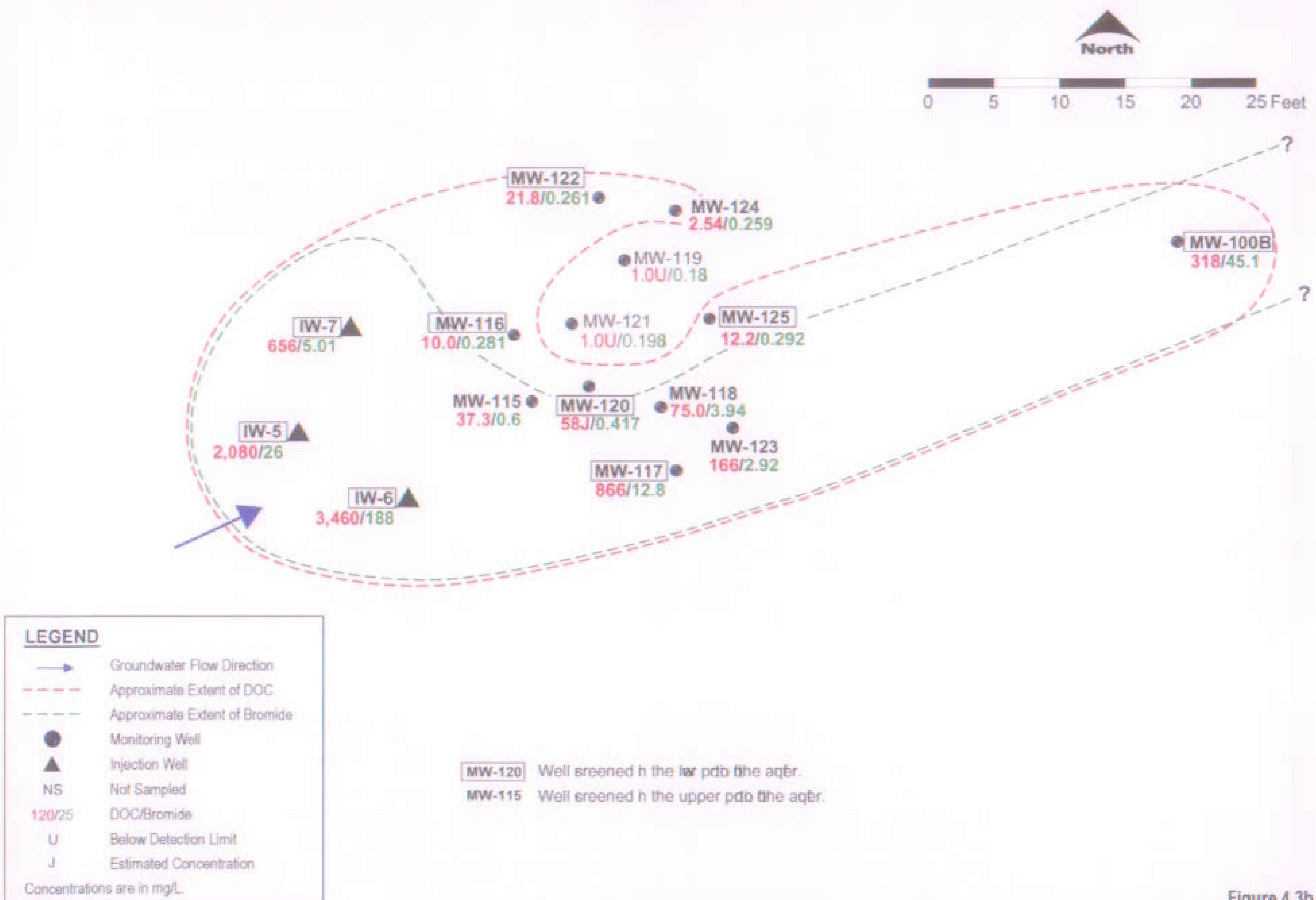

Figure 4.3b
Bromide and Dissolved Organic Carbon (DOC) Concentrations in Groundwater, January 2003 - Post Injection #7
Study Area 1, Memphis Depot

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794 152

794 153

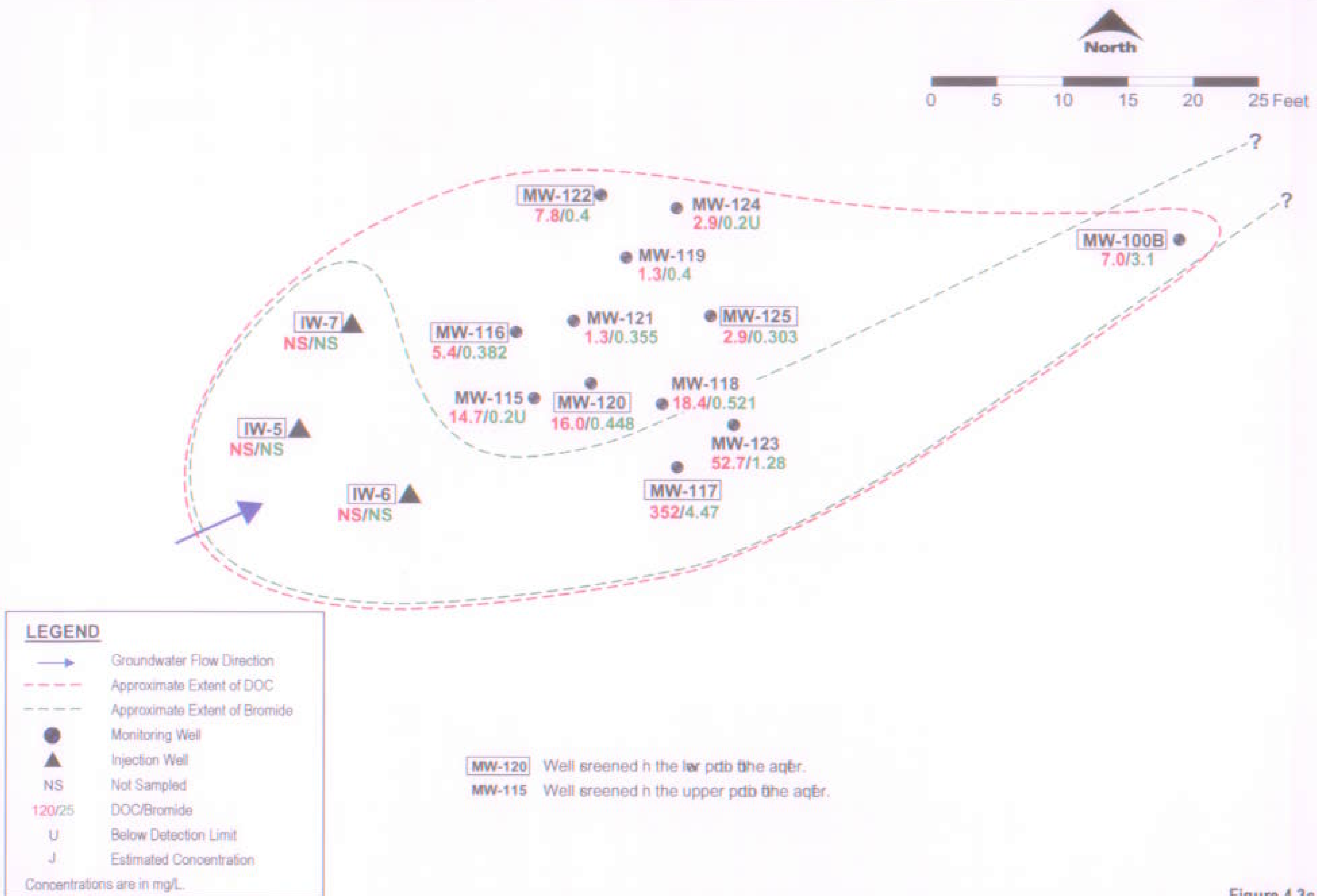

Figure 4.3c
Bromide and Dissolved Organic Carbon (DOC) Concentrations in Groundwater, July 2003 - Post Injection #13
Study Area 1, Memphis Depot

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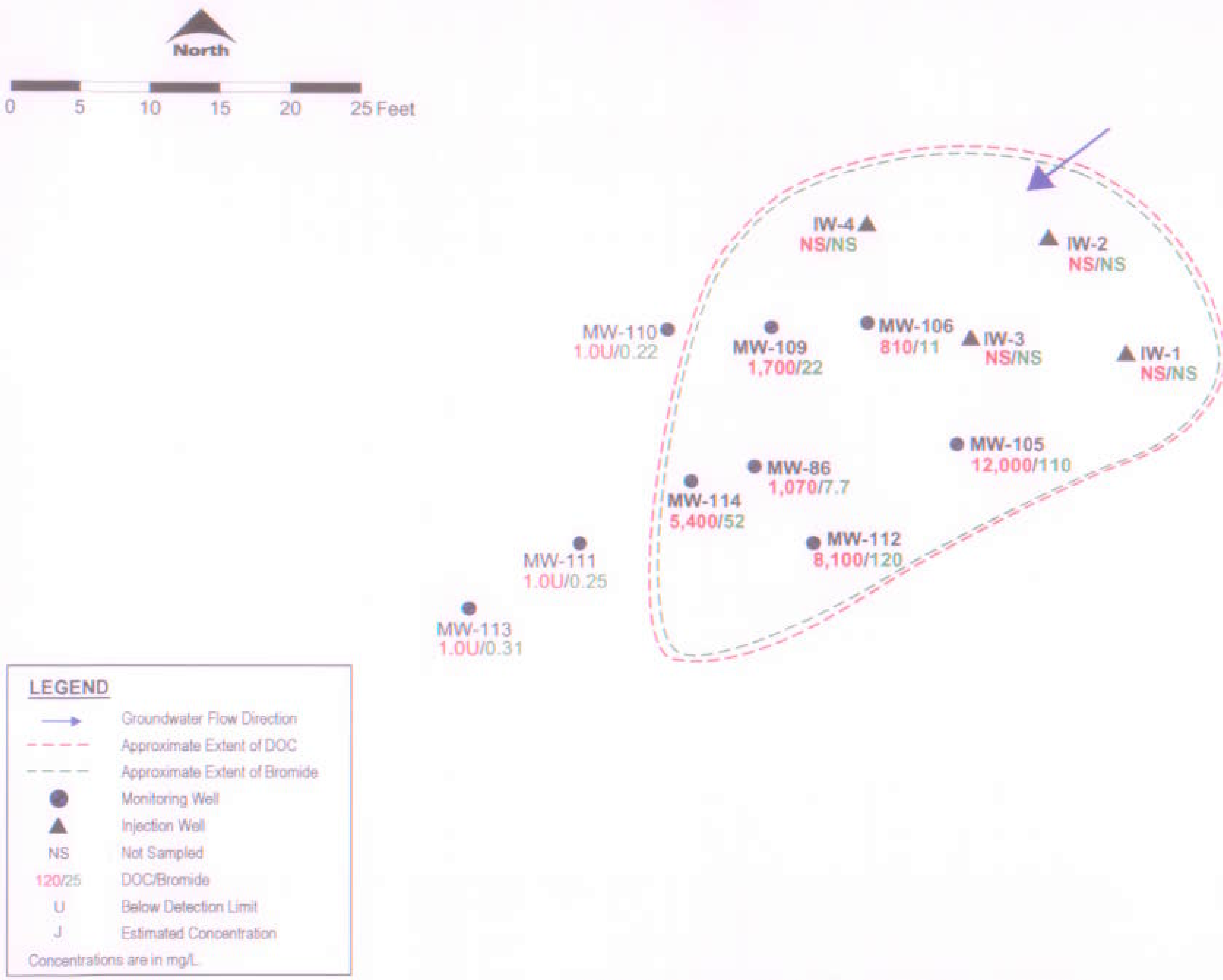

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Figure 4.4a
Bromide and Dissolved Organic Carbon (DOC) Concentrations in Groundwater, July 2002 - Post Injection #1
Study Area 2, Memphis Depot

794 154

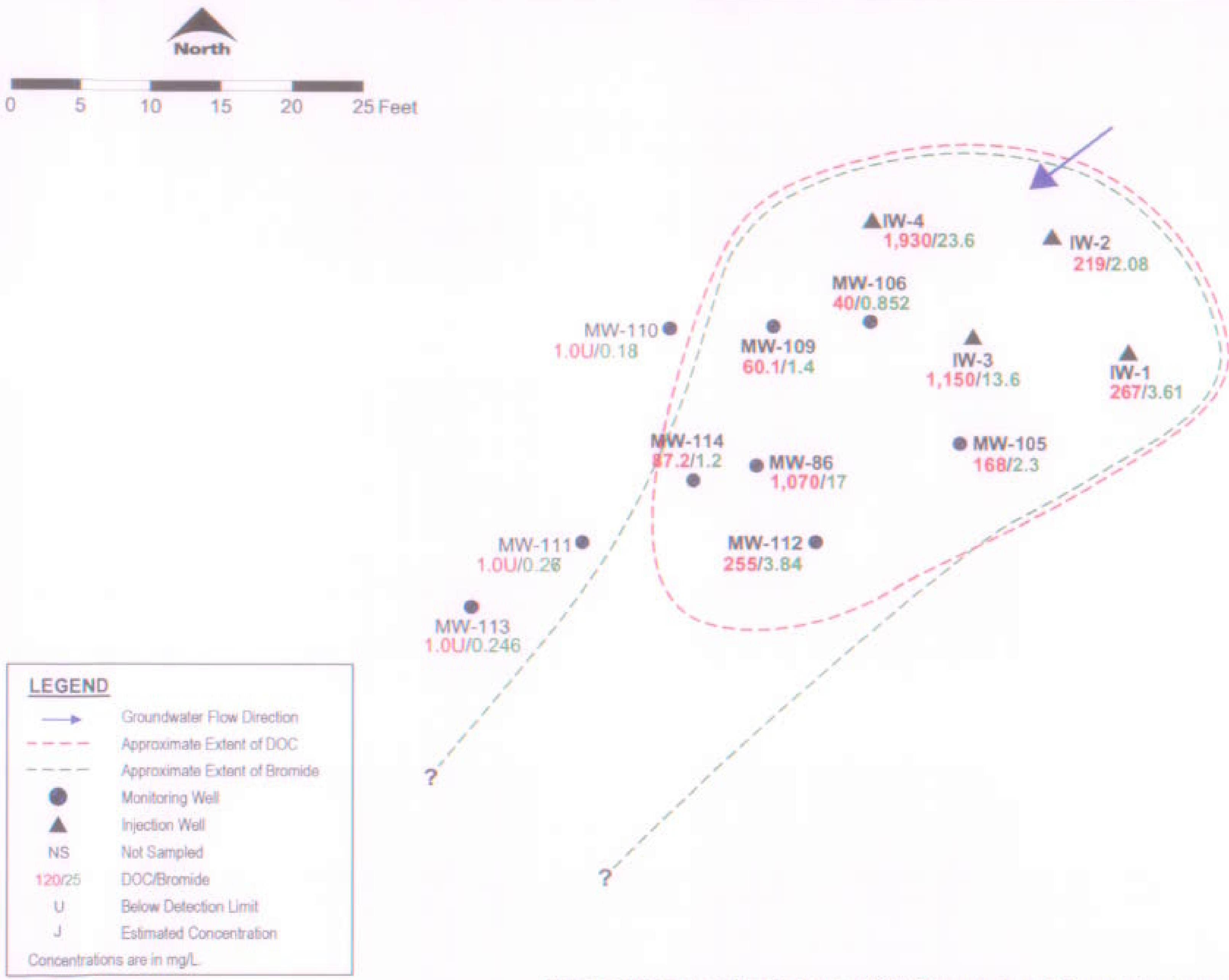

Figure 4.4b
Bromide and Dissolved Organic Carbon (DOC) Concentrations in Groundwater, January 2003 - Post Injection #7
Study Area 2, Memphis Depot

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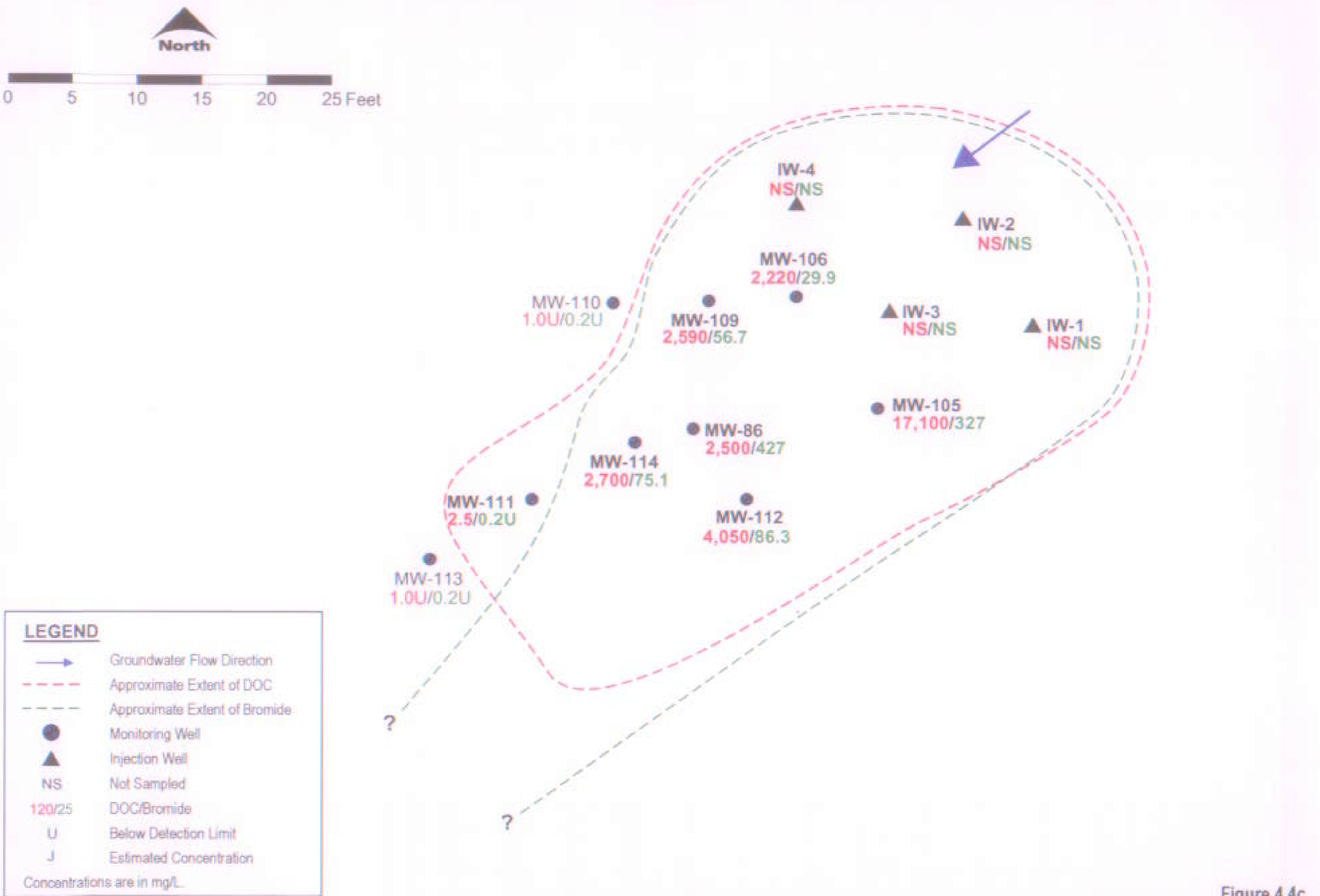

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Figure 4.4c
Bromide and Dissolved Organic Carbon (DOC) Concentrations in Groundwater, March 2003 - Post Injection #9
Study Area 2, Memphis Depot

794 156

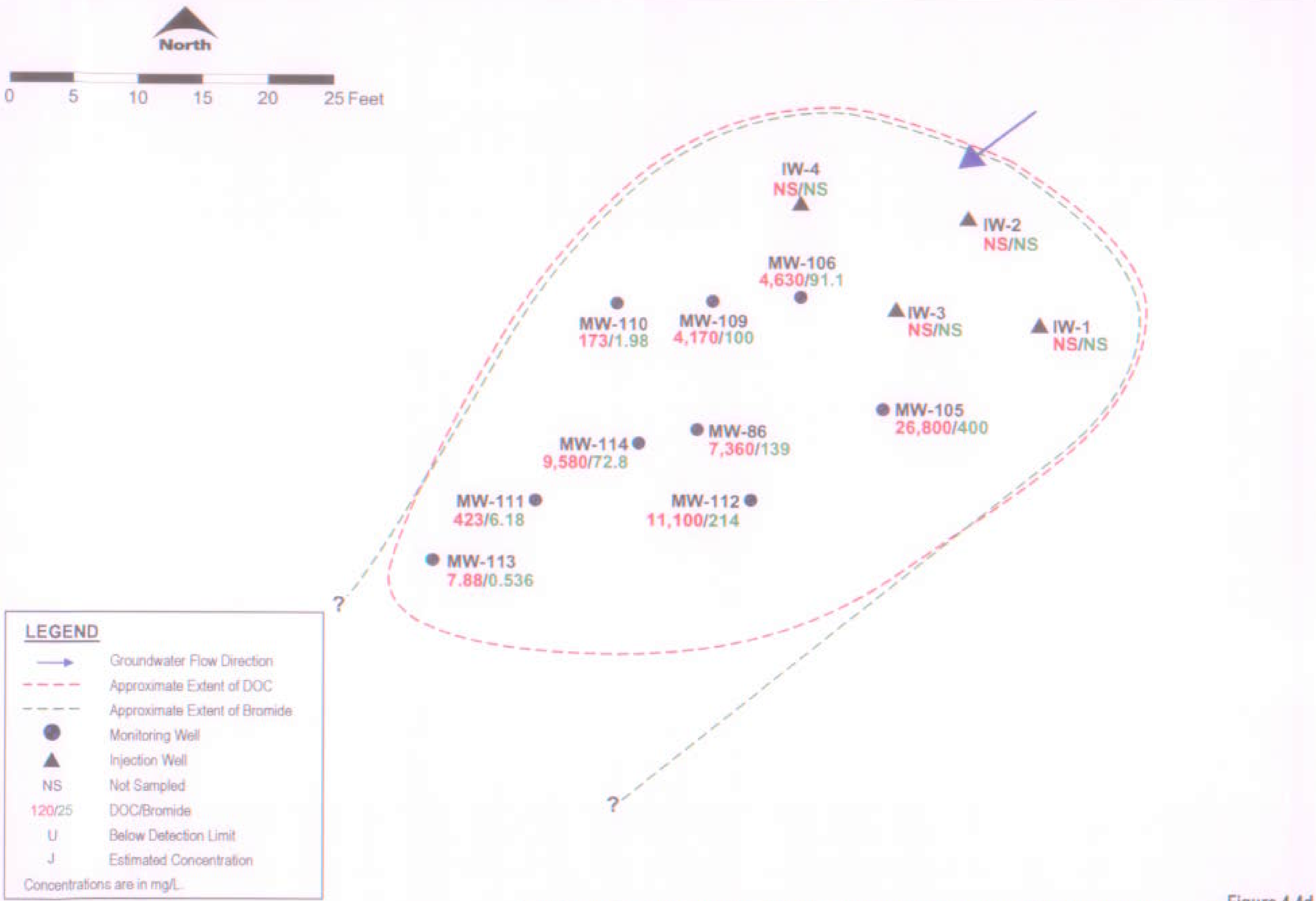

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Figure 4.4d
Bromide and Dissolved Organic Carbon (DOC) Concentrations in Groundwater, May 2003 - Post Injection #11
Study Area 2, Memphis Depot

794 157

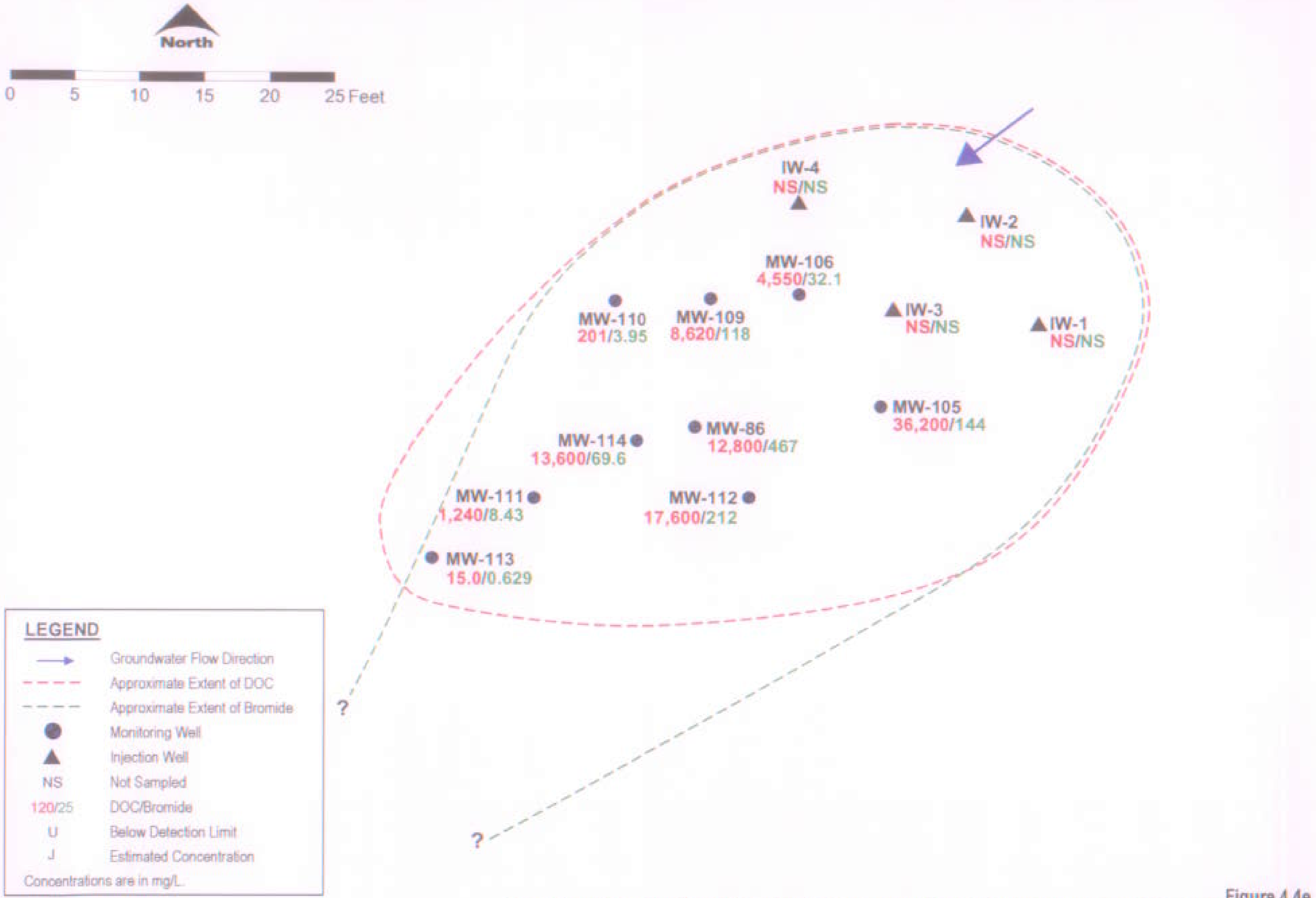

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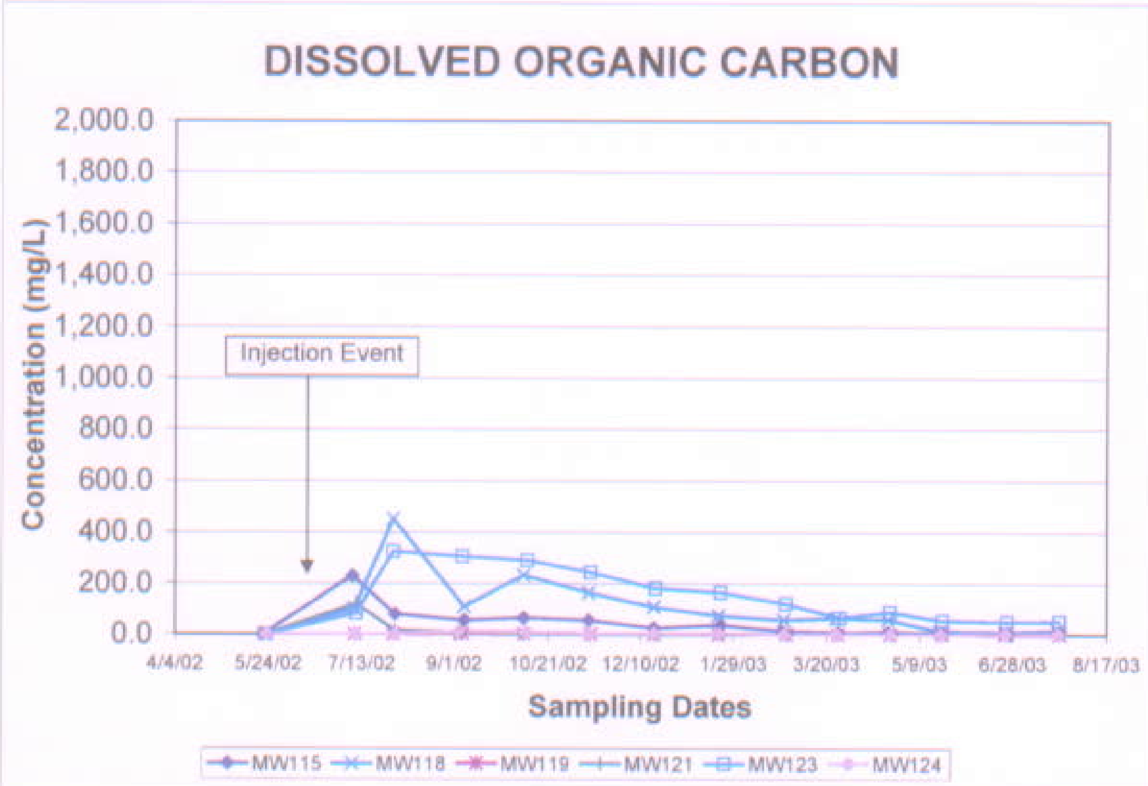
Figure 4.4e
Bromide and Dissolved Organic Carbon (DOC) Concentrations in Groundwater, June 2003 - Post Injection #12
Study Area 2, Memphis Depot

794 158

Table 4.5a
Dissolved Organic Carbon and Bromide Breakthrough
Area 1: Upper Screened Interval
Main Installation, Memphis Depot



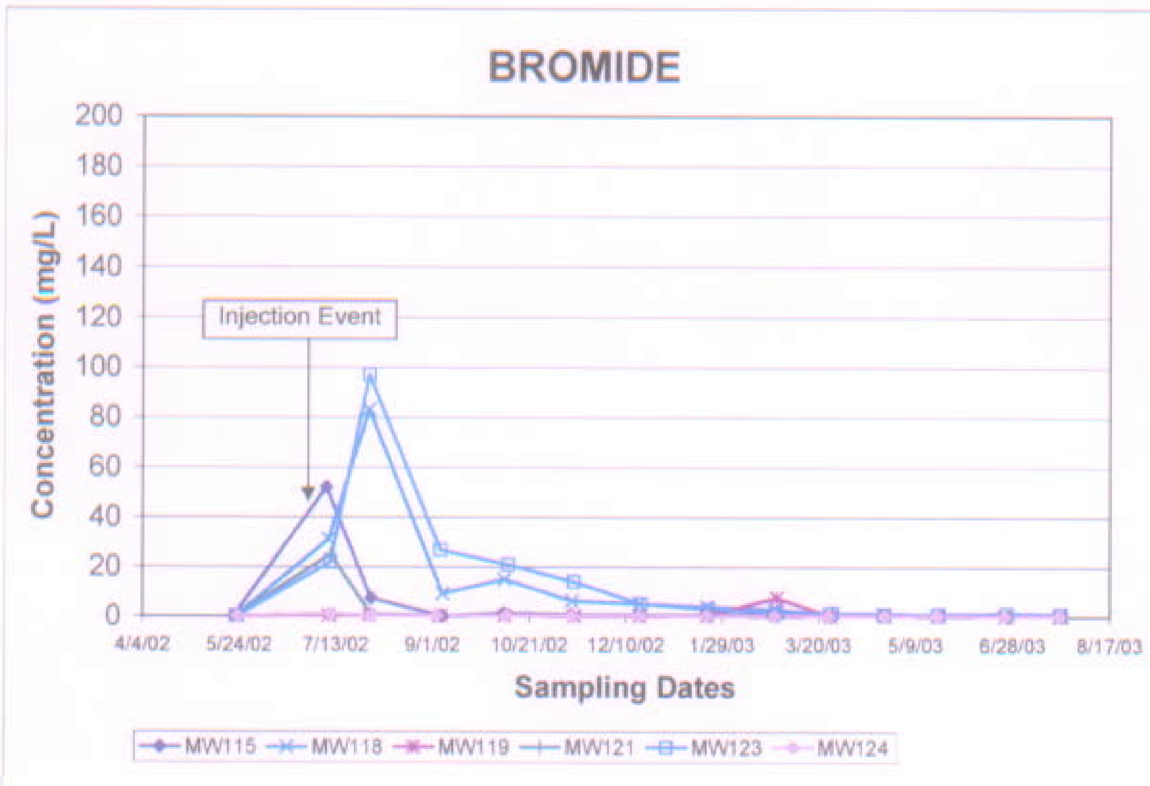
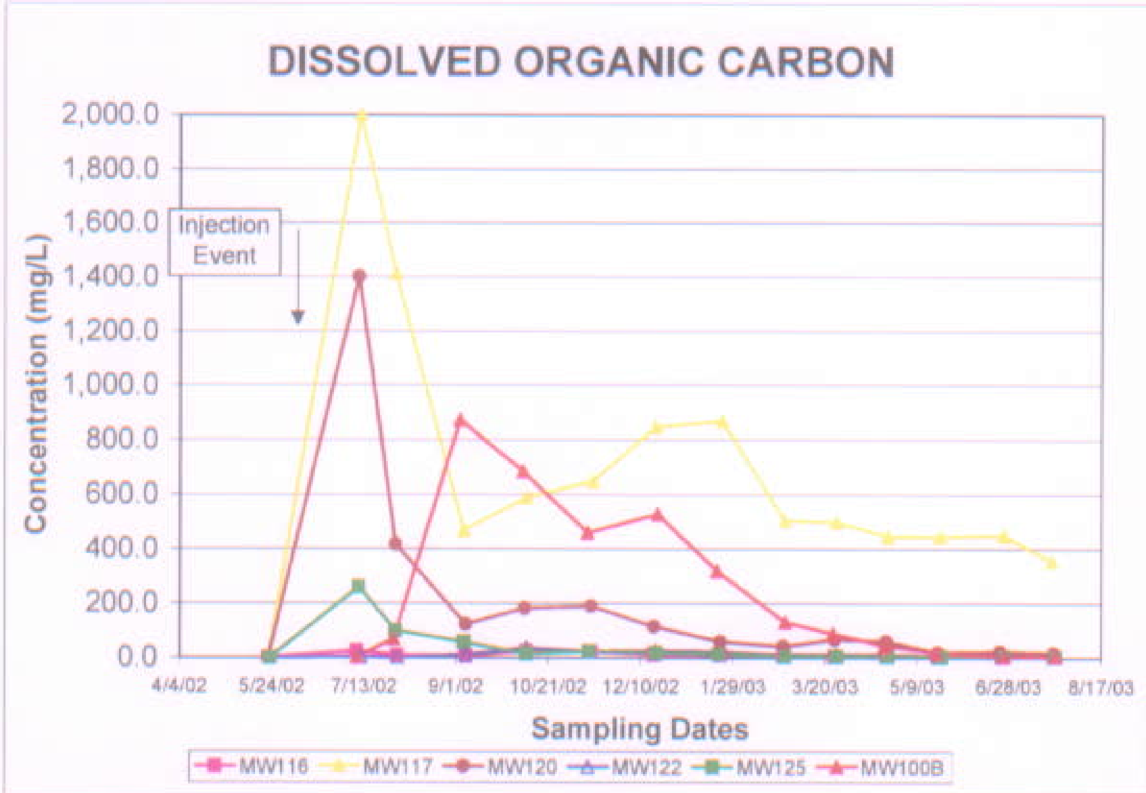


Table 4.5b
Dissolved Organic Carbon and Bromide Breakthrough
Area 1: Lower Screened Interval
Main Installation, Memphis Depot



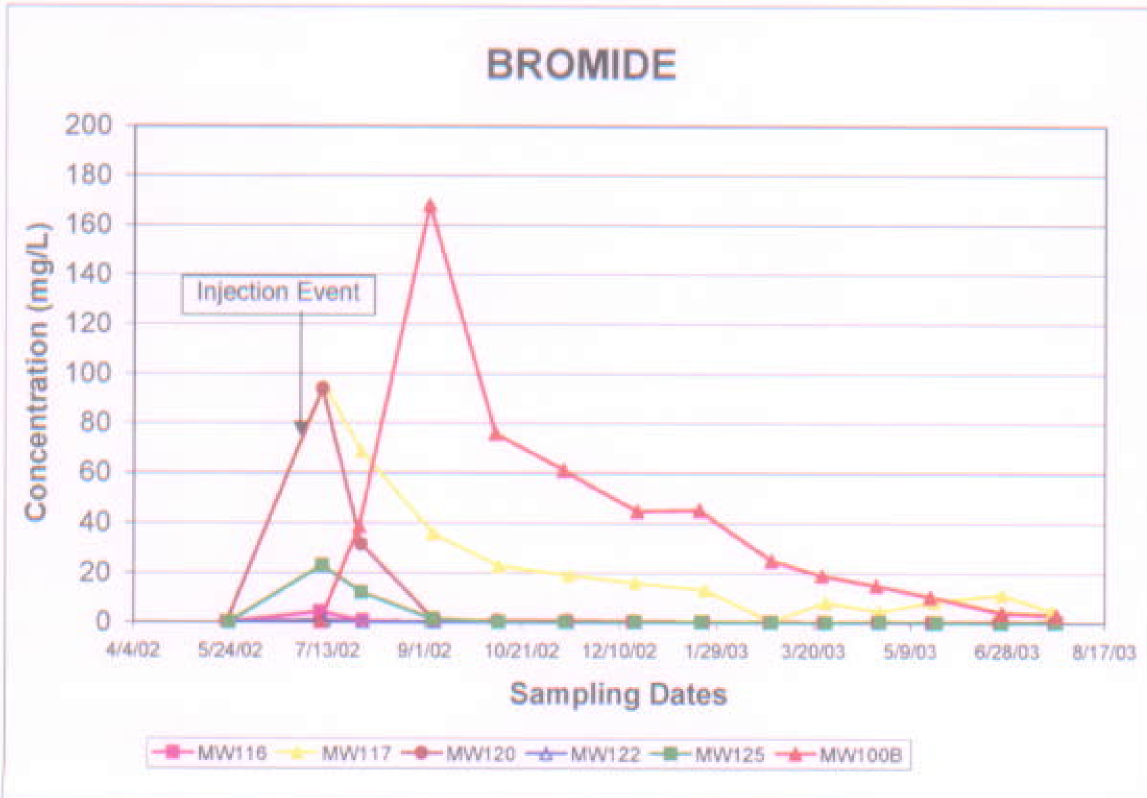
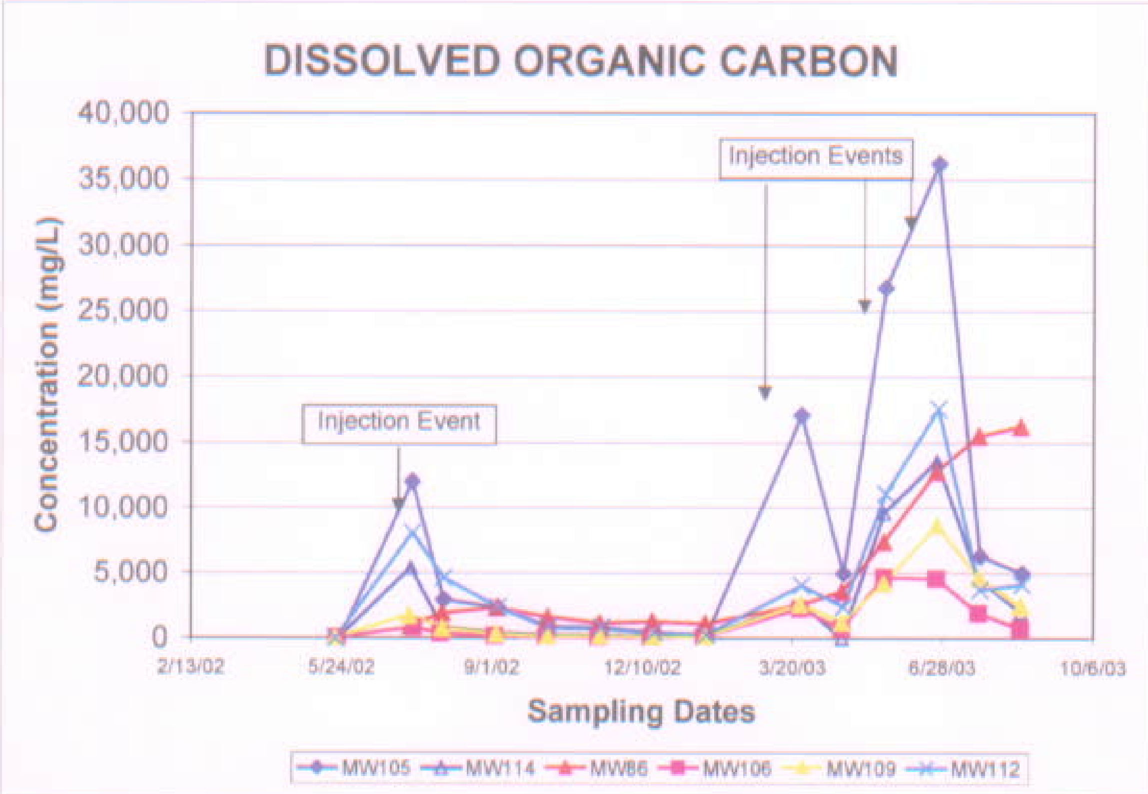


Table 4.6a
Dissolved Organic Carbon and Bromide Breakthrough
Area 2: Sodium Lactate Detected Following First Injection
Main Installation, Memphis Depot



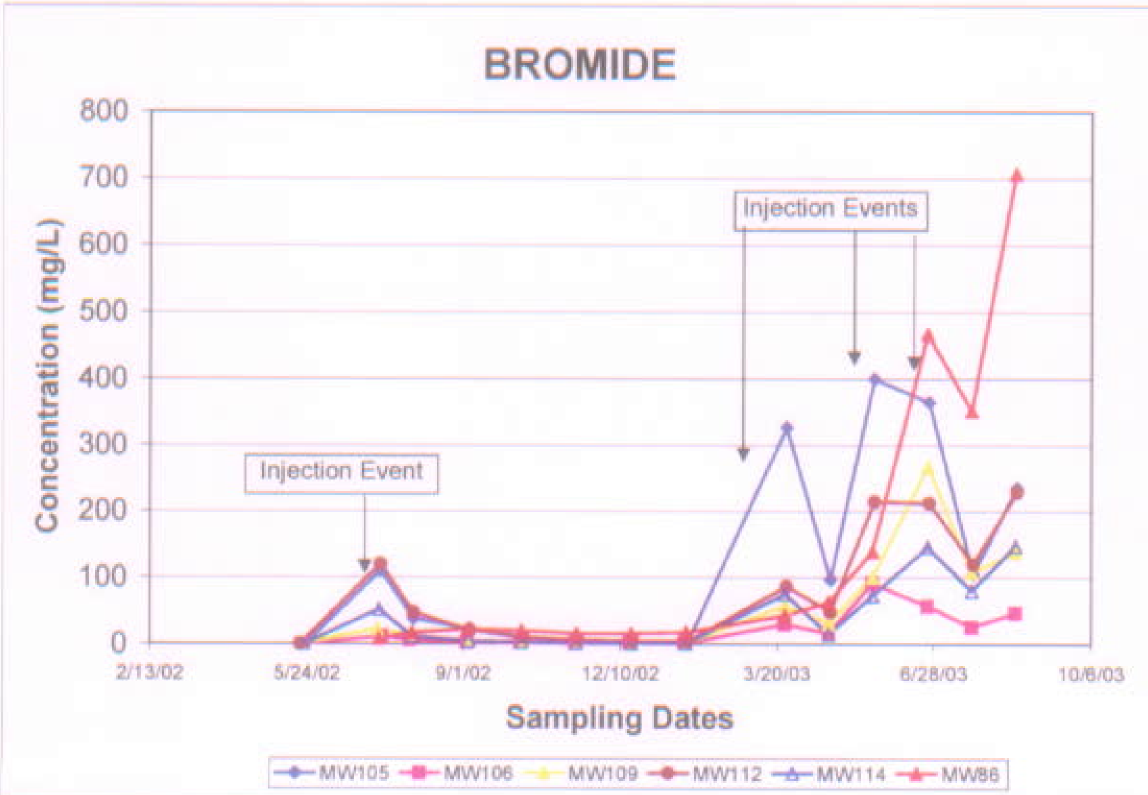
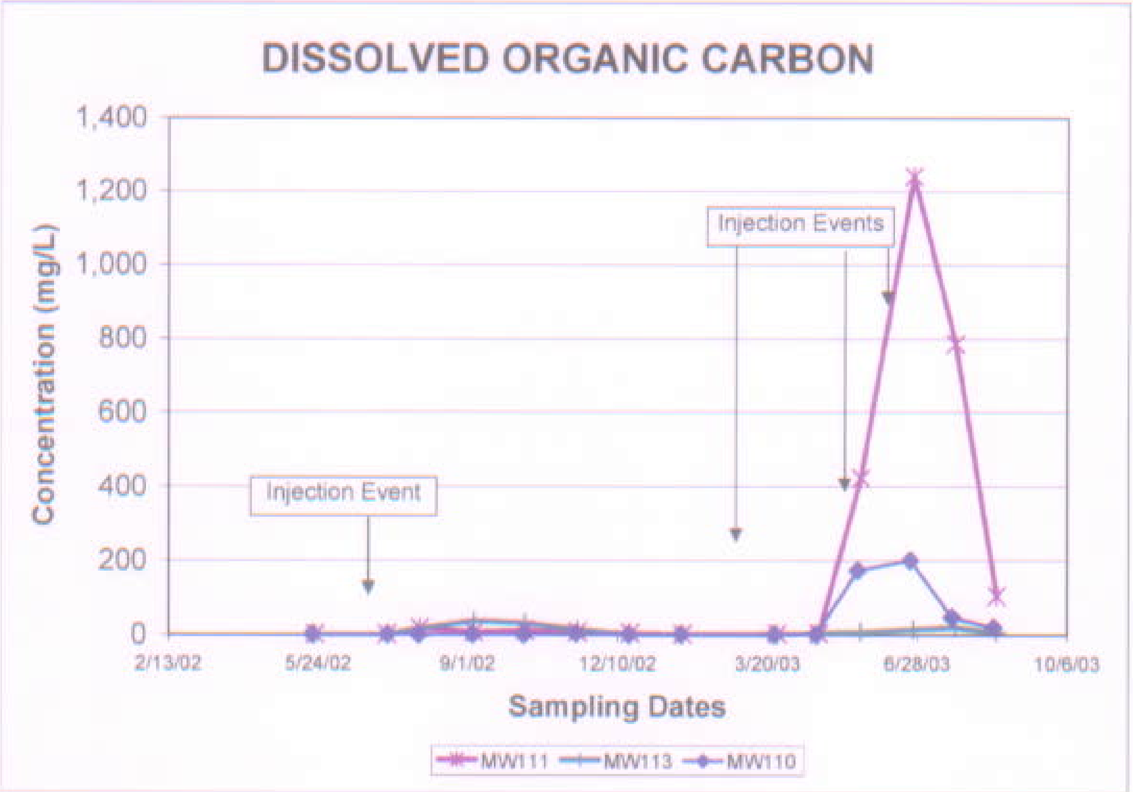


Table 4.6b
Dissolved Organic Carbon and Bromide Breakthrough
Area 2: Sodium Lactate Not Detected Following First Injection
Main Installation, Memphis Depot



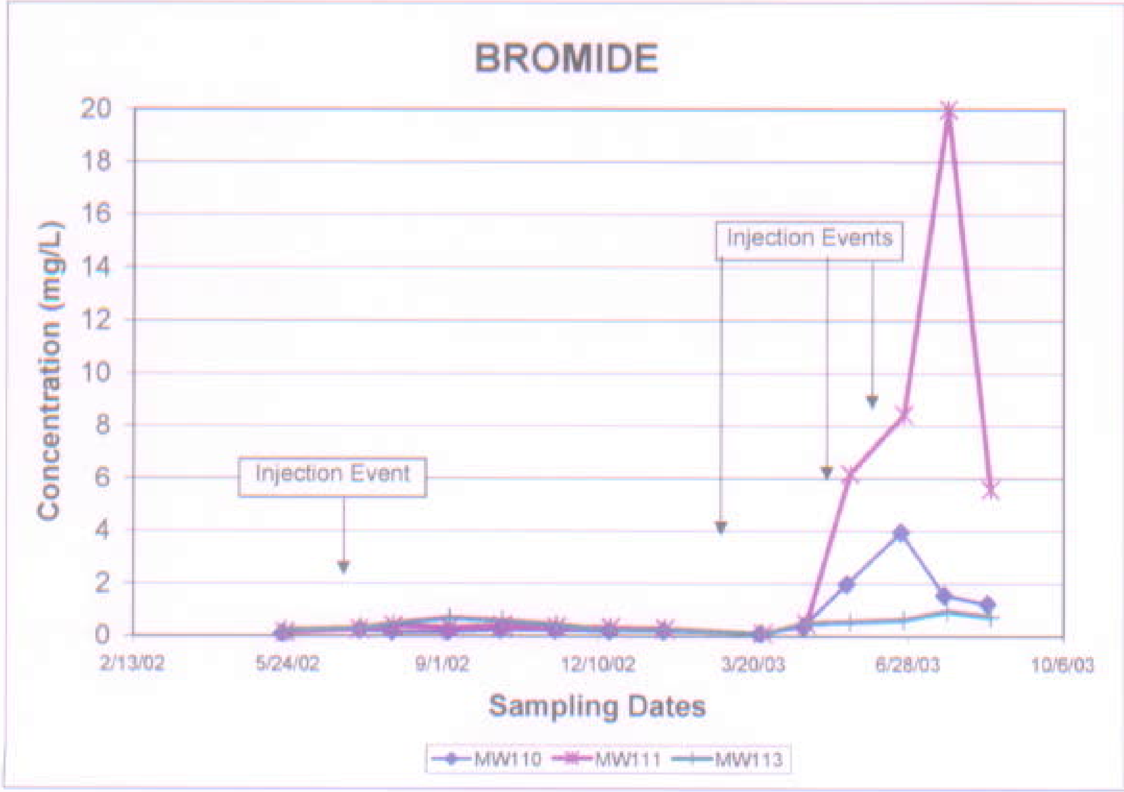


Figure 4.7a
Distribution of Geochemical Parameters - Baseline May 2002
Study Area 1, Memphis Depot

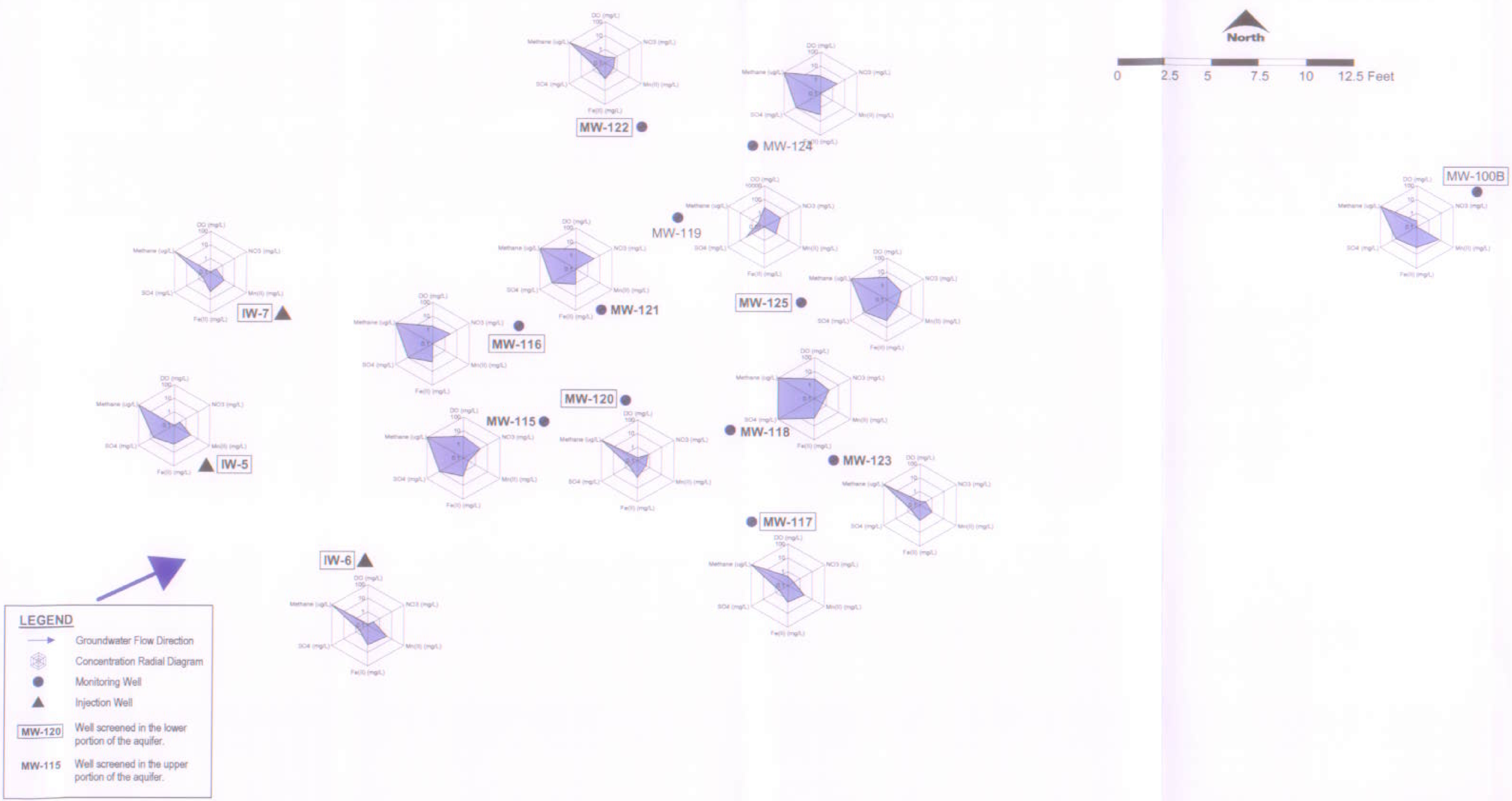


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Figure 4.7b
Distribution of Geochemical Parameters - January 2003
Study Area 1, Memphis Depot

Figure 4.7c
Distribution of Geochemical Parameters - July 2003
Study Area 1, Memphis Depot

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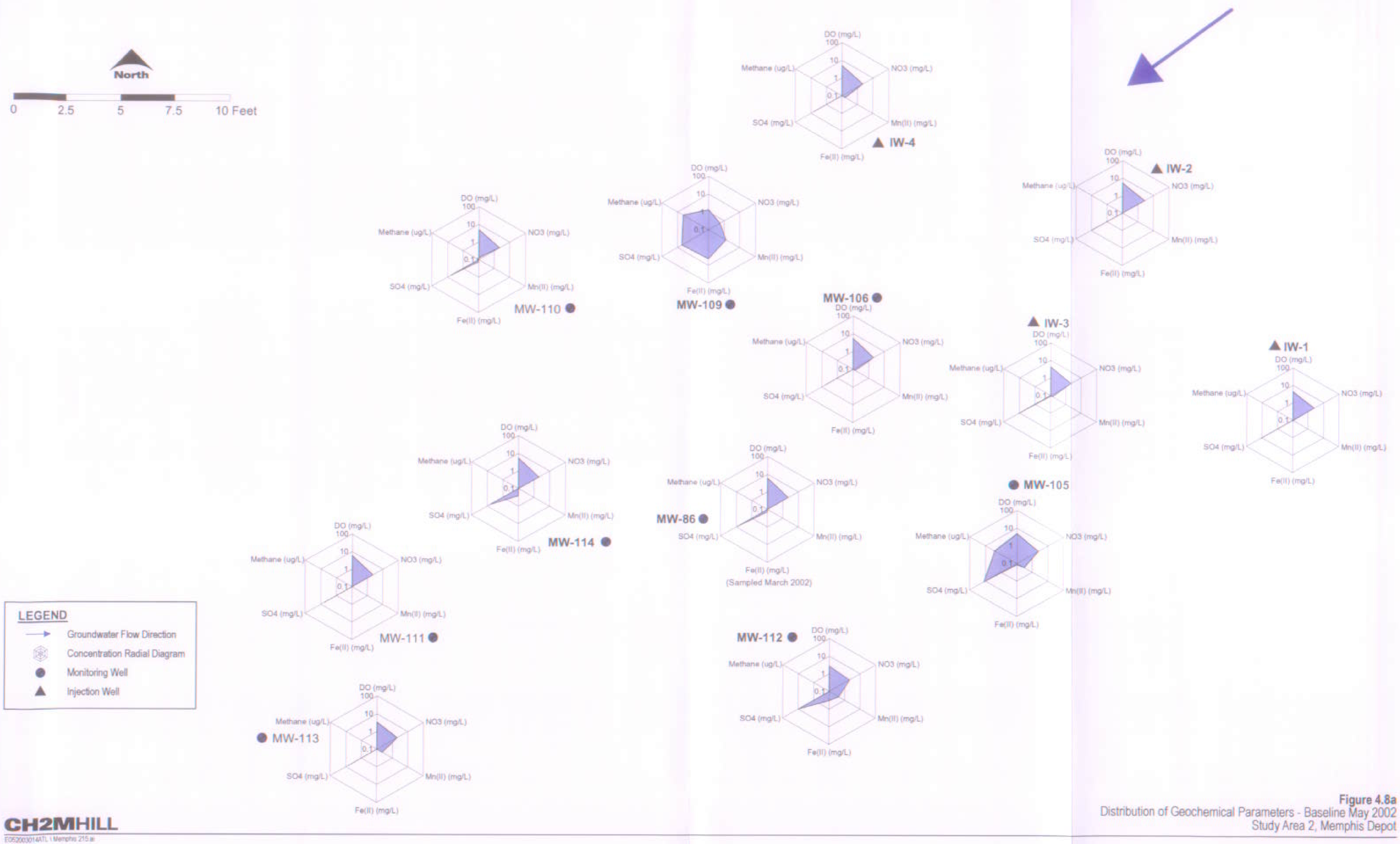

Figure 4.8a
Distribution of Geochemical Parameters - Baseline May 2002
Study Area 2, Memphis Depot

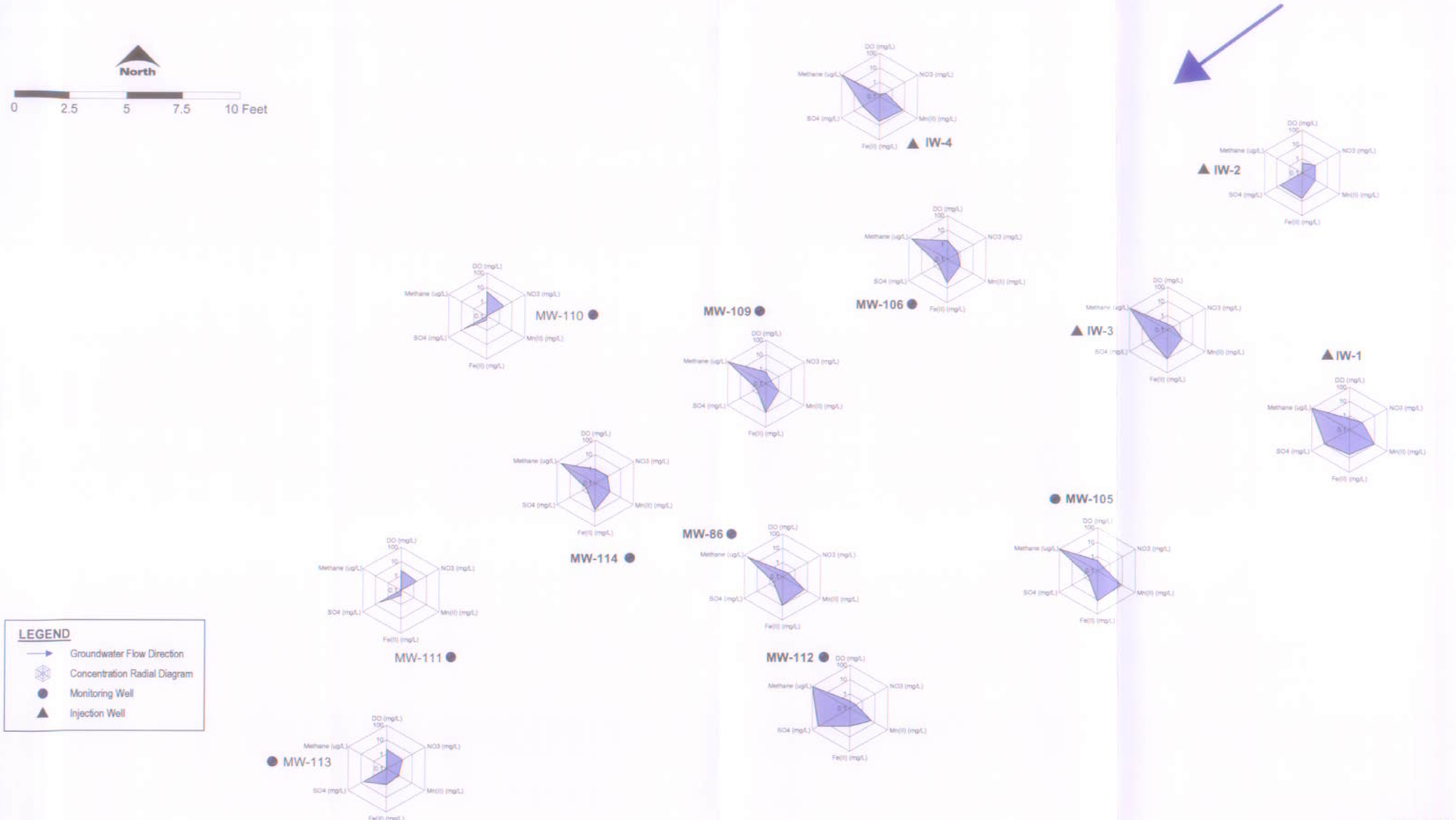

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Figure 4.8b
Distribution of Geochemical Parameters - January 2003
Study Area 2, Memphis Depot

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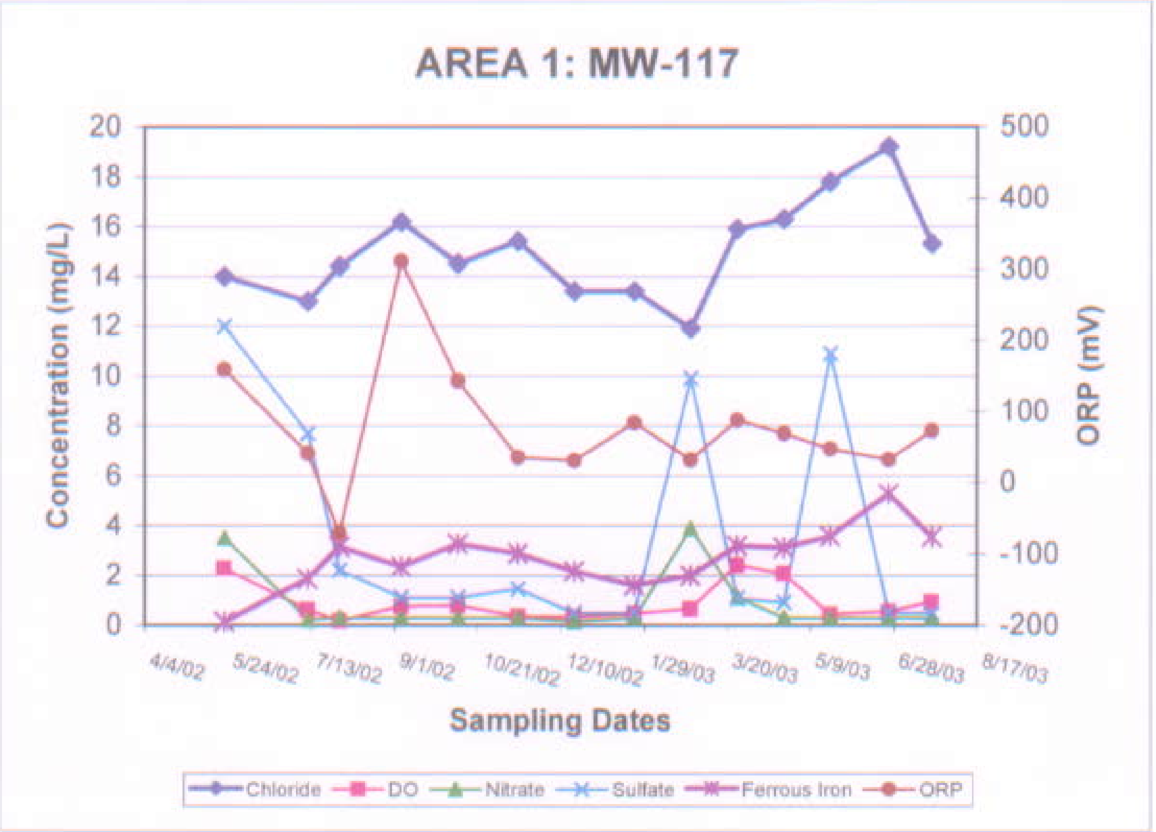
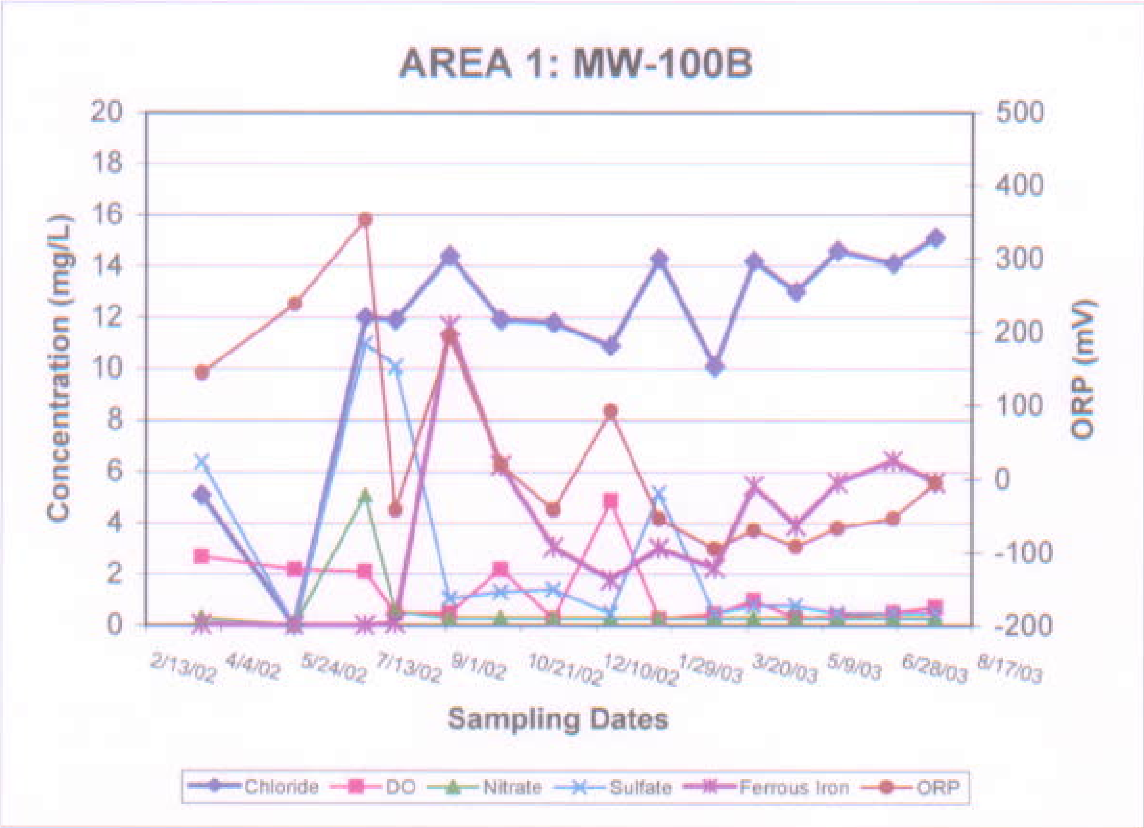
Figure 4.8c
Distribution of Geochemical Parameters - August 2003
Study Area 2, Memphis Depot

Table 4.9a
Area 1: Geochemical Parameters of Downgradient Monitoring Well MW-117
Main Installation, Memphis Depot



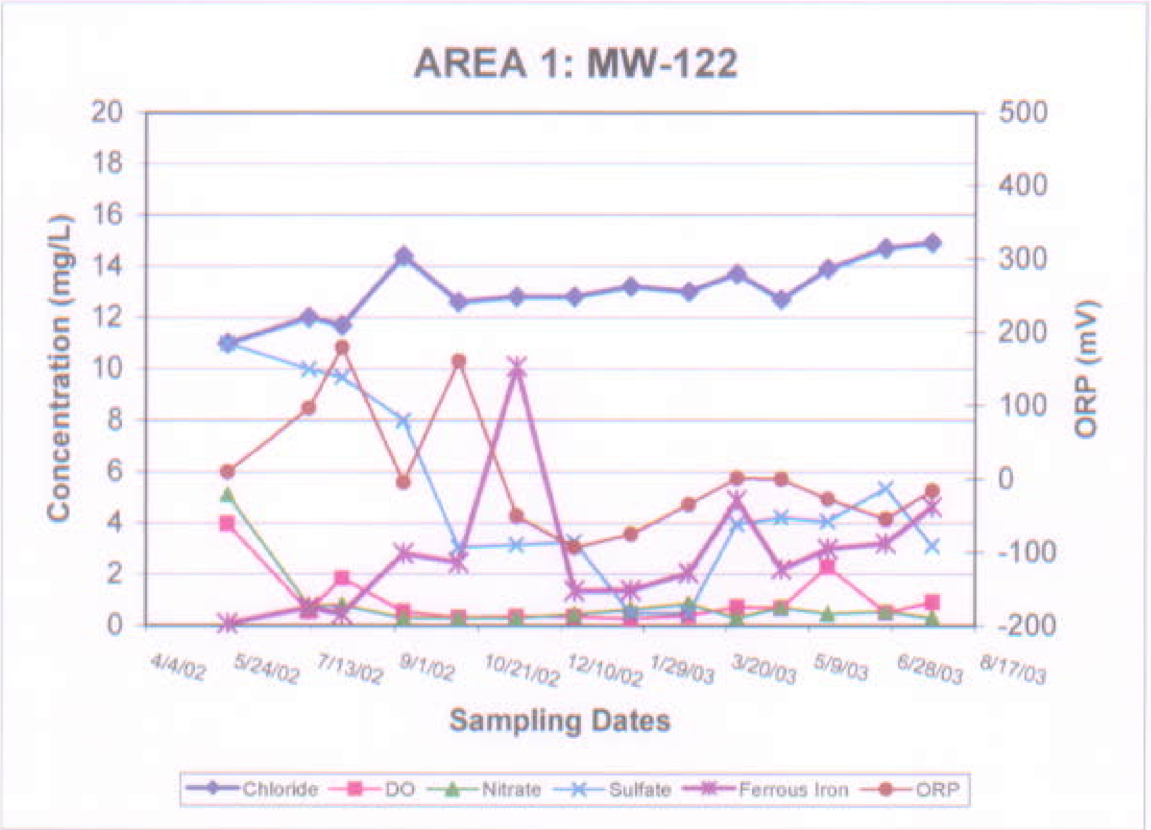
Note: Gap(s) in graph are due to suspect analytical data.

Table 4.9b
Area 1: Geochemical Parameters of Downgradient Monitoring Well MW-100B
Main Installation, Memphis Depot



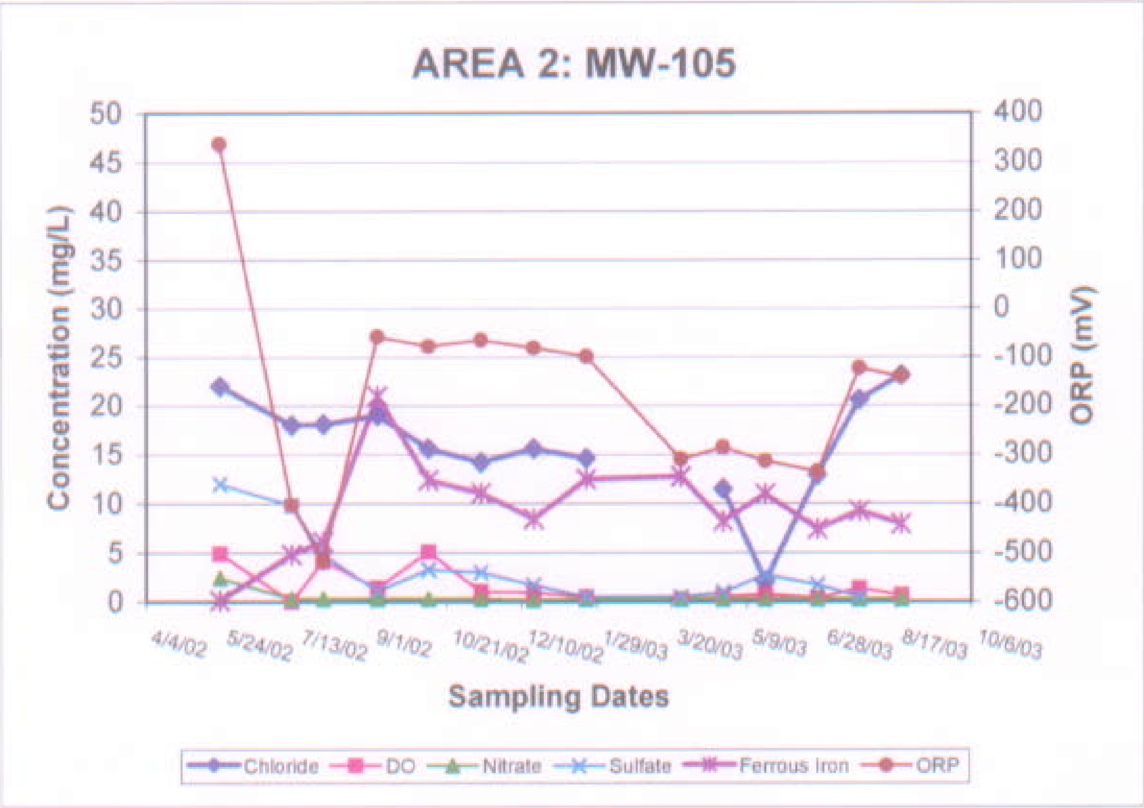
Note: Gap(s) in graph are due to suspect analytical data.

Table 4.9c
Area 1: Geochemical Parameters of Downgradient Monitoring Well MW-122
Main Installation, Memphis Depot



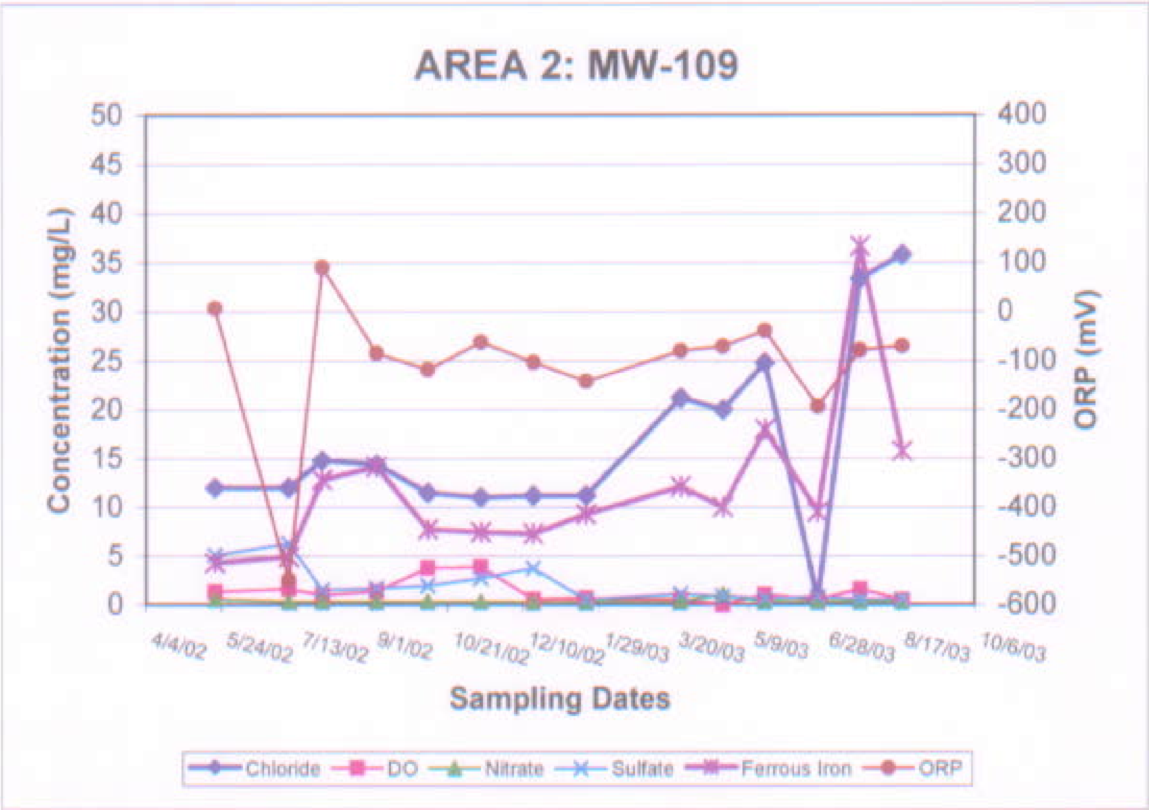
Note: Gap(s) in graph are due to suspect analytical data.

Table 4.10a
Area 1: Geochemical Parameters of Downgradient Monitoring Well MW-105
Main Installation, Memphis Depot



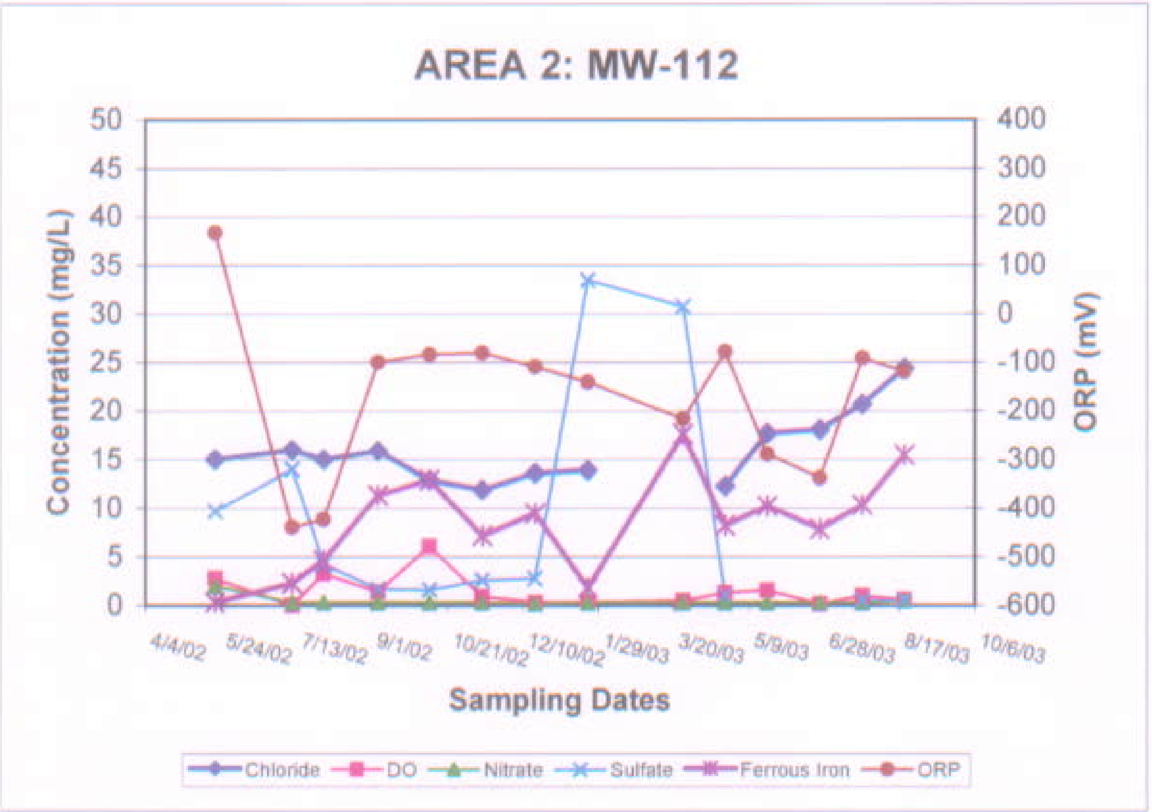
Note: Gap(s) in graph are due to suspect analytical data.

Table 4.10b
Area 1: Geochemical Parameters of Downgradient Monitoring Well MW-109
Main Installation, Memphis Depot

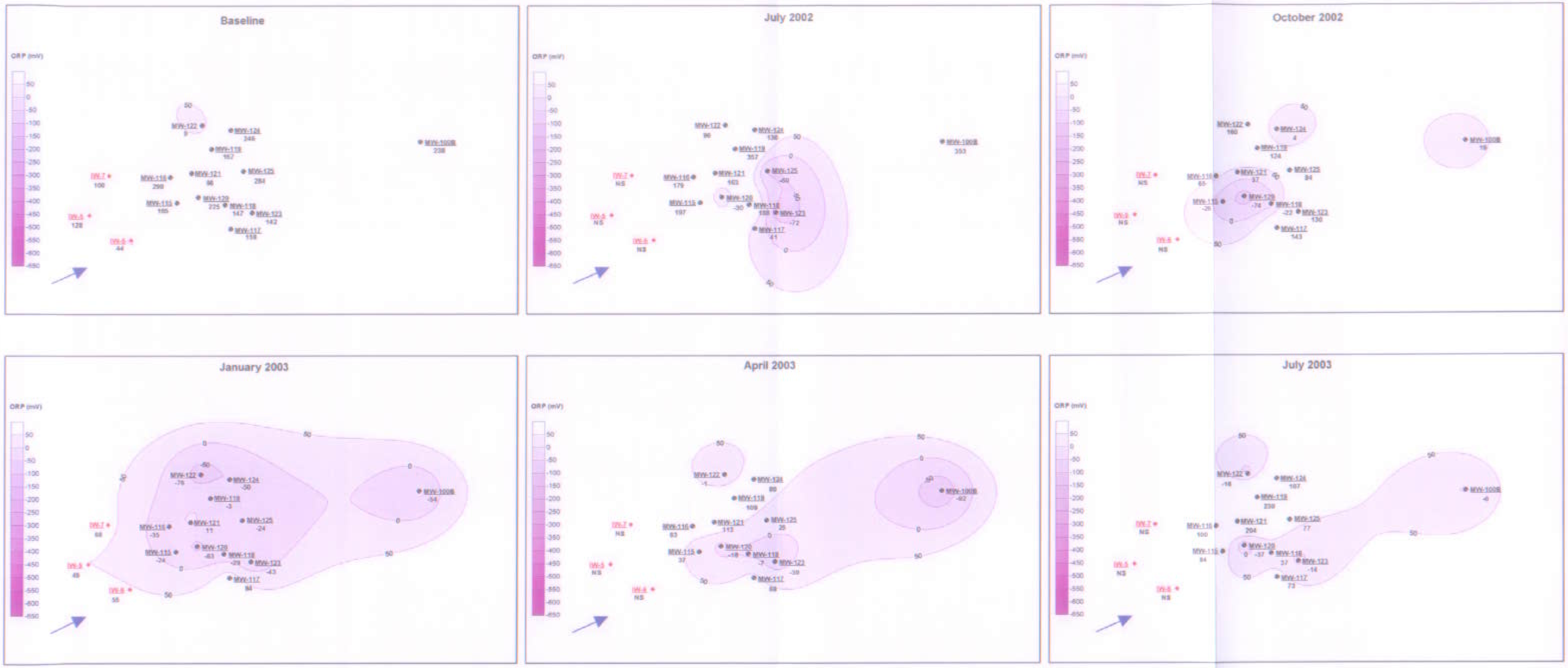


Note: Gap(s) in graph are due to suspect analytical data.

Table 4.10c
Area 1: Geochemical Parameters of Downgradient Monitoring Well MW-112
Main Installation, Memphis Depot



Note: Gap(s) in graph are due to suspect analytical data.



LEGEND

Groundwater Flow Direction

Monitoring Well Location

Injection Well Location

NS not sampled

Note: All measurements in millivolts (mV).

N

Scale: 0 2 4 6 8 10 FEET

FIGURE 4.11
Oxidation-Reduction Potential in Groundwater
Study Area 1
Main Installation, Memphis Depot

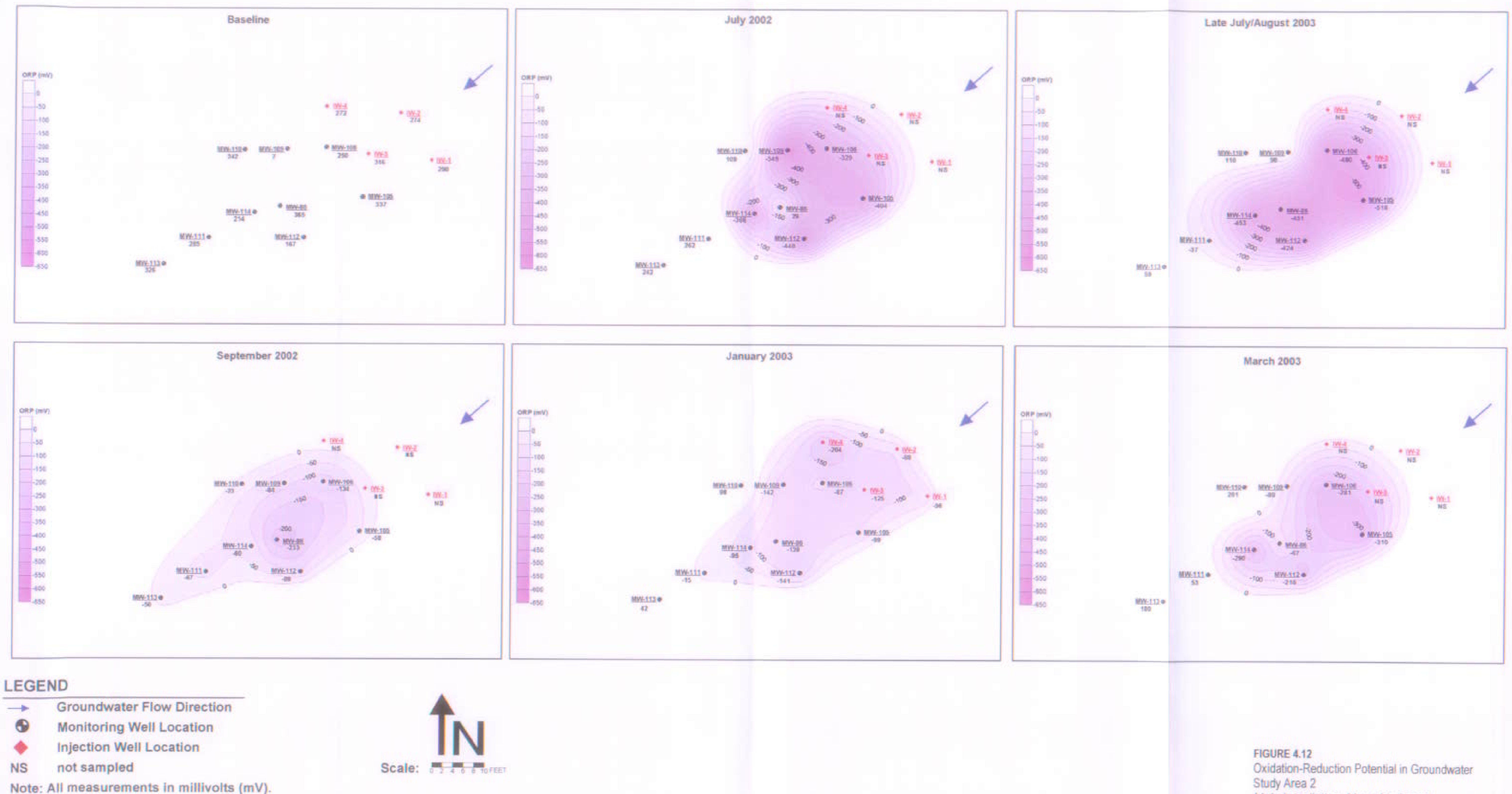
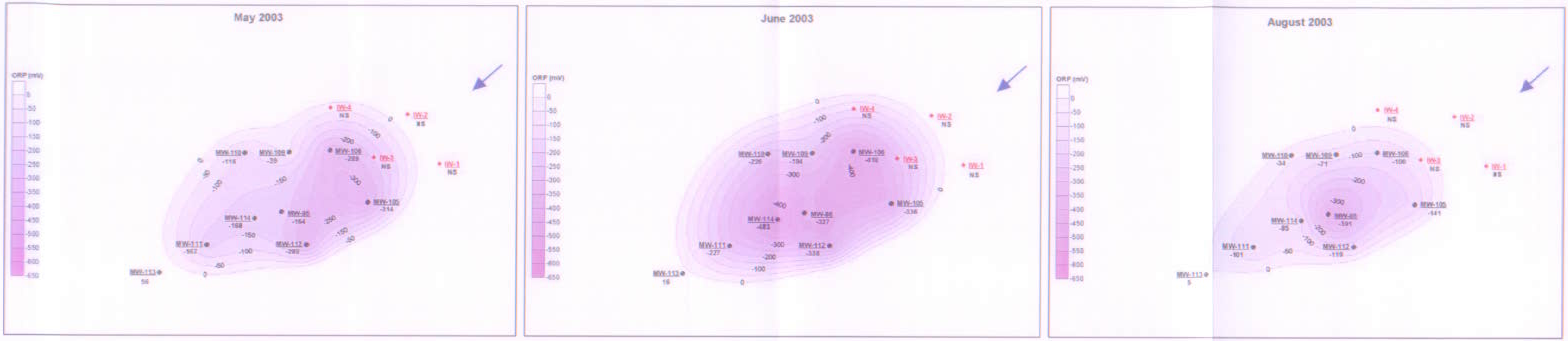


FIGURE 4.12
Oxidation-Reduction Potential in Groundwater
Study Area 2
Main Installation, Memphis Depot



LEGEND

- → Groundwater Flow Direction
- Monitoring Well Location
- Injection Well Location
- NS not sampled

Note: All measurements in millivolts (mV).

Scale:

FIGURE 4.12, CONTINUED
Oxidation-Reduction Potential in Groundwater
Study Area 2
Main Installation, Memphis Depot

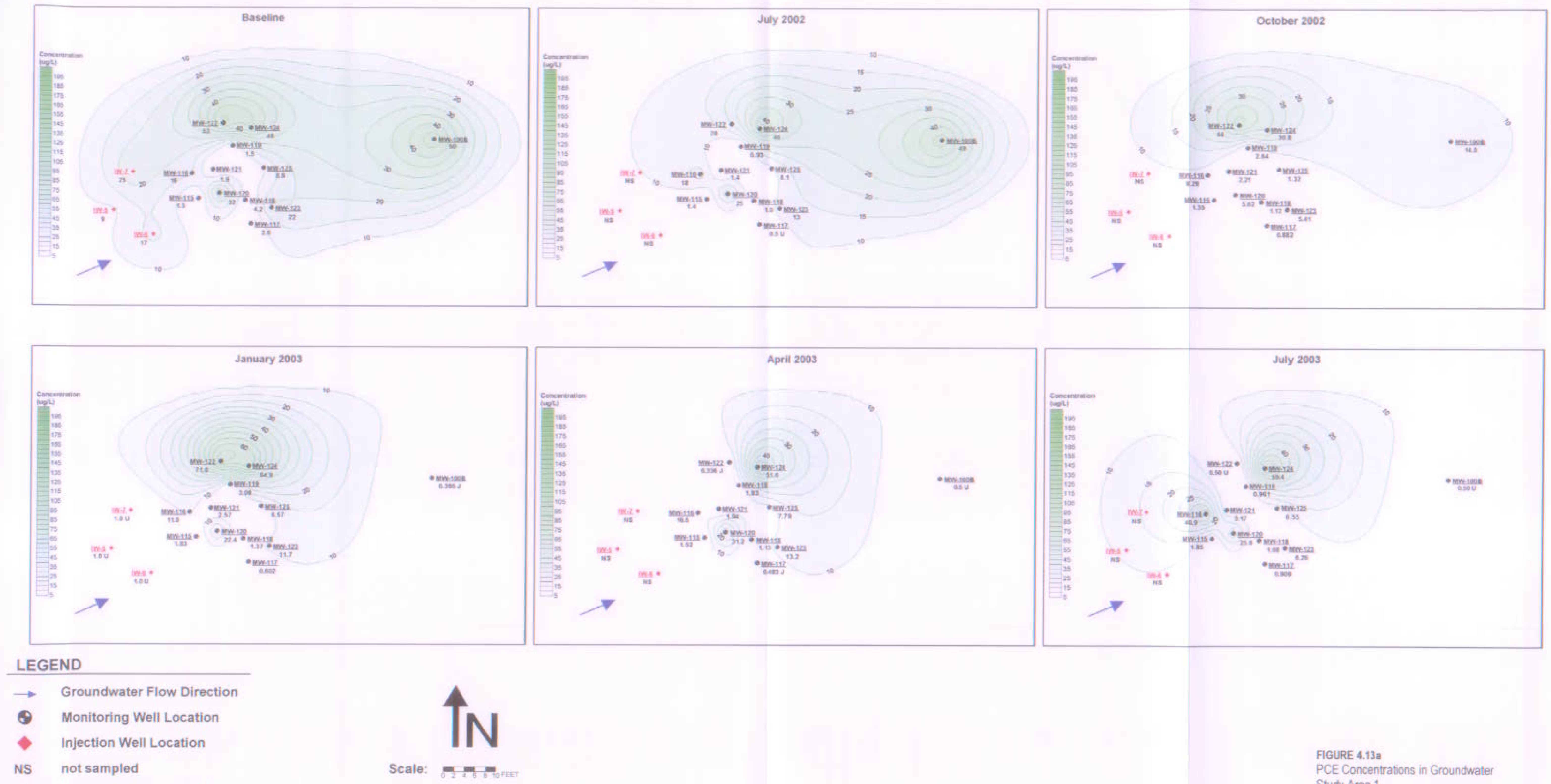
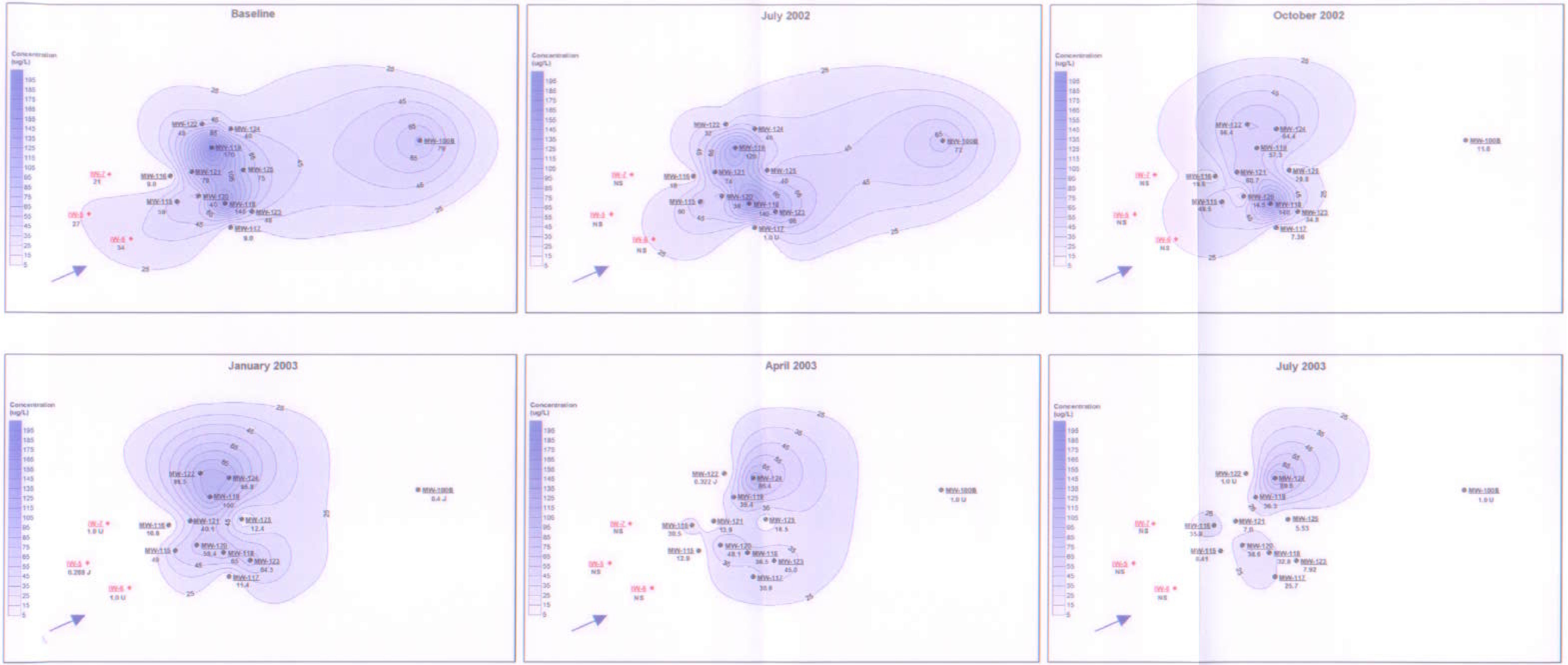


FIGURE 4.13a
PCE Concentrations in Groundwater
Study Area 1
Main Installation, Memphis Depot



LEGEND

- Groundwater Flow Direction
- Monitoring Well Location
- Injection Well Location
- NS not sampled

Note: All concentrations in µg/L.

Scale: 0 2 4 6 8 10 FEET

FIGURE 4.13b
TCE Concentrations in Groundwater
Study Area 1
Main Installation, Memphis Depot

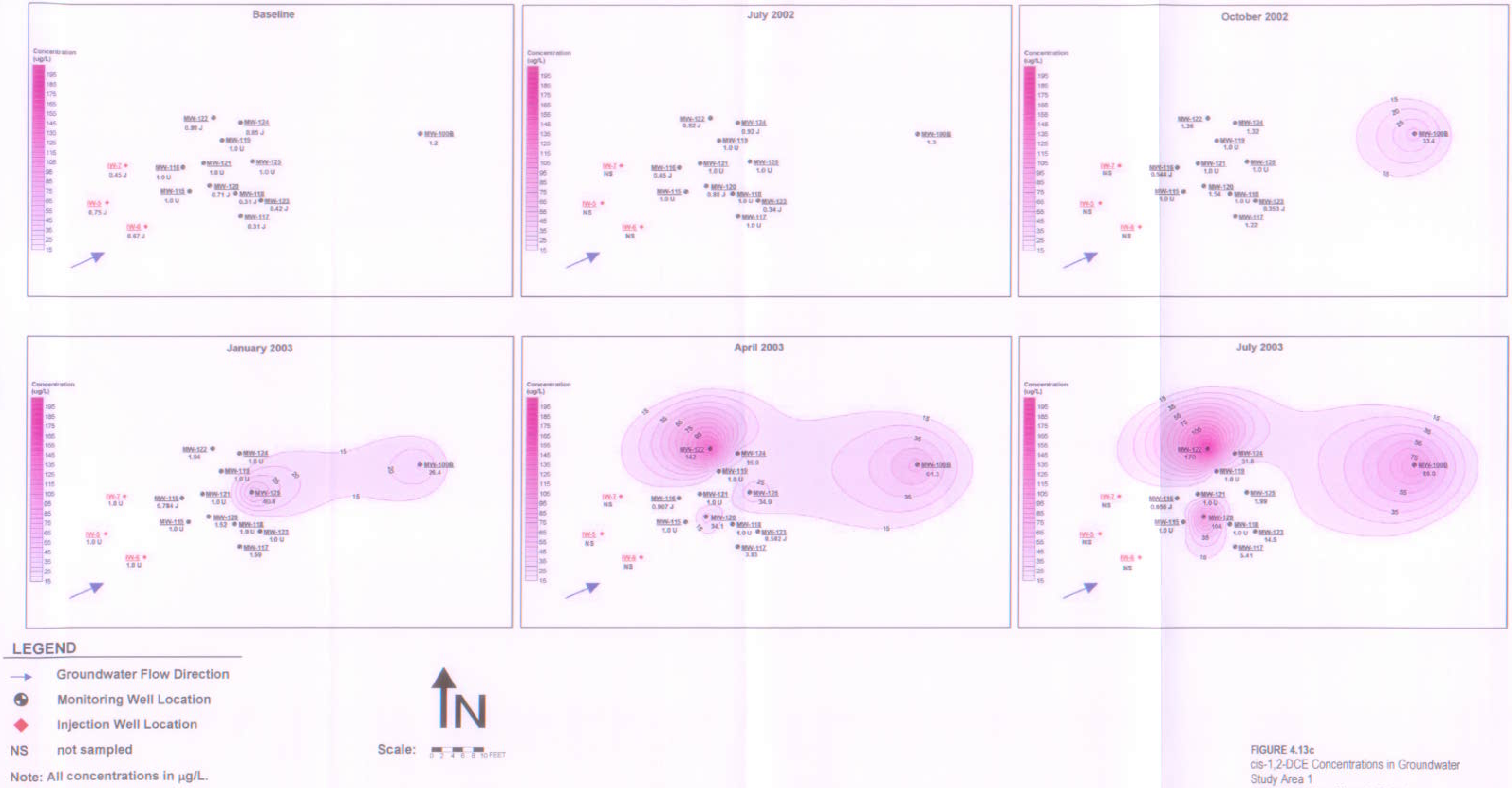


FIGURE 4.13c
cis-1,2-DCE Concentrations in Groundwater
Study Area 1
Main Installation, Memphis Depot

Figure 4.14
Study Area 1: Trends in Chlorinated Ethene Concentrations
Main Installation, Memphis Depot

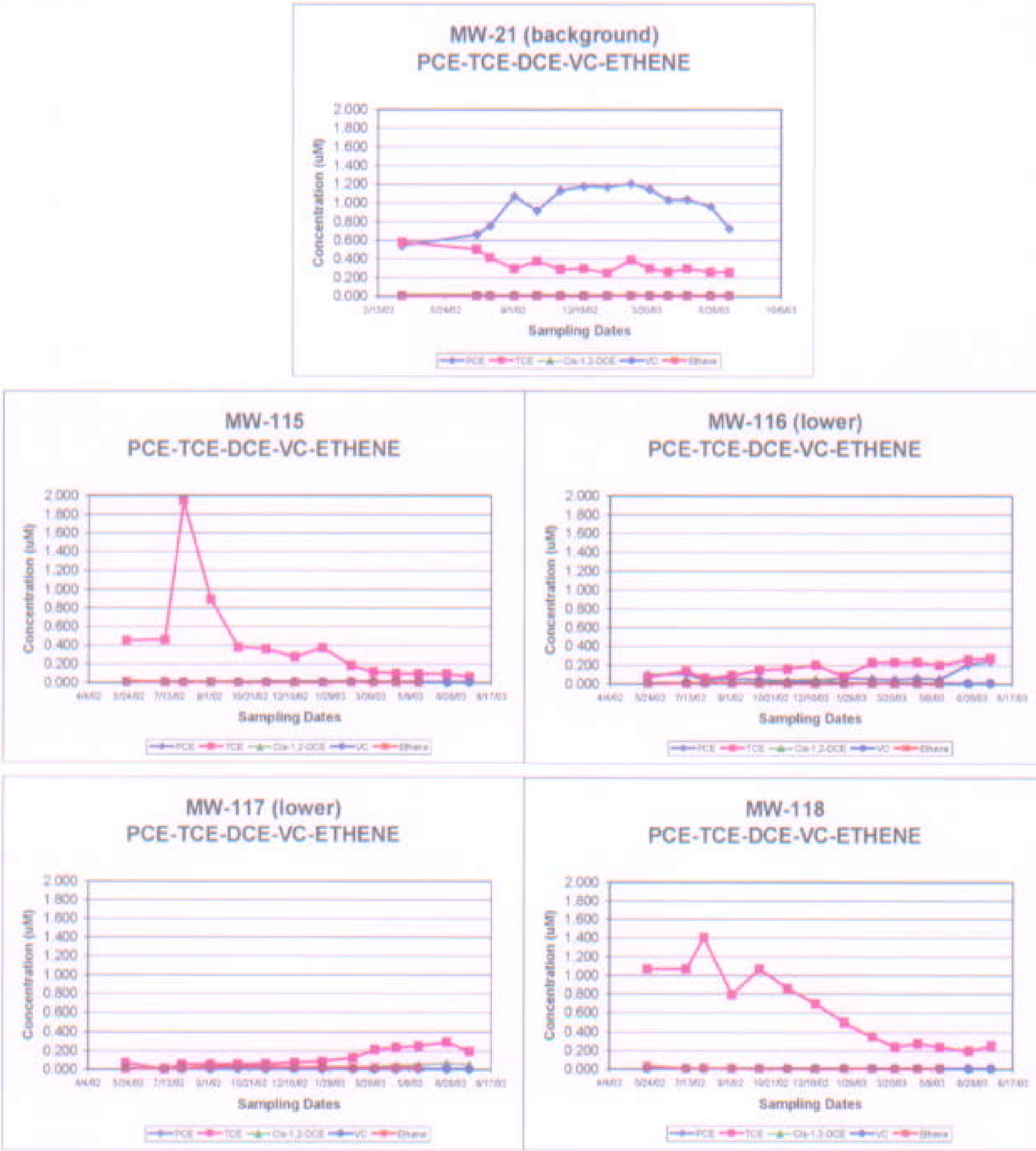


Figure 4.14
Study Area 1: Trends in Chlorinated Ethene Concentrations
Main Installation, Memphis Depot

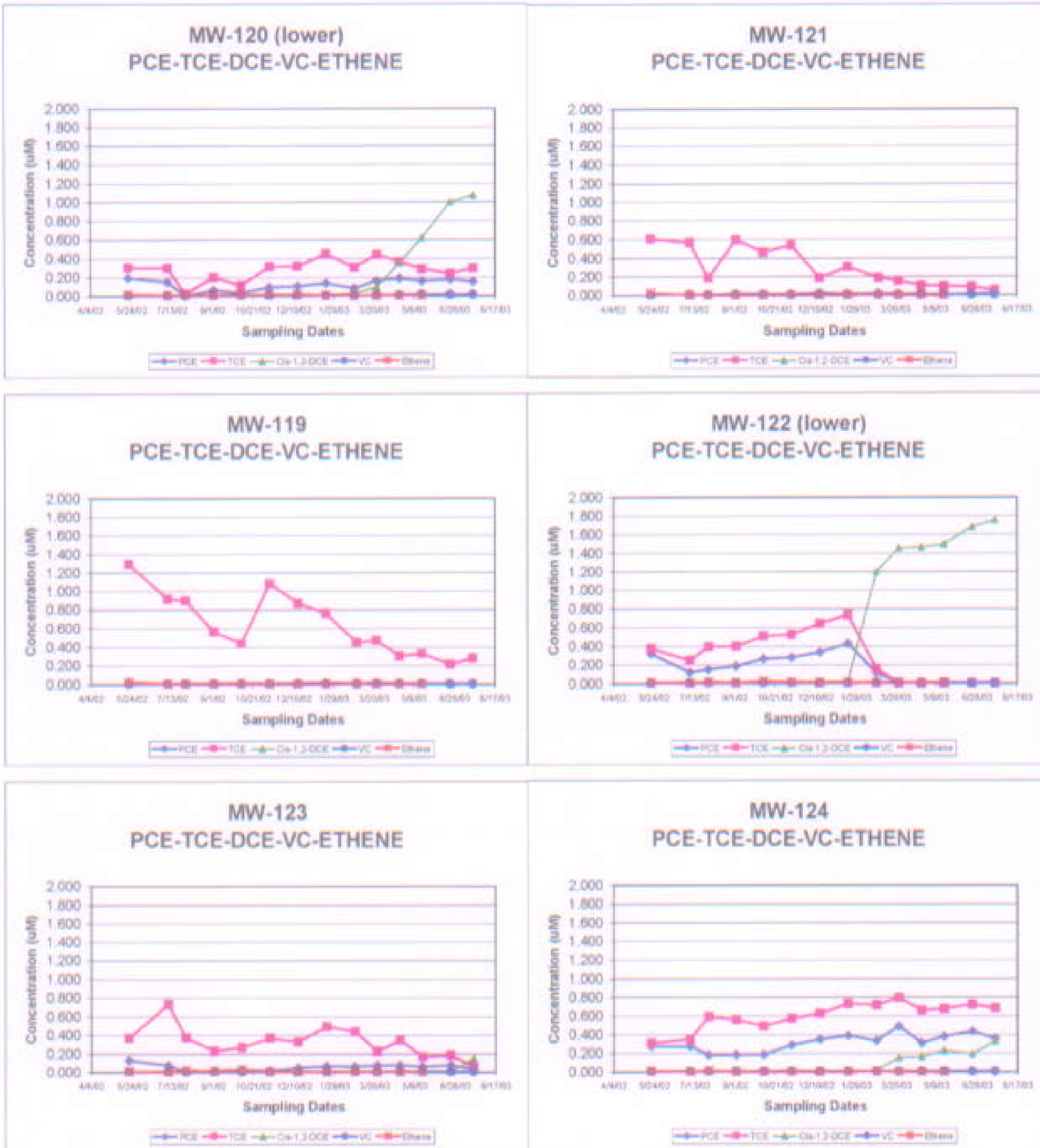
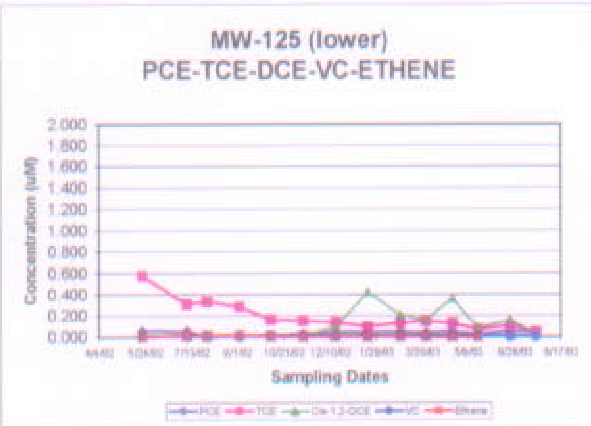


Figure 4.14
Study Area 1: Trends in Chlorinated Ethene Concentrations
Main Installation, Memphis Depot



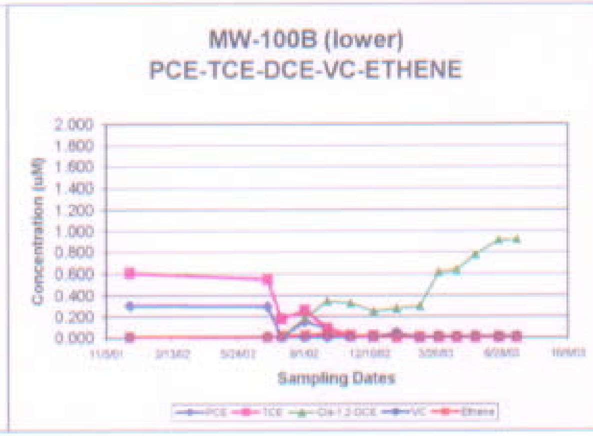


Figure 4.15
Chlorinated Volatile Organic Compound Concentrations vs. Distance Downgradient of Injection Wells
Study Area 1
Main Installation, Memphis Depot

After one injection event (June 2002).

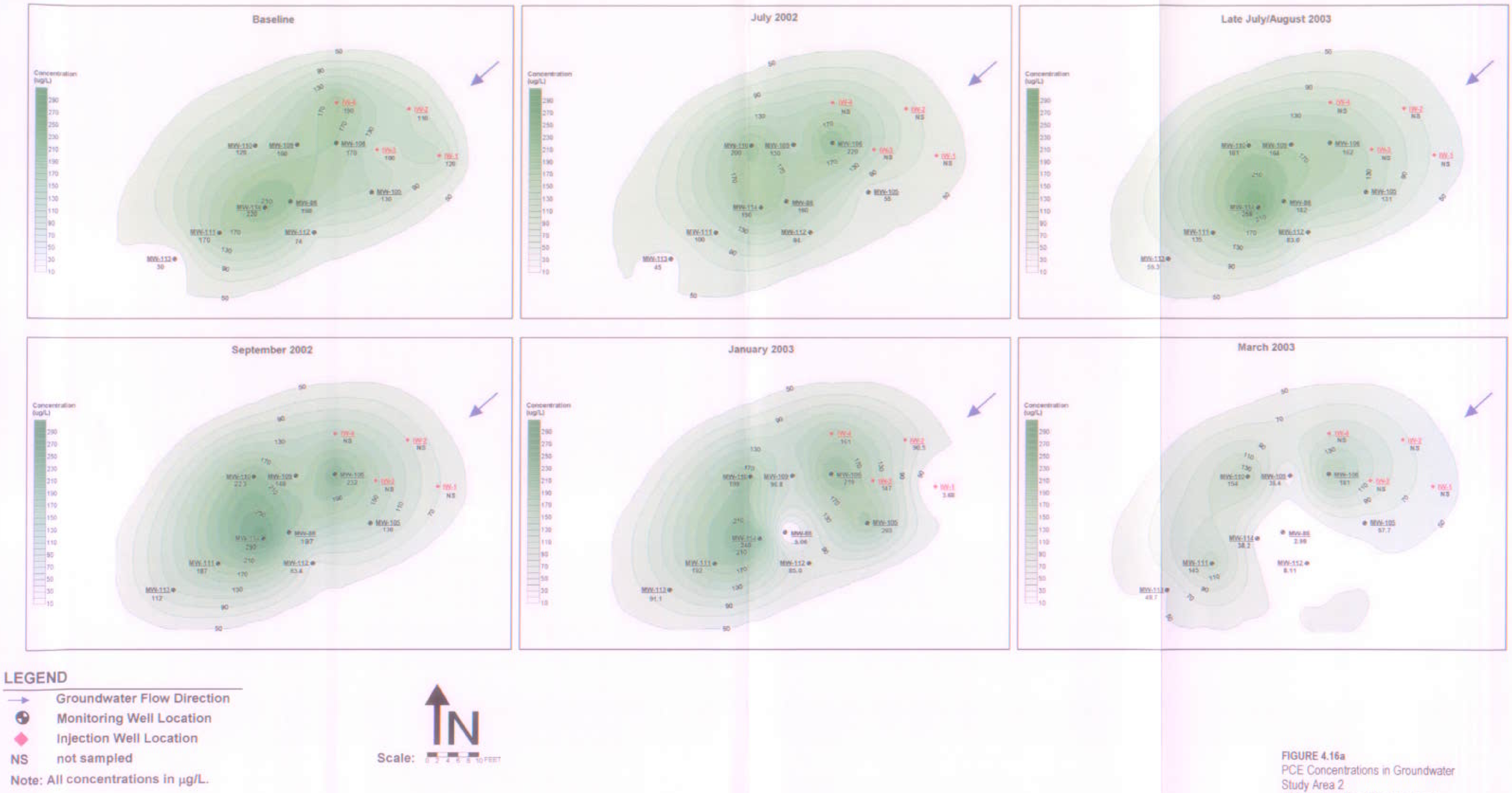
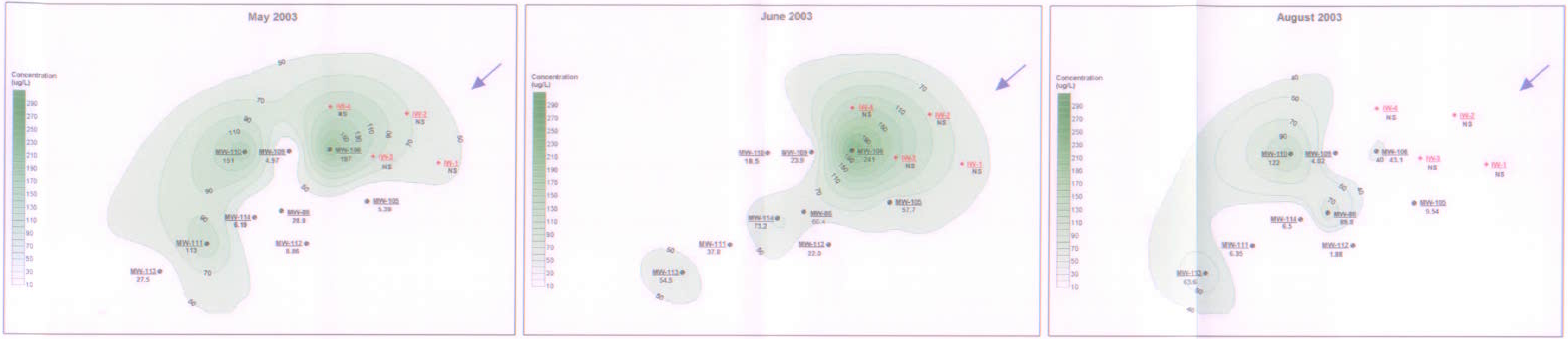


FIGURE 4.16a
PCE Concentrations in Groundwater
Study Area 2
Main Installation, Memphis Depot



LEGEND

- Groundwater Flow Direction
- Monitoring Well Location
- Injection Well Location
- NS not sampled

Note: All concentrations in μg/L.

Scale: 0 2 4 6 8 10 FEET

N

FIGURE 4.16a, CONTINUED
PCE Concentrations in Groundwater
Study Area 2
Main Installation, Memphis Depot

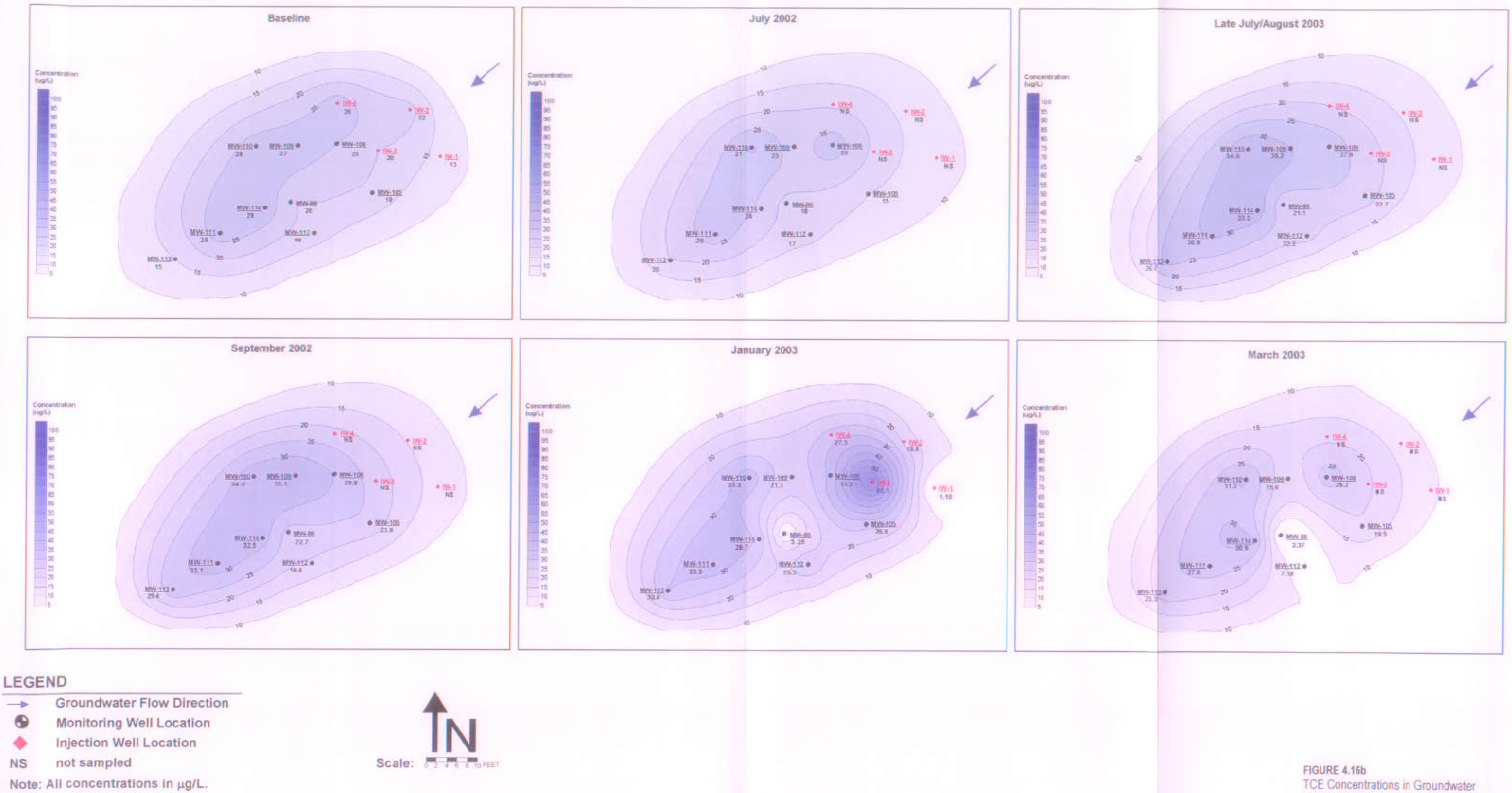
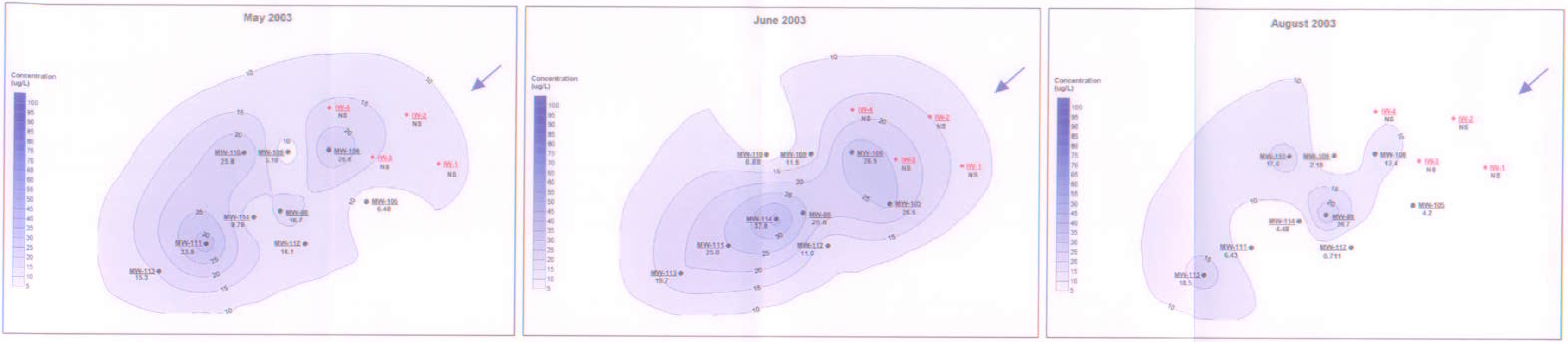


FIGURE 4.16b
TCE Concentrations in Groundwater
Study Area 2
Main Installation, Memphis Depot



LEGEND

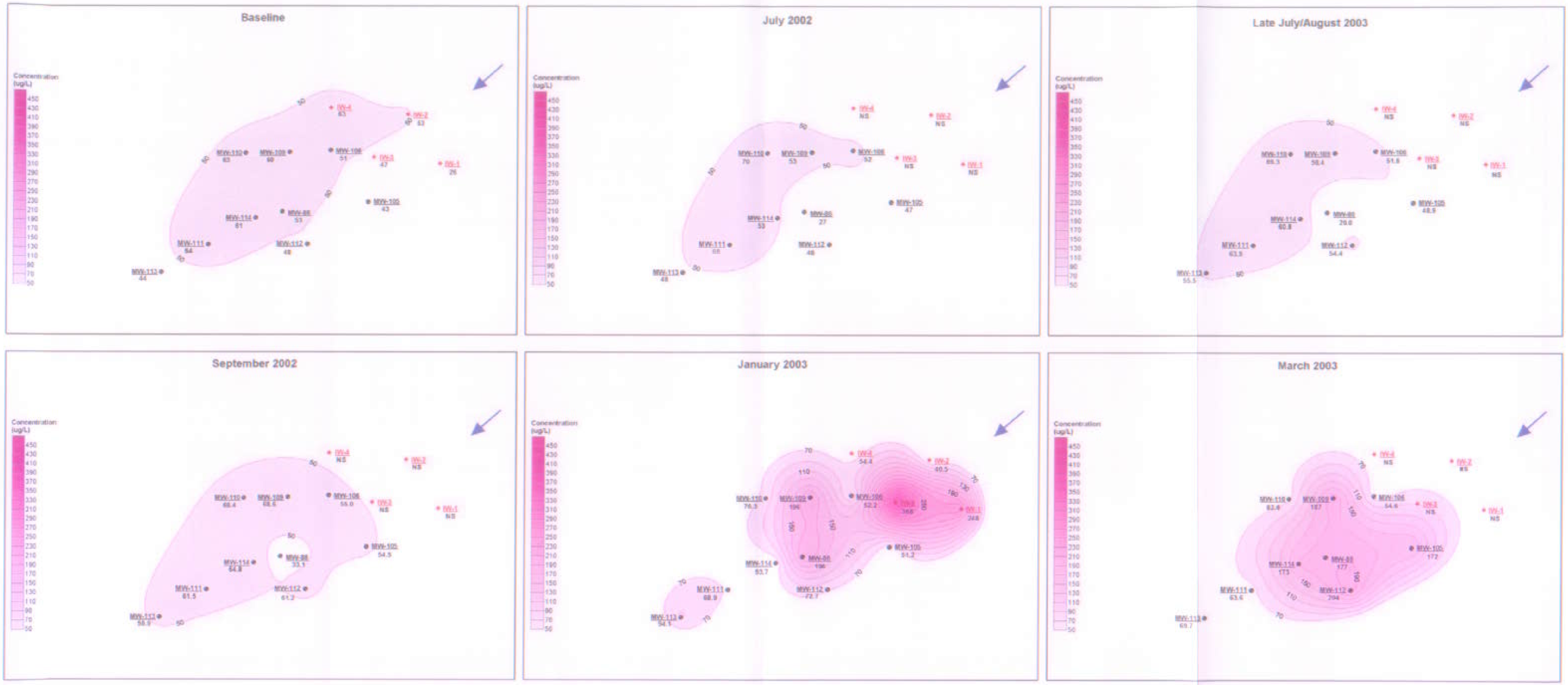
- Groundwater Flow Direction
- Monitoring Well Location
- Injection Well Location
- NS not sampled

Note: All concentrations in µg/L.

N

Scale: 0 2 4 6 8 10 FEET

FIGURE 4.16b, CONTINUED
TCE Concentrations in Groundwater
Study Area 2
Main Installation, Memphis Depot



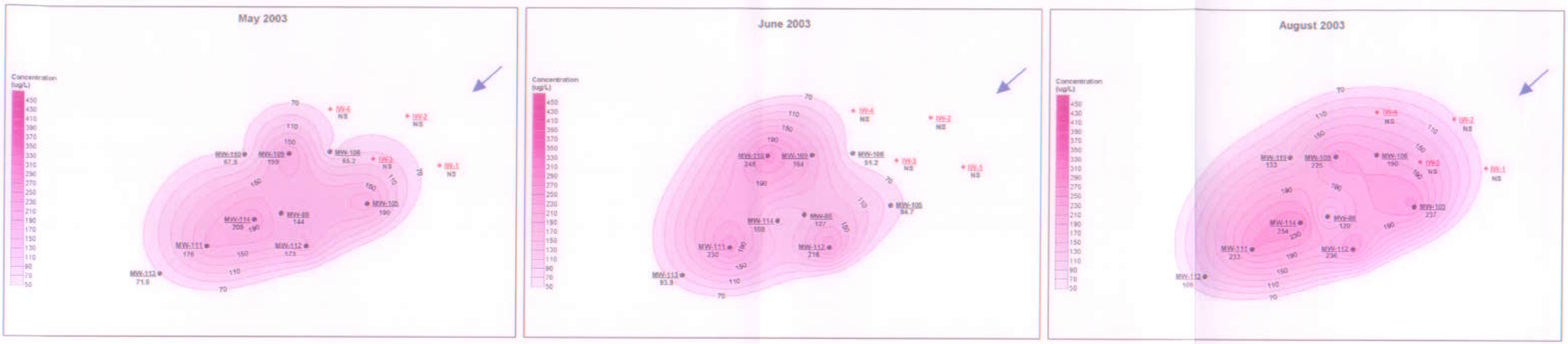
LEGEND

- Groundwater Flow Direction
- Monitoring Well Location
- Injection Well Location
- NS not sampled

Note: All concentrations in µg/L.

Scale: 0 2 4 6 8 10 FEET

FIGURE 4.16c
cis-1,2-DCE Concentrations in Groundwater
Study Area 2
Main Installation, Memphis Depot



LEGEND

- Groundwater Flow Direction
- Monitoring Well Location
- Injection Well Location
- NS not sampled

Note: All concentrations in μg/L.

FIGURE 4.16c, CONTINUED
cis-1,2-DCE Concentrations in Groundwater
Study Area 2
Main Installation, Memphis Depot

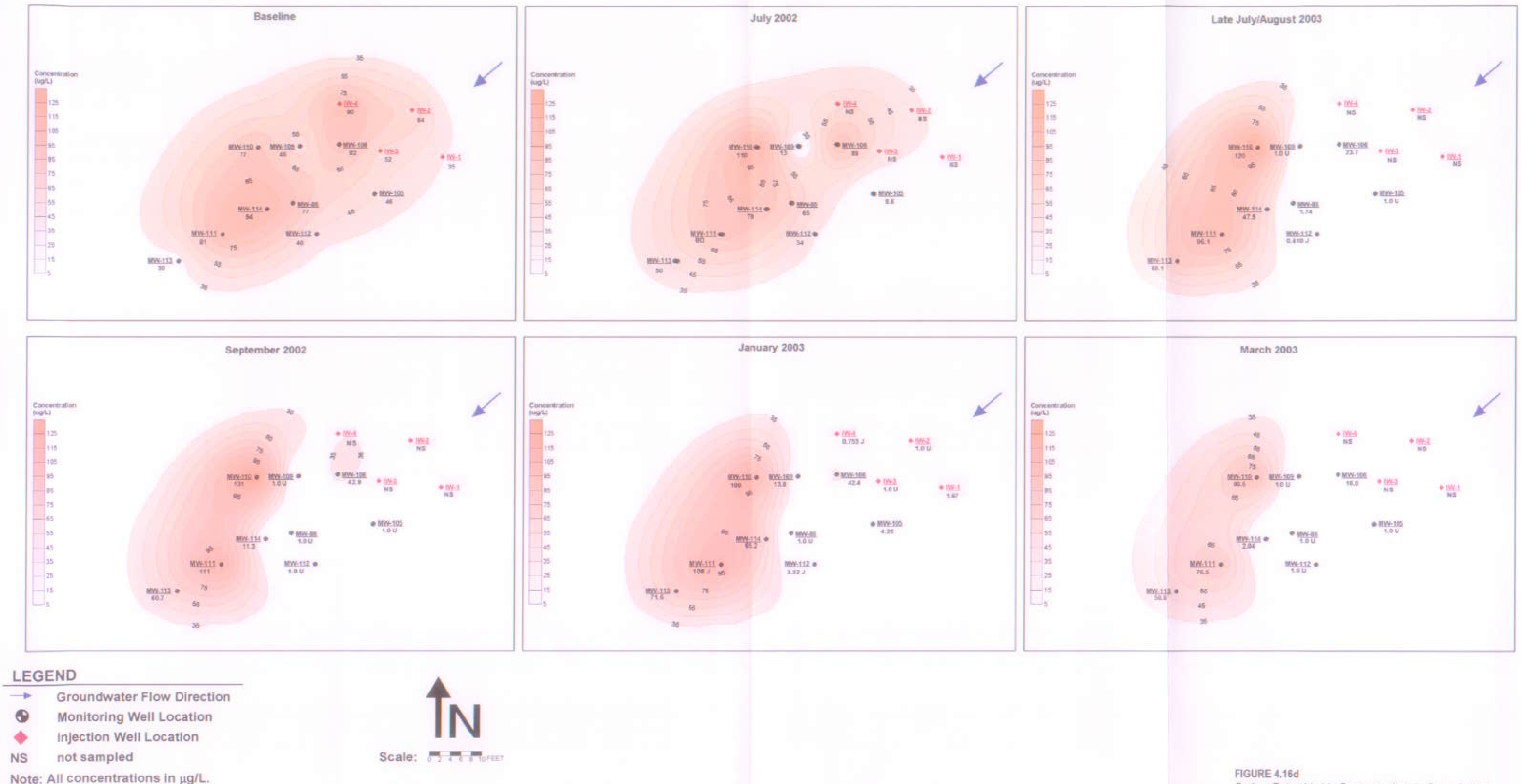
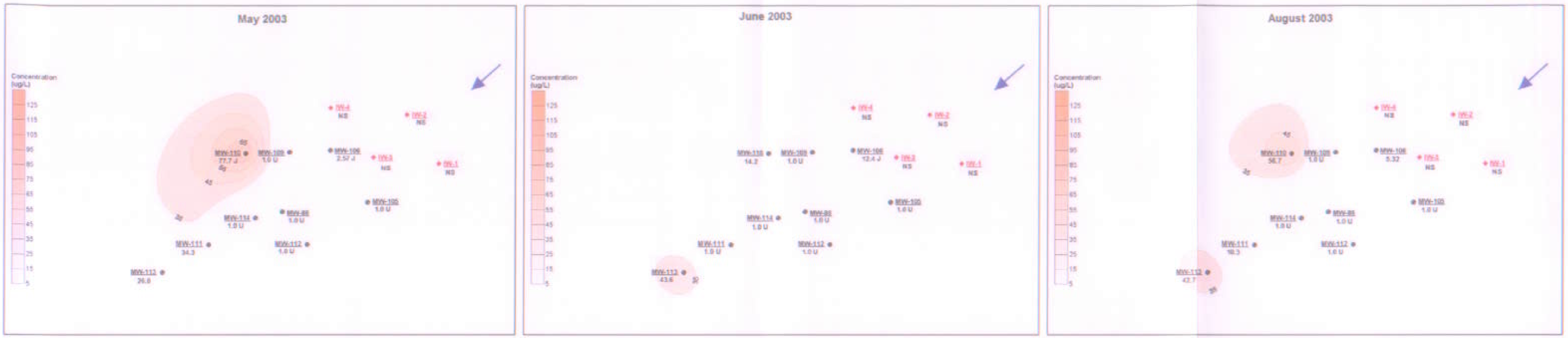


FIGURE 4.16d
Carbon Tetrachloride Concentrations in Groundwater
Study Area 2
Main Installation, Memphis Depot

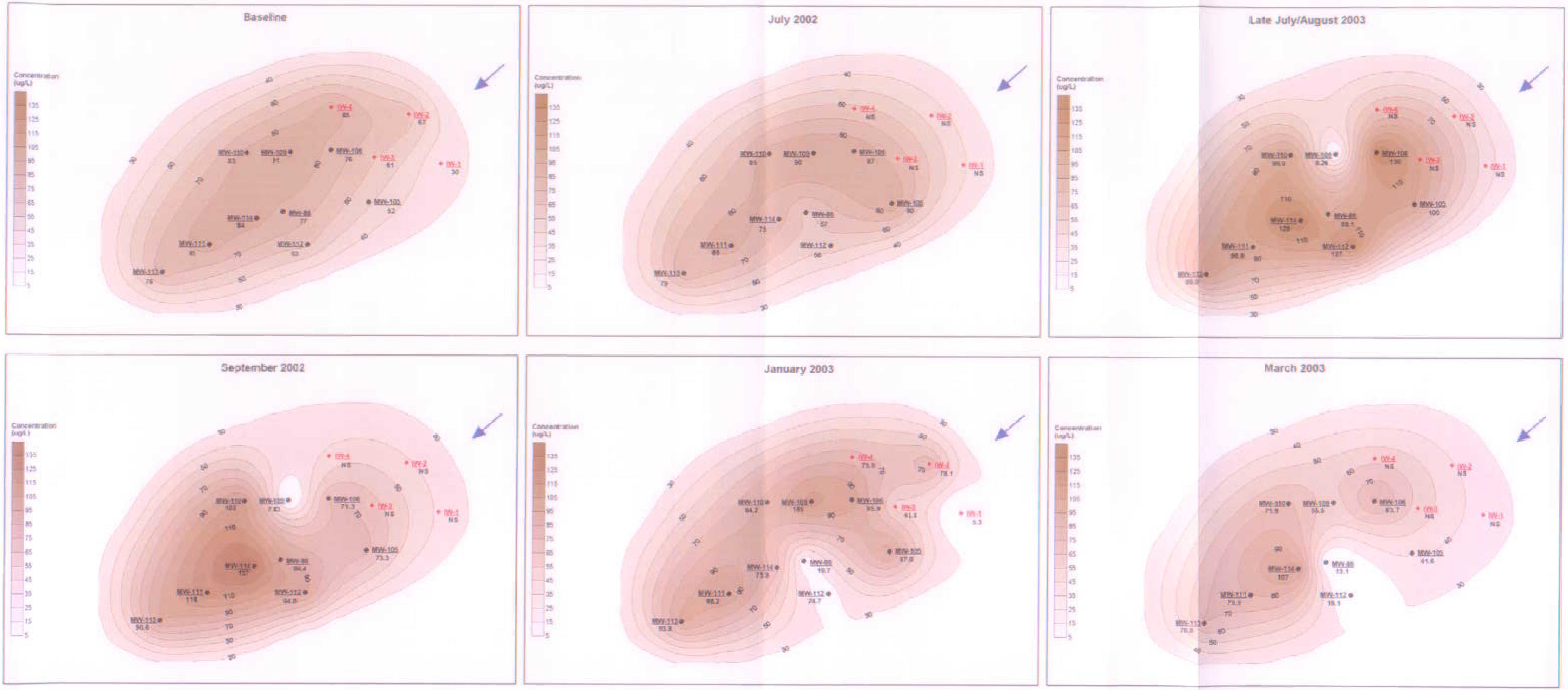


LEGEND

- Groundwater Flow Direction
- Monitoring Well Location
- Injection Well Location
- NS not sampled

Note: All concentrations in µg/L.

FIGURE 4.16d, CONTINUED
Carbon Tetrachloride Concentrations in Groundwater
Study Area 2
Main Installation, Memphis Depot



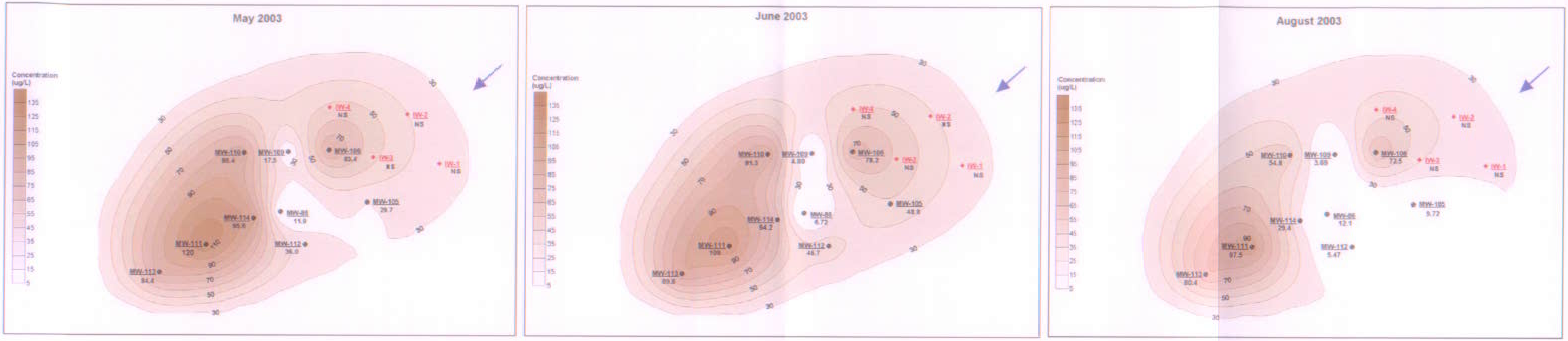
LEGEND

- Groundwater Flow Direction
- Monitoring Well Location
- Injection Well Location
- NS not sampled

Note: All concentrations in µg/L.

Scale: 0 2 4 6 8 10 FEET

FIGURE 4.16e
Chloroform Concentrations in Groundwater
Study Area 2
Main Installation, Memphis Depot



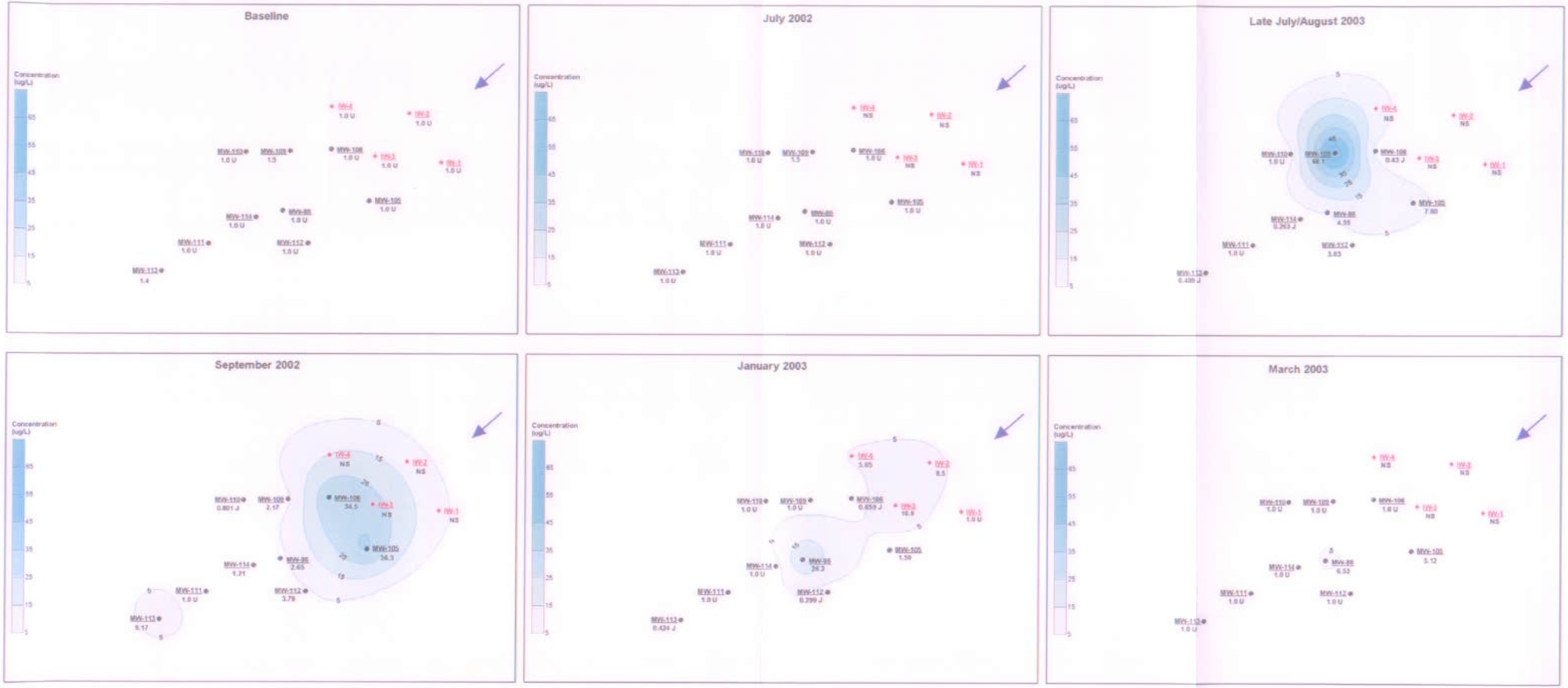
LEGEND

- Groundwater Flow Direction
- Monitoring Well Location
- Injection Well Location
- NS not sampled

Note: All concentrations in µg/L.

Scale: 0 2 4 6 8 10 FEET

FIGURE 4.16e, CONTINUED
Chloroform Concentrations in Groundwater
Study Area 2
Main Installation, Memphis Depot

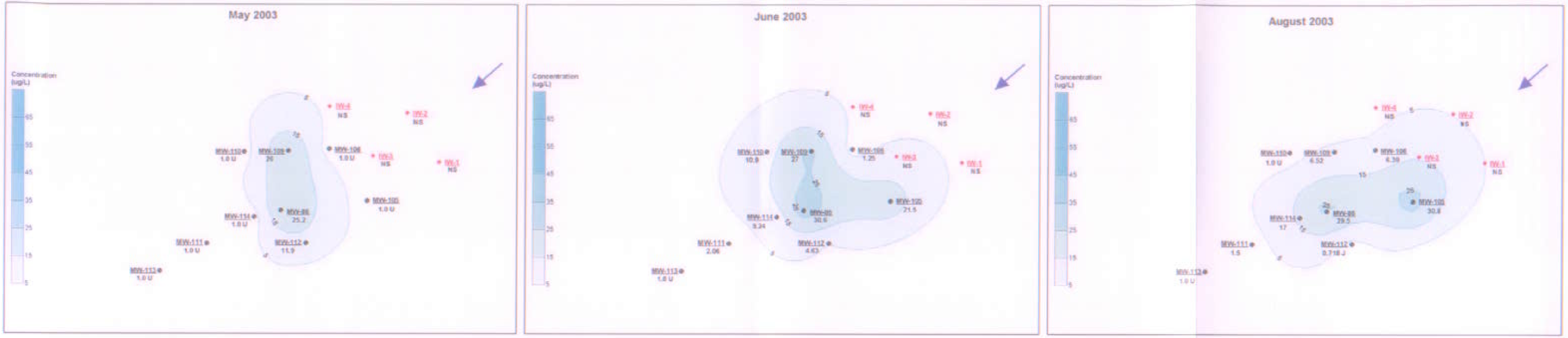


LEGEND

- Groundwater Flow Direction
- Monitoring Well Location
- Injection Well Location
- NS not sampled

Note: All concentrations in µg/L.

FIGURE 4.16f
Methylene Chloride Concentrations in Groundwater
Study Area 2
Main Installation, Memphis Depot



LEGEND
- Groundwater Flow Direction
- Monitoring Well Location
- Injection Well Location
- NS not sampled

Note: All concentrations in µg/L.

FIGURE 4.16f, CONTINUED
Methylene Chloride Concentrations in Groundwater
Study Area 2
Main Installation, Memphis Depot

Figure 4.17
Study Area 2: Trends in Chlorinated Ethene Concentrations
Main Installation, Memphis Depot

Figure 4.18
Study Area 2: Trends in Chlorinated Methane Concentrations
Main Installation, Memphis Depot

Figure 4.18
Study Area 2: Trends in Chlorinated Methane Concentrations
Main Installation, Memphis Depot

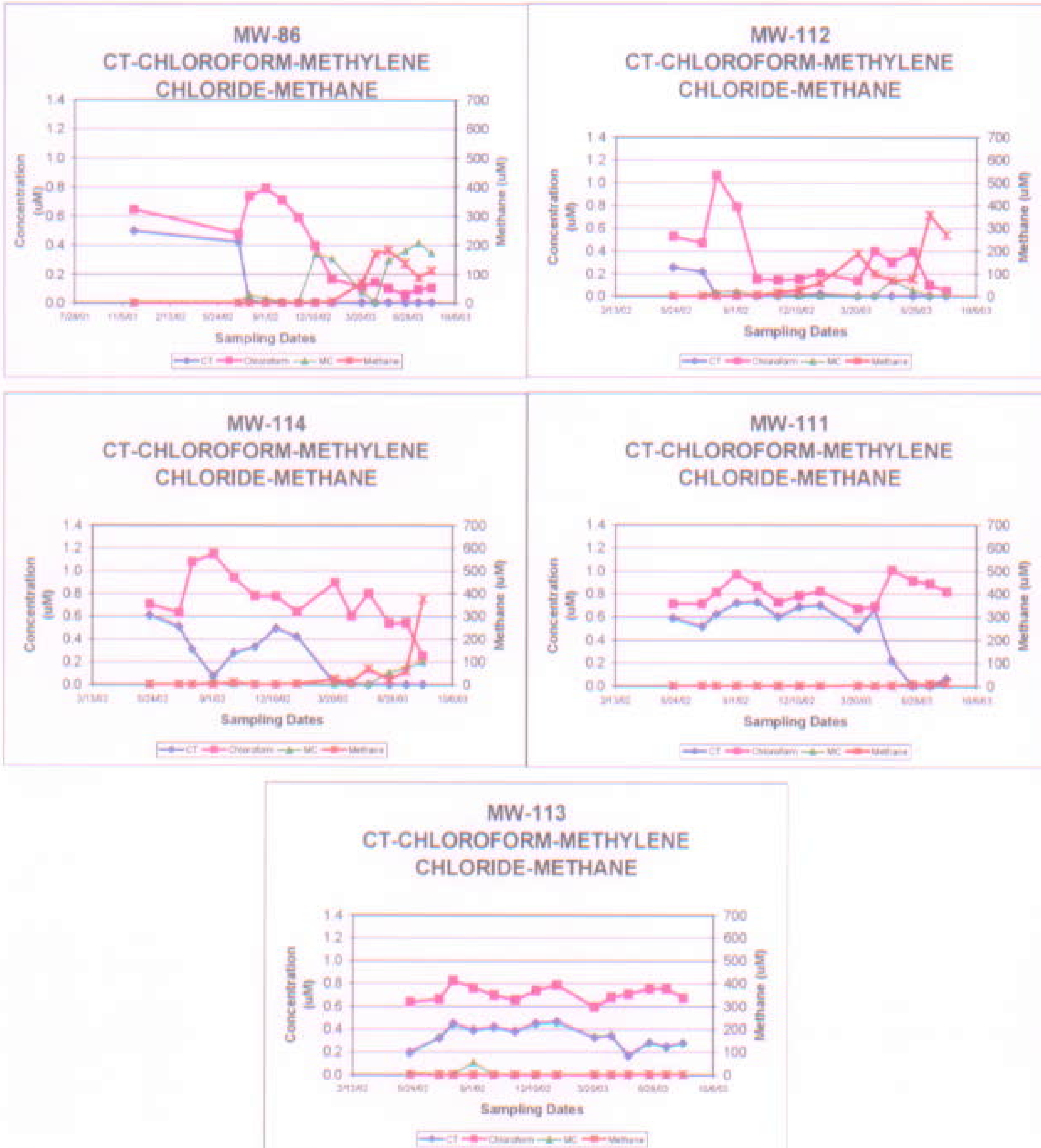
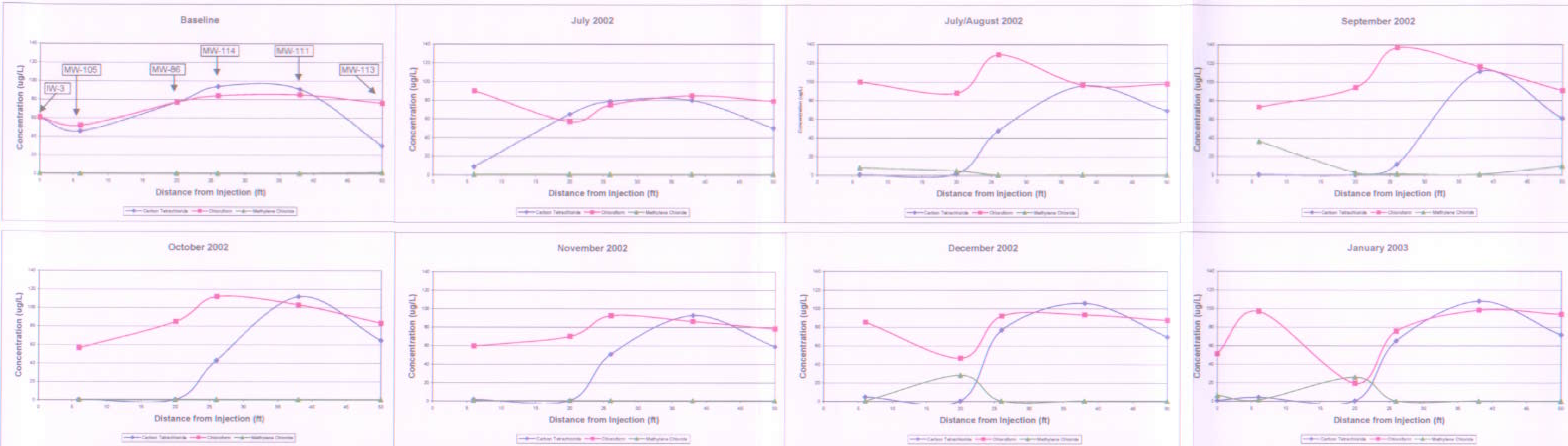


Table 4.19
Chlorinated Methane Concentrations vs. Distance Downgradient of Injection Wells
Study Area 2
Main Installation, Memphis Depot

After one injection event (June 2002).



After three injection events (February 2003, April 2003, and May 2003).

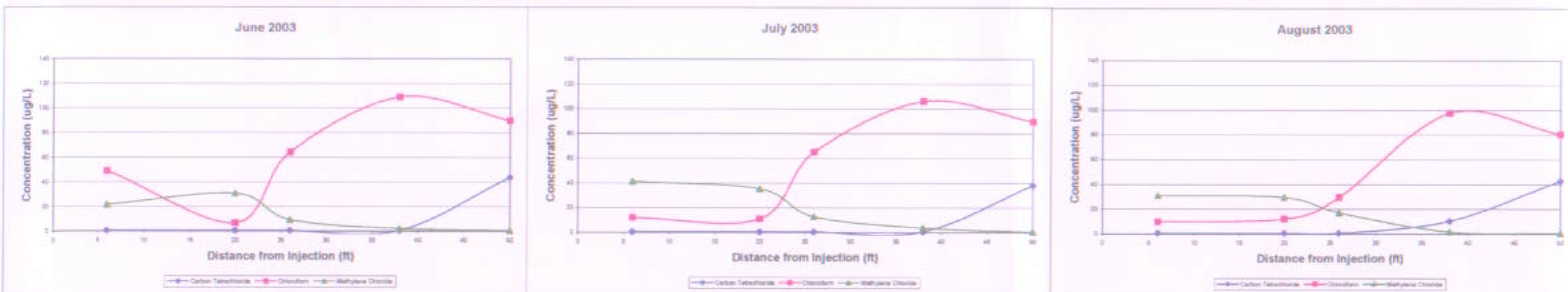
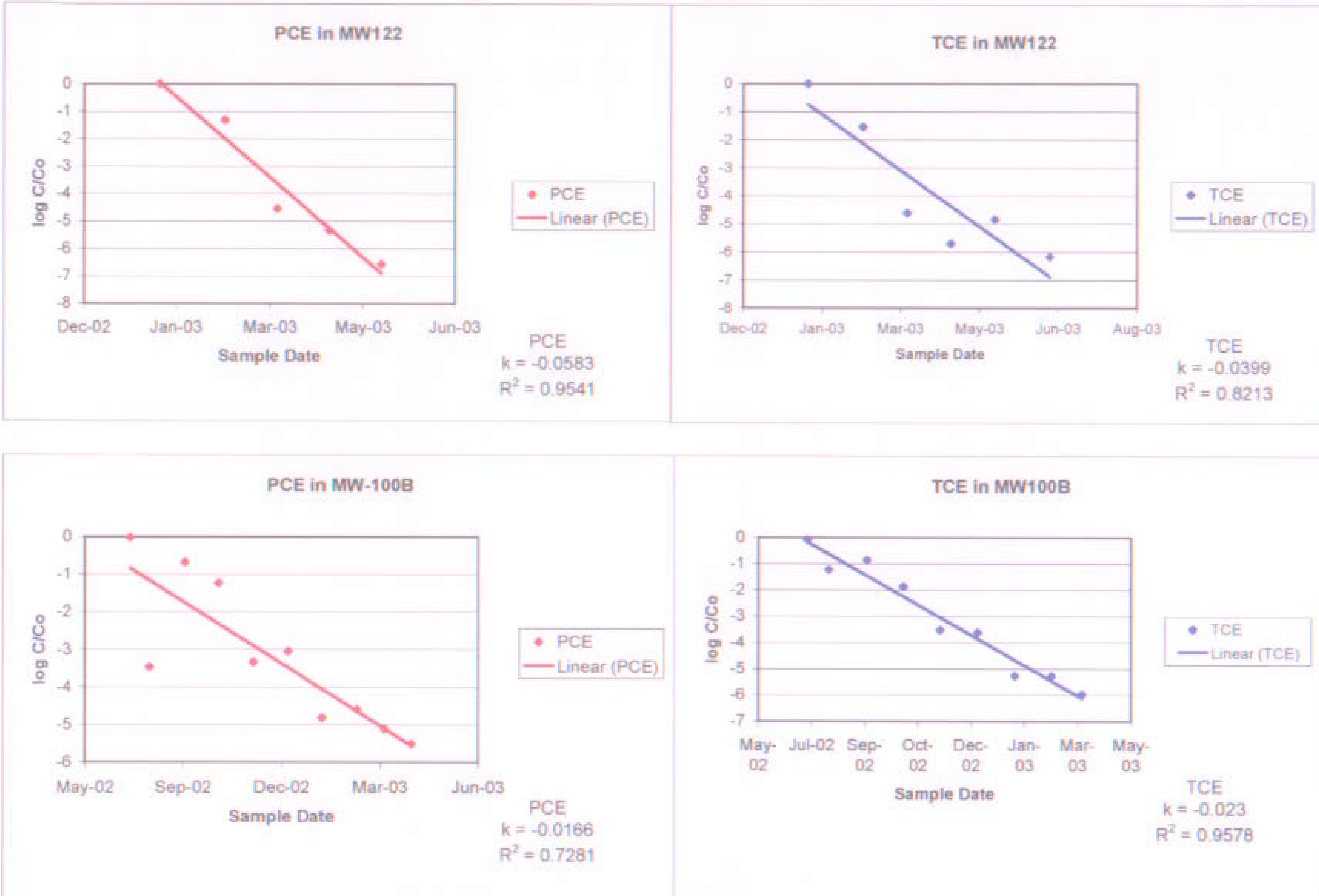
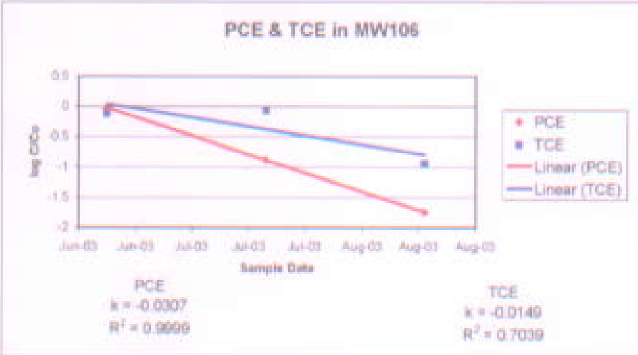


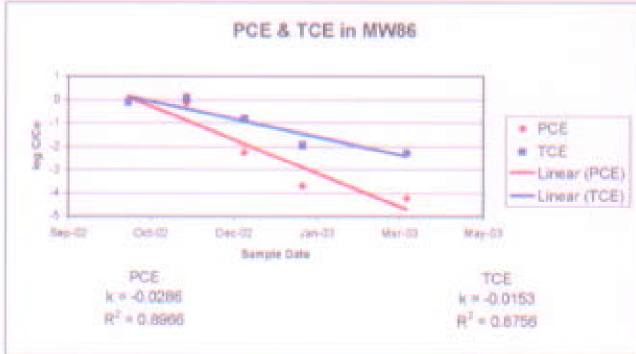
Figure 4.20
Study Area 1: Changes in Concentration of PCE and TCE Degradation Rates
Main Installation, Memphis Depot

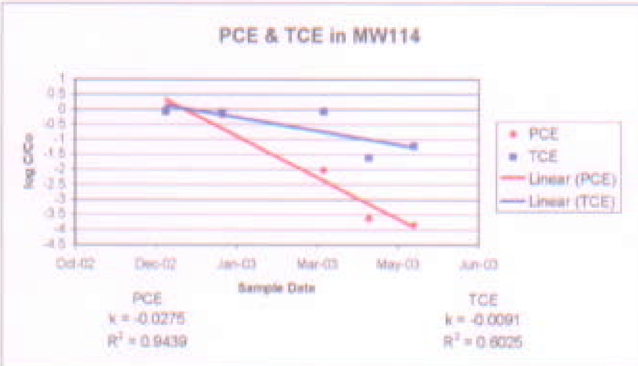


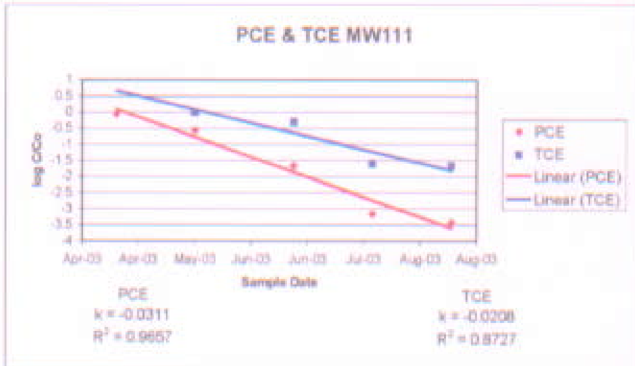
794 201

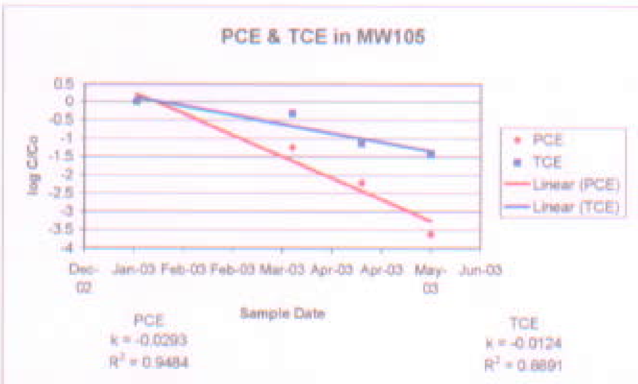
Figure 4.21a
Study Area 2: Changes in Concentration of PCE and TCE
Main Installation, Memphis Depot

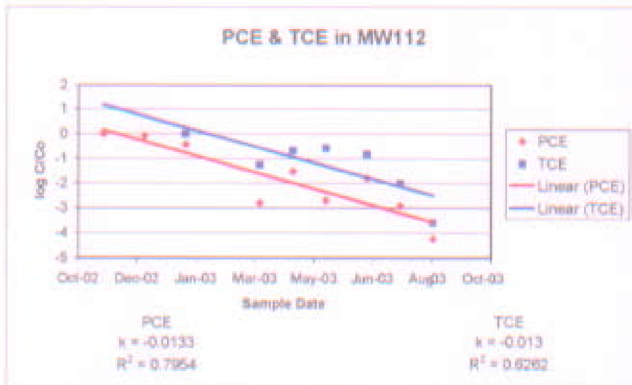


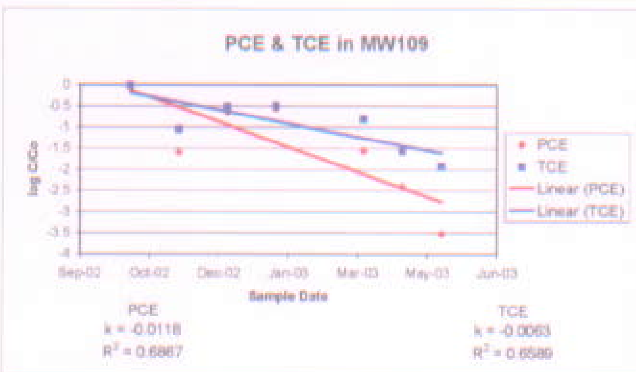












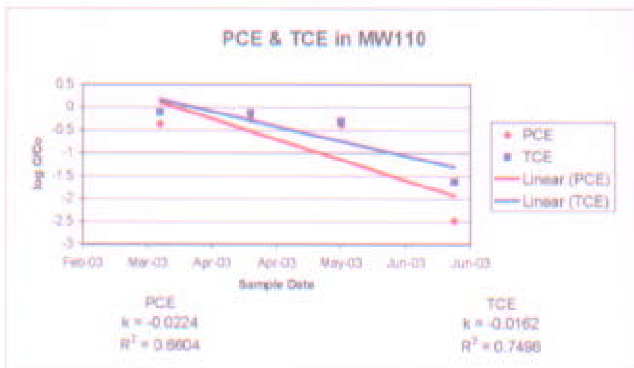


Figure 4.21b
Study Area 2: Changes in Carbon Tetrachloride (CT) and Chloroform Concentration
Main Installation, Memphis Depot

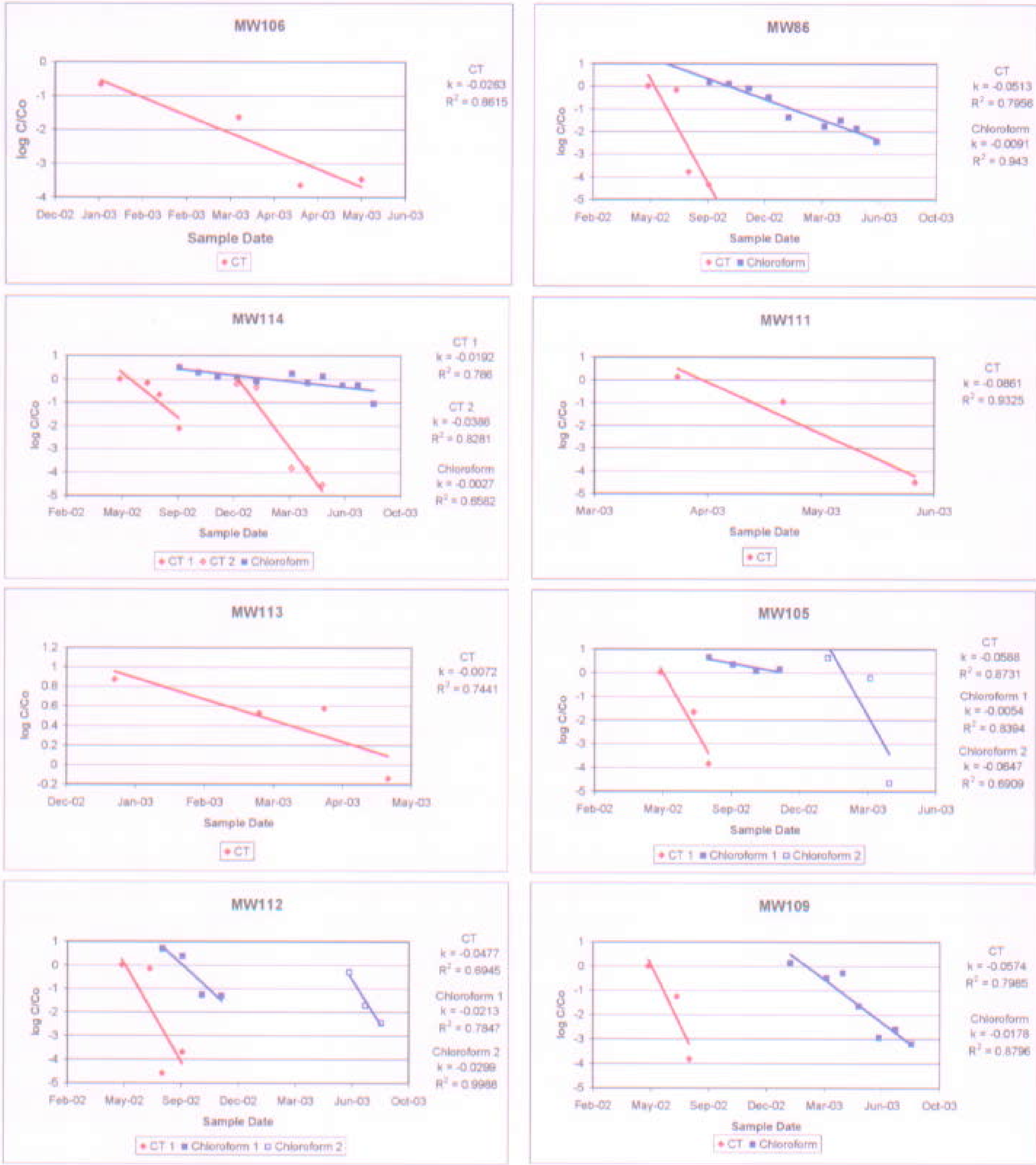


TABLE 4.1
Summary of Hydrogeological Properties within Study Areas 1 and 2
Main Installation, Memphis Depot

Identification	Ground Elevation (feet MSL)	TOC Elevation (feet MSL)	Clay Elevation (feet MSL)	Depth to Clay (feet bgs)	Average Depth to Water (feet BTOC)	Average Fluvial Aquifer Thickness (feet)	Location within Each Study Area	Screen Interval Within Aquifer
AREA 1								
IW-5	292.43	292.12	179.43	113.00	93.3	19.4	Injection Point	Lower
IW-6	292.27	291.94	183.27	109.00	93.2	15.5	Injection Point	Lower
IW-7	292.26	292.00	182.76	109.50	93.2	16.0	Injection Point	Lower
MW-21	295.21	295.00	NA	NA	94.5	NA	Upgradient	Upper
MW-100B	291.50	290.90	164.10	127.40	92.3	34.5	Downgradient	Entire
MW-115	291.92	291.67	NA	NA	92.6	NA	Downgradient	Upper
MW-116	291.92	291.67	183.42	108.50	92.6	15.6	Downgradient	Lower
MW-117	291.57	291.38	182.57	109.00	92.5	16.3	Downgradient	Lower
MW-118	291.58	291.17	NA	NA	92.2	NA	Downgradient	Upper
MW-119	291.74	291.50	NA	NA	92.4	NA	Downgradient	Upper
MW-120	291.72	291.56	183.72	108.00	92.5	15.3	Downgradient	Lower
MW-121	291.83	291.63	NA	NA	92.6	NA	Downgradient	Upper
MW-122	291.76	291.62	183.26	108.50	92.6	15.8	Downgradient	Lower
MW-123	291.36	291.09	NA	NA	92.3	NA	Downgradient	Upper
MW-124	291.58	291.39	NA	NA	92.4	NA	Downgradient	Upper
MW-125	291.47	291.35	182.47	109.00	92.4	16.5	Downgradient	Lower
AREA 2								
IW-1	304.29	304.03	205.29	99.00	95.8	3.0	Injection Point	Entire
IW-2	304.49	304.21	199.49	105.00	95.8	9.0	Injection Point	Entire
IW-3	304.47	304.21	201.47	103.00	96.1	6.7	Injection Point	Entire
IW-4	304.66	304.53	199.66	105.00	96.3	8.5	Injection Point	Entire
MW-86	304.76	304.29	187.89	116.87	96.5	19.9	Downgradient	Entire
MW-88	305.47	305.15	208.47	97.00	80.0	16.7	Upgradient	Entire
MW-105	304.42	304.25	205.42	99.00	96.1	2.8	Downgradient	Entire
MW-106	304.65	304.44	197.65	107.00	96.2	10.6	Downgradient	Entire
MW-109	304.75	304.57	201.75	103.00	96.5	6.3	Downgradient	Entire
MW-110	304.82	304.64	202.82	102.00	96.6	5.2	Downgradient	Entire
MW-111	304.87	304.66	205.87	99.00	96.9	1.9	Downgradient	Entire
MW-112	304.77	304.57	204.77	100.00	96.6	3.2	Downgradient	Entire
MW-113	304.92	304.81	199.92	105.00	97.2	7.7	Downgradient	Entire
MW-114	304.84	304.66	202.84	102.00	96.7	5.1	Downgradient	Entire

Notes.
NA : Not Available.
MSL : Mean Sea Level
BTOC . below top of casing

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Table 4.2
Slug Test Results for Pilot Study Wells
Main Installation, Memphis Depot

Well	Fully or Partially Penetrating Well	Well Screen Radius (r, ft)	Well Casing Radius (R, ft)	Elevation of Top of Screen (MSL)	Elevation of Bottom of Screen (MSL)	Well Screen Length (ft)	TOC (MSL)	Depth to Static Water Level (ft)	Groundwater Elevation (MSL)	Length of Screen within the Aquifer (ft)	Clay Elev. (MSL)	Saturated Aquifer Thickness (D, ft)	Total Depth of Well (ft)	Height of the Stagnant Water Column (b, ft)	Is water level in the well screen?	Use r_{se} (r_{e})?	Water Level/ref point (ft) @ t=0	GW Elev. from the ref point	Hydraulic Conductivities (cm/s)	Hydraulic Conductivities (ft/day)
Area 1																				
IW-6	P	0.0833	0.292	192.9	182.9	10	291.94	93.26	198.68	10	183.27	15.41	110	15.78	No	No	675.51	670.23	6.55E-04	1.86
MW-21	P	0.0833	0.333	202.9	187.9	15	292.12	94.80	197.32	9.42	179.43	17.89	107.5	9.42	Yes	Yes	675.51	673.62	1.99E-02	56.41
MW-100B	P	0.0833	0.292	183.6	163.6	20	290.90	92.50	198.40	20	164.10	34.30	127.5	34.60	No	No	675.51	673.55	4.13E-04	1.17
MW-115	P	0.0833	0.292	202.2	192.2	10	291.67	92.87	198.80	6.60	183.42	15.38	100.5	6.60	Yes	Yes	675.51	673.51	9.33E-03	26.45
MW-119	P	0.0833	0.292	201.5	191.5	10	291.50	92.75	198.75	7.25	183.26	15.49	101	7.25	Yes	Yes	675.51	674.30	2.27E-02	64.35
Area 2																				
IW-3	F	0.0833	0.292	216.2	201.2	15	304.21	96.41	207.80	6.60	201.47	6.33	104.5	6.60	Yes	Yes	675.51	673.59	4.05E-03	11.48
MW-26	P	0.0833	0.333	206.1	196.1	10	303.69	100.66	203.03	6.93	193.89	9.14	107.6	6.93	Yes	Yes	675.51	673.52	4.80E-03	13.61
MW-86	F	0.0833	0.333	206.9	186.9	20	304.29	96.66	207.63	20	187.89	19.74	117.5	20.73	Yes	yes	675.51	673.66	6.92E-04	1.96
MW-88	F	0.0833	0.333	223.2	208.2	15	305.15	80.07	225.08	15	208.47	16.61	97.5	16.88	Yes	Yes	675.51	673.62	1.50E-04	0.43
MW-111	F	0.0833	0.292	215.7	205.7	10	304.66	97.15	207.51	1.81	205.87	1.64	100	1.81	Yes	Yes	675.51	674.82	1.12E-02	31.75

Notes.
1 Saturated Aquifer Thickness = groundwater elevation - clay elevation
2. Height of the stagnant water column = total depth - depth to water
3. For fully penetrating wells (the entire aquifer thickness was screened): saturated aquifer thickness = hight of the stagnant water column
4 For some partially penetrating wells (e.g. the bottom of well screen was not installed at the bottom of the aquifer): saturated aquifer thickness > hight of the stagnant water column
5. Aquifer thickness for some partially penetrating wells (MW-21, MW-26, MW-115, and MW-119) were determined by nearby cluster wells
6. r_{se} was used if the water level was in the screen or if the water level falled within the screened interval during the slug test, r_{se}=sqrt(r^2 * (1-n) + n * R^2), r:piezometer radius; n:porosity; and R:bore hole radius
7 Pressure Head measurement was utilized using a MiniTroll Pro manufactured by In-Situ Inc.

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Table 4.4
Summary of Total Organic Carbon in Soil
Main Installation: Memphis Depot

Study Area 1			
Well	**Sample Date**	**Sample Depth (feet bgs)**	**TOC (mg/kg)**
IW-5	18-Apr-2002	100.0	<u>120</u>
IW-6	05-May-2002	97.0	<u>115</u>
IW-7	05-May-2002	108.0	290
MW-100B	08-Oct-2001	98.0	601
MW-115	22-Apr-2002	97.0	<u>115</u>
MW-116	21-Apr-2002	100.0	669
MW-117	01-May-2002	95.0	<u>115</u>
MW-118	01-May-2002	100.0	<u>115</u>
MW-119	02-May-2002	98.0	<u>110</u>
MW-120	20-Apr-2002	100.0	<u>115</u>
MW-121	20-Apr-2002	102.0	627
MW-122	04-May-2002	102.0	<u>110</u>
MW-123	29-Apr-2002	100.0	<u>110</u>
MW-124	03-May-2002	100.0	<u>110</u>
MW-125	23-Apr-2002	105.0	<u>120</u>

Study Area 2			
Well	**Sample Date**	**Sample Depth (feet bgs)**	**TOC (mg/kg)**
IW-1	16-Apr-2002	97.5	<u>120</u>
IW-2	19-Apr-2002	104.0	681
IW-3	20-Apr-2002	103.0	645
IW-4	16-Apr-2002	100.0	<u>225</u>
MW-86	20-Sep-2001	103.0	<u>60</u>
MW-88	20-Sep-2001	83.0	<u>60</u>
MW-105	01-May-2002	97.0	<u>115</u>
MW-106	17-Apr-2002	104.0	<u>135</u>
MW-109	02-May-2002	97.0	<u>120</u>
MW-110	04-May-2002	98.0	<u>120</u>
MW-111	23-Apr-2002	98.0	<u>120</u>
MW-112	21-Apr-2002	98.0	288
MW-113	17-Apr-2002	105.0	<u>135</u>
MW-114	30-Apr-2002	102.0	<u>125</u>

Notes:
mg/kg : milligrams per kilogram
bgs : below ground surface
Underlined value : half of the reporting limit for a non-detected parameter

Table 4.5
Study Area 1: Summary of VOCs
Main Installation, Memphis Depot

Well	Sample Date	Sample Event	Units	PCE	TCE	Cis-1,2-DCE	VC	Ethene*	Carbon Tetrachloride	Chloroform	Methylene Chloride	Chloromethane	Methane*	1,2-DCA	Chloroethane	Ethane*
IW-5	21-May-2002	Baseline	ug/L	9	27	0.75	0.5	1	0.5	0.82	0.5	0.5	2.6	0.5	0.5	1
	20-Jan-2003	Post-Inj. 7	ug/L	0.5	0.288	0.5	0.5	1.6	0.5	0.5	0.5	0.5	12000	0.5	0.5	0.66
IW-6	21-May-2002	Baseline	ug/L	17	34	0.67	0.5	0.66	0.5	0.5	0.5	0.5	2.9	0.35	0.5	0.99
	20-Jan-2003	Post-Inj 7	ug/L	0.5	0.5	0.5	0.5	1.8	0.5	0.5	0.5	0.5	8500	0.5	0.5	0.89
IW-7	21-May-2002	Baseline	ug/L	25	21	0.45	0.5	0.0025	0.5	0.5	0.5	0.5	0.0075	0.35	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	0.5	0.5	0.5	0.5	0.78	0.5	0.5	0.5	0.5	12000	0.5	0.5	0.35
MW-21	20-Mar-2002	Baseline	ug/L	90	76	1.9	0.5	0.0025	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.0025
(Background)	09-Jul-2002	Post-Inj. 1	ug/L	110	66	1.7	0.5	0.0025	0.5	0.5	0.5	0.5	0.61	0.5	0.5	0.0025
	29-Jul-2002	Post-Inj. 2	ug/L	125	53.6	1.27	0.5	0.0025	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.0025
	03-Sep-2002	Post-Inj. 3	ug/L	178	38.1	1.02	0.5	0.0025	0.5	0.132	0.5	0.5	7.2	0.5	0.5	0.0025
	07-Oct-2002	Post-Inj. 4	ug/L	152	49.2	1.63	0.5	0.0025	0.5	0.18	0.5	0.5	0.0075	0.5	0.5	0.0025
	11-Nov-2002	Post-Inj. 5	ug/L	188	37.6	1.32	0.5	0.0025	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.0025
	16-Dec-2002	Post-Inj. 6	ug/L	195	38.3	1.22	0.5	0.0025	0.5	0.171	0.5	0.5	0.0075	0.5	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	194	32.4	0.985	0.5	0.016	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.0052
	24-Feb-2003	Post-Inj. 8	ug/L	200	50.7	1.68	0.5	0.18	0.5	0.5	0.5	0.5	2	0.5	0.5	0.0025
	24-Mar-2003	Post-Inj. 9	ug/L	190	38.6	1.28	0.5	0.0058	0.5	0.14	0.5	0.5	21	0.5	0.5	0.0025
	21-Apr-2003	Post-Inj. 10	ug/L	171	33.8	1.12	0.5	0.014	0.5	0.5	0.5	0.5	9.2	0.5	0.5	0.015
	19-May-2003	Post-Inj. 11	ug/L	172	38.6	1.25	0.5	0.0025	0.5	0.5	0.5	0.5	3.9	0.5	0.5	0.0025
	23-Jun-2003	Post-Inj. 12	ug/L	159	34	1.36	0.5	0.0025	0.5	0.5	0.5	0.5	34	0.5	0.5	0.0025
	21-Jul-2003	Post-Inj. 13	ug/L	120	33.6	1.25	0.5	0.017	0.5	0.5	0.5	0.5	4.9	0.5	0.5	0.01
MW-100B	11-Dec-2001	Baseline	ug/L	50	79	1.2	0.5	0.27	0.5	0.5	0.5	0.5	0.0075	0.2	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	49	72	1.3	0.5	0.039	0.5	0.19	0.5	0.5	1	0.5	0.5	0.41
	29-Jul-2002	Post-Inj 2	ug/L	1.56	22.8	0.509	0.5	0.38	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.24
	03-Sep-2002	Post-Inj 3	ug/L	25.3	33.1	17.7	0.5	0.66	0.5	0.5	0.5	0.5	17	0.5	0.5	0.52
	07-Oct-2002	Post-Inj 4	ug/L	14.5	11.6	33.4	0.5	0.91	0.5	0.5	0.5	0.5	3600	0.5	0.5	0.66
	11-Nov-2002	Post-Inj 5	ug/L	1.77	2.27	31.4	0.5	0.41	0.5	0.5	0.5	0.5	17000	0.5	0.5	0.31
	16-Dec-2002	Post-Inj 6	ug/L	2.35	2.06	24.1	0.5	0.18	0.5	0.5	0.5	0.5	7000	0.5	0.5	0.08
	20-Jan-2003	Post-Inj. 7	ug/L	0.395	0.4	26.4	2.57	0.23	0.5	0.5	0.5	0.5	19000	0.5	0.5	0.38
	24-Feb-2003	Post-Inj 8	ug/L	0.53	0.407	28.7	0.436	0.18	0.5	0.5	0.5	0.5	24000	0.5	0.5	0.3
	24-Mar-2003	Post-Inj 9	ug/L	0.341	0.5	59.4	0.968	0.11	0.5	0.5	0.5	0.5	26000	0.5	0.5	0.78
	21-Apr-2003	Post-Inj. 10	ug/L	0.25	0.5	61.3	0.797	0.19	0.5	0.5	0.5	0.5	26000	0.5	0.5	0.46
	19-May-2003	Post-Inj 11	ug/L	0.25	0.5	75.2	0.619	0.11	0.5	0.5	0.5	0.5	22000	0.5	0.5	0.28
	23-Jun-2003	Post-Inj 12	ug/L	0.25	0.5	88.2	0.646	0.18	0.5	0.5	0.5	0.5	11000	0.5	0.5	0.0025
	21-Jul-2003	Post-Inj 13	ug/L	0.25	0.5	89	0.66	0.059	0.5	0.5	0.5	0.5	22000	0.5	0.5	0.15
MW-115	21-May-2002	Baseline	ug/L	1.3	59	0.5	0.5	0.42	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.75
	08-Jul-2002	Post-Inj. 1	ug/L	1.4	60	0.5	0.5	0.17	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.51
	31-Jul-2002	Post-Inj. 2	ug/L	0.25	255	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.24
	03-Sep-2002	Post-Inj. 3	ug/L	0.744	117	0.5	0.5	0.13	0.5	0.5	0.5	0.5	530	0.5	0.5	0.08
	07-Oct-2002	Post-Inj. 4	ug/L	1.35	49.5	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	3000	0.5	0.5	0.014
	11-Nov-2002	Post-Inj 5	ug/L	1.76	47	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	2900	0.5	0.5	0.0025
	16-Dec-2002	Post-Inj 6	ug/L	2.11	38	0.5	0.5	0.027	0.5	0.5	0.5	0.5	4000	0.261	0.5	0.0025
	20-Jan-2003	Post-Inj 7	ug/L	1.83	49	0.5	0.5	0.037	0.5	0.5	0.5	0.5	4900	0.5	0.5	0.051
	24-Feb-2003	Post-Inj 8	ug/L	1.89	23.6	0.5	0.5	0.14	0.5	0.5	0.5	0.5	4900	0.5	0.5	0.05
	24-Mar-2003	Post-Inj 9	ug/L	1.95	15.2	0.5	0.5	0.028	0.5	0.5	0.5	0.5	4800	0.5	0.5	0.028
	21-Apr-2003	Post-Inj. 10	ug/L	1.52	12.9	0.5	0.5	0.047	0.5	0.5	0.5	0.5	4500	0.5	0.5	0.042
	19-May-2003	Post-Inj. 11	ug/L	0.367	12.1	0.5	0.5	0.03	0.5	0.5	0.5	0.5	5400	0.5	0.5	0.033
	23-Jun-2003	Post-Inj. 12	ug/L	0.584	12.8	0.5	0.5	0.0082	0.5	0.5	0.5	0.5	5100	0.5	0.5	0.0025
	21-Jul-2003	Post-Inj 13	ug/L	1.85	8.41	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	1.9	0.5	0.5	0.0025
MW-116	21-May-2002	Baseline	ug/L	16	9	0.5	0.5	0.0025	0.5	0.16	0.5	0.5	0.0075	0.31	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	18	18	0.45	0.5	0.049	0.5	0.5	0.5	0.5	1.1	0.37	0.5	0.042
	31-Jul-2002	Post-Inj. 2	ug/L	7.20	7.96	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.0075	0.38	0.5	0.0025
	03-Sep-2002	Post-Inj. 3	ug/L	9.00	11.7	0.5	0.5	0.19	0.5	0.5	0.5	0.5	230	0.44	0.5	0.078
	07-Oct-2002	Post-Inj 4	ug/L	8.28	19.8	0.544	0.5	0.0025	0.5	0.5	0.5	0.5	2400	0.53	0.5	0.043
	11-Nov-2002	Post-Inj 5	ug/L	5.38	21	4.13	0.5	0.0025	0.5	0.5	0.5	0.5	3600	0.40	0.5	0.0025
	16-Dec-2002	Post-Inj 6	ug/L	6.09	26.2	5.31	0.5	0.0025	0.5	0.5	0.5	0.5	590	0.38	0.5	0.0025
	20-Jan-2003	Post-Inj 7	ug/L	11.00	10.6	0.784	0.5	0.02	0.5	0.5	0.5	0.5	2200	0.41	0.5	0.014
	24-Feb-2003	Post-Inj 8	ug/L	9.27	29.7	1.29	0.5	0.18	0.5	0.5	0.5	0.5	2200	0.33	0.5	0.022
	24-Mar-2003	Post-Inj. 9	ug/L	7.72	29.9	1.01	0.5	0.031	0.5	0.5	0.5	0.5	3300	0.29	0.5	0.008
	21-Apr-2003	Post-Inj 10	ug/L	10.50	30.5	0.907	0.5	0.034	0.5	0.5	0.5	0.5	3200	0.5	0.5	0.017
	19-May-2003	Post-Inj 11	ug/L	8.72	25.9	0.645	0.5	0.026	0.5	0.5	0.5	0.5	2600	0.302	0.5	0.014
	23-Jun-2003	Post-Inj. 12	ug/L	34.40	34.2	0.713	0.5	0.0025	0.5	0.5	0.5	0.5	2100	0.383	0.5	0.0025
	21-Jul-2003	Post-Inj 13	ug/L	40.90	35.9	0.656	0.5	0.0025	0.5	0.5	0.5	0.5	14	0.348	0.5	0.0025

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Table 4.5
Study Area 1: Summary of VOCs
Main Installation, Memphis Depot

Well	Sample Date	Sample Event	Units	PCE	TCE	Cis-1,2-DCE	VC	Ethene*	Carbon Tetrachloride	Chloroform	Methylene Chloride	Chloromethane	Methane*	1,2-DCA	Chloroethane	Ethane*
MW-117	21-May-2002	Baseline	ug/L	2.6	9	0.31	0.5	0.0025	0.5	0.25	0.5	0.5	0.0075	0.5	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	0.25	0.5	0.5	0.5	0.3	0.5	0.5	0.5	0.5	1.7	0.5	0.5	1.7
	30-Jul-2002	Post-Inj. 2	ug/L	0.25	6.73	0.867	0.5	0.27	0.5	0.5	0.5	0.5	18	0.5	0.5	3
	03-Sep-2002	Post-Inj. 3	ug/L	0.4	7.04	1.11	0.5	0.74	0.5	0.5	0.5	0.5	2600	0.5	0.5	0.81
	07-Oct-2002	Post-Inj. 4	ug/L	0.882	7.36	1.22	0.5	1	0.5	0.5	0.5	0.5	6200	0.268	0.5	2.8
	11-Nov-2002	Post-Inj. 5	ug/L	0.69	7.6	1.27	0.5	0.73	0.5	0.5	0.5	0.5	12000	0.5	0.5	1
	16-Dec-2002	Post-Inj. 6	ug/L	0.786	9.35	1.34	0.5	0.67	0.5	0.5	0.5	0.5	15000	0.5	0.5	0.31
	20-Jan-2003	Post-Inj. 7	ug/L	0.602	11.4	1.59	0.5	0.64	0.5	0.5	0.5	0.5	9100	0.5	0.5	0.43
	27-Feb-2003	Post-Inj. 8	ug/L	0.25	16.7	2.12	0.5	0.58	0.5	0.5	0.5	0.5	16000	0.5	0.5	0.23
	26-Mar-2003	Post-Inj. 9	ug/L	0.61	28.2	3.05	0.389	0.59	0.5	0.5	0.5	0.5	19000	0.5	0.5	0.25
	21-Apr-2003	Post-Inj. 10	ug/L	0.483	30.9	3.83	0.393	0.49	0.5	0.5	0.5	0.5	18000	0.5	0.5	0.21
	19-May-2003	Post-Inj. 11	ug/L	0.25	32.9	4.65	0.502	0.58	0.5	0.5	0.5	0.5	18000	0.5	0.5	0.28
	23-Jun-2003	Post-Inj. 12	ug/L	0.25	38.1	6.43	0.526	0.26	0.5	0.5	0.5	0.5	14000	0.5	0.5	0.0025
	21-Jul-2003	Post-Inj. 13	ug/L	0.909	25.7	5.41	0.349	0.38	0.5	0.5	0.5	0.5	13000	0.5	0.5	1
MW-118	21-May-2002	Baseline	ug/L	4.2	140	0.31	0.5	0.88	0.5	0.16	0.5	0.5	0.0075	0.5	0.5	1.2
	08-Jul-2002	Post-Inj. 1	ug/L	1	140	0.5	0.5	0.16	0.5	0.5	0.5	0.5	0.97	0.5	0.5	0.2
	30-Jul-2002	Post-Inj. 2	ug/L	0.25	184	0.5	0.5	0.32	0.5	0.5	0.5	0.5	3.4	0.5	0.5	2.2
	03-Sep-2002	Post-Inj. 3	ug/L	0.794	104	0.5	0.5	0.17	0.5	0.5	0.5	0.5	130	0.5	0.5	0.2
	07-Oct-2002	Post-Inj. 4	ug/L	1.12	140	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	3400	0.5	0.5	0.06
	11-Nov-2002	Post-Inj. 5	ug/L	1.53	113	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	4600	0.5	0.5	0.0025
	16-Dec-2002	Post-Inj. 6	ug/L	0.787	91	0.5	0.5	0.03	0.5	0.5	0.5	0.5	5300	0.5	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	1.37	65	0.5	0.5	0.051	0.5	0.5	0.5	0.5	6800	0.5	0.5	0.044
	24-Feb-2003	Post-Inj. 8	ug/L	0.734	45.4	0.386	0.5	0.12	0.5	0.5	0.5	0.5	6400	0.5	0.5	0.048
	24-Mar-2003	Post-Inj. 9	ug/L	1.52	31.3	0.5	0.5	0.036	0.5	0.5	0.5	0.5	6400	0.5	0.5	0.031
	21-Apr-2003	Post-Inj. 10	ug/L	1.13	36.5	0.5	0.5	0.042	0.5	0.5	0.5	0.5	7100	0.5	0.5	0.05
	19-May-2003	Post-Inj. 11	ug/L	0.25	31.1	0.5	0.5	0.055	0.5	0.5	0.5	0.5	3200	0.5	0.5	0.036
	23-Jun-2003	Post-Inj. 12	ug/L	0.25	25.8	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	5700	0.5	0.5	0.0025
	21-Jul-2003	Post-Inj. 13	ug/L	1.08	32.8	0.5	0.5	0.025	0.5	0.5	0.5	0.5	6900	0.5	0.5	0.077
MW-119	21-May-2002	Baseline	ug/L	1.5	170	0.5	0.5	0.62	0.5	0.13	0.5	0.5	0.0075	0.5	0.5	0.77
	08-Jul-2002	Post-Inj. 1	ug/L	0.93	120	0.5	0.5	0.096	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.036
	30-Jul-2002	Post-Inj. 2	ug/L	0.25	118	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.0025
	03-Sep-2002	Post-Inj. 3	ug/L	1.89	74.1	0.5	0.5	0.027	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.0025
	07-Oct-2002	Post-Inj. 4	ug/L	2.64	57.3	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.014
	11-Nov-2002	Post-Inj. 5	ug/L	1.27	142	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.0025
	16-Dec-2002	Post-Inj. 6	ug/L	2.45	114	0.5	0.5	0.028	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	3.08	100	0.5	0.5	0.0094	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.011
	27-Feb-2003	Post-Inj. 8	ug/L	2.14	59	0.5	0.5	0.12	0.5	0.5	0.5	0.5	11	0.5	0.5	0.0025
	24-Mar-2003	Post-Inj. 9	ug/L	2.69	61.6	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	19	0.5	0.5	0.0025
	21-Apr-2003	Post-Inj. 10	ug/L	1.83	39.4	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	92	0.5	0.5	0.0025
	19-May-2003	Post-Inj. 11	ug/L	0.25	42.8	0.5	0.5	0.0067	0.5	0.5	0.5	0.5	27	0.5	0.5	0.0025
	23-Jun-2003	Post-Inj. 12	ug/L	0.25	27.6	0.5	0.5	0.012	0.5	0.5	0.5	0.5	6.1	0.5	0.5	0.0097
	21-Jul-2003	Post-Inj. 13	ug/L	0.961	36.3	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	0.8	0.5	0.5	0.0025
MW-120	21-May-2002	Baseline	ug/L	32	40	0.71	0.5	0.49	0.5	0.5	0.5	0.5	0.0075	0.31	0.5	0.81
	08-Jul-2002	Post-Inj. 1	ug/L	25	39	0.88	0.5	0.17	0.5	0.5	0.5	0.5	0.71	0.5	0.5	0.52
	30-Jul-2002	Post-Inj. 2	ug/L	0.25	2.83	0.5	0.5	0.35	0.5	0.5	0.5	0.5	4.4	0.254	0.5	0.99
	03-Sep-2002	Post-Inj. 3	ug/L	10.5	26.3	1.47	0.5	0.23	0.5	0.5	0.5	0.5	3800	0.5	0.5	0.19
	07-Oct-2002	Post-Inj. 4	ug/L	5.62	14.5	1.54	0.5	0.37	0.5	0.5	0.5	0.5	9400	0.5	0.5	0.42
	11-Nov-2002	Post-Inj. 5	ug/L	15.2	41	1.8	0.5	0.35	0.5	0.5	0.5	0.5	12000	0.252	0.5	1.8
	16-Dec-2002	Post-Inj. 6	ug/L	17.1	41.4	1.59	0.5	0.42	0.5	0.5	0.5	0.5	13000	0.5	0.5	0.5
	20-Jan-2003	Post-Inj. 7	ug/L	22.4	59.4	1.52	0.5	0.066	0.5	0.5	0.5	0.5	12000	0.5	0.5	0.081
	24-Feb-2003	Post-Inj. 8	ug/L	13.5	40.1	2.55	0.253	0.12	0.5	0.5	0.5	0.5	15000	0.5	0.5	0.016
	24-Mar-2003	Post-Inj. 9	ug/L	27.1	58.2	9	0.368	0.059	0.5	0.5	0.5	0.5	14000	0.5	0.5	0.038
	21-Apr-2003	Post-Inj. 10	ug/L	31.2	48.1	34.1	0.526	0.095	0.5	0.5	0.5	0.5	15000	0.5	0.5	0.082
	19-May-2003	Post-Inj. 11	ug/L	26.2	37.8	60.1	0.851	0.072	0.5	0.5	0.5	0.5	17000	0.5	0.5	0.078
	23-Jun-2003	Post-Inj. 12	ug/L	29.5	31.3	97.2	0.918	0.0025	0.5	0.5	0.5	0.5	18000	0.273	0.5	0.0025
	21-Jul-2003	Post-Inj. 13	ug/L	25.6	38.6	104	0.977	0.046	0.5	0.5	0.5	0.5	14000	0.279	0.5	0.064
MW-121	21-May-2002	Baseline	ug/L	1.9	79	0.5	0.5	0.62	0.5	0.23	0.5	0.5	2.7	0.5	0.5	1
	08-Jul-2002	Post-Inj. 1	ug/L	1.4	74	0.5	0.5	0.087	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.19
	31-Jul-2002	Post-Inj. 2	ug/L	0.25	24.0	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.0025
	03-Sep-2002	Post-Inj. 3	ug/L	2.72	78.0	0.5	0.5	0.036	0.5	0.5	0.5	0.5	51	0.5	0.5	0.0025
	07-Oct-2002	Post-Inj. 4	ug/L	2.21	60.7	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	210	0.5	0.5	0.0082
	11-Nov-2002	Post-Inj. 5	ug/L	1.93	70.5	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	320	0.5	0.5	0.0025
	16-Dec-2002	Post-Inj. 6	ug/L	3.93	24.1	0.5	0.5	0.027	0.5	0.5	0.5	0.5	320	0.5	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	2.57	40.1	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	840	0.5	0.5	0.0025
	27-Feb-2003	Post-Inj. 8	ug/L	2.82	24.3	0.5	0.5	0.12	0.5	0.5	0.5	0.5	460	0.5	0.5	0.0025
	24-Mar-2003	Post-Inj. 9	ug/L	2.23	20.3	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	630	0.5	0.5	0.0025
	21-Apr-2003	Post-Inj. 10	ug/L	1.94	13.9	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	1600	0.5	0.5	0.011
	19-May-2003	Post-Inj. 11	ug/L	0.25	12.8	0.5	0.5	0.015	0.5	0.5	0.5	0.5	890	0.5	0.5	0.013
	23-Jun-2003	Post-Inj. 12	ug/L	1.8	11.6	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	960	0.5	0.5	0.0025
	21-Jul-2003	Post-Inj. 13	ug/L	3.17	7.0	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	16	0.5	0.5	0.0025

Table 4.5
Study Area 1: Summary of VOCs
Main Installation, Memphis Depot

Well	Sample Date	Sample Event	Units	PCE	TCE	Cis-1,2-DCE	VC	Ethene*	Carbon Tetrachloride	Chloroform	Methylene Chloride	Chloromethane	Methane*	1,2-DCA	Chloroethane	Ethane*
MW-122	21-May-2002	Baseline	ug/L	53	49	*0.99*	0.5	0.2	0.5	0.5	0.5	0.5	0.0075	*0.26*	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	20	32	*0.82*	0.5	0.038	0.5	0.5	0.5	0.5	0.0075	*0.34*	0.5	0.084
	31-Jul-2002	Post-Inj 2	ug/L	25.3	51.8	*0.866*	0.5	0.43	0.5	0.5	0.5	0.5	0.0075	*0.435*	0.5	0.56
	03-Sep-2002	Post-Inj. 3	ug/L	30.7	52	*0.97*	0.5	0.069	0.5	0.5	0.5	0.5	0.0075	*0.367*	0.5	0.82
	07-Oct-2002	Post-Inj. 4	ug/L	44	66.4	1.36	0.5	0.62	0.5	0.5	0.5	0.5	0.0075	*0.275*	0.5	3.7
	11-Nov-2002	Post-Inj. 5	ug/L	46.4	68.3	1.69	0.5	0.34	0.5	0.5	0.5	0.5	450	*0.307*	0.5	0.28
	16-Dec-2002	Post-Inj. 6	ug/L	55.4	84.4	1.81	0.5	0.25	0.5	0.5	0.5	0.5	860	*0.317*	0.5	0.15
	20-Jan-2003	Post-Inj. 7	ug/L	71	96.5	1.94	0.5	0.18	0.5	0.5	0.5	0.5	1000	*0.281*	0.5	0.051
	24-Feb-2003	Post-Inj. 8	ug/L	18.9	20.4	116	0.5	0.16	0.5	0.5	0.5	0.5	2000	*0.282*	0.5	0.0025
	24-Mar-2003	Post-Inj 9	ug/L	0.754	*0.952*	141	0.5	0.068	0.5	0.5	0.5	0.5	4200	*0.364*	0.5	0.0057
	21-Apr-2003	Post-Inj. 10	ug/L	*0.336*	*0.322*	142	0.5	0.057	0.5	0.5	0.5	0.5	5200	*0.277*	0.5	0.0025
	19-May-2003	Post-Inj 11	ug/L	0.25	*0.763*	145	0.5	0.039	0.5	0.5	0.5	0.5	4600	*0.313*	0.5	0.0077
	23-Jun-2003	Post-Inj 12	ug/L	0.25	0.5	163	0.5	0.0025	0.5	0.5	0.5	0.5	7200	*0.275*	0.5	0.0025
	21-Jul-2003	Post-Inj. 13	ug/L	0.25	0.5	170	0.5	0.024	0.5	0.5	0.5	0.5	7100	*0.323*	0.5	0.0078
MW-123	21-May-2002	Baseline	ug/L	22	48	*0.42*	0.5	0.32	0.5	0.5	0.5	0.5	0.0075	0.3	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	13	96	*0.34*	0.5	0.0025	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.0025
	30-Jul-2002	Post-Inj. 2	ug/L	1.01	48.7	*0.418*	0.5	0.64	0.5	0.5	0.5	0.5	2.7	0.5	0.5	0.67
	03-Sep-2002	Post-Inj. 3	ug/L	3.44	29.8	*0.326*	0.5	0.4	0.5	0.5	0.5	0.5	1600	0.5	0.5	0.46
	07-Oct-2002	Post-Inj. 4	ug/L	5.41	34.8	*0.353*	0.5	0.72	0.5	0.5	0.5	0.5	8000	0.5	0.5	1.3
	11-Nov-2002	Post-Inj. 5	ug/L	2.89	48	*0.422*	0.5	0.15	0.5	0.5	0.5	0.5	13000	0.5	0.5	0.19
	16-Dec-2002	Post-Inj. 6	ug/L	8.55	42.8	*0.712*	0.5	0.11	0.5	0.5	0.5	0.5	14000	0.5	0.5	0.062
	20-Jan-2003	Post-Inj. 7	ug/L	11.7	64.3	0.5	0.5	0.13	0.5	0.5	0.5	0.5	16000	0.5	0.5	0.22
	24-Feb-2003	Post-Inj. 8	ug/L	10.6	57.7	*0.628*	0.5	0.16	0.5	0.5	0.5	0.5	17000	0.5	0.5	0.057
	24-Mar-2003	Post-Inj. 9	ug/L	13.1	29	*0.646*	0.5	0.097	0.5	0.5	0.5	0.5	19000	0.5	0.5	0.06
	21-Apr-2003	Post-Inj. 10	ug/L	13.2	45	*0.582*	0.5	0.087	0.5	0.5	0.5	0.5	18000	0.5	0.5	0.098
	19-May-2003	Post-Inj. 11	ug/L	10.7	21.7	*0.473*	0.5	0.09	0.5	0.5	0.5	0.5	21000	0.5	0.5	0.15
	23-Jun-2003	Post-Inj. 12	ug/L	13.3	23.6	1.12	0.5	0.0025	0.5	0.5	0.5	0.5	20000	0.5	0.5	0.0025
	21-Jul-2003	Post-Inj 13	ug/L	6.26	7.92	14.5	0.5	0.068	0.5	0.5	0.5	0.5	21000	0.5	0.5	0.1
MW-124	21-May-2002	Baseline	ug/L	46	40	*0.85*	0.5	0.28	0.5	0.5	0.5	0.5	0.0075	*0.28*	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	46	46	*0.92*	0.5	0.044	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.041
	31-Jul-2002	Post-Inj. 2	ug/L	30.6	77.5	*0.779*	0.5	0.42	0.5	0.5	0.5	0.5	0.0075	*0.337*	0.5	0.0025
	03-Sep-2002	Post-Inj. 3	ug/L	30.8	73.5	*0.873*	0.5	0.033	0.5	0.5	0.5	0.5	0.0075	*0.293*	0.5	0.034
	07-Oct-2002	Post-Inj. 4	ug/L	30.9	64.4	1.32	0.5	0.0025	0.5	0.5	0.5	0.5	0.0075	*0.273*	0.5	0.022
	11-Nov-2002	Post-Inj. 5	ug/L	48.1	75.3	1.57	0.5	0.0025	0.5	0.5	0.5	0.5	0.0075	*0.257*	0.5	0.0025
	16-Dec-2002	Post-Inj. 6	ug/L	57.7	82.1	1.36	0.5	0.013	0.5	0.5	0.5	0.5	68	0.5	0.5	0.0025
	20-Jan-2003	Post-Inj 7	ug/L	64.9	95.6	0.5	0.5	0.032	0.5	0.5	0.5	0.5	220	0.5	0.5	0.0025
	24-Feb-2003	Post-Inj 8	ug/L	55.5	94.2	1.98	0.5	0.14	0.5	0.5	0.5	0.5	410	0.5	0.5	0.0079
	24-Mar-2003	Post-Inj 9	ug/L	81.6	104	14.9	0.5	0.036	0.5	0.5	0.5	0.5	380	0.5	0.5	0.017
	21-Apr-2003	Post-Inj 10	ug/L	51.6	86.4	16	0.5	0.0095	0.5	0.5	0.5	0.5	580	0.5	0.5	0.0056
	19-May-2003	Post-Inj 11	ug/L	63.2	*88.9*	*22.2*	0.5	0.016	0.5	0.5	0.5	0.5	500	0.5	0.5	0.0094
	23-Jun-2003	Post-Inj 12	ug/L	72.2	95	18.5	0.5	0.0025	0.5	0.5	0.5	0.5	1200	0.5	0.5	0.035
	21-Jul-2003	Post-Inj 13	ug/L	59.4	89.6	31.6	0.5	0.0075	0.5	0.5	0.5	0.5	9.7	0.5	0.5	0.0086
MW-125	21-May-2002	Baseline	ug/L	8.9	75	0.5	0.5	0.0025	0.5	0.5	0.5	0.5	0.0075	0.5	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	8.1	40	0.5	0.5	0.38	0.5	0.5	0.5	0.5	3.8	0.5	0.5	2.8
	30-Jul-2002	Post-Inj. 2	ug/L	0.25	43.2	0.5	0.5	0.27	0.5	0.5	0.5	0.5	5	0.5	0.5	0.73
	03-Sep-2002	Post-Inj. 3	ug/L	1.32	38.7	0.5	0.5	0.42	0.5	0.5	0.5	0.5	3700	0.5	0.5	0.13
	07-Oct-2002	Post-Inj 4	ug/L	2.01	20.8	0.5	0.5	0.18	0.5	0.5	0.5	0.5	3500	0.5	0.5	0.048
	11-Nov-2002	Post-Inj 5	ug/L	3.65	19.4	*0.399*	0.5	0.0025	0.5	0.5	0.5	0.5	8600	0.5	0.5	0.0025
	16-Dec-2002	Post-Inj 6	ug/L	7.07	17.5	8.99	0.5	0.06	0.5	0.5	0.5	0.5	11000	0.5	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	6.57	12.4	40.8	0.5	0.036	0.5	0.5	0.5	0.5	7900	0.5	0.5	0.028
	24-Feb-2003	Post-Inj 8	ug/L	7.17	17	19.7	0.5	0.19	0.5	0.5	0.5	0.5	9200	0.5	0.5	0.025
	24-Mar-2003	Post-Inj 9	ug/L	5.68	19	15.4	0.5	0.034	0.5	0.5	0.5	0.5	15000	0.5	0.5	0.034
	21-Apr-2003	Post-Inj 10	ug/L	7.79	16.5	34.9	0.5	0.032	0.5	0.5	0.5	0.5	13000	0.5	0.5	0.026
	19-May-2003	Post-Inj. 11	ug/L	3.24	8.49	8.1	0.5	0.026	0.5	0.5	0.5	0.5	12000	0.5	0.5	0.031
	23-Jun-2003	Post-Inj. 12	ug/L	8.85	13.9	15	0.5	0.0025	0.5	0.5	0.5	0.5	12000	0.5	0.5	0.0025
	21-Jul-2003	Post-Inj. 13	ug/L	6.55	5.53	1.99	0.5	0.006	0.5	0.5	0.5	0.5	9100	0.5	0.5	0.013

Notes:
ND = Not Detected
NA = Not Analyzed
Italic = Estimated Value (J)
ug/L = Micrograms per liter
BL = Baseline value
Underlined value = half of the reporting limit for a non-detected parameter
* Check Chain-of-Custody summary table for collection dates associated with methane, ethane, and ethene.
Shaded results are not validated.

Table 4.6
Study Area 1: Summary of Other Analytes
Main Installation, Memphis Depot

Well	Sample Date	Sample Event	DOC (mg/L)	Arsenic (mg/L)	Selenium (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)	Chloride (mg/L)	Bromide (mg/L)	Manganese (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ferrous Iron (mg/L)
IW-5	21-May-2002	BaseLine	0.5	NA	NA	11	0.5	13	0.21	0.844	2.5	0.12	1.46
	23-Jan-2003	Post-Inj. 7	2,060	NA	NA	5.63	0.5	12.9	26	2.58	0.3	0.2	2.40
IW-6	21-May-2002	BaseLine	0.5	0.0005	0.0005	10	0.63	12	0.17	0.299	2.8	0.19	2.15
	23-Jan-2003	Post-Inj. 7	3,460	0.274	0.454	0.5	0.6	36	168	3.86	0.3	4.65	2.75
IW-7	21-May-2002	BaseLine	0.5	0.0005	0.0005	12	0.5	12	0.17	0.0782	3.3	0.15	0.98
	23-Jan-2003	Post-Inj. 7	658	0.019	0.013	0.5	0.5	11.8	5.01	1.42	0.3	0.2	2.71
MW-21	21-Mar-2002	MI BaseLine	0.5	NA	NA	8.1	0.5	13	0.1	0.005	3.5	0.2	0.08
(Background)	23-May-2002	BaseLine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	08-Jul-2002	Post-Inj. 1	0.5	NA	NA	7	0.5	13	0.27	0.005	3.4	0.2	0.02
	29-Jul-2002	Post-Inj. 2	0.5	NA	NA	7.28	0.5	13.3	0.161	0.005	3.40	0.2	0.08
	03-Sep-2002	Post-Inj. 3	1.6	NA	NA	7.34	0.5	14.7	0.18	0.005	3.43	0.2	0.03
	07-Oct-2002	Post-Inj. 4	0.5	NA	NA	6.84	0.5	11.8	0.218	0.005	3.25	0.2	0.18
	11-Nov-2002	Post-Inj. 5	0.7	NA	NA	6.79	0.5	12.4	0.219	0.005	3.25	0.2	0.15
	18-Dec-2002	Post-Inj. 6	0.5	NA	NA	6.80	0.5	12.5	0.23	0.005	3.21	0.2	0.07
	20-Jan-2003	Post-Inj. 7	0.5	NA	NA	6.9	0.5	12.6	0.489	0.005	3.22	0.2	0.02
	24-Feb-2003	Post-Inj. 8	0.5	NA	NA	6.6	0.5	12.2	0.235	0.005	3.18	0.2	0.10
	24-Mar-2003	Post-Inj. 9	0.5	NA	NA	6.29	0.5	12	0.1	0.005	2.96	0.2	0.16
	21-Apr-2003	Post-Inj. 10	0.5	NA	NA	6.63	0.5	11.8	0.361	0.005	2.87	0.2	0.07
	19-May-2003	Post-Inj. 11	0.5	NA	NA	7.25	0.5	12.8	0.373	0.005	3.15	0.2	0.03
	23-Jun-2003	Post-Inj. 12	0.5	NA	NA	7.85	0.5	12.8	0.251	0.00727	3.14	0.2	0.15
	21-Jul-2003	Post-Inj. 13	3.1	NA	NA	7.80	0.5	11.4	0.371	0.005	2.85	0.2	0.08
MW-100B	22-Mar-2002	MI BaseLine	0.6	NA	NA	8.4	0.5	5.1	0.58	0.005	0.3	0.2	0.05
	23-May-2002	BaseLine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	08-Jul-2002	Post-Inj. 1	0.5	NA	NA	11	0.5	12	0.28	0.005	5.1	0.2	0.01
	29-Jul-2002	Post-Inj. 2	87	NA	NA	10.1	0.5	11.8	38.5	0.005	0.564	0.2	0.08
	03-Sep-2002	Post-Inj. 3	671	NA	NA	1.07	0.5	14.4	188	2.82	0.3	0.2	11.68
	07-Oct-2002	Post-Inj. 4	682	NA	NA	1.32	0.5	11.8	75.8	2.12	0.3	0.2	6.24
	11-Nov-2002	Post-Inj. 5	458	NA	NA	1.42	0.5	11.8	81	3.58	0.3	0.2	3.08
	19-Dec-2002	Post-Inj. 6	526	NA	NA	0.5	0.5	10.8	44.5	4.81	0.3	0.2	1.79
	20-Jan-2003	Post-Inj. 7	318	NA	NA	6.18	0.5	14.3	45.1	6.74	0.3	0.2	3.04
	28-Feb-2003	Post-Inj. 8	131	NA	NA	0.5	0.5	10.1	24.8	4.8	0.3	0.2	2.25
	24-Mar-2003	Post-Inj. 9	88	NA	NA	0.802	0.5	14.2	18.8	5.18	0.3	0.2	5.46
	21-Apr-2003	Post-Inj. 10	43	NA	NA	0.799	0.5	13	14.8	4.69	0.3	0.2	3.92
	19-May-2003	Post-Inj. 11	20	NA	NA	0.5	0.5	14.8	10.4	4.22	0.3	0.2	5.58
	25-Jun-2003	Post-Inj. 12	7	NA	NA	0.5	0.5	14.1	4.03	3.2	0.3	0.2	6.44
	23-Jul-2003	Post-Inj. 13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	21-Aug-2003	Post-Inj. 14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-115	21-May-2002	Baseline	0.5	NA	NA	20	0.55	11	0.13	0.0926	4	0.17	0.88
	08-Jul-2002	Post-Inj. 1	230.0	NA	NA	12	0.5	12	52	0.0831	2.2	0.2	0.60
	31-Jul-2002	Post-Inj. 2	79.3	NA	NA	7.75	0.5	12.6	7.37	0.005	1.02	0.340	2.09
	08-Sep-2002	Post-Inj. 3	55.3	NA	NA	11.7	0.5	15.6	0.118	0.487	4.52	0.2	2.57
	08-Oct-2002	Post-Inj. 4	84.7	NA	NA	6.95	0.5	12.8	1.31	0.514	1.97	0.2	2.95
	12-Nov-2002	Post-Inj. 5	55.8	NA	NA	6.57	0.5	12.4	0.6	0.43	4.84	0.2	5.80
	17-Dec-2002	Post-Inj. 6	25.4	NA	NA	7.86	0.5	12.5	0.537	0.282	2.3	0.2	2.85
	23-Jan-2003	Post-Inj. 7	37.3	NA	NA	8	0.5	12.4	0.6	0.255	2.4	0.2	2.06
	24-Feb-2003	Post-Inj. 8	13.8	NA	NA	8.5	0.5	12.4	0.832	0.23	2.45	0.182	1.81
	28-Mar-2003	Post-Inj. 9	7.5	NA	NA	8.88	0.5	13.1	0.1	0.005	2.82	0.2	2.03
	22-Apr-2003	Post-Inj. 10	8.2	NA	NA	8.64	0.5	13.3	0.48	0.005	2.53	0.2	3.04
	21-May-2003	Post-Inj. 11	6.4	NA	NA	9.78	0.5	14.8	0.235	0.143	3.38	0.2	2.52
	25-Jun-2003	Post-Inj. 12	7.8	NA	NA	10.4	0.5	14.1	0.1	0.125	2.83	0.2	3.84
	23-Jul-2003	Post-Inj. 13	14.7	NA	NA	12.9	0.5	15.5	0.1	0.005	3.49	0.2	3.09

Well	Sample Date	Sample Event	Carbon Dioxide (mg/L)	Dissolved Oxygen (mg/L)	Alkalinity (mg/L)	pH	Conductivity (ms/cm²)	Temperature (°C)	ORP (mV)	Turbidity (NTU)	Oil & Grease (mg/L)	Acetic Acid (mg/L)	Butyric Acid (mg/L)	Formic Acid (mg/L)	Lactic Acid (mg/L)	Propionic Acid (mg/L)	Pyruvic Acid (mg/L)
IW-5	21-May-2002	BaseLine	87.8	1.0	79	6.08	0.31	18.6	128	8.7	NA	0.5	0.5	0.5	0.5	0.5	2.0
	23-Jan-2003	Post-Inj. 7	534	0.1	342	4.83	0.85	15.1	49	84.7	82	105.8	262.2	0.5	0.5	104.8	2.0
IW-6	21-May-2002	BaseLine	68.8	1.4	85	6.03	0.29	19.2	44	8.8	NA	0.5	0.5	0.5	0.5	0.5	2.0
	23-Jan-2003	Post-Inj. 7	454	0.1	883	4.94	2.27	18.8	55	172.8	174	837.1	508.7	0.5	0.5	230.2	2.0
IW-7	21-May-2002	BaseLine	60.4	3.3	85	6.04	0.30	18.5	100	8.2	NA	0.5	0.5	0.5	0.5	0.5	2.0
	23-Jan-2003	Post-Inj. 7	340	0.1	225	4.80	0.49	17.1	68	28.7	27.4	120.0	147.5	0.5	0.5	84.3	2.0
MW-21	21-Mar-2002	MI BaseLine	60.2	5.5	70	5.84	0.22	14.7	182	3.8	NA	0.6	0.5	0.3	0.6	0.5	2.0
(Background)	23-May-2002	BaseLine	NA	4.8	NA	6.90	0.26	21.6	391	6.0	NA	NA	NA	NA	NA	NA	NA
	08-Jul-2002	Post-Inj. 1	147	7.8	84	6.05	0.23	18.1	303	0.8	NA	0.5	0.5	0.5	0.5	0.5	2.0
	29-Jul-2002	Post-Inj. 2	133.2	3.3	77	5.81	0.22	18.8	377	8.8	NA	0.5	0.5	0.5	0.5	0.5	2.0
	03-Sep-2002	Post-Inj. 3	83	5.5	70	5.72	0.22	18.4	518	4.7	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	07-Oct-2002	Post-Inj. 4	128.8	2.4	85	6.04	0.25	18.7	124	8.8	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	11-Nov-2002	Post-Inj. 5	143.2	6.8	79	6.19	0.23	18.3	102	8.8	NA	0.5	0.5	0.5	0.5	0.5	2.0
	18-Dec-2002	Post-Inj. 6	113.2	4.8	82	5.89	0.24	18.1	173	8.4	NA	0.5	0.5	0.5	0.5	0.5	2.0
	20-Jan-2003	Post-Inj. 7	153	8.1	74	6.19	0.23	17.4	19	8.8	NA	0.5	0.5	3.9	0.5	0.5	2.0
	24-Feb-2003	Post-Inj. 8	125	5.8	73	5.80	0.24	14.8	172	8.4	NA	0.5	0.5	0.6	0.5	0.5	2.0
	24-Mar-2003	Post-Inj. 9	117	4.5	83	5.79	0.23	18.7	434	8.8	NA	0.5	0.5	0.5	0.5	0.5	2.0
	21-Apr-2003	Post-Inj. 10	144.2	5.6	68	6.80	0.22	18.4	142	7.1	NA	0.5	0.5	0.5	0.5	0.5	2.0
	19-May-2003	Post-Inj. 11	182	5.5	92	6.03	0.21	20.0	218	9.3	NA	0.5	0.5	0.5	0.5	0.5	2.0
	23-Jun-2003	Post-Inj. 12	103	6.8	87.8	6.00	0.22	18.9	178	9.8	NA	0.5	0.5	0.5	0.5	0.5	2.0
	21-Jul-2003	Post-Inj. 13	122.4	6.1	82.6	5.88	0.20	21.2	234	9.2	NA	0.5	0.5	0.5	0.5	0.5	3.8
MW-100B	22-Mar-2002	MI BaseLine	233	2.7	85	6.30	0.28	18.7	144	5.7	NA	0.8	0.5	0.5	0.7	0.5	2.0
	23-May-2002	BaseLine	NA	2.2	NA	6.01	0.27	23.8	238	15.3	NA	NA	NA	NA	NA	NA	NA
	08-Jul-2002	Post-Inj. 1	140	2.1	87	6.08	0.28	22.5	353	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	29-Jul-2002	Post-Inj. 2	268	0.5	139	6.50	0.48	19.3	-42	3.8	NA	29.2	2.0	0.5	0.5	37.5	2.0
	03-Sep-2002	Post-Inj. 3	431	0.5	343	4.47	0.78	20.3	182	8.5	6.7	181.0	44.3	0.5	0.7	379.3	2.0
	07-Oct-2002	Post-Inj. 4	448	2.2	355	5.20	0.81	19.8	18	44.8	2.7	164.0	41.5	0.5	0.5	229.2	2.0
	11-Nov-2002	Post-Inj. 5	854	0.3	411	5.80	0.84	18.8	-42	304.8	4.8	78.5	48.8	0.5	0.5	180.5	2.0
	19-Dec-2002	Post-Inj. 6	483	4.8	418	5.45	0.81	17.7	82	330.3	4.1	119.2	47.0	0.5	0.2	198.8	2.0
	20-Jan-2003	Post-Inj. 7	378	0.3	444	6.15	0.88	18.0	-64	49.8	2.5	53.8	29.0	0.7	0.5	187.8	2.0
	28-Feb-2003	Post-Inj. 8	218	0.8	358	5.95	0.70	13.2	-85	46.7	2.5	73.1	10.3	0.5	0.5	77.8	2.0
	24-Mar-2003	Post-Inj. 9	768	1.0	339	6.31	0.78	19.0	-70	21.8	2.5	13.4	0.8	0.5	0.5	28.1	2.0
	21-Apr-2003	Post-Inj. 10	808	0.3	300	6.10	0.75	18.8	-92	8.2	2.5	7.8	0.6	0.5	0.5	9.8	2.0
	19-May-2003	Post-Inj. 11	600	0.4	5	6.24	0.45	20.0	-67	268.3	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	25-Jun-2003	Post-Inj. 12	512	0.5	100	6.12	0.57	21.8	-54	128.8	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	23-Jul-2003	Post-Inj. 13	NA	0.5	NA	6.28	0.51	21.8	-82	5.4	NA	NA	NA	NA	NA	NA	NA
	21-Aug-2003	Post-Inj. 14	NA	0.5	NA	6.29	0.51	21.9	-42	5.4	NA	NA	NA	NA	NA	NA	NA
MW-115	21-May-2002	Baseline	51.8	5.0	78	6.29	0.30	18.4	165	8.8	NA	0.5	0.5	0.5	0.5	0.5	2.0
	08-Jul-2002	Post-Inj. 1	103	5.5	110	5.95	0.32	21.2	187	8.8	NA	43.1	1.5	5.9	0.5	49.8	2.0
	31-Jul-2002	Post-Inj. 2	176	1.4	113	5.83	0.28	21.3	90	8.2	NA	21.5	0.5	0.5	0.7	20.3	2.0
	08-Sep-2002	Post-Inj. 3	114	5.1	100	5.86	0.31	20.3	-87	8.4	2.5	27.8	6.7	0.5	0.5	30.3	2.0
	08-Oct-2002	Post-Inj. 4	282	0.1	133	5.90	0.33	18.6	-26	8.8	2.5	20.8	2.9	0.5	0.5	28.6	2.0
	12-Nov-2002	Post-Inj. 5	178	3.5	117	6.35	0.29	17.2	51	8.1	2.5	26.7	8.2	0.5	0.5	28.7	2.0
	17-Dec-2002	Post-Inj. 6	80	3.0	118	5.86	0.28	18.3	-34	8.8	2.5	0.5	1.8	0.5	0.5	17.7	2.0
	23-Jan-2003	Post-Inj. 7	83	3.8	104	6.40	0.31	16.5	-24	7.2	2.5	0.5	0.4	0.7	0.5	21.1	2.0
	24-Feb-2003	Post-Inj. 8	125	3.6	108	6.04	0.30	15.6	-34	2.1	2.5	2.8	0.5	0.6	0.5	13.4	2.0
	28-Mar-2003	Post-Inj. 9	150	3.2	103	6.28	0.24	18.0	48	3.2	2.5	11.0	0.5	0.5	0.5	2.5	2.0
	22-Apr-2003	Post-Inj. 10	270	2.8	120	5.88	0.29	18.2	37	7.2	2.5	2.7	0.5	0.5	0.5	7.1	2.0
	21-May-2003	Post-Inj. 11	154	3.8	88	6.25	0.29	18.0	21	7.2	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	25-Jun-2003	Post-Inj. 12	230	4.8	83.6	6.02	0.28	20.2	33	2.8	2.5	2.3	0.5	0.6	0.5	3.5	2.0
	23-Jul-2003	Post-Inj. 13	160	4.6	83.3	5.88	0.24	21.1	64	7.8	2.5	0.5	0.5	0.5	0.5	0.5	4.0

Table 4.6
Study Area 1: Summary of Other Analytes
Main Installation, Memphis Depot

Well	Sample Date	Sample Event	DOC (mg/L)	Arsenic (mg/L)	Selenium (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)	Chloride (mg/L)	Bromide (mg/L)	Manganese (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ferrous Iron (mg/L)	Carbon Dioxide (mg/L)	Dissolved Oxygen (mg/L)	Alkalinity (mg/L)	pH	Conductivity (ms/cm³)	Temperature (°C)	ORP (mV)	Turbidity (NTU)	Oil & Grease (mg/L)	Acetic Acid (mg/L)	Butyric Acid (mg/L)	Formic Acid (mg/L)	Lactic Acid (mg/L)	Propionic Acid (mg/L)	Pyruvic Acid (mg/L)
MW-116	22-May-2002	Baseline	0.5	NA	NA	10	0.5	11	0.14	0.0098	4.7	0.14	0.00	94.8	4.3	84	6.02	0.28	18.7	290	8.7	NA	0.5	0.5	0.5	0.5	0.5	2.0
	08-Jul-2002	Post-Inj. 1	24.0	NA	NA	8.7	0.5	11	4.3	0.005	0.3	0.2	1.18	181.2	1.5	88	6.02	0.28	20.7	179	8.9	NA	8.9	0.5	0.5	0.5	3.7	2.0
	31-Jul-2002	Post-Inj. 2	8.2	NA	NA	7.11	0.5	10.9	0.820	0.005	0.806	0.2	2.81	196	0.8	118	5.88	0.28	22.4	218	-0.2	NA	0.5	0.5	0.5	0.5	0.5	2.0
	06-Sep-2002	Post-Inj. 3	6.5	NA	NA	7.87	0.5	11.4	0.229	0.18	1.63	0.2	3.00	211	0.3	82	5.66	0.22	20.0	544	6.8	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	09-Oct-2002	Post-Inj. 4	23.1	NA	NA	8.47	0.5	12	0.288	0.169	2.1	0.176	2.54	192	1.2	105	6.15	0.28	18.8	65	6.7	2.5	1.9	0.5	0.5	0.5	0.5	2.0
	13-Nov-2002	Post-Inj. 5	21.7	NA	NA	9.2	0.5	11.7	0.230	0.187	2.23	0.162	2.70	208	1.9	108	6.34	0.29	18.3	-18	6.8	2.5	1.7	0.5	0.5	0.5	6.5	2.0
	17-Dec-2002	Post-Inj. 6	11.8	NA	NA	9.96	0.5	11.8	0.216	0.005	2.89	0.2	1.10	71	1.8	89	5.93	0.27	18.2	-42	2.3	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	22-Jan-2003	Post-Inj. 7	10.0	NA	NA	9.78	0.5	12.3	0.281	0.005	2.63	0.2	2.01	79	1.8	99	6.23	0.29	15.9	-36	6.1	2.5	0.5	0.8	0.6	0.5	1.8	2.0
	25-Feb-2003	Post-Inj. 8	7.8	NA	NA	10.5	0.5	11.8	0.291	0.005	3.81	0.202	1.10	118	1.8	101	5.98	0.27	14.9	69	0.0	2.5	2.8	1.0	0.8	0.5	5.4	2.0
	25-Mar-2003	Post-Inj. 9	5.3	NA	NA	8.99	0.5	12.2	0.1	0.005	2.33	0.2	1.88	193	1.3	109	5.90	0.28	18.7	132	0.1	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	22-Apr-2003	Post-Inj. 10	9.3	NA	NA	9.65	0.5	12.5	0.299	0.005	2.47	0.2	1.14	194	0.8	98	5.89	0.28	18.3	63	1.7	2.5	2.7	0.5	0.5	0.5	3.8	2.0
	20-May-2003	Post-Inj. 11	5.7	NA	NA	11	0.5	13.4	0.1	0.0498	2.79	0.2	0.63	168	1.8	113	6.10	0.28	18.5	74	1.0	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	24-Jun-2003	Post-Inj. 12	4.0	NA	NA	12	0.5	12.8	0.108	0.0518	2.9	0.2	0.82	184	1.0	113	6.00	0.28	19.7	58	0.0	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	22-Jul-2003	Post-Inj. 13	6.4	NA	NA	12.8	0.5	12.9	0.382	0.005	3.37	0.2	0.18	154	1.1	81.2	5.87	0.26	21.0	100	0.3	2.5	0.5	0.5	0.5	0.5	0.5	4.2
MW-117	22-May-2002	Baseline	0.5	NA	NA	12	0.5	14	0.19	0.005	3.5	0.13	0.14	83.2	2.3	93	6.02	0.30	18.2	158	9.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	11-Jul-2002	Post-Inj. 1	2,000	NA	NA	7.7	1.1	13	95	0.183	0.23	0.2	1.84	280	0.6	370	5.30	0.44	18.8	41	1,583.2	25	92.5	15.8	3.8	0.5	139.8	2.0
	30-Jul-2002	Post-Inj. 2	1,410	NA	NA	2.21	0.5	14.4	88.4	0.005	0.3	0.2	3.14	427	0.2	106	4.81	0.40	18.6	-71	1,357.1	313	103.1	24.2	0.5	1.3	218.5	2.0
	06-Sep-2002	Post-Inj. 3	465	NA	NA	1.11	0.5	16.2	35.5	0.828	0.3	0.2	2.34	502	0.8	84	4.43	0.38	20.4	311	147.8	185	130.0	31.7	0.5	0.5	201.4	2.0
	09-Oct-2002	Post-Inj. 4	588	NA	NA	1.11	0.5	14.5	22.4	0.887	0.3	0.2	3.25	480	0.8	214	5.04	0.43	18.8	143	120.7	182	154.3	89.1	0.5	0.5	190.3	2.0
	14-Nov-2002	Post-Inj. 5	645	NA	NA	1.48	0.5	15.4	18.7	1.25	0.3	0.2	2.88	668	0.4	238	4.98	0.52	18.3	35	238.0	45.2	173.8	87.4	0.5	0.5	181.5	2.0
	18-Dec-2002	Post-Inj. 6	844	NA	NA	0.5	0.5	13.4	15.7	2.12	0.166	0.2	2.18	127	0.3	315	4.85	0.85	17.8	31	45.5	2.5	170.8	118.9	0.5	0.2	231.1	2.0
	23-Jan-2003	Post-Inj. 7	888	NA	NA	0.5	0.5	13.4	12.8	2.3	0.3	0.2	1.59	278	0.5	400	5.10	0.80	15.8	84	138.1	48.5	119.3	113.0	2.2	0.5	218.0	2.0
	26-Feb-2003	Post-Inj. 8	500	NA	NA	9.92	0.5	11.9	0.243	2.1	3.84	0.179	1.98	172	0.7	309	4.87	0.64	18.7	32	33.5	86.9	254.3	101.7	2.2	0.5	164.2	2.0
	26-Mar-2003	Post-Inj. 9	494	NA	NA	1.09	0.5	15.9	7.81	2.88	1.12	0.2	3.18	498	2.4	352	4.98	0.58	18.4	88	2.7	8.19	224.8	135.9	2.0	0.5	174.0	2.0
	23-Apr-2003	Post-Inj. 10	443	NA	NA	0.918	0.5	16.3	4.19	2.18	0.3	0.216	3.10	1024	2.1	337	4.87	0.83	18.2	89	6.9	3.03	45.0	25.4	0.5	0.5	30.8	2.0
	21-May-2003	Post-Inj. 11	442	NA	NA	10.9	0.5	17.6	6.11	2.37	0.3	0.2	3.58	333	0.4	340	5.14	0.82	18.3	47	9.8	4.02	168.7	107.9	0.5	0.5	137.8	2.0
	25-Jun-2003	Post-Inj. 12	448	NA	NA	0.5	0.5	19.2	11	2.38	0.3	0.2	5.26	830	0.8	348	5.21	0.80	20.5	32	23.2	8.98	101.2	104.8	0.5	1.1	136.9	2.0
	21-Jul-2003	Post-Inj. 13	352	NA	NA	0.5	0.5	15.3	4.47	2.05	0.3	0.2	3.84	774	0.9	302	5.04	0.81	22.0	73	69.9	7.01	71.9	85.1	0.5	0.5	122.0	4.3
MW-118	22-May-2002	Baseline	0.5	NA	NA	20	0.5	11	0.16	0.0818	4.1	0.1	0.29	50.8	5.2	84	6.06	0.27	18.8	147	9.3	NA	0.5	0.5	0.5	0.5	0.5	2.0
	09-Jul-2002	Post-Inj. 1	100.0	NA	NA	19	0.5	12	31	0.005	2.9	0.2	1.90	122.8	7.4	100	5.95	0.40	23.1	168	1.1	NA	34.6	0.5	10.7	0.9	42.0	2.0
	30-Jul-2002	Post-Inj. 2	452.0	NA	NA	12.5	0.5	12.2	83.2	0.005	1.93	0.2	2.51	284	3.8	153	4.37	0.47	19.8	338	143.2	NA	86.3	21.3	0.5	0.5	147.8	2.0
	06-Sep-2002	Post-Inj. 3	110.0	NA	NA	8.83	0.5	15	9.37	0.31	1.34	0.105	4.48	296	1.4	132	5.48	0.22	21.5	881	0.1	8.8	47.1	11.5	0.5	0.4	41.7	2.0
	08-Oct-2002	Post-Inj. 4	232.0	NA	NA	7.02	0.5	13.1	15	0.473	1.38	0.2	2.84	306	0.5	171	5.62	0.43	19.4	-22	8.8	8.5	48.8	12.8	0.5	0.5	77.0	2.0
	12-Nov-2002	Post-Inj. 5	184.0	NA	NA	8.8	0.5	12.8	6.36	0.825	1.56	0.2	2.11	244	3.0	158	6.30	0.35	18.2	18	0.0	2.5	28.3	18.8	0.5	0.5	48.5	2.0
	17-Dec-2002	Post-Inj. 6	109.0	NA	NA	8.12	0.5	13.3	5.18	0.818	1.81	0.211	1.87	85	2.4	180	5.98	0.34	18.5	-89	13.6	2.5	24.4	15.4	0.5	0.5	32.2	2.0
	21-Jan-2003	Post-Inj. 7	75.0	NA	NA	140	0.5	13.3	3.94	0.475	1.59	0.2	2.81	82	2.7	187	6.37	0.40	16.8	-29	5.8	2.5	20.1	14.2	0.7	0.5	38.9	2.0
	25-Feb-2003	Post-Inj. 8	57.8	NA	NA	7.42	0.5	12.8	2.88	0.606	1.57	0.2	1.82	119	5.3	143	6.14	0.38	16.1	-63	1.8	2.5	12.8	4.9	1.0	0.5	45.4	2.0
	25-Mar-2003	Post-Inj. 9	64.7	NA	NA	8.39	0.5	13.5	1.3	0.338	1.69	0.187	4.69	245	2.2	130	6.22	0.29	16.8	15	4.3	2.5	7.7	0.5	0.5	0.5	5.8	4.1
	22-Apr-2003	Post-Inj. 10	59.6	NA	NA	7.28	0.5	13.1	1.34	0.005	1.67	0.2	2.28	258	1.7	153	5.95	0.36	18.9	-7	1.1	2.5	9.2	1.4	0.5	0.5	26.0	2.0
	20-May-2003	Post-Inj. 11	13.7	NA	NA	9.11	0.5	14.2	0.718	0.307	2.31	0.2	2.58	160	4.6	110	6.30	0.30	19.5	14	8.8	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	24-Jun-2003	Post-Inj. 12	8.5	NA	NA	10.7	0.5	14.5	0.199	0.178	2.61	0.2	2.51	230	3.8	108	6.12	0.29	22.7	30	2.2	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	22-Jul-2003	Post-Inj. 13	16.4	NA	NA	14.1	0.5	14.4	0.521	0.288	2.41	0.2	5.90	280	2.6	135	6.03	0.30	20.1	37	3.7	2.5	4.2	0.5	0.5	0.5	10.1	4.1
MW-119	22-May-2002	Baseline	0.5	NA	NA	8.5	0.5	10	0.11	0.0717	4.7	0.11	0.21	50.9	5.3	72	6.07	0.24	20.1	187	9.1	NA	0.5	0.5	0.5	0.5	0.5	2.0
	08-Jul-2002	Post-Inj. 1	0.5	NA	NA	8.7	0.5	10	0.23	0.005	4.8	0.2	0.01	99	9.4	58	6.11	0.23	21.8	357	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	30-Jul-2002	Post-Inj. 2	0.5	NA	NA	8.34	0.5	10.2	0.278	0.005	4.73	0.2	0.06	110	5.0	70	5.95	0.22	21.1	337	5.4	NA	0.5	0.5	0.5	0.5	0.5	2.0
	05-Sep-2002	Post-Inj. 3	1.6	NA	NA	10.2	0.5	10.4	0.211	0.005	4.74	0.2	0.10	128	6.9	48	6.20	0.19	19.9	433	3.1	2.5	0.5	0.5	0.5	0.6	0.5	2.0
	08-Oct-2002	Post-Inj. 4	0.5	NA	NA	8.75	0.5	9.89	0.189	0.005	4.29	0.2	0.03	204	1.7	72	6.15	0.28	18.5	124	7.7	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	13-Nov-2002	Post-Inj. 5	0.5	NA	NA	10	0.5	9.95	0.166	0.005	4.22	0.2	0.11	110	6.5	71	6.50	0.24	17.7	36	0.0	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	17-Dec-2002	Post-Inj. 6	0.5	NA	NA	10.2	0.5	10.2	0.168	0.005	4.18	0.2	0.06	128	6.0	85	5.94	0.24	17.7	200	8.6	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	21-Jan-2003	Post-Inj. 7	0.5	NA	NA	10.1	0.5	10.4	0.188	0.603	4.11	0.2	0.00	91	6.7	85	6.24	0.24	16.5	-3	9.7	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	26-Feb-2003	Post-Inj. 8	0.5	NA	NA	0.5	0.5	12.9	7.53	0.005	0.3	0.2	0.04	130	6.9	65	6.01	0.23	10.1	131	9.4	2.5	1.7	0.5	0.5	0.5	0.5	2.0
	26-Mar-2003	Post-Inj. 9	0.5	NA	NA	9.57	0.5	10.9	0.1	0.005	3.80	0.2	0.03	94	4.0	80	6.14	0.21	18.1	282	0.0	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	23-Apr-2003	Post-Inj. 10	0.5	NA	NA	9.85	0.5	11	0.421	0.005	3.86	0.2	0.02	158	5.7	82	5.94	0.24	18.0	109	3.9	2.5	1.7	0.5	0.5	0.5	1.6	2.0
	21-May-2003	Post-Inj. 11	0.5	NA	NA	10.7	0.5	11.7	0.1	0.005	4.32	0.2	0.00	150	4.4	70	6.17	0.24	16.4	161	0.7	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	24-Jun-2003	Post-Inj. 12	0.6	NA	NA	10.9	0.5	11.5	0.1	0.00667	4.2	0.2	0.02	130	4.7	84.6	6.06	0.23	21.3	173	1.4	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	23-Jul-2003	Post-Inj. 13	1.3	NA	NA	11.2	0.5	11.8	0.1	0.005	4.42	0.2	0.12	168	3.9	87.5	5.82	0.22	20.1	230	0.0	2.5	0.5	0.5	0.5	0.5	0.5	2.0

Table 4.6
Study Area 1: Summary of Other Analytes
Main Installation, Memphis Depot

Well	Sample Date	Sample Event	DOC (mg/L)	Arsenic (mg/L)	Selenium (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)	Chloride (mg/L)	Bromide (mg/L)	Manganese (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ferrous Iron (mg/L)
MW-120	22-May-2002	Baseline	0.5	NA	NA	13	0.5	11	0.17	0.037	3.8	0.18	0.05
	10-Jul-2002	Post-Inj. 1	1,400.0	NA	NA	12	2	12	84	0.005	0.77	0.2	0.85
	30-Jul-2002	Post-Inj. 2	415.0	NA	NA	3.58	0.830	12.5	31.3	0.183	0.884	0.2	4.20
	09-Sep-2002	Post-Inj. 3	123.0	NA	NA	1.04	0.5	12.3	0.87	0.519	0.3	0.2	3.15
	09-Oct-2002	Post-Inj. 4	181.0	NA	NA	3.77	0.5	14	0.728	0.809	0.3	0.228	3.10
	13-Nov-2002	Post-Inj. 5	188.0	NA	NA	3.9	0.5	13.8	0.741	0.581	0.3	0.2	3.10
	17-Dec-2002	Post-Inj. 6	114.0	NA	NA	4.03	1	13.4	0.538	0.498	0.883	0.2	10.40
	22-Jan-2003	Post-Inj. 7	88.0	NA	NA	0.5	0.5	13.7	0.417	0.497	0.727	0.2	1.87
	25-Feb-2003	Post-Inj. 8	41.2	NA	NA	0.5	0.5	13.8	0.402	0.387	0.783	0.2	2.83
	25-Mar-2003	Post-Inj. 9	68.3	NA	NA	5	0.5	13.8	0.1	0.388	0.3	0.2	2.58
	22-Apr-2003	Post-Inj. 10	88.0	NA	NA	4.68	0.5	13.8	0.371	0.005	0.805	0.2	1.83
	20-May-2003	Post-Inj. 11	18.4	NA	NA	5.28	0.5	15	0.295	0.265	0.721	0.2	4.00
	23-Jun-2003	Post-Inj. 12	21.5	NA	NA	5.86	0.5	15.2	0.31	0.292	0.822	0.2	3.03
	22-Jul-2003	Post-Inj. 13	18.0	NA	NA	8.52	0.5	14.4	0.448	0.23	0.3	0.2	5.40
MW-121	22-May-2002	Baseline	0.5	0.0005	0.0005	17	0.5	10	0.12	0.0448	3.8	0.3	0.32
	10-Jul-2002	Post-Inj. 1	120.0	NA	NA	12	0.5	11	25	0.0618	1.8	0.2	1.14
	31-Jul-2002	Post-Inj. 2	19.5	NA	NA	8.73	0.5	11.1	0.885	0.005	1.86	0.172	2.51
	04-Sep-2002	Post-Inj. 3	5.8	NA	NA	12.1	0.5	11.8	0.1	0.137	4.18	0.2	2.52
	08-Oct-2002	Post-Inj. 4	0.5	NA	NA	9.32	0.5	10.8	0.219	0.131	3.14	0.158	2.71
	12-Nov-2002	Post-Inj. 5	1.3	NA	NA	9.53	0.5	11.4	0.189	0.118	3.32	0.14	1.71
	18-Dec-2002	Post-Inj. 6	0.5	NA	NA	8.65	0.5	11.4	0.223	0.005	3.28	0.185	1.41
	22-Jan-2003	Post-Inj. 7	0.5	0.0005	0.0005	8.4	0.5	12	0.198	0.005	3.3	0.2	1.25
	27-Feb-2003	Post-Inj. 8	0.5	NA	NA	10.8	0.5	11.5	0.169	0.005	3.48	0.188	1.08
	25-Mar-2003	Post-Inj. 9	0.5	NA	NA	8.19	0.5	11.8	0.1	0.005	3.22	0.2	0.83
	24-Apr-2003	Post-Inj. 10	0.5	NA	NA	9.3	0.5	11.3	0.298	0.005	3.27	0.2	0.43
	21-May-2003	Post-Inj. 11	0.5	NA	NA	11.1	0.5	12.8	0.1	0.0679	3.83	0.2	0.24
	26-Jun-2003	Post-Inj. 12	2.4	NA	NA	12.5	0.5	12.9	0.1	0.0648	3.6	0.2	0.28
	23-Jul-2003	Post-Inj. 13	1.3	NA	NA	12.1	0.5	12.7	0.353	0.005	3.75	0.2	0.32
MW-122	23-May-2002	Baseline	0.5	NA	NA	11	0.5	11	0.19	0.0257	5.1	0.19	0.05
	11-Jul-2002	Post-Inj. 1	3.8	NA	NA	10	0.5	12	1	0.0551	0.77	0.2	0.71
	31-Jul-2002	Post-Inj. 2	0.5	NA	NA	9.63	0.5	11.7	0.230	0.005	0.802	0.2	0.48
	06-Sep-2002	Post-Inj. 3	11.8	NA	NA	8.01	0.5	14.4	0.189	0.332	0.3	0.108	2.80
	09-Oct-2002	Post-Inj. 4	35.5	NA	NA	3.06	0.5	12.8	0.268	1.1	0.3	0.2	2.45
	13-Nov-2002	Post-Inj. 5	21.3	NA	NA	3.15	0.5	12.8	0.231	0.828	0.3	0.198	10.08
	18-Dec-2002	Post-Inj. 6	24.8	NA	NA	3.28	0.5	12.6	0.255	0.683	0.444	0.2	1.35
	21-Jan-2003	Post-Inj. 7	21.8	NA	NA	0.5	0.5	13.2	0.281	0.49	0.838	0.182	1.37
	25-Feb-2003	Post-Inj. 8	10.5	NA	NA	0.5	0.5	13	0.253	0.344	0.858	0.2	2.04
	26-Mar-2003	Post-Inj. 9	10.5	NA	NA	3.87	0.5	13.7	0.1	0.376	0.3	0.2	4.86
	22-Apr-2003	Post-Inj. 10	10.8	NA	NA	4.23	0.5	12.7	0.383	0.005	0.72	0.2	2.19
	20-May-2003	Post-Inj. 11	8.32	NA	NA	4.08	0.5	13.9	0.188	0.312	0.48	0.2	2.89
	24-Jun-2003	Post-Inj. 12	7.5	NA	NA	8.35	0.5	14.7	0.1	0.275	0.864	0.2	3.20
	22-Jul-2003	Post-Inj. 13	7.8	NA	NA	3.12	0.5	14.8	0.4	0.281	0.3	0.2	4.82
MW-123	23-May-2002	Baseline	0.5	0.0005	0.0005	12	0.5	12	0.16	0.0437	3.8	0.12	0.25
	10-Jul-2002	Post-Inj. 1	83.0	NA	NA	8.8	0.5	13	22	0.005	0.3	0.2	2.06
	30-Jul-2002	Post-Inj. 2	326.0	NA	NA	5.87	0.960	12.8	87.2	0.005	0.252	0.164	2.03
	05-Sep-2002	Post-Inj. 3	307.0	NA	NA	2.79	0.5	14.2	26.8	0.479	0.3	0.2	2.55
	10-Oct-2002	Post-Inj. 4	281.0	NA	NA	2.03	0.5	12.7	21	0.503	0.3	0.129	2.48
	13-Nov-2002	Post-Inj. 5	244.0	NA	NA	2.85	0.5	12.8	14	0.747	0.3	0.273	2.40
	18-Dec-2002	Post-Inj. 6	181.0	NA	NA	2.11	0.5	13.2	5.23	0.996	0.816	0.2	1.75
	22-Jan-2003	Post-Inj. 7	168.0	0.035	0.00917	0.5	0.5	13.8	2.82	1	0.3	0.2	1.34
	26-Feb-2003	Post-Inj. 8	122.0	NA	NA	0.5	0.5	13.6	1.55	0.868	0.3	0.2	4.42
	27-Mar-2003	Post-Inj. 9	66.0	NA	NA	1.86	0.5	13.7	1.48	0.859	0.3	0.2	2.84
	23-Apr-2003	Post-Inj. 10	89.0	NA	NA	1.84	0.5	18.9	1.04	0.768	0.226	0.104	5.24
	21-May-2003	Post-Inj. 11	56.0	NA	NA	1.13	0.5	14.9	1.13	0.807	0.3	0.2	5.28
	25-Jun-2003	Post-Inj. 12	50.7	NA	NA	1.8	0.5	13.8	1.38	0.843	0.3	0.2	5.08
	23-Jul-2003	Post-Inj. 13	52.7	NA	NA	2.8	0.5	12.4	1.28	0.884	0.3	0.2	2.78

Well	Sample Date	Carbon Dioxide (mg/L)	Dissolved Oxygen (mg/L)	Alkalinity (mg/L)	pH	Conductivity (ms/cm³)	Temperature (°C)	ORP (mV)	Turbidity (NTU)	Oil & Grease (mg/L)	Acetic Acid (mg/L)	Butyric Acid (mg/L)	Formic Acid (mg/L)	Lactic Acid (mg/L)	Propionic Acid (mg/L)	Pyruvic Acid (mg/L)
MW-120	22-May-2002	63.2	2.8	77	6.02	0.27	19.8	225	9.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	10-Jul-2002	340	0.8	5	5.18	0.48	20.7	-30	1,654.0	4.8	84.7	19.8	3.3	0.5	157.2	2.0
	30-Jul-2002	283	1.5	141	4.82	0.35	20.8	63	318.3	NA	0.5	7.2	0.5	0.5	41.8	2.0
	09-Sep-2002	353	0.8	148	6.29	0.38	20.7	-114	1.9	4.6	54.3	15.6	0.5	0.8	83.2	2.0
	09-Oct-2002	538	0.0	160	5.70	0.42	20.1	-74	58.7	18.4	28.8	10.8	0.5	0.5	85.7	5.4
	13-Nov-2002	440	0.3	188	5.84	0.37	18.8	-34	21.8	8.7	28.8	12.1	0.7	0.5	83.5	2.0
	17-Dec-2002	63	0.3	128	5.58	0.35	16.7	-48	100.7	17.1	21.1	5.8	0.5	0.5	57.1	4.8
	22-Jan-2003	131	0.2	151	6.11	0.35	17.3	-83	7.2	2.5	17.8	11.8	0.8	0.5	43.1	3.8
	25-Feb-2003	183	0.4	129	5.87	0.35	15.8	-47	8.1	2.5	11.7	2.1	0.5	0.5	28.4	2.0
	25-Mar-2003	165	0.6	142	6.02	0.30	18.4	-5	0.0	2.5	10.8	0.5	0.5	0.5	10.7	3.7
	22-Apr-2003	354	0.6	157	5.80	0.34	18.6	-18	8.8	2.5	9.0	0.5	0.5	0.5	10.7	2.0
	20-May-2003	312	0.2	130	6.12	0.33	19.7	-39	7.8	2.78	7.3	0.5	0.5	0.5	5.4	2.0
	23-Jun-2003	338	0.3	123	6.00	0.30	19.5	-60	5.9	4.44	8.8	0.5	0.5	0.5	1.8	2.0
	22-Jul-2003	270	0.8	151	5.68	0.29	19.4	-37	8.2	2.5	8.0	0.5	0.5	0.5	3.1	4.3
MW-121	22-May-2002	68.6	5.4	91	6.27	0.28	19.2	88	8.8	NA	0.5	0.5	0.5	0.5	0.5	2.0
	10-Jul-2002	149	3.8	83	6.00	0.29	20.0	183	7.8	NA	20.2	0.5	0.5	0.5	25.8	2.0
	31-Jul-2002	201	1.8	108	5.83	0.29	20.8	139	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	04-Sep-2002	162	3.7	84	6.08	0.25	20.2	48	0.7	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	08-Oct-2002	162	0.3	80	6.18	0.28	19.3	37	8.8	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	12-Nov-2002	202	3.8	80	6.45	0.28	18.1	32	0.0	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	18-Dec-2002	72	2.9	84	5.74	0.25	18.1	183	8.8	2.5	0.5	0.5	0.5	2.2	0.5	2.0
	22-Jan-2003	65	2.9	85	6.28	0.26	15.7	11	7.7	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	27-Feb-2003	153	2.2	81	5.87	0.28	18.4	61	0.2	2.5	1.8	0.5	0.5	0.5	0.5	2.0
	25-Mar-2003	133	2.3	81	6.07	0.22	19.5	241	0.0	2.5	0.5	0.5	0.8	0.5	0.5	2.0
	24-Apr-2003	180	3.2	83	5.81	0.25	17.8	113	8.4	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	21-May-2003	109	3.8	80	6.19	0.28	18.8	127	1.7	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	26-Jun-2003	188	3.2	84.9	6.07	0.25	18.7	144	2.4	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	23-Jul-2003	158	2.2	71.8	5.81	0.25	19.7	204	3.8	2.5	0.5	0.5	0.5	0.5	0.5	2.0
MW-122	23-May-2002	38.8	4.0	83	6.03	0.27	18.8	8	8.8	NA	0.5	0.5	0.5	0.5	0.5	2.0
	11-Jul-2002	178	0.8	86	6.07	0.25	19.7	86	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	31-Jul-2002	235	1.6	100	5.72	0.24	21.7	179	3.8	NA	0.5	0.5	0.5	0.5	0.5	2.0
	06-Sep-2002	298	0.6	98	6.10	0.20	18.5	-5	38.8	52.2	0.5	0.5	0.5	0.5	3.8	2.0
	09-Oct-2002	188	0.3	111	6.28	0.27	20.1	160	354.7	59.3	14.1	7.0	0.5	1.3	15.5	4.9
	13-Nov-2002	178	0.4	133	6.54	0.32	18.7	-61	8.8	2.5	15.0	3.8	0.5	0.5	10.2	4.7
	18-Dec-2002	65	0.4	136	5.88	0.30	18.1	-84	4.8	2.8	17.4	0.5	0.5	0.2	0.5	4.0
	21-Jan-2003	167	0.3	133	6.31	0.31	15.8	-78	8.6	2.8	0.5	0.8	0.7	0.5	4.8	2.0
	25-Feb-2003	211	0.4	124	6.05	0.31	14.4	-35	2.0	2.5	10.8	0.5	0.8	0.5	4.1	2.0
	26-Mar-2003	188	0.7	145	6.31	0.27	17.8	1	0.0	3.88	2.5	0.5	0.5	6.3	3.0	2.0
	22-Apr-2003	182	0.7	138	5.65	0.30	16.5	-1	1.9	2.5	8.2	0.5	0.5	0.5	3.2	2.0
	20-May-2003	272	2.3	123	6.24	0.23	19.1	-28	2.8	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	24-Jun-2003	238	0.5	137	6.13	0.28	18.8	-55	0.8	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	22-Jul-2003	184	0.8	148	6.02	0.26	19.8	-16	4.3	2.5	0.5	0.5	0.5	0.5	0.5	5.0
MW-123	23-May-2002	77.4	3.6	88	6.03	0.27	19.1	142	8.1	NA	0.5	0.5	0.5	0.5	0.5	2.0
	10-Jul-2002	222	0.4	83	6.02	0.30	19.7	-72	5.2	NA	27.8	0.8	2.2	0.5	22.8	2.0
	30-Jul-2002	351	0.1	177	5.07	0.48	20.8	-84	111.6	NA	88.5	28.4	0.5	1.8	162.1	2.0
	05-Sep-2002	324	0.3	159	5.31	0.35	20.4	-129	62.6	170	63.8	20.8	0.5	0.4	122.6	2.0
	10-Oct-2002	328	1.0	201	5.53	0.38	18.8	130	64.8	64.8	78.3	28.9	0.5	0.5	106.7	2.0
	13-Nov-2002	482	0.3	198	5.83	0.45	18.4	-17	13.4	23.4	83.8	23.5	0.5	0.5	84.1	2.0
	18-Dec-2002	38	0.2	210	5.60	0.42	18.0	-81	38.4	3.7	28.8	20.2	0.5	0.2	68.3	2.0
	22-Jan-2003	183	0.2	218	6.28	0.44	11.4	-43	8.8	2.8	42.8	17.7	0.9	0.5	80.8	4.6
	26-Feb-2003	69	0.4	215	5.86	0.44	15.6	-75	2.1	2.5	32.1	7.4	0.5	0.5	74.8	2.0
	27-Mar-2003	314	1.8	184	6.29	0.37	17.4	-15	4.8	5.18	18.3	2.1	0.5	24.2	58.7	4.3
	23-Apr-2003	480	0.9	181	5.78	0.44	18.8	-30	3.8	2.5	54.9	20.7	0.5	63.2	84.8	2.0
	21-May-2003	594	0.3	137	6.17	0.45	18.8	-63	8.3	5.84	18.8	5.0	0.5	13.2	45.1	2.0
	25-Jun-2003	424	0.5	138	6.08	0.40	20.7	-43	2.8	3.67	15.5	1.8	0.5	1.2	33.8	2.0
	23-Jul-2003	380	0.6	185	6.04	0.48	21.1	-14	3.8	2.5	11.8	0.5	0.5	0.5	24.1	2.0

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Table 4.6
Study Area 1: Summary of Other Analytes
Main Installation, Memphis Depot

Well	Sample Date	Sample Event	DOC (mg/L)	Arsenic (mg/L)	Selenium (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)	Chloride (mg/L)	Bromide (mg/L)	Manganese (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ferrous Iron (mg/L)	Carbon Dioxide (mg/L)
MW-124	23-May-2002	Baseline	0.5	NA	NA	11	0.5	11	*0.17*	0.023	4.2	*0.11*	0.07	132
	10-Jul-2002	Post-Inj. 1	0.5	NA	NA	11	0.5	12	1.2	0.104	1.5	0.2	0.88	171
	31-Jul-2002	Post-Inj. 2	0.5	NA	NA	12.3	0.5	11.8	0.282	0.005	1.87	0.2	0.28	178
	03-Sep-2002	Post-Inj. 3	9.3	NA	NA	11	0.5	12.2	0.2	0.580	1.84	0.2	2.48	229
	09-Oct-2002	Post-Inj. 4	8.0	NA	NA	10.8	0.5	11.7	0.211	0.515	1.8	0.2	3.10	274
	12-Nov-2002	Post-Inj. 5	3.8	NA	NA	9.3	0.6	11.3	0.218	0.328	4.75	*0.173*	2.98	258
	17-Dec-2002	Post-Inj. 6	3.4	NA	NA	10.9	0.5	12	0.228	0.218	2.45	*0.174*	5.88	85
	21-Jan-2003	Post-Inj. 7	2.54	NA	NA	9.83	0.5	12	0.258	0.005	2.41	*0.179*	3.22	104
	25-Feb-2003	Post-Inj. 8	0.5	NA	NA	9.48	0.5	11.8	0.218	0.005	3.44	0.2	2.84	177
	25-Mar-2003	Post-Inj. 9	0.5	NA	NA	9.03	0.5	11.7	0.1	0.005	2.86	0.2	1.85	155
	23-Apr-2003	Post-Inj. 10	0.5	NA	NA	9.09	0.5	11.3	0.294	0.005	2.44	0.2	1.45	242
	20-May-2003	Post-Inj. 11	0.5	NA	NA	10.7	0.5	12.4	0.252	0.0532	3.33	0.2	1.00	196
	24-Jun-2003	Post-Inj. 12	2.0	NA	NA	10.8	0.5	12.3	0.1	0.061	3.1	0.2	1.10	204
	22-Jul-2003	Post-Inj. 13	2.9	NA	NA	11.7	0.5	12	0.1	0.005	*2.85*	0.2	1.08	176
MW-126	23-May-2002	Baseline	0.5	NA	NA	12	0.5	12	*0.16*	0.011	3.7	*0.15*	0.00	141
	10-Jul-2002	Post-Inj. 1	280.0	NA	NA	8.5	*0.7*	12	23	0.12	0.3	0.2	3.17	244
	30-Jul-2002	Post-Inj. 2	100.0	NA	NA	5.99	0.5	12.5	12.1	0.005	0.3	0.2	2.28	169
	05-Sep-2002	Post-Inj. 3	87.2	NA	NA	5.44	0.5	14.5	1.55	0.956	0.3	*0.103*	3.27	278
	09-Oct-2002	Post-Inj. 4	14.0	NA	NA	8.24	0.5	11.4	0.404	0.404	2.27	0.2	4.84	214
	12-Nov-2002	Post-Inj. 5	24.5	NA	NA	6.86	0.5	12.1	0.378	0.928	1.84	0.2	2.85	240
	18-Dec-2002	Post-Inj. 6	18.6	NA	NA	6.83	0.5	13.2	0.299	0.747	1.3	0.2	2.70	65
	21-Jan-2003	Post-Inj. 7	12.2	NA	NA	6.89	0.5	13.2	0.292	0.883	1.51	*0.181*	3.18	165
	26-Feb-2003	Post-Inj. 8	5.7	NA	NA	7.69	0.5	13.2	0.258	0.553	2.01	0.2	2.08	98
	26-Mar-2003	Post-Inj. 9	5.04	NA	NA	6.53	0.5	12.8	0.1	0.877	1.42	0.2	2.88	218
	23-Apr-2003	Post-Inj. 10	5.54	NA	NA	8.85	0.5	13.8	0.508	0.005	1.34	0.2	3.17	288
	22-May-2003	Post-Inj. 11	3.64	NA	NA	9.59	0.5	14.7	0.1	0.429	2.40	0.2	2.89	172
	25-Jun-2003	Post-Inj. 12	5.0	NA	NA	9.85	0.5	12.6	0.1	0.344	2.38	0.2	4.08	258
	23-Jul-2003	Post-Inj. 13	2.9	NA	NA	10.1	0.5	13.4	0.303	0.335	2.84	0.2	6.42	234

Well	Sample Date	Sample Event	Dissolved Oxygen (mg/L)	Alkalinity (mg/L)	pH	Conductivity (ms/cm^3)	Temperature (°C)	ORP (mV)	Turbidity (NTU)	Oil & Grease (mg/L)	Acetic Acid (mg/L)	Butyric Acid (mg/L)	Formic Acid (mg/L)	Lactic Acid (mg/L)	Propionic Acid (mg/L)	Pyruvic Acid (mg/L)
MW-124	23-May-2002	Baseline	3.1	98	5.89	0.28	19.2	248	8.4	NA	0.5	0.5	0.5	0.5	0.5	2.0
	10-Jul-2002	Post-Inj. 1	2.0	88	6.07	0.28	18.7	130	3.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	31-Jul-2002	Post-Inj. 2	2.0	98	5.86	0.25	20.8	348	2.8	NA	0.5	0.5	0.5	0.5	0.5	2.0
	03-Sep-2002	Post-Inj. 3	1.3	91	5.90	0.25	20.1	-7	8.3	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	09-Oct-2002	Post-Inj. 4	0.3	130	6.36	0.30	18.8	4	7.1	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	12-Nov-2002	Post-Inj. 5	2.4	103	6.50	0.28	17.3	19	0.4	2.5	1.7	0.5	0.5	0.5	8.5	2.0
	17-Dec-2002	Post-Inj. 6	1.8	97	6.03	0.28	18.5	-50	8.8	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	21-Jan-2003	Post-Inj. 7	1.8	107	6.27	0.28	17.2	-50	6.1	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	25-Feb-2003	Post-Inj. 8	2.9	97	5.99	0.28	13.4	23	1.6	2.5	1.8	0.5	0.7	0.5	1.8	2.0
	25-Mar-2003	Post-Inj. 9	2.4	144	6.21	0.24	18.0	82	0.0	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	23-Apr-2003	Post-Inj. 10	2.3	108	5.86	0.27	17.7	80	3.6	2.5	2.4	0.5	0.5	2.3	3.1	2.0
	20-May-2003	Post-Inj. 11	2.8	96	6.17	0.27	16.5	28	0.8	2.5	0.5	0.5	0.5	0.5	0.5	4.2
	24-Jun-2003	Post-Inj. 12	2.2	114	6.10	0.27	18.8	87	1.6	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	22-Jul-2003	Post-Inj. 13	2.3	96.3	5.96	0.25	19.2	107	8.3	2.5	0.5	0.5	0.5	0.5	0.5	2.0
MW-126	23-May-2002	Baseline	1.8	96	6.01	0.29	19.8	284	9.1	NA	0.5	0.5	0.5	0.5	0.5	2.0
	10-Jul-2002	Post-Inj. 1	0.4	130	5.78	0.34	20.5	-80	236.0	4.8	41.9	*1.0*	0.5	1.0	70.2	2.0
	30-Jul-2002	Post-Inj. 2	1.4	135	5.80	0.33	21.8	-84	9.3	NA	41.6	3.5	0.5	0.5	69.7	2.0
	05-Sep-2002	Post-Inj. 3	1.3	123	5.56	0.26	20.8	42	91.9	2.5	18.9	0.9	0.5	0.5	30.9	2.0
	09-Oct-2002	Post-Inj. 4	0.8	124	6.21	0.28	19.2	84	9.8	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	12-Nov-2002	Post-Inj. 5	1.3	136	6.48	0.34	17.9	27	112.7	2.5	0.5	0.5	0.5	0.5	2.4	2.0
	18-Dec-2002	Post-Inj. 6	0.5	136	5.83	0.31	18.1	-117	14.3	2.5	0.5	0.5	0.5	0.5	17.2	2.0
	21-Jan-2003	Post-Inj. 7	4.2	127	6.37	0.33	17.2	-24	7.1	2.5	0.5	0.5	0.5	0.5	7.6	2.0
	26-Feb-2003	Post-Inj. 8	0.7	118	6.01	0.31	14.7	-32	0.0	2.5	2.9	0.5	0.5	0.5	3.9	2.0
	26-Mar-2003	Post-Inj. 9	0.8	139	6.05	0.29	18.4	27	0.0	2.5	0.5	0.5	0.5	0.5	0.5	2.0
	23-Apr-2003	Post-Inj. 10	2.5	103	5.94	0.32	16.7	25	4.1	2.5	2.2	0.5	0.5	*0.6*	2.2	2.0
	22-May-2003	Post-Inj. 11	0.7	108	6.20	0.31	16.3	22	0.7	2.5	2.3	0.3	0.5	33.9	3.1	2.0
	25-Jun-2003	Post-Inj. 12	0.3	111	6.03	0.28	21.7	19	0.5	2.5	0.5	0.5	0.5	*0.2*	0.5	2.0
	23-Jul-2003	Post-Inj. 13	0.4	108	6.02	0.29	18.9	77	4.0	2.5	0.5	0.5	0.5	0.5	0.5	4.1

Notes.
BL = Baseline value
Italic = Estimated Value (J)
ND = Not Detected
NA = Not Analyzed
ug/L = Micrograms per liter
Underlined value = half of the reporting limit for a non-detected parameter
Red results for conductivity = Could not calibrate field meter. Received new meter on July 31, 2002

Table 4.7
Study Area 2: Summary of VOCs
Main Installation, Memphis Depot

Well	Sample Date	Sample Event	Units	PCE	TCE	Cis-1,2-DCE	VC	Ethene*	Carbon Tetrachloride	Chloroform	Methylene Chloride	Chloromethane	Methane*	1,2-DCA	Chloroethane	Ethane*
IW-1	20-May-2002	Baseline	ug/L	120	13	26	0.5	0.0025	35	30	0.5	0.5	0.0075	0.79	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	3.68	1.19	248	0.5	0.23	1.67	5.3	0.5	0.5	3400	1.08	0.5	0.18
IW-2	20-May-2002	Baseline	ug/L	110	22	53	0.5	0.21	64	67	0.5	0.5	0.0075	17	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	90.5	18.8	40.5	0.5	0.29	0.5	78.1	8.5	0.5	0.0075	3.19	0.5	0.22
IW-3	20-May-2002	Baseline	ug/L	100	20	47	0.5	0.89	52	61	0.5	0.5	0.0075	1.2	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	147	65.1	368	0.5	0.63	0.5	45.6	10.9	0.5	320	13.9	0.5	0.062
IW-4	20-May-2002	Baseline	ug/L	190	28	63	0.5	0.2	90	85	0.5	0.5	0.0075	1.8	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	161	27.3	54.4	0.5	0.47	0.753	75.8	5.65	0.5	1600	6.69	0.5	0.1
MW-26	24-Jul-2003	Post-Inj. 13	ug/L	7.92	1.72	0.5	0.5	0.0025	3.29	1.11	0.5	0.5	4	0.5	0.5	0.0025
	18-Aug-2003	Post-Inj. 14	ug/L	13.8	1.9	0.5	0.5	0.021	5.17	1.28	0.5	0.5	0.18	0.5	0.5	0.017
MW-86	30-Nov-2001	Baseline	ug/L	198	20	53	0.5	0.0025	77	77	0.5	0.5	0.0075	3.6	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	160	18	27	0.5	0.099	65	57	0.5	0.5	0.0075	16	0.5	0.059
	30-Jul-2002	Post-Inj. 2	ug/L	182	21.1	29	0.5	0.0025	1.74	88.1	4.55	0.5	0.0075	19.1	0.5	0.19
	03-Sep-2002	Post-Inj. 3	ug/L	197	22.7	33.1	0.5	0.17	0.5	94.4	2.61	0.5	0.0075	20.9	0.5	0.3
	07-Oct-2002	Post-Inj. 4	ug/L	205	20.7	29.3	0.5	0.0025	0.5	85	0.5	0.5	0.0075	18	0.5	0.3
	11-Nov-2002	Post-Inj. 5	ug/L	180	25	63.3	0.5	0.27	0.5	70.1	0.5	0.5	0.0075	15.1	0.5	0.058
	16-Dec-2002	Post-Inj. 6	ug/L	21.4	10.2	201	0.5	0.4	0.5	46.8	28.5	0.5	0.0075	16.8	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	5.06	3.25	196	0.5	0.44	0.5	19.7	26.2	0.5	57	17.1	0.5	0.038
	24-Mar-2003	Post-Inj. 9	ug/L	2.99	2.37	177	0.5	0.54	0.5	13.1	6.53	0.5	1100	14.2	0.5	0.16
	21-Apr-2003	Post-Inj. 10	ug/L	14.4	7.63	173	0.5	0.55	0.5	17.1	0.5	0.5	2700	12.8	0.5	0.12
	19-May-2003	Post-Inj. 11	ug/L	28.9	16.7	144	0.5	0.43	0.5	11.9	25.2	0.5	2900	17.5	0.5	0.057
	23-Jun-2003	Post-Inj. 12	ug/L	60.4	25.8	127	0.5	0.16	0.5	6.72	30.6	0.5	2200	12	0.5	0.01
	21-Jul-2003	Post-Inj. 13	ug/L	73.4	28.7	137	0.5	0.12	0.5	11	35.2	0.5	1400	10.7	0.5	0.11
	18-Aug-2003	Post-Inj. 14	ug/L	89.8	26.7	120	0.5	0.26	0.5	12.1	29.5	0.5	1800	13.2	0.5	0.0094
MW-88 (Backgound)	30-Nov-2001	Baseline	ug/L	10.7	2.4	1.3	0.5	0.0025	3	1.1	0.5	0.5	0.0075	0.5	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	17	7.1	1.5	0.5	0.0025	4.7	1.9	0.5	0.5	1.6	0.5	0.5	0.0025
	01-Aug-2002	Post-Inj. 2	ug/L	17.2	7.55	1.37	0.5	0.0025	5.54	2.10	0.5	0.5	7.7	0.5	0.5	0.0025
	03-Sep-2002	Post-Inj. 3	ug/L	21.8	7.72	0.93	0.5	0.0025	6.61	1.86	0.5	0.5	11	0.5	0.5	0.0025
	07-Oct-2002	Post-Inj. 4	ug/L	16.1	6.9	1.23	0.5	0.0025	5.3	1.81	0.5	0.5	0.0075	0.5	0.5	0.0025
	11-Nov-2002	Post-Inj. 5	ug/L	23.8	7.66	1.66	0.5	0.0025	5.79	1.69	0.5	0.5	0.0075	0.5	0.5	0.0025
	16-Dec-2002	Post-Inj. 6	ug/L	22.2	7.41	1.22	0.5	0.056	6.76	1.88	0.5	0.5	64	0.5	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	19.8	7.24	0.99	0.5	0.011	6.98	1.64	0.5	0.5	0.058	0.5	0.5	0.0025
	24-Mar-2003	Post-Inj. 9	ug/L	13.4	6.49	0.793	0.5	0.0025	4.63	1.23	0.5	0.5	59	0.5	0.5	0.0025
	21-Apr-2003	Post-Inj. 10	ug/L	18.2	6.65	0.869	0.5	0.0025	5.61	1.43	0.5	0.5	51	0.5	0.5	0.0025
	19-May-2003	Post-Inj. 11	ug/L	14.5	5.34	1.1	0.5	0.0051	5.08	1.71	0.5	0.5	44	0.5	0.5	0.0025
	23-Jun-2003	Post-Inj. 12	ug/L	19.9	5.98	1.32	0.5	0.017	6.17	1.93	0.5	0.5	150	0.5	0.5	0.0025
	21-Jul-2003	Post-Inj. 13	ug/L	21.8	6.26	1.41	0.5	0.0025	8.17	2.08	0.5	0.5	63	0.5	0.5	0.0025
	18-Aug-2003	Post-Inj. 14	ug/L	21	5.37	1.34	0.5	0.019	7.3	1.51	0.5	0.5	82	0.5	0.5	0.0025
MW-105	20-May-2002	Baseline	ug/L	130	19	43	0.5	0.32	46	52	0.5	0.5	2.5	1.2	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	55	15	47	0.5	0.2	8.6	90	0.5	0.5	0.65	4.1	0.5	0.1
	31-Jul-2002	Post-Inj. 2	ug/L	131	22.7	48.9	0.5	0.22	0.5	100	7.80	0.5	7.5	4.27	0.5	0.095
	03-Sep-2002	Post-Inj. 3	ug/L	136	23.6	54.5	0.5	0.26	0.5	73.3	36.30	0.5	200	4.34	0.5	0.044
	07-Oct-2002	Post-Inj. 4	ug/L	133	22.6	46.4	0.5	0.0025	0.5	56.4	0.5	0.5	170	3.82	0.5	0.019
	11-Nov-2002	Post-Inj. 5	ug/L	163	24.2	49	0.5	0.15	1.81	59.5	0.5	0.5	160	2.84	0.5	0.0025
	16-Dec-2002	Post-Inj. 6	ug/L	167	23.5	0.5	0.5	0.18	4.88	85.4	0.5	0.5	200	3.05	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	203	26.9	51.2	0.5	0.11	4.28	97	1.59	0.5	130	2.73	0.5	0.027
	24-Mar-2003	Post-Inj. 9	ug/L	57.7	19.5	172	0.5	0.4	0.5	41.6	5.12	0.5	3400	3.66	0.5	0.17
	21-Apr-2003	Post-Inj. 10	ug/L	22	8.69	193	0.5	0.26	0.5	0.5	0.5	0.5	1700	4.14	0.5	0.11
	19-May-2003	Post-Inj. 11	ug/L	5.39	6.48	190	0.5	0.4	0.5	29.7	0.5	0.5	2000	6.46	0.5	0.18
	23-Jun-2003	Post-Inj. 12	ug/L	57.7	26.5	84.7	0.5	0.55	0.5	48.8	21.5	0.5	5200	7.65	0.5	0.037
	21-Jul-2003	Post-Inj. 13	ug/L	92.3	27.6	128	0.5	0.98	0.5	12	41.4	0.5	7000	9.49	0.5	0.68
	18-Aug-2003	Post-Inj. 14	ug/L	9.54	4.2	237	0.5	1.1	0.5	9.72	30.8	0.5	6700	7.41	0.5	0.18
MW-106	20-May-2002	Baseline	ug/L	170	25	51	0.5	0.21	82	76	0.5	0.5	0.0075	7.2	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	220	28	52	0.5	0.15	89	87	0.5	0.5	0.0075	6.6	0.5	0.034
	29-Jul-2002	Post-Inj. 2	ug/L	162	27.9	51.6	0.5	0.47	23.7	130	0.43	0.5	0.0075	6.56	0.5	0.0025
	03-Sep-2002	Post-Inj. 3	ug/L	232	29.9	55	0.5	0.18	42.9	71.3	34.5	0.5	0.0075	6.26	0.5	0.065
	07-Oct-2002	Post-Inj. 4	ug/L	208	28.5	53.4	0.5	0.0025	39.2	75.7	0.5	0.5	0.0075	6.75	0.5	0.05
	11-Nov-2002	Post-Inj. 5	ug/L	207	31	55.8	0.5	0.13	42	78.7	0.5	0.5	0.0075	6.48	0.5	0.0025
	16-Dec-2002	Post-Inj. 6	ug/L	176	27.5	53.5	0.5	0.12	44.1	90.3	0.5	0.5	29	6.29	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	219	31.2	62.2	0.5	0.098	42.4	95.9	0.659	0.5	58	5.81	0.5	0.02
	24-Mar-2003	Post-Inj. 9	ug/L	181	28.2	54.6	0.5	0.058	16	83.7	0.5	0.5	15	4.1	0.5	0.09
	21-Apr-2003	Post-Inj. 10	ug/L	249	32.2	52.7	0.5	0.15	2.16	90.1	0.5	0.5	160	5.35	0.5	0.084
	19-May-2003	Post-Inj. 11	ug/L	197	26.6	65.2	0.5	0.19	2.57	83.4	0.5	0.5	160	5.17	0.5	0.12
	23-Jun-2003	Post-Inj. 12	ug/L	241	28.5	51.2	0.5	0.087	12.4	83.9	21.5	0.5	260	7.65	0.5	0.05
	21-Jul-2003	Post-Inj. 13	ug/L	103	30	173	0.5	0.2	0.5	85.8	5.08	0.5	1600	5.16	0.5	0.11
	18-Aug-2003	Post-Inj. 14	ug/L	43.1	12.4	190	0.5	0.25	5.32	72.5	0.5	0.5	4400	5.77	0.5	0.0025

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Table 4.7
Study Area 2: Summary of VOCs
Main Installation, Memphis Depot

Well	Sample Date	Sample Event	Units	PCE	TCE	Cis-1,2-DCE	VC	Ethene*	Carbon Tetrachloride	Chloroform	Methylene Chloride	Chloromethane	Methane*	1,2-DCA	Chloroethane	Ethane*
MW-109	20-May-2002	Baseline	ug/L	160	27	60	0.5	1.3	46	91	1.5	0.5	4.4	1.7	0.5	1.6
	08-Jul-2002	Post-Inj. 1	ug/L	130	23	53	0.5	0.24	13	90	1.5	0.5	3.4	3.5	0.5	0.098
	30-Jul-2002	Post-Inj. 2	ug/L	164	30.2	58.4	0.5	0.93	0.5	9.26	68.1	0.5	45	3.35	0.5	0.0025
	03-Sep-2002	Post-Inj. 3	ug/L	148	35.1	68.6	0.5	0.28	0.5	7.83	2.17	0.5	300	2.86	0.5	0.0025
	07-Oct-2002	Post-Inj. 4	ug/L	170	34.4	52.6	0.5	0.0025	4.45	34.1	0.5	0.5	490	3.01	0.5	0.031
	11-Nov-2002	Post-Inj. 5	ug/L	34.1	12.3	448	0.5	0.23	12.8	53.5	0.5	0.5	260	2.27	0.5	0.049
	16-Dec-2002	Post-Inj. 6	ug/L	88.6	20.8	179	0.5	0.25	11.6	98.7	0.5	0.5	1200	3.2	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	96.8	21.3	196	0.5	0.16	13.8	105	0.5	0.5	2800	3.62	0.5	0.02
	24-Mar-2003	Post-Inj. 9	ug/L	35.4	15.6	187	0.5	0.34	0.5	55.5	0.5	0.5	2900	3.4	0.5	0.031
	21-Apr-2003	Post-Inj. 10	ug/L	15.3	7.3	259	0.5	0.28	0.5	69	0.5	0.5	6500	3.27	0.5	0.042
	19-May-2003	Post-Inj. 11	ug/L	4.97	5.1	199	0.5	0.41	0.5	17.5	26	0.339	5200	3.27	0.5	0.03
	23-Jun-2003	Post-Inj. 12	ug/L	23.9	11.9	164	0.5	0.016	0.5	4.8	27	0.5	10000	3.12	0.5	0.0025
	21-Jul-2003	Post-Inj. 13	ug/L	28.3	11.7	198	0.5	0.091	0.5	6.81	32.6	0.5	7900	4.51	0.5	0.0071
	18-Aug-2003	Post-Inj. 14	ug/L	4.02	2.18	225	0.5	0.16	0.5	3.69	6.52	0.5	9600	3.82	0.5	0.0025
MW-110	20-May-2002	Baseline	ug/L	120	28	63	0.5	0.0025	77	83	0.5	0.5	0.0075	1.8	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	200	31	70	0.5	0.0025	110	85	0.5	0.5	0.0075	2.7	0.5	0.014
	30-Jul-2002	Post-Inj. 2	ug/L	181	34.9	69.3	0.5	0.36	120	99.9	0.5	0.5	0.0075	2.84	0.5	0.0025
	03-Sep-2002	Post-Inj. 3	ug/L	223	34	68.4	0.5	0.0025	131	103	0.801	0.5	0.0075	4.05	0.5	0.0025
	07-Oct-2002	Post-Inj. 4	ug/L	169	30.2	62.9	0.5	0.0025	94.1	89	0.5	0.5	0.0075	3.53	0.5	0.012
	11-Nov-2002	Post-Inj. 5	ug/L	182	33	67.2	0.5	0.0025	98.3	78.1	0.5	0.5	0.0075	3.02	0.5	0.0025
	16-Dec-2002	Post-Inj. 6	ug/L	201	33	67	0.5	0.016	120	85.4	0.5	0.5	0.0075	3.49	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	199	33.3	76.3	0.5	0.0063	109	84.2	0.5	0.5	0.0075	3.03	0.5	0.0025
	24-Mar-2003	Post-Inj. 9	ug/L	154	31.2	62.6	0.5	0.06	90.5	71.8	0.5	0.5	1.1	3.23	0.5	0.0025
	21-Apr-2003	Post-Inj. 10	ug/L	171	31.1	55.6	0.5	0.016	101	76.3	0.5	0.5	0.32	2.94	0.5	0.0025
	19-May-2003	Post-Inj. 11	ug/L	151	25.8	67.9	0.5	0.042	77.7	86.4	0.5	0.5	3.2	5.54	0.5	0.0025
	23-Jun-2003	Post-Inj. 12	ug/L	18.5	6.88	246	0.5	0.056	14.2	91.3	10.9	0.5	20	7.56	0.5	0.016
	21-Jul-2003	Post-Inj. 13	ug/L	96.7	18.8	127	0.5	0.18	60.8	78.3	0.5	0.5	16	5.27	0.5	0.011
	18-Aug-2003	Post-Inj. 14	ug/L	122	17.6	133	0.5	0.18	56.7	54.8	0.5	0.5	26	5.25	0.5	0.0074
MW-111	20-May-2002	Baseline	ug/L	170	28	64	0.5	0.0025	91	85	0.5	0.5	0.0075	3.3	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	100	28	68	0.5	0.0025	80	85	0.5	0.5	0.0075	3.6	0.5	0.0097
	31-Jul-2002	Post-Inj. 2	ug/L	135	30.8	63.9	0.5	0.0025	96.1	96.8	0.5	0.5	0.0075	3.18	0.5	0.0025
	03-Sep-2002	Post-Inj. 3	ug/L	187	33.1	61.5	0.5	0.099	111	116	0.5	0.5	0.0075	3.17	0.5	0.0025
	07-Oct-2002	Post-Inj. 4	ug/L	201	29.1	53.9	0.5	0.0025	112	103	0.5	0.5	0.0075	3.57	0.5	0.0081
	11-Nov-2002	Post-Inj. 5	ug/L	177	30.5	54.8	0.5	0.0025	92.8	86.3	0.5	0.5	0.0075	2.98	0.5	0.0025
	16-Dec-2002	Post-Inj. 6	ug/L	189	31.3	56.1	0.5	0.035	106	93.4	0.5	0.5	0.0075	3.3	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	192	33.3	68.9	0.5	0.029	108	98.2	0.5	0.5	0.0075	3.03	0.5	0.0025
	24-Mar-2003	Post-Inj. 9	ug/L	145	27.9	63.6	0.5	0.048	76.5	79.9	0.5	0.5	27	3.66	0.5	0.0025
	21-Apr-2003	Post-Inj. 10	ug/L	188	31.8	56.8	0.5	0.038	103	82.2	0.5	0.5	4.8	2.62	0.5	0.0025
	19-May-2003	Post-Inj. 11	ug/L	113	33.9	176	0.5	0.071	34.3	120	0.5	0.5	18	4.31	0.5	0.029
	23-Jun-2003	Post-Inj. 12	ug/L	37.8	25	248	0.5	0.09	0.5	109	2.06	0.5	99	5.04	0.5	0.023
	21-Jul-2003	Post-Inj. 13	ug/L	8.46	6.83	277	0.5	0.06	0.5	106	0.5	0.5	140	2.9	0.5	0.0094
	18-Aug-2003	Post-Inj. 14	ug/L	6.35	6.43	233	0.5	0.063	10.3	97.5	1.5	0.5	170	3.36	0.5	0.0094
MW-112	20-May-2002	Baseline	ug/L	74	18	48	0.5	0.47	40	63	0.5	0.5	0.0075	1.8	0.5	0.51
	08-Jul-2002	Post-Inj. 1	ug/L	94	17	46	0.5	0.13	34	56	0.5	0.5	0.98	1.3	0.5	0.069
	31-Jul-2002	Post-Inj. 2	ug/L	83.0	22.2	54.4	0.5	0.27	0.410	127	3.03	0.5	0.0075	4.20	0.5	0.091
	03-Sep-2002	Post-Inj. 3	ug/L	63.4	19.4	61.2	0.5	0.39	0.5	94	3.79	0.5	0.0075	4.01	0.5	0.084
	07-Oct-2002	Post-Inj. 4	ug/L	87.6	20.4	45.8	0.5	0.0025	0.5	18	0.5	0.5	55	3.32	0.5	0.025
	11-Nov-2002	Post-Inj. 5	ug/L	133.0	25.3	48.9	0.5	0.27	0.5	17	0.5	0.5	230	3.90	0.5	0.0025
	16-Dec-2002	Post-Inj. 6	ug/L	121.0	24.4	48.8	0.5	0.21	1.73	17.8	0.5	0.5	440	4.31	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	85.0	25.3	72.7	0.5	0.2	3.32	24.7	0.299	0.5	930	4.04	0.5	0.015
	24-Mar-2003	Post-Inj. 9	ug/L	8.11	7.19	204	0.5	0.29	0.5	16.1	0.5	0.5	3000	1.43	0.5	0.057
	21-Apr-2003	Post-Inj. 10	ug/L	28.7	12.9	186	0.5	0.2	0.5	47.5	0.5	0.5	1600	4.22	0.5	0.072
	19-May-2003	Post-Inj. 11	ug/L	8.86	14.1	173	0.5	0.26	0.5	36	11.9	0.4	1100	2.72	0.5	0.1
	23-Jun-2003	Post-Inj. 12	ug/L	22	11	216	0.5	0.28	0.5	46.7	4.63	0.5	1200	3.49	0.5	0.033
	21-Jul-2003	Post-Inj. 13	ug/L	7.22	3.39	233	0.263	0.27	0.5	11.4	0.5	0.5	5700	4.79	0.5	0.066
	18-Aug-2003	Post-Inj. 14	ug/L	1.88	0.711	236	0.5	0.33	0.5	5.47	0.718	0.5	4300	4.44	0.5	0.0025
MW-113	20-May-2002	Baseline	ug/L	30	15	44	0.5	0.48	30	76	1.4	0.5	0.0075	2	0.5	0.55
	08-Jul-2002	Post-Inj. 1	ug/L	45	20	48	0.5	0.087	50	79	0.5	0.5	1.8	2.3	0.5	0.1
	31-Jul-2002	Post-Inj. 2	ug/L	59.3	26.7	55.5	0.5	0.0025	69.1	98.0	0.489	0.5	4.8	2.53	0.5	0.0025
	03-Sep-2002	Post-Inj. 3	ug/L	112	29.4	59.9	0.5	0.099	60.7	90.6	9.17	0.5	15	2.62	0.5	0.034
	07-Oct-2002	Post-Inj. 4	ug/L	80.4	28	92.4	0.5	0.0025	64.5	83.2	0.5	0.5	0.0075	2.99	0.5	0.033
	11-Nov-2002	Post-Inj. 5	ug/L	97	31.6	77.3	0.5	0.0025	59	78.2	0.5	0.5	0.0075	2.21	0.5	0.0025
	16-Dec-2002	Post-Inj. 6	ug/L	96.9	32.7	83.4	0.5	0.041	69.6	87.6	0.5	0.5	0.0075	2.41	0.5	0.0025
	20-Jan-2003	Post-Inj. 7	ug/L	91.1	30.4	94.1	0.5	0.056	71.6	93.8	0.424	0.5	0.0075	2.22	0.5	0.012
	24-Mar-2003	Post-Inj. 9	ug/L	48.7	23.3	69.7	0.5	0.035	50.8	70.8	0.5	0.5	9.9	2.15	0.5	0.01
	21-Apr-2003	Post-Inj. 10	ug/L	49.4	21.1	71.2	0.5	0.051	53.2	81	0.5	0.5	4.3	1.79	0.5	0.0099
	19-May-2003	Post-Inj. 11	ug/L	27.5	15.3	71.6	0.5	0.053	28	84.4	0.5	0.5	28	1.99	0.5	0.028
	23-Jun-2003	Post-Inj. 12	ug/L	54.5	19.7	93.9	0.5	0.062	43.6	89.8	0.5	0.5	29	2.34	0.5	0.021
	21-Jul-2003	Post-Inj. 13	ug/L	56.1	19.3	102	0.5	0.043	38	89.7	0.5	0.5	22	1.97	0.5	0.012
	18-Aug-2003	Post-Inj. 14	ug/L	63.6	18.5	109	0.5	0.061	42.7	80.4	0.5	0.5	19	1.85	0.5	0.0092

Table 4.7
Study Area 2: Summary of VOCs
Main Installation, Memphis Depot

Well	Sample Date	Sample Event	Units	PCE	TCE	Cis-1,2-DCE	VC	Ethene*	Carbon Tetrachloride	Chloroform	Methylene Chloride	Chloromethane	Methane*	1,2-DCA	Chloroethane	Ethane*
MW-114	20-May-2002	Baseline	ug/L	220	29	61	0.5	0.22	94	64	0.5	0.5	0.0075	4.5	0.5	0.0025
	08-Jul-2002	Post-Inj. 1	ug/L	190	24	53	0.5	0.092	79	75	0.5	0.5	0.0075	7.8	0.5	0.047
	30-Jul-2002	Post-Inj. 2	ug/L	258	33.0	60.6	0.5	0.0025	47.5	129	*0.263*	0.5	0.0075	5.13	0.5	0.0025
	03-Sep-2002	Post-Inj. 3	ug/L	290	32.5	64.6	0.5	0.33	11.3	137	1.21	0.5	0.0075	4.38	0.5	0.0025
	07-Oct-2002	Post-Inj. 4	ug/L	221	31.1	53.1	0.5	0.0025	42.9	112	0.5	0.5	130	5.48	0.5	0.029
	11-Nov-2002	Post-Inj. 5	ug/L	270	31.3	57.4	0.5	0.0025	50.8	92.6	0.5	0.5	0.0075	3.71	0.5	0.0025
	16-Dec-2002	Post-Inj 6	ug/L	268	31.2	53.5	0.5	0.059	76.8	92.3	0.5	0.5	0.0075	4.06	0.5	0.0025
	20-Jan-2003	Post-Inj 7	ug/L	240	29.7	53.7	0.5	0.065	65.2	75.9	0.5	0.5	49	4	0.5	0.008
	24-Mar-2003	Post-Inj 9	ug/L	38.2	30.9	173	0.5	0.11	2.04	107	0.5	0.5	360	2.68	0.5	0.11
	21-Apr-2003	Post-Inj. 10	ug/L	7.57	6.62	231	0.5	0.11	*2.01*	72	0.5	0.5	180	3.19	0.5	0.061
	19-May-2003	Post-Inj. 11	ug/L	6.19	9.79	209	0.5	0.14	0.5	95.6	0.5	0.5	1100	3.34	0.5	0.11
	23-Jun-2003	Post-Inj 12	ug/L	73.2	37.8	100	0.5	0.086	0.5	64 2	9.24	0.5	360	3.22	0.5	0.024
	21-Jul-2003	Post-Inj. 13	ug/L	66.5	28.5	*180*	0.5	0.078	0.5	64.9	12.8	0.5	940	5.63	0.5	0.032
	18-Aug-2003	Post-Inj. 14	ug/L	6.5	4.48	254	0.5	0.24	0.5	29.4	17	0.5	6000	4.54	0.5	0.0025

Notes:
ND = Not Detected
NA = Not Analyzed
Italic = Estimated Value (J)
ug/L = Micrograms per liter
BL = Baseline value
Underlined value = half of the reporting limit for a non-detected parameter
* Check Chain-of-Custody summary table for collection dates associated with methane, ethane, and ethene.

Table 4.8
Study Area 2: Summary of Other Analytes
Main Installation, Memphis Depot

Well	Sample Date	Sample Event	DOC (mg/L)	Arsenic (mg/L)	Selenium (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)	Chloride (mg/L)	Bromide (mg/L)	Manganese (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ferrous Iron (mg/L)	Carbon Dioxide (mg/L)
IW-1	21-May-2002	Baseline	0.5	0.0005	0.0005	12	0.5	25	0.19	0.106	2.4	0.13	0	53
	23-Jan-2003	Post-Inj. 7	267	0.00822	0.00852	9.41	0.5	21.2	3.81	8.8	1.03	0.2	3.54	222
IW-2	22-May-2002	Baseline	0.5	NA	NA	9.7	0.5	17	0.29	0.0799	2.8	0.2	0	69.8
	23-Jan-2003	Post-Inj. 7	219	NA	NA	5.26	0.5	12.8	2.08	1.09	1.08	0.43	8.32	145
IW-3	21-May-2002	Baseline	0.5	NA	NA	11	0.61	20	0.23	0.135	2.2	0.12	0.11	63
	23-Jan-2003	Post-Inj. 7	1,150	NA	NA	2.24	0.5	8.18	13.8	1.47	0.284	0.2	10.78	292
IW-4	21-May-2002	Baseline	0.5	0.0005	0.0005	8.8	0.5	13	0.18	0.158	2.1	0.1	0	40
	23-Jan-2003	Post-Inj. 7	1,930	0.0247	0.0839	2.08	0.5	10.3	23.8	7.13	0.3	0.2	5.12	354
MW-26	24-Jul-2003	Post-Inj. 13	1.0	NA	NA	17.6	0.5	48.3	0.384	0.005	2.94	0.2	0.02	105
	18-Aug-2003	Post-Inj. 14	2.8	NA	NA	17.3	0.5	47	0.414	0.005	3.08	0.2	0.02	87
MW-86	20-Mar-2002	MI Baseline	0.5	NA	NA	7.8	0.5	13	0.1	0.0508	2.2	0.2	0.14	102.4
	23-May-2002	Baseline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	09-Jul-2002	Post-Inj. 1	620	NA	NA	30	0.5	8.8	7.7	1.29	0.3	0.2	1.81	71.4
	30-Jul-2002	Post-Inj. 2	1,880	NA	NA	18.8	0.5	8.86	18.9	3.21	0.3	0.2	5.82	200
	04-Sep-2002	Post-Inj. 3	2,300	NA	NA	2.87	0.5	9.12	21.7	4.75	0.3	0.2	12.24	294
	08-Oct-2002	Post-Inj. 4	1,580	NA	NA	10.9	0.5	8.01	19.5	4.74	0.3	0.2	11.20	483
	12-Nov-2002	Post-Inj. 5	1,110	NA	NA	1.54	0.5	7.61	15.4	4.78	0.3	0.2	11.24	401
	17-Dec-2002	Post-Inj. 6	1,220	NA	NA	0.5	0.5	7.80	15.3	6.31	0.3	0.2	18.08	485
	21-Jan-2003	Post-Inj. 7	1,070	NA	NA	0.5	0.5	7.77	17	5.48	0.3	0.2	9.28	404
	25-Mar-2003	Post-Inj. 9	2,500	NA	NA	2.8	0.5	28.1	42.7	12.4	0.3	0.2	18.16	485
	22-Apr-2003	Post-Inj. 10	3,550	NA	NA	0.883	1.5	27.7	82.2	9.23	0.3	0.2	10.48	302
	20-May-2003	Post-Inj. 11	7,360	NA	NA	1.58	0.5	22.1	139	28.8	0.3	0.2	13.52	529
	24-Jun-2003	Post-Inj. 12	12,800	NA	NA	1.87	2.9	255	487	24.6	0.3	0.2	8.24	635
	22-Jul-2003	Post-Inj. 13	15,500	NA	NA	0.5	0.5	11.8	351	17.7	1.1	0.2	8.08	600
	19-Aug-2003	Post-Inj. 14	18,200	NA	NA	2.78	0.5	50.4	707	14.8	0.3	0.2	6.32	622
MW-88 (Background)	21-Mar-2002	MI Baseline	4.3	NA	NA	14	0.5	48	0.1	0.143	1.8	0.2	0.00	198
	11-Jul-2002	Post-Inj. 1	0.5	NA	NA	18	0.5	41	0.3	0.005	2.4	0.2	0.00	60.2
	01-Aug-2002	Post-Inj. 2	0.5	NA	NA	18.1	0.5	39.3	0.172	0.005	2.43	0.2	0.05	114
	06-Sep-2002	Post-Inj. 3	0.5	NA	NA	18.1	0.5	42.1	0.213	0.005	2.42	0.2	0.08	105
	10-Oct-2002	Post-Inj. 4	0.5	NA	NA	12.7	0.5	28.8	0.148	0.005	1.83	0.2	0.00	52
	14-Nov-2002	Post-Inj. 5	0.5	NA	NA	16.6	0.5	38.5	0.214	0.005	2.29	0.2	0.02	101
	19-Dec-2002	Post-Inj. 6	0.5	NA	NA	13.7	0.5	27.9	0.412	0.005	1.88	0.2	0.00	99
	24-Jan-2003	Post-Inj. 7	0.5	NA	NA	18.9	0.5	40.7	0.251	0.005	2.34	0.2	0.01	78
	27-Mar-2003	Post-Inj. 9	0.5	NA	NA	17	0.5	39.7	0.1	0.005	2.05	0.2	0.08	85
	24-Apr-2003	Post-Inj. 10	0.5	NA	NA	17.7	0.5	38.8	0.283	0.005	2.32	0.2	0.11	87
	22-May-2003	Post-Inj. 11	10.7	NA	NA	20.1	0.5	43.1	0.1	0.005	10.50	0.2	0.05	102
	28-Jun-2003	Post-Inj. 12	1.5	NA	NA	77	0.5	39.1	0.1	0.00482	2.39	0.2	0.02	90
	24-Jul-2003	Post-Inj. 13	1.1	NA	NA	18.8	0.5	39.6	0.1	0.005	2.27	0.2	0.02	105
	21-Aug-2003	Post-Inj. 14	0.8	NA	NA	19.5	0.5	40.2	0.352	0.005	2.54	0.2	0.00	93
MW-105	23-May-2002	Baseline	0.5	NA	NA	12	0.5	22	0.22	0.298	2.4	0.17	0.12	45.2
	10-Jul-2002	Post-Inj. 1	12,000	NA	NA	8.8	0.5	18	110	31.3	0.3	0.2	4.78	108
	31-Jul-2002	Post-Inj. 2	2,830	NA	NA	4.78	0.5	18.1	38.5	8.19	0.3	0.2	8.10	220
	05-Sep-2002	Post-Inj. 3	2,330	NA	NA	1.11	0.5	18	22.2	28.8	0.3	0.2	20.98	255
	08-Oct-2002	Post-Inj. 4	750	NA	NA	3.29	0.5	15.8	10.3	19.8	0.3	0.2	12.36	300
	13-Nov-2002	Post-Inj. 5	707	NA	NA	3.02	0.5	14.2	5.85	13.4	0.3	0.2	11.04	253
	18-Dec-2002	Post-Inj. 6	348	NA	NA	1.71	0.5	15.8	3.97	9.63	0.15	0.2	6.40	214
	22-Jan-2003	Post-Inj. 7	188	NA	NA	0.5	0.5	14.8	2.3	7.4	0.3	0.2	12.44	187
	26-Mar-2003	Post-Inj. 9	17,100	NA	NA	0.5	1.1	347	327	49.8	0.3	0.2	12.72	721
	23-Apr-2003	Post-Inj. 10	4,870	NA	NA	0.993	0.5	11.5	87.1	27.1	0.3	0.2	8.20	537
	21-May-2003	Post-Inj. 11	26,800	NA	NA	2.8	0.5	2.09	400	68.7	0.3	0.2	10.98	425
	25-Jun-2003	Post-Inj. 12	36,200	NA	NA	1.74	0.5	12.9	365	45.4	0.3	0.2	7.40	650
	23-Jul-2003	Post-Inj. 13	6,320	NA	NA	0.5	0.5	20.8	105	21.8	0.3	0.2	9.20	457
	20-Aug-2003	Post-Inj. 14	4,890	NA	NA	47.8	0.5	23.1	235	8.87	0.3	0.2	7.82	531

Well	Sample Date	Sample Event	Dissolved Oxygen (mg/L)	Alkalinity (mg/L)	pH	Conductivity (ms/cm)	Temperature (°C)	ORP (mV)	Turbidity (NTU)	Oil & Grease (mg/L)	Acetic Acid (mg/L)	Butyric Acid (mg/L)	Formic Acid (mg/L)	Lactic Acid (mg/L)	Propionic Acid (mg/L)	Pyruvic Acid (mg/L)
IW-1	21-May-2002	Baseline	4.3	47	5.84	0.25	22.5	280	10.3	NA	0.5	0.5	0.5	0.5	0.5	2.0
	23-Jan-2003	Post-Inj. 7	0.8	830	6.50	1.84	18.0	-88	6.1	NA	178.8	19.7	0.8	80.4	278.9	2.0
IW-2	22-May-2002	Baseline	5.2	36	5.83	0.21	18.4	274	10.5	NA	0.5	0.5	0.5	0.5	0.5	2.0
	23-Jan-2003	Post-Inj. 7	0.5	375	6.21	1.16	19.4	-88	6.0	NA	111.1	47.0	0.8	72.7	147.1	3.7
IW-3	21-May-2002	Baseline	4.2	60	6.07	0.23	23.9	318	7.6	NA	0.5	0.5	0.5	0.5	0.5	2.0
	23-Jan-2003	Post-Inj. 7	0.3	1,440	6.54	3.85	17.2	-125	4.5	NA	328.9	204.0	0.8	0.7	862.8	4.8
IW-4	21-May-2002	Baseline	5.0	49	5.90	0.18	22.2	272	10.2	NA	0.5	0.5	0.5	0.5	0.5	2.0
	23-Jan-2003	Post-Inj. 7	0.1	2,360	6.49	6.80	17.8	-204	8.9	NA	313.8	538.7	14.0	389.8	890.5	2.0
MW-26	24-Jul-2003	Post-Inj. 13	5.3	39	6.13	0.38	23.4	277	5.3	NA	0.5	0.5	0.5	0.5	0.5	2.0
	18-Aug-2003	Post-Inj. 14	5.6	61	6.20	0.32	21.7	308	1.3	NA	0.5	0.5	0.5	0.5	0.5	2.0
MW-86	20-Mar-2002	MI Baseline	8.0	5	6.10	0.16	20.1	122	20.1	NA	0.5	0.5	0.5	0.5	0.5	2.0
	23-May-2002	Baseline	6.0	NA	5.82	0.20	25.9	365	8.1	NA	NA	NA	NA	NA	NA	NA
	09-Jul-2002	Post-Inj. 1	8.3	460	5.83	1.68	28.5	29	0.1	NA	18.0	0.5	0.5	1,895.8	0.5	2.0
	30-Jul-2002	Post-Inj. 2	1.8	815	6.07	0.00	27.6	-451	0.2	NA	157.0	0.5	0.5	3,011.0	184.8	6.3
	04-Sep-2002	Post-Inj. 3	1.0	1,540	6.08	4.03	34.1	-233	0.0	NA	214.9	13.8	0.5	759.9	294.0	2.0
	08-Oct-2002	Post-Inj. 4	0.5	1,750	6.33	2.85	23.5	-182	0.0	NA	616.8	51.2	29.7	1,075.7	718.6	10.4
	12-Nov-2002	Post-Inj. 5	1.5	1,810	5.74	2.83	20.8	-139	1.1	NA	480.8	87.4	5.0	245.4	683.0	2.0
	17-Dec-2002	Post-Inj. 6	0.2	1,410	6.03	2.78	20.8	-120	0.0	NA	596.1	138.8	5.0	120.9	858.4	2.0
	21-Jan-2003	Post-Inj. 7	0.3	1,880	6.51	8.22	18.1	-133	3.9	NA	528.0	170.5	0.7	54.8	807.4	2.0
	25-Mar-2003	Post-Inj. 9	0.6	4,040	6.24	5.50	21.8	-87	0.0	NA	1,471.8	601.1	5.0	578.8	1,945.5	2.0
	22-Apr-2003	Post-Inj. 10	0.5	4,780	6.18	8.51	22.0	-127	1.8	NA	1,894.2	1,018.5	5.0	220.3	2,743.3	2.0
	20-May-2003	Post-Inj. 11	1.1	9,270	6.38	13.88	25.8	-164	6.6	NA	2,734.4	1,834.1	5.0	3,898.4	4,070.2	2.0
	24-Jun-2003	Post-Inj. 12	0.6	17,300	6.64	18.07	25.5	-327	7.0	NA	3,027.8	4,522.7	5.0	13,471.0	5,779.8	2.0
	22-Jul-2003	Post-Inj. 13	1.2	19,200	7.14	27.23	28.0	-170	7.4	NA	1,763.8	3,529.0	5.0	23,491.0	4,031.8	2.0
	19-Aug-2003	Post-Inj. 14	0.7	12,700	6.78	21.83	28.9	-391	0.4	NA	1,778.9	4,911.0	5.0	26,800.0	3,969.8	108.8
MW-88 (Background)	21-Mar-2002	MI Baseline	8.8	5	7.00	0.28	19.8	125	993.0	NA	1.4	0.5	0.3	0.7	0.5	2.0
	11-Jul-2002	Post-Inj. 1	13.1	48	5.87	0.30	35.2	221	5.4	NA	0.5	0.5	0.5	0.5	0.5	2.0
	01-Aug-2002	Post-Inj. 2	0.8	54	5.81	0.30	27.0	186	0.4	NA	0.5	0.5	0.5	0.5	0.5	2.0
	06-Sep-2002	Post-Inj. 3	8.8	48	5.87	0.34	25.9	27	0.0	NA	0.5	0.5	0.5	0.8	0.5	2.0
	10-Oct-2002	Post-Inj. 4	2.0	56	6.37	0.19	22.4	186	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	14-Nov-2002	Post-Inj. 5	5.3	5	5.43	0.30	19.1	218	4.1	NA	0.5	0.5	0.5	0.5	0.5	2.0
	19-Dec-2002	Post-Inj. 6	7.2	5	6.04	0.22	15.9	182	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	24-Jan-2003	Post-Inj. 7	2.9	65	5.82	0.47	17.2	75	7.7	NA	0.5	0.5	0.5	0.5	0.5	2.0
	27-Mar-2003	Post-Inj. 9	3.1	46	6.03	0.27	18.5	233	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	24-Apr-2003	Post-Inj. 10	3.3	57	5.83	0.29	15.8	246	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	22-May-2003	Post-Inj. 11	4.4	54	5.88	0.29	20.8	219	5.7	NA	5.8	1.2	0.5	123.4	8.8	2.0
	28-Jun-2003	Post-Inj. 12	3.8	51.9	6.03	0.29	25.5	284	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	24-Jul-2003	Post-Inj. 13	4.5	45.1	6.17	0.34	24.3	257	7.3	NA	0.5	0.5	0.5	0.5	0.5	2.0
	21-Aug-2003	Post-Inj. 14	4.4	61.7	5.91	0.28	25.8	187	2.5	NA	0.5	0.5	0.5	0.5	0.5	2.0
MW-105	23-May-2002	Baseline	4.8	55	5.86	0.25	21.1	337	6.5	NA	0.5	0.5	0.5	0.5	0.5	2.0
	10-Jul-2002	Post-Inj. 1	0.0	4,800	6.17	18.89	27.4	-404	0.5	NA	288.3	0.5	0.5	20,456.0	318.8	52.2
	31-Jul-2002	Post-Inj. 2	4.1	2,200	6.22	2.20	25.3	-518	1.1	NA	880.9	75.1	0.5	3,512.0	854.4	2.0
	05-Sep-2002	Post-Inj. 3	1.4	1,850	6.39	4.73	29.8	-58	3.7	NA	653.4	47.8	0.5	171.5	1,105.8	2.0
	08-Oct-2002	Post-Inj. 4	5.1	1,050	6.59	1.71	21.7	-78	0.0	NA	323.1	20.1	0.5	0.5	530.4	2.0
	13-Nov-2002	Post-Inj. 5	1.0	704	6.00	1.54	22.0	-65	4.4	NA	208.8	25.0	0.5	0.5	322.1	2.0
	18-Dec-2002	Post-Inj. 6	0.9	483	6.55	1.01	14.8	-82	0.0	NA	182.8	28.5	0.5	0.5	217.4	5.2
	22-Jan-2003	Post-Inj. 7	0.5	363	6.58	1.15	11.8	-89	5.1	NA	120.4	20.3	0.8	0.5	148.2	2.0
	26-Mar-2003	Post-Inj. 9	0.3	1,100	6.65	29.04	20.3	-310	0.0	NA	1,258	278.8	0.5	22,595	2,076	2.0
	23-Apr-2003	Post-Inj. 10	0.5	4,480	6.33	12.53	24.7	-288	0.0	NA	1,481.1	507.4	0.5	5,504.4	2,884.8	2.0
	21-May-2003	Post-Inj. 11	0.8	17,500	6.87	32.94	22.8	-314	7.2	NA	861.7	877.2	0.5	58,446.0	1,587.6	2.0
	25-Jun-2003	Post-Inj. 12	0.4	6,000	6.89	40.33	28.4	-338	0.0	NA	1,089.2	2,006.1	0.5	48,301.0	2,585.8	2.0
	23-Jul-2003	Post-Inj. 13	1.4	7,380	6.89	13.88	26.5	-123	8.8	NA	788.1	1,553.2	0.5	7,657.8	1,839.8	2.0
	20-Aug-2003	Post-Inj. 14	0.8	5,830	6.63	10.91	29.6	-141	2.2	NA	1,118.3	1,808.2	0.5	4,374.2	2,118.5	23.5

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Table 4.8
Study Area 2: Summary of Other Analytes
Main Installation, Memphis Depot

Well	Sample Date	Sample Event	DOC (mg/L)	Arsenic (mg/L)	Selenium (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)	Chloride (mg/L)	Bromide (mg/L)	Manganese (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ferrous Iron (mg/L)
MW-106	21-May-2002	Baseline	0.5	NA	NA	6.5	0.5	11	0.18	0.134	2	0.099	0.06
	11-Jul-2002	Post-Inj. 1	810	NA	NA	7.1	0.5	11	11	3.45	0.41	0.2	1.55
	28-Jul-2002	Post-Inj. 2	312	NA	NA	5.27	0.5	11.3	6.17	2.97	0.67	0.2	5.46
	03-Sep-2002	Post-Inj. 3	151	NA	NA	3.96	0.5	11.3	2.25	1.82	0.3	0.2	4.52
	07-Oct-2002	Post-Inj. 4	64	NA	NA	4.25	0.5	8.92	1.29	1.03	0.818	0.2	4.52
	11-Nov-2002	Post-Inj. 5	48	NA	NA	4.7	5.7	8.42	0.87	0.879	0.755	0.2	4.20
	16-Dec-2002	Post-Inj. 6	35	NA	NA	5.09	0.5	8.66	0.713	0.904	0.869	0.2	4.16
	20-Jan-2003	Post-Inj. 7	40	NA	NA	0.5	0.5	10.1	0.852	0.955	0.85	0.188	4.40
	25-Mar-2003	Post-Inj. 9	2,220	NA	NA	2.8	0.5	11.6	29.9	2.2	0.3	0.2	8.60
	22-Apr-2003	Post-Inj. 10	731	NA	NA	2.48	0.5	11	16.1	1.67	0.38	0.2	7.04
	20-May-2003	Post-Inj. 11	4,830	NA	NA	3.83	0.5	17.7	81.1	2.12	0.31	0.2	6.88
	24-Jun-2003	Post-Inj. 12	4,550	NA	NA	3.81	0.5	4.33	57.1	3.5	0.128	0.2	6.84
	22-Jul-2003	Post-Inj. 13	1,890	NA	NA	5.74	0.5	23.7	25.7	4.53	0.3	0.2	9.80
	19-Aug-2003	Post-Inj. 14	715	NA	NA	2.52	0.5	22.8	46.5	1.87	0.835	0.2	9.72
MW-109	20-May-2002	Baseline	0.5	NA	NA	5.1	0.5	12	0.28	1.3	0.54	0.28	4.28
	08-Jul-2002	Post-Inj. 1	1,700	NA	NA	8.3	1.3	12	22	2.86	0.3	0.2	4.90
	30-Jul-2002	Post-Inj. 2	738	NA	NA	1.52	0.5	14.8	12.0	5.94	0.3	0.2	12.60
	04-Sep-2002	Post-Inj. 3	258	NA	NA	1.89	0.5	14.4	4.7	4.54	0.3	0.2	14.16
	08-Oct-2002	Post-Inj. 4	85	NA	NA	1.92	0.5	11.5	2.0	2.74	0.3	0.2	7.73
	12-Nov-2002	Post-Inj. 5	114	NA	NA	2.72	0.6	11	1.8	1.82	0.3	0.2	7.44
	17-Dec-2002	Post-Inj. 6	49	NA	NA	3.74	0.5	11.2	1.0	1.2	0.231	0.17	7.28
	21-Jan-2003	Post-Inj. 7	80	NA	NA	0.5	0.5	11.2	1.4	0.882	0.251	0.2	8.26
	25-Mar-2003	Post-Inj. 9	2,580	NA	NA	1.11	0.5	21.2	58.7	5.87	0.3	0.2	12.08
	23-Apr-2003	Post-Inj. 10	1,180	NA	NA	0.866	0.5	20	31	1.86	1.03	0.2	10.00
	20-May-2003	Post-Inj. 11	4,170	NA	NA	0.618	0.5	24.8	100	17.4	0.3	0.2	17.96
	24-Jun-2003	Post-Inj. 12	8,620	NA	NA	0.603	3.8	0.5	287.0	20.4	0.3	0.2	8.48
	22-Jul-2003	Post-Inj. 13	4,800	NA	NA	0.5	0.5	33.4	107.0	5	0.3	0.2	38.64
	19-Aug-2003	Post-Inj. 14	2,410	NA	NA	0.5	0.5	35.8	137.0	2.62	0.3	0.2	15.78
MW-110	20-May-2002	Baseline	0.5	0.0005	0.0005	6.3	0.5	13	0.11	0.0795	2.2	0.2	0.13
	09-Jul-2002	Post-Inj. 1	0.5	NA	NA	6.2	0.5	13	0.22	0.005	2.2	0.2	0.09
	30-Jul-2002	Post-Inj. 2	0.5	NA	NA	6.39	0.5	13.8	0.169	0.005	2.03	0.2	0.15
	04-Sep-2002	Post-Inj. 3	1.9	NA	NA	6.65	0.5	14.7	0.166	0.005	2.28	0.2	0.03
	08-Oct-2002	Post-Inj. 4	0.5	NA	NA	6.33	0.5	12.5	0.233	0.005	2.1	0.2	0.48
	12-Nov-2002	Post-Inj. 5	4.5	NA	NA	6.15	0.5	11.8	0.222	0.355	2.1	0.2	0.78
	17-Dec-2002	Post-Inj. 6	0.5	NA	NA	5.22	0.5	13.1	0.182	0.005	2.23	0.2	0.12
	21-Jan-2003	Post-Inj. 7	0.8	0.0005	0.0005	6.27	0.5	13	0.189	0.005	2.25	0.2	0.19
	24-Mar-2003	Post-Inj. 9	0.5	NA	NA	46.5	0.5	13.5	0.1	0.005	2.23	0.2	0.16
	21-Apr-2003	Post-Inj. 10	0.5	NA	NA	5.78	0.5	12.9	0.363	0.005	2.08	0.2	0.45
	19-May-2003	Post-Inj. 11	173	NA	NA	4.88	0.5	15.4	1.98	2.83	0.61	0.2	4.32
	23-Jun-2003	Post-Inj. 12	201	NA	NA	1.56	0.5	17.9	3.95	3.84	0.121	0.2	6.12
	21-Jul-2003	Post-Inj. 13	47	NA	NA	66.5	0.5	15.6	1.55	1.07	1.43	0.2	12.12
	18-Aug-2003	Post-Inj. 14	20	NA	NA	6.59	0.5	14.9	1.22	0.565	2.02	0.2	3.20
MW-111	22-May-2002	Baseline	0.5	NA	NA	6.2	0.5	12	0.14	0.0108	2.3	0.084	0.10
	09-Jul-2002	Post-Inj. 1	0.5	NA	NA	8.4	0.5	12	0.25	0.005	2.1	0.2	0.08
	31-Jul-2002	Post-Inj. 2	18.1	NA	NA	5.94	0.5	12.3	0.396	0.005	1.02	0.2	0.89
	05-Sep-2002	Post-Inj. 3	7.0	NA	NA	5.7	0.5	13.6	0.317	0.005	1.1	0.136	1.1
	09-Oct-2002	Post-Inj. 4	11.2	NA	NA	5.28	0.5	11.9	0.401	0.265	1.09	0.166	0.48
	13-Nov-2002	Post-Inj. 5	7.7	NA	NA	5.54	0.5	11.4	0.337	0.005	1.2	0.169	0.39
	18-Dec-2002	Post-Inj. 6	4.8	NA	NA	5.17	0.5	11.8	0.312	0.005	1.32	0.156	0.22
	22-Jan-2003	Post-Inj. 7	0.5	NA	NA	5.3	0.5	12.2	0.267	0.005	1.61	0.197	0.23
	26-Mar-2003	Post-Inj. 9	2.6	NA	NA	4.33	0.5	12.4	0.1	0.005	1.46	0.2	0.83
	23-Apr-2003	Post-Inj. 10	3.21	NA	NA	4.5	0.5	12.5	0.481	0.005	1.42	0.2	0.95
	21-May-2003	Post-Inj. 11	423	NA	NA	121	0.5	16.7	6.18	2.31	0.3	0.2	10.0
	25-Jun-2003	Post-Inj. 12	1,240	NA	NA	0.5	0.5	20	8.43	12.7	0.3	0.2	18.8
	23-Jul-2003	Post-Inj. 13	788	NA	NA	0.5	0.5	20.3	20	2.32	0.3	0.2	9.3
	20-Aug-2003	Post-Inj. 14	105	NA	NA	151	0.5	16.3	5.66	0.659	0.3	0.2	6.4

Well	Sample Date	Carbon Dioxide (mg/L)	Dissolved Oxygen (mg/L)	Alkalinity (mg/L)	pH	Conductivity (ms/cm²)	Temperature (°C)	ORP (mV)	Turbidity (NTU)	Oil & Grease (mg/L)	Acetic Acid (mg/L)	Butyric Acid (mg/L)	Formic Acid (mg/L)	Lactic Acid (mg/L)	Propionic Acid (mg/L)	Pyruvic Acid (mg/L)
MW-106	21-May-2002	77.6	5.5	40	5.90	0.18	25.1	250	10.0	NA	0.5	0.5	1.7	0.5	0.5	2.0
	11-Jul-2002	78	7.5	490	5.97	1.86	27.1	-329	148.1	NA	58.0	0.5	0.5	772	56.8	0.6
	28-Jul-2002	207	1.0	413	6.06	0.02	25.5	-480	8.3	NA	91.5	2.0	0.5	643	98.5	2.0
	03-Sep-2002	168	1.7	214	6.08	0.51	26.7	-134	1.2	NA	82.5	6.1	0.5	6.6	81.7	2.0
	07-Oct-2002	137	0.3	174	6.40	0.38	23.4	-58	5.7	NA	49.2	0.5	0.5	0.5	30.4	5.0
	11-Nov-2002	91	0.8	132	6.41	0.29	22.4	-183	0.7	NA	29.8	3.1	0.5	0.5	28.1	2.0
	16-Dec-2002	109	1.7	100	6.19	0.27	20.4	-39	2.7	NA	22.8	0.7	0.5	0.5	22.8	4.5
	20-Jan-2003	109	1.9	132	6.48	0.36	16.6	-87	0.6	NA	29.4	0.7	0.6	0.5	25.1	4.7
	25-Mar-2003	289	0.4	1,070	6.21	3.31	21.2	-281	1.7	NA	337.3	48.0	0.5	3,109	544	10.8
	22-Apr-2003	481	0.5	984	6.19	2.24	19.8	-334	1.5	NA	186.7	105.5	0.5	1,125.9	307.9	2.0
	20-May-2003	491	0.7	3,970	6.35	8.34	22.9	-288	100.1	NA	245.4	375.1	0.5	6,808.8	554.6	2.0
	24-Jun-2003	209	0.2	3,540	6.48	6.23	24.5	-418	7.4	NA	234.9	310.1	0.5	8,238.0	516.8	2.0
	22-Jul-2003	210	1.2	2,380	6.71	4.81	23.9	-117	6.1	NA	274.5	548.7	0.8	1,576.6	787.5	2.0
	19-Aug-2003	502	0.4	1,210	6.41	1.86	25.2	-100	0.6	NA	428.0	738.3	0.5	459.8	1,135.4	2.0
MW-109	20-May-2002	70	1.3	55	6.33	0.23	21.7	7	10.8	NA	0.5	0.5	0.5	0.5	0.5	2.0
	08-Jul-2002	201	1.8	1,400	6.15	3.88	28.5	-549	4.2	NA	177.9	3.8	0.5	3,944.0	245.8	1.1
	30-Jul-2002	260	1.0	954	6.06	-0.01	27.4	80	3.4	NA	348.4	7.3	0.5	234.8	408.6	2.0
	04-Sep-2002	221	1.3	385	6.27	0.85	26.9	-44	0.0	NA	173.0	10.0	0.5	33.8	183.3	2.0
	08-Oct-2002	187	3.7	207	6.59	0.41	18.2	-118	0.0	NA	73.8	2.7	0.5	0.5	81.8	4.2
	12-Nov-2002	144	3.8	198	5.89	0.42	17.1	-82	0.1	NA	86.5	5.1	1.4	0.5	67.2	2.0
	17-Dec-2002	177	0.5	112	6.02	0.40	19.8	-103	0.0	NA	38.4	0.7	0.5	0.5	26.8	4.6
	21-Jan-2003	184	0.8	179	6.48	1.22	5.6	-142	6.0	NA	58.1	2.3	0.8	0.5	48.1	5.1
	25-Mar-2003	588	0.5	3,870	6.14	8.30	19.2	-80	0.8	NA	3,285	251	0.5	4,745	5,272	2.0
	23-Apr-2003	304	Bad Probe	1,750	6.27	3.33	18.4	-71	0.8	NA	820.7	258.4	0.5	159.7	1,288.7	2.0
	20-May-2003	475	1.0	7,320	6.41	8.84	22.7	-38	9.0	NA	1,637.8	1,176.8	0.5	2,814.7	3,324.8	2.0
	24-Jun-2003	725	0.5	16,000	6.84	18.61	26.5	-194	0.2	NA	1,832.2	4,071.3	0.5	12,522.0	8,335.6	2.0
	22-Jul-2003	490	1.6	6,580	6.90	11.62	23.9	-78	8.4	NA	1,000.9	2,068.3	0.5	1,128.3	2,852.7	2.0
	19-Aug-2003	380	0.5	3,700	6.62	5.34	27.8	-71	3.4	NA	1,089.2	1,053.1	0.5	180.2	1,645.8	2.0
MW-110	20-May-2002	53.4	5.0	43	5.84	0.17	22.9	242	12.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	09-Jul-2002	51.2	9.2	29	5.75	0.16	25.1	109	3.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	30-Jul-2002	111	5.7	44	5.96	0.05	24.1	110	0.4	NA	0.5	0.5	0.5	0.5	0.5	2.0
	04-Sep-2002	101	6.4	5	5.86	0.17	25.6	-23	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	08-Oct-2002	109	6.9	5	6.08	0.14	22.4	77	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	12-Nov-2002	97	5.9	5	5.44	0.17	19.7	118	2.2	NA	11.2	1.0	0.5	0.5	11.8	2.0
	17-Dec-2002	87	6.8	5	5.60	0.18	19.8	115	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	21-Jan-2003	78	5.0	5	5.80	0.45	14.8	98	1.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	24-Mar-2003	54	4.4	45	5.81	0.14	23.7	261	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	21-Apr-2003	95	4.1	5	5.73	0.16	25.3	249	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	19-May-2003	99	0.9	252	6.15	0.49	23.6	-118	3.6	NA	145.6	0.5	0.5	305.8	34.2	4.4
	23-Jun-2003	48	0.5	374	6.12	0.71	23.0	-228	0.0	NA	148.1	26.0	5.9	21.7	204.1	2.0
	21-Jul-2003	141	1.3	137	5.95	0.31	28.0	-2	8.8	NA	21.0	11.6	0.5	0.5	22.3	3.9
	18-Aug-2003	105	2.3	80	5.52	0.23	25.0	-34	0.9	NA	8.5	0.5	0.5	0.5	6.1	2.0
MW-111	22-May-2002	38.4	8.2	36	5.89	0.16	24.0	285	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	09-Jul-2002	59.6	6.5	28	5.86	0.15	31.2	262	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	31-Jul-2002	132	0.0	68	5.86	0.21	24.6	-37	1.3	NA	0.5	0.5	0.5	15.2	0.5	2.0
	05-Sep-2002	99	3.7	85	6.87	0.20	26.7	-67	0.2	NA	1.9	0.5	0.5	1.1	0.5	2.0
	09-Oct-2002	67	5.7	59	6.18	0.16	22.4	-12	0.0	NA	2.0	0.5	0.5	0.5	0.5	2.0
	13-Nov-2002	101	3.4	80	5.63	0.17	20.4	75	8.4	NA	73.4	7.1	0.8	0.5	88.4	4.1
	18-Dec-2002	95	3.9	5	5.99	0.17	19.5	51	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	22-Jan-2003	83	2.4	55	5.96	0.24	11.4	-15	7.8	NA	0.5	0.5	0.5	0.5	2.1	2.0
	26-Mar-2003	89	3.1	88	6.30	0.18	18.7	53	0.0	NA	1.9	0.5	0.5	0.5	1.8	2.0
	23-Apr-2003	88	2.4	59	5.83	0.19	19.5	94	0.0	NA	2.0	0.5	0.5	0.5	2.4	2.0
	21-May-2003	59	0.9	643	6.31	1.13	21.8	-167	3.4	NA	270.4	0.5	0.5	278.5	385.8	2.0
	25-Jun-2003	159	0.5	1870	6.27	2.58	24.3	-227	0.0	NA	530.3	41.5	0.5	1,124.0	741.7	2.0
	23-Jul-2003	215	0.9	926	6.69	1.65	23.2	-118	9.1	NA	278.0	153.9	0.5	22.5	506.7	2.0
	20-Aug-2003	83	0.4	302	6.60	0.52	23.3	-101	0.0	NA	83.8	46.7	0.5	3.7	98.2	2.0

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Table 4.8
Study Area 2. Summary of Other Analytes
Main Installation, Memphis Depot

Well	Sample Date	Sample Event	DOC (mg/L)	Arsenic (mg/L)	Selenium (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)	Chloride (mg/L)	Bromide (mg/L)	Manganese (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ferrous Iron (mg/L)	Carbon Dioxide (mg/L)	Dissolved Oxygen (mg/L)	Alkalinity (mg/L)	pH	Conductivity (ms/cm^3)	Temperature (°C)	ORP (mV)	Turbidity (NTU)	Oil & Grease (mg/L)	Acetic Acid (mg/L)	Butyric Acid (mg/L)	Formic Acid (mg/L)	Lactic Acid (mg/L)	Propionic Acid (mg/L)	Pyruvic Acid (mg/L)
MW-112	20-May-2002	Baseline	0.5	NA	NA	8.7	0.5	15	0.15	0.414	2	0.2	0.33	54.2	2.7	54	6.07	0.23	23.0	187	9.6	NA	0.5	0.5	0.5	0.5	0.5	2.0
	10-Jul-2002	Post-Inj. 1	6,100	NA	NA	14	0.5	16	120	35.3	0.3	0.2	2.30	69.2	0.0	4,900	6.40	14.91	25.5	-440	0.0	NA	107	0.5	0.5	23,827	57.5	51.8
	31-Jul-2002	Post-Inj. 2	4,620	NA	NA	4.28	0.5	15.0	47.2	8.13	0.3	0.2	4.82	240	3.3	1,930	6.25	2.82	24.6	-424	5.1	NA	288	11.2	0.5	8,098	328	3.9
	05-Sep-2002	Post-Inj. 3	2,380	NA	NA	1.72	0.5	15.9	20.5	18.4	0.3	0.2	11.32	421	1.4	1,620	6.23	3.54	25.7	-89	0.2	NA	486	24.4	0.5	1,048	753	2.9
	08-Oct-2002	Post-Inj. 4	885	NA	NA	1.82	0.5	12.9	8.29	17.5	0.3	0.2	12.88	266	6.0	1,000	6.48	1.50	22.9	-84	0.0	NA	322	53.2	18.0	118	442	4.7
	13-Nov-2002	Post-Inj. 5	618	NA	NA	2.63	0.5	11.9	5.82	12.8	0.3	0.2	7.18	253	0.8	725	5.87	1.34	21.7	-80	8.1	NA	208	50.2	0.6	26.7	271	2.0
	18-Dec-2002	Post-Inj. 6	420	NA	NA	2.8	0.5	13.8	3.97	5.84	0.177	0.2	8.44	157	0.3	480	6.42	0.88	18.8	-108	0.0	NA	167	35.8	0.5	16.2	182	4.8
	22-Jan-2003	Post-Inj. 7	255	NA	NA	33.5	0.5	13.8	3.84	5.38	0.3	0.2	1.81	183	0.3	387	6.43	1.21	13.0	-141	4.8	NA	145	25.1	0.6	4.8	134	4.1
	28-Mar-2003	Post-Inj. 9	4,050	NA	NA	30.8	0.5	80.7	86.3	34.4	0.3	0.2	17.80	554	0.5	6,370	6.43	7.54	22.1	-218	0.0	NA	1,311	233	0.5	5,112	2,135	8.5
	23-Apr-2003	Post-Inj. 10	2,420	NA	NA	1.02	0.5	12.3	48.4	14.2	0.3	0.2	8.20	301	1.3	3,260	6.21	6.15	22.8	-78	0.0	NA	811.5	414.8	0.5	1,861.9	1,567.6	2.0
	21-May-2003	Post-Inj. 11	11,100	NA	NA	149	0.5	17.7	214	25.7	0.3	0.2	10.20	370	1.8	10,200	6.55	14.28	24.5	-289	5.1	NA	1,178.2	1,068.5	0.5	17,824.6	2,120.8	2.0
	25-Jun-2003	Post-Inj. 12	17,800	NA	NA	217	0.5	18.1	212	22.6	0.3	0.2	7.84	520	0.1	14,500	6.73	23.78	25.8	-338	0.0	NA	1,010.6	905.3	0.5	35,907.0	2,004.7	2.0
	23-Jul-2003	Post-Inj. 13	3,730	NA	NA	0.5	0.5	20.7	120	8.66	0.3	0.2	10.32	210	1.0	6,140	6.81	8.08	28.8	-81	0.0	NA	650.7	1,016.3	0.5	8,855.8	1,430.2	2.0
	20-Aug-2003	Post-Inj. 14	4,120	NA	NA	0.5	0.5	24.4	228	13.8	0.518	0.2	18.47	110	0.6	5,480	6.63	6.82	28.5	-119	1.2	NA	819.7	1,933.5	115.4	6,304.2	1,658.1	24.5
MW-113	22-May-2002	Baseline	0.5	NA	NA	8.9	0.5	16	0.23	0.223	2	0.11	0.00	70	3.4	42	5.91	0.19	24.8	328	3.2	NA	0.5	0.5	0.5	0.5	0.5	2.0
	10-Jul-2002	Post-Inj. 1	0.5	NA	NA	8.7	0.5	14	0.31	0.109	2	0.2	0.11	35.6	3.9	47	5.87	0.16	27.1	242	0.0	NA	0.5	0.5	0.5	0.5	0.5	2.0
	31-Jul-2002	Post-Inj. 2	17.3	NA	NA	7.65	0.5	14.4	0.467	0.005	1.29	0.2	0.73	103	4.4	105	5.97	0.21	27.5	58	4.2	NA	0.5	0.5	0.5	29.0	0.5	2.0
	05-Sep-2002	Post-Inj. 3	37.3	NA	NA	8.14	0.5	18.5	0.685	0.871	1.4	0.2	1.79	85	2.7	82	5.94	0.29	34.3	-60	0.0	NA	20.0	0.5	0.5	4.4	18.0	2.0
	08-Oct-2002	Post-Inj. 4	31.8	NA	NA	5.5	0.5	14	0.593	1.71	1.15	0.183	3.04	128	4.8	124	6.33	0.20	20.3	-30	0.0	NA	22.1	0.5	0.5	0.8	21.8	2.0
	13-Nov-2002	Post-Inj. 5	14.0	NA	NA	5.63	0.5	13	0.441	1.48	1.36	0.2	2.12	103	3.9	64	5.63	0.21	20.7	34	6.1	NA	10.1	2.1	0.5	0.5	10.3	2.0
	18-Dec-2002	Post-Inj. 6	0.5	NA	NA	5.77	0.5	13.4	0.224	0.005	1.72	0.171	0.52	81	5.0	5	6.00	0.18	18.8	34	4.3	NA	0.5	0.5	0.5	0.5	0.5	2.0
	22-Jan-2003	Post-Inj. 7	0.5	NA	NA	6.13	0.5	14.4	0.246	0.885	1.89	0.209	1.28	86	2.2	51	6.04	0.27	6.0	42	4.3	NA	0.5	0.5	0.5	0.5	2.3	2.0
	28-Mar-2003	Post-Inj. 9	0.5	NA	NA	5.93	0.5	14.5	0.1	0.484	1.74	0.2	0.68	85	3.8	45	6.16	0.18	18.2	180	0.0	NA	3.2	0.5	0.5	0.5	0.5	2.0
	23-Apr-2003	Post-Inj. 10	4.74	NA	NA	5.48	0.5	15.2	0.488	0.992	1.53	0.2	2.58	53	2.5	68	5.85	0.21	20.1	84	0.0	NA	3.8	0.5	0.5	0.5	5.4	4.0
	21-May-2003	Post-Inj. 11	7.86	NA	NA	48.1	0.5	15.3	0.536	1.09	1.64	0.2	4.48	45	3.0	71	6.23	0.18	20.9	56	7.2	NA	18.2	0.5	0.5	0.5	8.6	2.0
	25-Jun-2003	Post-Inj. 12	15.0	NA	NA	5.28	0.5	15.9	0.829	1.38	1.18	0.2	4.54	95	1.4	91.3	6.35	0.21	28.2	18	0.0	NA	8.3	0.5	0.5	0.5	2.1	2.0
	23-Jul-2003	Post-Inj. 13	20.4	NA	NA	5	0.5	15.7	0.944	1.75	1.15	0.2	4.86	95	2.0	130	6.56	0.29	25.3	64	7.3	NA	20.2	1.5	0.5	0.5	13.5	2.0
	20-Aug-2003	Post-Inj. 14	6.6	NA	NA	5.78	0.5	15.7	0.724	0.673	1.47	0.2	3.10	21	3.0	78.4	6.17	0.21	25.6	5	0.7	NA	11.0	2.5	0.5	0.5	7.6	2.0
MW-114	22-May-2002	Baseline	0.5	0.0005	0.0005	6.6	0.5	12	0.16	0.0778	2	0.2	0.28	52.4	5.3	42	5.32	0.18	23.0	214	2.8	NA	0.5	0.5	0.5	0.5	0.5	2.0
	08-Jul-2002	Post-Inj. 1	6,400	NA	NA	10	0.5	14	52	4.85	0.3	5.9	4.38	72.6	7.0	2,000	6.21	5.39	28.4	-388	0.0	NA	60.8	0.5	0.5	8,730.5	21.6	4.0
	30-Jul-2002	Post-Inj. 2	803	NA	NA	4.03	0.5	12.0	11.7	1.88	0.165	0.103	5.00	148	3.6	801	6.00	0.54	25.9	-453	7.4	NA	170.3	0.5	0.5	1,748.2	186.0	2.0
	04-Sep-2002	Post-Inj. 3	378	NA	NA	2.35	0.5	13.8	4.56	3.84	0.3	0.102	4.04	110	6.2	416	6.29	1.04	34.0	-80	3.4	NA	183.1	7.7	0.5	104.0	203.5	2.0
	08-Oct-2002	Post-Inj. 4	180	NA	NA	2.79	0.5	11.3	2.76	3.15	0.3	0.2	7.32	115	3.8	382	6.42	0.58	23.4	-109	0.0	NA	117.8	5.5	0.6	0.5	138.9	4.4
	12-Nov-2002	Post-Inj. 5	167	NA	NA	3.69	0.5	11.7	1.69	2.09	0.3	0.2	5.12	128	1.3	223	5.78	0.43	21.2	-45	0.0	NA	73.0	7.2	0.5	0.5	83.9	2.0
	17-Dec-2002	Post-Inj. 6	86.8	NA	NA	3.76	0.5	11.7	1.38	2.19	0.683	0.2	3.10	81	6.8	180	6.32	0.38	20.8	-48	2.4	NA	84.7	6.7	0.5	0.5	71.7	2.0
	21-Jan-2003	Post-Inj. 7	87.2	0.00266	0.00328	0.5	0.5	11.8	1.2	1.41	0.688	0.2	7.44	89	1.0	163	6.42	1.06	18.1	-65	4.7	NA	54.8	12.4	4.0	0.5	63.1	2.0
	25-Mar-2003	Post-Inj. 9	2,700	NA	NA	2.75	0.5	18.7	75.1	6.94	0.3	0.2	8.84	674	0.4	4,130	6.02	7.65	22.3	-290	0.0	NA	1,217.0	72.1	0.5	7,833	1,864	28.9
	22-Apr-2003	Post-Inj. 10	0.5	NA	NA	1.28	0.5	17.8	15.2	3.24	0.3	0.2	11.24	231	0.5	1,310	6.10	2.88	22.4	-138	0.0	NA	624.4	80.0	0.5	14.2	621.7	2.0
	20-May-2003	Post-Inj. 11	9,580	NA	NA	1.22	0.5	21.2	72.8	16.3	0.3	0.2	18.32	508	0.7	981	6.13	8.11	24.0	-168	6.8	NA	2,034.8	423.4	0.5	4,338.0	2,868.0	2.0
	24-Jun-2003	Post-Inj. 12	13,800	NA	NA	0.785	0.5	0.5	148	9.07	0.298	0.2	10.78	620	0.4	13,000	6.54	18.19	27.1	-483	0.0	NA	814.8	1,601.1	0.5	22,885.0	1,867.7	2.0
	22-Jul-2003	Post-Inj. 13	4,590	NA	NA	0.5	0.5	21.8	79.8	2.86	0.3	0.2	10.20	512	1.5	3,340	6.58	8.88	25.1	-245	8.1	NA	838.8	1,530.1	0.5	2,144.4	2,145.2	2.0
	18-Aug-2003	Post-Inj. 14	1,880	NA	NA	0.5	0.5	34.0	148	2.03	0.3	0.2	17.80	211	0.7	3,560	6.37	3.75	27.0	-65	0.8	NA	677.8	1,282.1	0.5	32.8	1,610.0	2.0

Notes,
BL = Baseline value
Italic = Estimated Value (J)
ND = Not Detected
NA = Not Analyzed
ug/L = Micrograms per liter
Underlined value = half of the reporting limit for a non-detected parameter
Red results for conductivity = Could not calibrate field meter. Received new meter on July 31, 2002

Table 4.9
Theoretical Radius of Influence During Injections
Main Installation, Memphis Depot

Injection Event	Study Area	Injection Well	Injection Date	Volume Injected (gallons)	Height of Aquifer Effected (h)	Assumed Porosity (%)	Calculated Radius of Influence (r)
1	2	IW-1	Jun-02	1762	3	0.3	25.0
		IW-2	Jun-02	2642	9	0.3	17.6
		IW-3	Jun-02	2642	6.7	0.3	20.5
		IW-4	Jun-02	2642	8.5	0.3	18.2
1	1	IW-5	Jun-02	3864	10	0.3	20.2
		IW-6	Jun-02	3864	10	0.3	20.2
		IW-7	Jun-02	3864	10	0.3	20.2
2	2	IW-1	Feb-03	297	3	0.3	10.2
		IW-2	Feb-03	897	9	0.3	10.3
		IW-3	Feb-03	697	6.7	0.3	10.5
		IW-4	Feb-03	898	8.5	0.3	10.6
3	2	IW-1	Apr-03	355	3	0.3	11.2
		IW-2	Apr-03	1066	9	0.3	11.2
		IW-3	Apr-03	829	6.7	0.3	11.5
		IW-4	Apr-03	1066	8.5	0.3	11.5
4	2	IW-1	May-03	347	3	0.3	11.1
		IW-2	May-03	1040	9	0.3	11.1
		IW-3	May-03	809	6.7	0.3	11.3
		IW-4	May-03	1040	8.5	0.3	11.4

Table 4.10
Influence of Injections on Water Levels
Main Installation, Memphis Depot

Injection Well/Event	Wells Influenced	Time from Start of Injection	Change in water level (feet)	Distance from Injection Well (feet)
AREA 1				
IW-6/ 1	IW-5	3hr 33min	31.91	10
IW-5/ 1	IW-6	No measurement due to injection influence		10
IW-7/ 1	IW-5	No measurement due to injection influence		10
AREA 2				
Injection Well/Event	**Wells Influenced**	**Time from Start of Injection**	**Change in water level (feet)**	**Distance from Injection Well (feet)**
IW-1/ 1	None			
IW-2 /1	IW-3	2hr 20min	3.9	10
IW-3/ 1	IW-2	9hr 55min	1.08	10
IW-4/ 1	IW-2	3hr 44min	0.76	11
	IW-3	3hr 44min	1.68	10
IW-1/ 2	Not Measured			
IW-2/ 2	IW-3	7hr 20min	44.15	10
	IW-4	1hr 20min	1.4	11
IW-3/ 2	IW-2	7hr 43min	1.35	11
	MW-106	2hr	14.8	9
		6hr	30.64	9
		7hr 43min	39.35	9
IW-4/ 2	None			
IW-1/ 3	Not Measured			
IW-2/ 3	IW-3	1hr 40min	6.89	10
	IW-4	2hr 8min	78.59	11
IW-3/ 3	IW-4	2hr 14min	6.6	10
	MW-106	2hr 14min	2.29	9
IW-4/ 3	IW-2	3hr 25min	40.21	11
	IW-3	3hr 25min	4.92	10
IW-1/ 4	Not Measured			
IW-2/ 4	IW-3	2hr 8min	2.5	10
	IW-4	2hr 8min	83.64	11
IW-3/4	MW-106	56 min	26.95	9
	MW-109	1hr 49min	1.86	17
IW-4/4	None			

Table 4.12
BART IRB Analysis Summary
Main Installation, Memphis Depot

Well ID	Sample Date	Present/ Absent	Advance Test Info	Comments
Study Area 1				
MW116 IRB	05/22/2002	Present	IRB, 100	
	07/09/2002	Present	BL, 100,000	
	07/31/2002	Present	BL, 5,000	
	09/04/2002	Present	BL, 100,000	
	10/09/2002	Present	BL, 5,000 - 100,000	
	11/13/2002	Present	BL, 5,000 - 100,000	
	12/17/2002	Present	BL, 5,000	IRB indicated by brown ring at waterline.
	01/22/2003	Present	BL, 100 - 5,000	IRB indicated by brown ring at waterline.
	02/25/2003	Present	BL, 100	
	03/25/2003	Present	BL, 100 - 5,000	
	04/22/2003	Present	BL, 100 - 5,000	IRB indcated by brown solution.
	05/20/2003	Present	BL, 100	IRB indicated by brown solution.
	06/24/2003	Present	BL, 100,000	
	07/22/2003	Present	BL, 100,000	
MW116D IRB	05/22/2002	Present	IRB, 5,000	
	07/09/2002	Present	BL, 100,000	IRB indicated by brown ring at waterline.
	07/31/2002	Present	BL, 100,000	
	09/04/2002	Present	BL, 100,000	
	10/09/2002	Present	BL, 5,000 - 100,000	IRB indicated by brown ring at waterline.
	11/13/2002	Present	BL, 5,000	
	12/17/2002	Present	BL, 5,000	IRB indicated by brown ring at waterline.
	01/22/2003	Present	BL, 100 - 5,000	IRB indicated by brown ring at waterline.
	02/25/2003	Present	BL, 100	IRB indicated by brown solution.
	03/25/2003	Present	BL, 100	
	04/22/2003	Present	BL, 5,000	IRB indicated by brown solution.
	05/20/2003	Present	BL, 100 - 5,000	IRB indicated by brown solution.
	06/24/2003	Present	BL, 100,000	
	07/22/2003	Present	BL, 100,000	

Table 4.12
BART IRB Analysis Summary
Main Installation, Memphis Depot

Well ID	Sample Date	Present/ Absent	Advance Test Info	Comments
MW118 IRB	05/22/2002	Present	BL, 5,000	IRB indicated by brown film ring at waterline.
	07/09/2002	Present	BL, 100,000	IRB indicated by brown film ring at waterline.
	07/30/2002	Present	BL, 100 - 5,000	
	09/04/2002	Present	BL, 100,000	
	10/08/2002	Present	BL, 100 - 5,000	
	11/12/2002	Present	BL, 5,000 - 100,000	
	12/17/2002	Present	BL, 5,000 - 100,000	IRB indicated by brown film ring at waterline.
	01/21/2003	Present	FO, 100	
	02/25/2003	Present	BL, 100	
	03/25/2003	Present	BL, 100 - 5,000	
	04/22/2003	Present	BL, 100	
	05/20/2003	Present	BL, 5,000	
	06/24/2003	Present	BL, 5,000 - 100,000	IRB indicated by brown film ring at waterline.
	07/22/2003	Present	BL, 5,000 - 100,000	IRB indicated by brown film ring at waterline.
MW119 IRB	05/22/2002	Present	IRB, 100 - 5,000	
MW120 IRB	05/22/2002	Present	IRB, 100	
	07/10/2002	Present	BL, 100 - 5,000	
	07/30/2002	Present	BL, 5,000 - 100,000	
	09/04/2002	Present	BL, 5,000 - 100,000	
	10/08/2002	Present	BL, 100	IRB indicated by brown ring at waterline.
	11/13/2002	Present	BL, 100	
	12/17/2002	Present	BL, 100	
	01/21/2003	Present	FO, 100	
	02/25/2003	Present	FO, 100	
	04/22/2003	Absent		FO indicated by foam at waterline.
	05/20/2003	Present	BL, 5,000	IRB indicated by brown ring at waterline.
	06/23/2003	Present	BL, 100,000	
	07/22/2003	Present	BL, 100,000	

Table 4.12
BART IRB Analysis Summary
Main Installation, Memphis Depot

Well ID	Sample Date	Present/ Absent	Advance Test Info	Comments
MW122 IRB	05/22/2002	Present	BL, 5,000 - 100,000	IRB indicated by brown film ring at waterline.
	07/11/2002	Present	BL, 5,000 - 100,000	
	07/31/2002	Present	BL, 5,000	
	09/06/2002	Present	BL, 100,000	
	10/09/2002	Present	BL, 5,000 - 100,000	
	11/13/2002	Present	BL, 5,000 - 100,000	
	12/18/2002	Present	BL, 100 - 5,000	IRB indicated by brown film ring at waterline.
	01/21/2003	Absent		
	02/25/2003	Present	BL, 100	
	03/26/2003	Present	BL, 100	
	04/22/2003	Present	BL, 5,000	
	05/20/2003	Present	BL, 100	
	06/24/2003	Present	BL, 100,000	
	07/22/2003	Present	BL, 100,000	
MW124 IRB	05/22/2002	Present	IRB, 5,000 - 100,000	
	07/10/2002	Present	BL, 100,000	IRB indicated by brown ring and solution.
	07/31/2002	Present	BL, 5,000	
	09/03/2002	Present	BL, 100,000	
	10/09/2002	Present	BL, 5,000 - 100,000	
	11/12/2002	Present	BL, 5,000 - 100,000	
	12/17/2002	Present	BL, 100 - 5,000	
	01/21/2003	Absent		
	02/25/2003	Present	BL, 100	IRB indicated by brown ring and solution.
	04/23/2003	Present	BL, 5,000	IRB indicated by brown ring and solution.
	05/20/2003	Present	BL, 100	IRB indicated by brown ring and solution.
	06/24/2003	Present	BL, 100,000	
	07/22/2003	Present	BL, 100,000	

Table 4.12
BART IRB Analysis Summary
Main Installation, Memphis Depot

Well ID	Sample Date	Present/ Absent	Advance Test Info	Comments
		Study Area 2		
MW105 IRB	07/10/2002	Present	BL, 100,000	
	07/31/2002	Present	BL, 5,000	
	09/05/2002	Present	BL, 5,000 - 100,000	
	10/09/2002	Present	BL, 5,000 - 100,000	
	11/13/2002	Present	BL, 5,000 - 100,000	
	12/18/2002	Present	BL, 5,000	
	01/22/2003	Absent		
	03/26/2003	Absent		FO indicated by foam at waterline. No slime.
	04/23/2003	Absent		FO indicated by foam at waterline. No slime.
	05/21/2003	Absent		
	06/25/2003	Present	IRB, 100,000	
	07/23/2003	Present	BL, 5,000 - 100,000	
	08/20/2003	Present	IRB, 1,000	
MW110 IRB	05/20/2002	Present	BL, 100 - 5,000	
	07/09/2002	Present	BL, 100,000	IRB indicated by brown film at waterline.
	07/30/2002	Present	BL, 5,000 - 100,000	
	09/04/2002	Present	BL, 5,000 - 100,000	
	10/08/2002	Present	BL, 5,000 - 100,000	
	11/12/2002	Present	BL, 5,000 - 100,000	
	12/17/2002	Present	BL, 100	
	01/21/2003	Present	BL, 100	IRB indicated by brown film at waterline.
	03/24/2003	Present	BL, 100	IRB indicated by brown film at waterline.
	04/21/2003	Present	BL, 100 - 5,000	IRB indicated by brown film at waterline.
	05/19/2003	Present	BL, 5,000 - 100,000	IRB indicated by brown film at waterline.
	06/23/2003	Present	BL, 100,000	
	07/21/2003	Present	BL, 100,000	
	08/18/2003	Present	BL, 100,000	

Table 4.12
BART IRB Analysis Summary
Main Installation, Memphis Depot

Well ID	Sample Date	Present/ Absent	Advance Test Info	Comments
MW110D IRB	07/09/2002	Present	BL, 100,000	IRB indicated by brown film ring at waterline.
	07/30/2002	Present	BL, 5,000 - 100,000	
	09/04/2002	Present	BL, 100,000	
	10/08/2002	Present	BL, 5,000 - 100,000	
	11/12/2002	Present	BL, 100 - 5,000	
	12/17/2002	Present	BL, 100 - 5,000	
	01/21/2003	Absent		
	03/24/2003	Present	BL, 100 - 5,000	IRB indicated by brown film ring at waterline.
	04/21/2003	Absent		
	05/19/2003	Present	BL, 5,000 - 100,000	IRB indicated by brown film ring at waterline.
	06/23/2003	Present	BL, 100,000	
	07/21/2003	Present	BL, 100,000	
	08/18/2003	Present	BL, 5,000	
MW111 IRB	05/22/2002	Absent		
MW112 IRB	07/10/2002	Present	BL, 100,000	
	07/31/2002	Present	BL, 5,000	
	09/05/2002	Present	BL, 5,000 - 100,000	
	10/09/2002	Present	BL, 5,000 - 100,000	
	11/13/2002	Present	BL, 5,000	
	12/18/2002	Present	BL, 5,000	IRB indicated by brown ring at waterline.
	01/22/2003	Absent		
	03/26/2003	Absent		IRB possible, brown solution.
	04/23/2003	Present	BL, 100	
	05/21/2003	Absent		BL possible, very thin black film at waterline.
	06/25/2003	Present	IRB, 100,000	
	07/23/2003	Present	IRB, 100	
	08/20/2003	Present	IRB, 100	

Table 4.12
BART IRB Analysis Summary
Main Installation, Memphis Depot

Well ID	Sample Date	Present/ Absent	Advance Test Info	Comments
MW113 IRB	07/10/2002	Present	BL, 100,000	IRB indicated by brown ring at waterline.
	07/31/2002	Present	BL, 100 - 5,000	
	09/05/2002	Present	BL, 100,000	IRB indicated by brown film on sides.
	10/09/2002	Present	BL, 5,000 - 100,000	IRB indicated by brown ring at waterline.
	11/13/2002	Present	BL, 5,000 - 100,000	
	12/18/2002	Present	BL, 100 - 5,000	
	01/22/2003	Absent		
	03/26/2003	Present	BL, 100	IRB indicated by brown solution.
	04/23/2003	Present	IRB, 100	
	05/21/2003	Present	BL, 5,000 - 100,000	IRB indicated by brown ring at waterline.
	06/25/2003	Present	BL, 5,000	
	07/23/2003	Present	BL, 5,000 - 100,000	
	08/20/2003	Present	BL, 100 - 5,000	
MW114 IRB	05/22/2002	Present	IRB, 100 - 5,000	
	07/09/2002	Present	BL, 100,000	
	07/30/2002	Present	BL, 5,000 - 100,00	
	09/04/2002	Present	BL, 100,000	
	10/08/2002	Present	BL, 5,000 - 100,00	IRB indicated by brown ring at waterline.
	11/12/2002	Present	BL, 5,000 - 100,00	
	12/17/2002	Present	BL, 5,000	IRB indicated by brown ring at waterline.
	01/21/2003	Absent		FO indicated by foam at waterline. No slime
	03/25/2003	Present	IRB, 100	IRB indicated by brown ring at waterline.
	04/22/2003	Present	BL, 100	
	05/20/2003	Absent		FO indicated by foam at waterline. No slime
	06/24/2003	Absent		
	07/22/2003	Present	IRB, 100,000	
	08/19/2003	Present	BL, 100,000	

Table 4.13
BART SRB Analysis Summary
Main Installation, Memphis Depot

Well ID	Sample Date	Present/ Absent	Advance Test Info	Comments
		Study Area 1		
MW116 SRB	06/17/2002	Absent		
	07/09/2002	Present	BA, 10,000 - 100,000	
	07/31/2002	Present	BA, 10,000	
	09/04/2002	Present	BA, 100,000	
	10/09/2002	Present	BA, 10,000 - 100,000	
	11/13/2002	Present	BA, 10,000	
	12/17/2002	Present	BA, 1,000	
	01/22/2003	Present	BA, 1,000	
	02/25/2003	Present	BA, 1,000	
	03/25/2003	Present	BA, 1,000	
	04/22/2003	Present	BA, 1,000 - 10,000	
	05/20/2003	Present	BA, 1,000	
	06/24/2003	Present	BA, 10,000	
	07/22/2003	Present	BA, 10,000	
MW116D SRB	06/17/2002	Absent		
	07/09/2002	Present	BA, 10,000 - 100,000	
	07/31/2002	Present	BA, 10,000	
	09/04/2002	Present	BA, 100,000	
	10/09/2002	Present	BA, 10,000 - 100,000	
	11/13/2002	Present	BA, 10,000 - 100,000	
	12/17/2002	Present	BB, 1,000 - 10,000	
	01/21/2003	Present	BA, 1,000 - 10,000	
	02/25/2003	Present	BA, 10,000	
	03/25/2003	Present	BA, 1,000	
	04/22/2003	Present	BA, 1,000 - 10,000	
	05/20/2003	Present	BA, 1,000 - 10,000	
	06/24/2003	Present	BA, 10,000	
	07/22/2003	Present	BA, 100,000	
MW118 SRB	06/17/2002	Present	BB, 100 - 1,000	
	07/09/2002	Present	BA, 10,000	
	07/30/2002	Present	BA, 1,000 - 10,000	
	09/04/2002	Present	BA, 10,000 - 100,000	
	10/08/2002	Present	BA, 10,000 - 100,000	
	11/12/2002	Present	BA, 10,000 - 100,000	
	12/17/2002	Present	BA, 10,000 - 100,000	
	01/21/2003	Present	BA, 10,000	
	02/25/2003	Present	BA, 10,000 - 100,000	
	03/25/2003	Present	BA, 1,000 - 10,000	
	04/22/2003	Present	BA, 10,000 - 100,000	
	05/20/2003	Present	BA, 10,000 - 100,000	
	06/24/2003	Present	BA, 100,000	
	07/22/2003	Present	BA, 100,000	

Table 4.13
BART SRB Analysis Summary
Main Installation, Memphis Depot

Well ID	Sample Date	Present/ Absent	Advance Test Info	Comments
MW120 SRB	06/17/2002	Absent		
	07/10/2002	Present	BA, 10,000	
	07/30/2002	Present	BA, 1,000 - 10,000	
	09/04/2002	Present	BA, 100,000	
	10/08/2002	Present	BA, 10,000 - 100,000	
	11/13/2002	Present	BA, 1,000 - 10,000	
	12/17/2002	Present	BA, 10,000 - 100,000	
	01/22/2003	Present	BA, 10,000 - 100,000	
	02/25/2003	Present	BA, 10,000 - 100,000	
	04/22/2003	Present	BA, 1,000 - 10,000	
	05/20/2003	Present	BA, 100,000	
	06/23/2003	Present	BA, 100,000	
	07/22/2003	Present	BA, 100,000	
MW122 SRB	06/17/2002	Absent		
	07/11/2002	Present	BA, 100,000	
	07/31/2002	Present	BA, 10,000	
	09/06/2002	Present	BA, 100,000	
	10/09/2002	Present	BA, 10,000 - 100,000	
	11/13/2002	Present	BA, 10,000 - 100,000	
	12/18/2002	Present	BA, 10,000 - 100,000	
	01/21/2003	Present	BA, 10,000 - 100,000	
	02/25/2003	Present	BA, 10,000 - 100,000	
	03/26/2003	Present	BA, 10,000	
	04/22/2003	Present	BA, 10,000 - 100,000	
	05/20/2003	Present	BA, 10,000	
	06/24/2003	Present	BA, 100,000	
	07/22/2003	Present	BA, 100,000	
MW124 SRB	06/17/2002	Present	BA, 1,000 - 10,000	
	07/10/2002	Present	BA, 100,000	
	07/31/2002	Present	BA, 1,000 - 10,000	
	09/03/2002	Present	BA, 100,000	
	10/09/2002	Present	BA, 10,000 - 100,000	
	11/12/2002	Present	BA, 10,000 - 100,000	
	12/17/2002	Present	BA, 10,000	
	01/21/2003	Present	BA, 1,000 - 10,000	
	02/25/2003	Present	BA, 100	
	04/23/2003	Present	BA, 100,000	
	05/20/2003	Present	BA, 10,000	
	06/24/2003	Present	BA, 10,000	
	07/22/2003	Present	BA, 10,000	

Table 4.13
BART SRB Analysis Summary
Main Installation, Memphis Depot

Well ID	Sample Date	Present/ Absent	Advance Test Info	Comments
Study Area 2				
MW105 SRB	07/10/2002	Present	BA, 100,000	
	07/31/2002	Present	BA, 10,000	
	09/05/2002	Present	BA, 100,000	
	10/09/2002	Present	BA, 10,000 - 100,000	
	11/13/2002	Present	BA, 10,000 - 100,000	
	12/18/2002	Present	BA, 10,000	
	01/22/2003	Present	BA, 10,000	
	02/25/2003	Present	BA, 1,000	
	03/26/2003	Present	BA, 10,000	
	04/23/2003	Present	BA, 10,000	
	05/21/2003	Present	BA, 100 - 1,000	
	06/25/2003	Present	BB, 10,000	
	07/23/2003	Present	BA, 10,000 - 100,000	
	08/20/2003	Present	BA, 100,000	
MW110 SRB	06/17/2002	Absent		
	07/09/2002	Present	BT, 10,000	
	07/30/2002	Present	BA, 1,000 - 10,000	
	09/04/2002	Present	BA, 10,000 - 100,000	
	10/08/2002	Present	BA, 10,000	
	11/12/2002	Present	BB, 1,000 - 10,000	BA indicated by small patches on ball.
	12/17/2002	Present	BA, 1,000	
	01/21/2003	Present	BA, 1,000	
	03/24/2003	Present	BA, 1,000 - 10,000	
	04/21/2003	Present	BA, 1,000 - 10,000	
	05/19/2003	Present	BA, 10,000 - 100,000	
	06/23/2003	Present	BA, 100,000	
	07/21/2003	Present	BA, 100,000	
	08/18/2003	Present	BA, 100,000	
MW110D SRB	07/09/2002	Present	BA, 10,000	
	07/30/2002	Present	BA, 1,000 - 10,000	
	09/04/2002	Present	BA, 100,000	
	10/08/2002	Present	BA, 10,000	
	11/12/2002	Present	BB, 10,000	
	12/17/2002	Present	BA, 1,000 - 10,000	
	01/21/2003	Present	BB, 1,000	BA possible, small black patch on ball.
	03/24/2003	Present	BA, 10,000	
	04/21/2003	Present	BA, 10,000	
	05/19/2003	Present	BA, 10,000	
	06/23/2003	Present	BA, 100,000	
	07/21/2003	Present	BA, 100,000	
	08/18/2003	Present	BA, 100,000	

Table 4.13
BART SRB Analysis Summary
Main Installation, Memphis Depot

Well ID	Sample Date	Present/ Absent	Advance Test Info	Comments
MW111 SRB	06/17/2002	Absent		
MW112 SRB	06/17/2002	Present	BA, 100	
	07/10/2003	Present	BA, 100,000	
	09/05/2002	Present	BA, 100,000	
	10/09/2002	Present	BA, 10,000 - 100,000	
	11/13/2002	Present	BA, 10,000 - 100,000	
	12/18/2002	Present	BA, 10,000 - 100,000	
	01/22/2003	Present	BA, 1,000	
	03/26/2003	Present	BA, 10,000 - 100,000	
	04/23/2003	Present	BA, 10,000 - 100,000	
	05/21/2003	Present	BA, 100,000	
	06/25/2003	Present	BA, 100,000	
	07/23/2003	Present	BA, 100,000	
	08/20/2003	Present	BA, 10,000 - 100,000	
MW112D SRB	06/17/2002	Present	BA, 100	
MW113 SRB	06/17/2002	Absent		
	07/10/2002	Present	BA, 100 - 1,000	
	07/31/2002	Present	BA, 10,000	
	09/05/2002	Present	BA, 100,000	
	10/09/2002	Present	BA, 10,000 - 100,000	
	11/13/2002	Present	BT, 10,000	
	12/18/2002	Present	BB, 100 - 1,000	
	01/22/2003	Present	BA, 1,000 - 10,000	
	03/26/2003	Present	BA, 1,000 - 10,000	
	04/23/2003	Present	BA, 1,000 - 10,000	
	05/21/2003	Present	BA, 1,000 - 10,000	
	06/25/2003	Present	BA, 100,000	
	07/23/2003	Present	BA, 100,000	
	08/20/2003	Present	BA, 100,000	
MW114 SRB	06/17/2002	Absent		
	07/09/2002	Present	BA, 100,000	
	07/30/2002	Present	BA, 1,000 - 10,000	
	09/04/2002	Present	BA, 100,000	
	10/08/2002	Present	BA, 10,000 - 100,000	
	11/12/2002	Present	BA, 10,000 - 100,000	
	12/17/2002	Present	BA, 100,000	
	01/21/2003	Present	BA, 10,000	
	03/25/2003	Present	BA, 10,000 - 100,000	
	04/22/2003	Present	BA, 10,000	
	05/20/2003	Present	BA, 10,000	
	06/23/2003	Present	BA, 10,000	
	07/22/2003	Present	BA, 100,000	
	08/19/2003	Present	BA, 10,000	

5.0 Conclusions

5.1 Summary

Contaminant plumes beneath the MI at Memphis Depot contain CVOCs, primarily PCE, TCE, CT and chloroform. The ROD specifies that EBT will be used to cleanup the most contaminated portions of the aquifer. CH2M HILL beginning in June 2002 conducted two pilot studies of electron donors to determine design parameters and a suitable donor for full-scale implementation. In Study Area 1 a vegetable oil emulsion (food grade soybean oil mixed with lecithin, commercially known as *Centromix BR*™) was injected. In Study Area 2, a 15 to 40 percent solution of sodium lactate was injected. Study Area 1 had PCE and TCE contamination; Study Area 2 had these contaminants plus CT and chloroform.

Both study areas were prepared by installation of multiple monitoring wells and 3-4 injection wells. Background aquifer chemistry was established and soil samples were analyzed for organic carbon. Slug tests made on wells in the study areas indicated the aquifer was reasonably representative of other parts of the MI. At Study Area 1 a total of 11,592 gallons of oil emulsion with bromide tracer were injected. The injection immediately affected a zone up to 60 ft downgradient of the injection wells. At Study Area 2 an initial injection of 9,705 gallons lactate and bromide solution was made, with an affected zone up to 35 ft downgradient of the injection wells. Subsequent lactate injection of 2,995, 3,375, and 3,338 gallons were made in February, April and May 2003, respectively. Groundwater samples were collected periodically at both areas until August 2003. Samples were analyzed for DOC, CVOCs, bromide, dissolved gases, geochemical indicator parameters, and volatile fatty acids.

The bromide tracer and DOC results indicated heterogeneities in the aquifer created preferential pathways for migration of the injected fluids. Both study areas showed small unaffected areas near the injection wells that were interpreted to be the result of low permeability zones within the aquifer. These zones showed much less change in geochemical conditions and much less EBT than nearby wells affected by the electron donor. Almost immediately both donors created changes in geochemical conditions favorable for reductive dechlorination. DO, nitrate, sulfate, and ORP levels declined, while iron and manganese, DOC, alkalinity, CO_2, chloride, and dissolved gases (especially methane) increased. Changes were more dramatic with the lactate injections indicating that substrate was more available to stimulate microbial activity. During the study, water samples were tested for iron related and sulfate-reducing bacteria. Both types were identified repeatedly at reasonably high population levels suggesting the electron donors were sustaining conditions suitable for reductive dechlorination. Tests for a particular bacterium, *Dehalococcoides ethenogenes*, known to be effective at completely transforming PCE and TCE to ethane, were negative (less than 500 cells per gram).

During the one year period of the study, PCE and TCE levels declined in Study Area 1. Some transformation to cis-1,2-DCE was noted and overall attenuation rates for PCE and TCE were up to 100 times the natural attenuation rates. However, some of the attenuation is apparently due to absorption of PCE and TCE into the vegetable oil, not transformation. Within 3 months of the initial lactate injection, PCE, TCE, CT and its daughter products were degrading in areas affected by the electron donor. The reductive dechlorination reaction appeared to slow somewhat as the lactate became depleted, but subsequent injections were very effective in removing these contaminants from nearly all of the study area. Buildup of cis-1,2-DCE suggests the lactate EBT will not completely transform the PCE and TCE to ethene. Ongoing remedial actions at the nearby Memphis Airport suggest that a more continuous lactate injection might stimulate effective treatment of cis-1,2-DCE over time. Buildup of cis-1,2-DCE was not noted at Study Area 1 but the slow rate of cis-1,2-DCE generation indicates the EBT rates for the vegetable oil are slower than the lactate.

5.2 Conclusions

Drilling to prepare for the pilot studies indicated the fluvial aquifer within the study areas was reasonably representative of the MI. Injection pressures had no measurable effect on water levels in wells > 20 ft from the injection well. The estimated radius of injection for the oil emulsion was 27 to 63 feet downgradient of the injection wells; the sodium lactate affected areas 25 to 38 feet downgradient of the injection wells. Comparison of the levels of bromide and DOC in downgradient wells indicated the lactate was transported in groundwater at approximately an equal rate as the tracer. DOC from the oil emulsion also travels downgradient at a rate approximately the same as the tracer. The DOC from both substrates is degradable and levels were substantially depleted within a few hundred feet downgradient of the injection zone. Variations in bromide and DOC within the study areas indicated aquifer heterogeneities created preferential pathways for migration. At both test sites, an area near the injection wells showed very little effect from the (initial) injection, suggesting a local zone of lower permeability. This has implications to full-scale implementation because a uniform radius of influence cannot be assumed. Multiple injections may be required to assure all areas within the target area are treated.

Both electron donors persisted for more than 6 months in the aquifer. After one year the oil emulsion is still detectable near the injection zone. The lactate was substantially depleted within 7 months of the initial injection, and subsequent injections were made to sustain conditions necessary for reductive dechlorination. The vegetable oil is more persistent, because it supplies less DOC. Unfortunately, less DOC available to the microbial populations means less production of the H_2 needed to transform CVOCs. Throughout the entire study period, ORP levels within Study Area 1 were only marginally suitable for EBT. PCE and TCE were only slowly transformed to cis-1,2-DCE. When sufficient lactate was supplied nearly all of the PCE and TCE was depleted, and so were the CT and its daughter products. Unfortunately, after one year of biostimulation with lactate, the indigenous microbial communities did not transform the cis-1,2-DCE to vinyl chloride and then to ethane. This suggests that full-scale implementation may require longer treatment periods, or injection of special bacterial strains (bioaugmentation) to complete the transformation.

The two pilot tests showed that EBT can be effective in reducing CVOCs at the MI. The vegetable oil emulsion showed much higher attenuation rates for PCE and TCE than the natural attenuation rates in the aquifer. However, some of the attenuation is due to absorption of the contaminants into the oil phase. Slow buildup cis-1,2-DCE within the treatment zone suggests transformation rates in the oil EBT pilot study were lower than the transformation rates in the lactate EBT pilot study. Overall, the lactate showed better promise for EBT within the fluvial aquifer. Since short-term biostimulation with lactate does not cause complete transformation of the chlorinated ethenes, the design for full-scale implementation should be based on multiple injections to sustain lactate in the aquifer for a period of a year. As an alternative approach, EBT with lactate could be used to attenuate PCE/TCE to cis-1,2-DCE, with subsequent attenuation of the cis-1,2-DCE via aerobic oxidation in downgradient portions of the site (outside the active treatment zone). This approach would have to be shown effective via fate and transport modeling, or by results of continued monitoring of these pilot study sites. If continual EBT with lactate is used the time for complete treatment of the "hottest" plume areas is estimated to be at least 2 to 3 years. If limited EBT treatment creates cis-1,2-DCE that will attenuate via aerobic oxidation, the active treatment time would be about 1 year, with overall cleanup time of the "hottest" plume areas possibly in 2 to 5 years.

A third alternative is bioaugment with *Dehalococcoides ethenogenes* and other microbes that will completely transform the chlorinated ethenes. Currently, there is considerable uncertainty about the best (most practical) methods to inject and disperse bacteria within an aquifer. When this TM was prepared, few studies had been reported showing how many microorganisms are needed and how quickly the injected microorganisms can become established. Therefore, the total cleanup time using bioaugmentation cannot be estimated with any confidence.

6.0 References

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ATTACHMENT A

Soil Borings and Well Construction Details

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-1

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Mephis Depot

ELEVATION : — DRILLING CONTRACTOR Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing /6 inch outer casing)

WATER LEVELS : — START : 04/15/2002 — END : 04/16/2002 — LOGGER Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY %	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. PID (ppm) (Soil headspace)
					Asphalt,6 inches	
					Silt,brown,loess,moist	
						3.3
5		100			Silt,brown,loess,moist	
						6.4
10					Silt,brown,loess,moist	
						3.4
15		100			Silt,brown,loess,moist	
						5.5
20					Silt,brown,loess,moist	
					Sandy clay with silty sand inclusions (tan),brown	10.3
					Clayey Sand with slight silt,red,stiff with yellow and tan mottles,dense	
25		100			Same as above,sandy clay,red with tan to light brown mottles	
						9.2
30					Same as above,dense	
						12.2
					Silty to clayey sand,increase of fine grained sand,moist firmed with tan mottle	
35					Same as above	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-1

SOIL BORING LOG

PRECT : EBT Treatability Study — LOCATION · Mephis Depot

ELEXTION : — DRLING CONTRCTOR Boart Longyear

DRLING METBD AND EQIPMENT USED : Blasonic rig (4 inch saple casing /6 inch outer casing)

WATERLEELS : — STAR: 04/152002 — END: 04/162002 — LOGGER Bryan Burkingstock

DEPTH BELOW SURACE (FT)	INTERL (FT)	RCOVRY%	TPE	STANDAR PENETRTION TEST RSULTS 6"-6"-6" (N)	SOIL DESCRPTION: SOIL NAME, USCS GRUP SMBOL, COLOR, MOISTUR CONTENT, RLATIV DENSITY OR CONSISTENCY, SOIL STRCTURE, MINERLOGY	COMMENTS: DEPTH OF CASING, DRLING RTE, DRLING FLUID LOSS, TESTS, AND INSTRMENTATION. PID (ppm)
						6.7
					Sand (abrupt change),fine grained,well sorted,oist, golden	
					Sand,light yellow,fine grained,well sorted	
40					3 inches of silty sand lenses @ 40 feet,tan	
					Sand,well sorted,fine grained, golden to light yellow	
						3.4
					Sand,fine to coarse grained, poorly sorted,light yellow,slight pebbles (subangular) 0.25 inches,10%	
45		100				
						7.2
					Sand, yellowish white, poorly sortec	
					Sand, yellowish white, poorly sorted,slight pebbles (10-20%),1 inches,suban gula	
50					Sand, yellow,fine to edium grained, poorly sorted	
					Sand,brownish white,fine to edium grained, poorly sorted, pebbles (10-30%), 0.5 inches,suban gular	
						6.5
					Saeas above,tan,decrease in pebbles	
55					Sand,tan to yellowish tan,fine to coarse grained,oist	
						5.3
60					Sand,brownish yellow to light yellow,fine to coarse grained, poorly sorted	
						7.8
					Sand,white to yellowish white, poorly sorted,fine to edium grained	
65		100			Sand,brown, poorly sorted,fine to edium grained, pebbles (10%),0.25 inches	
						13.2
					Turning yellowish brown @ 68 feet bgs	
70					Sand, yellow,fine grained,well-sorted	
						11.1

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-1

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Mephis Depot

ELEVATION : DRLLING CONTRACTOR Boart Longyear

DRLLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch saple casing /6 inch outer casing)

WATER LEVELS : START : 04/152002 END: 04/162002 LOGGER Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY %	TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.	PID (ppm)
75					Gravelly sand,brown, poorly sorted,fine to edium grained, pebbles (20-30%), 0.25 inches		
					Sand,li ght yellow,fine grained,well sorted,dr y		9.0
80					Clayey sand (thin fine sand between thin clay layers),yellowish gray		
					Sand,tan,edium grained,well-sorted		14.0
					wet at approixtel y 84 feet bgs		
85		100			Sandy clay (interbedded thin layers of sand and clay), yellowish brown,firwet		
							2.1
90					Sandy clay,Increase of cla y, yellowish brown,dense,oist		
							2.6
95					Sand,white to li ght yellow,fine grained,well sorted,dr y		
					Silty sand,bands of gray and tan,fine grained,densel y packed,wet	Watertable @ approixtel y 96 feet bgs	
					Sand,tannish brown,fine to edium grained, poorly sorted,wet, pebbles,0.25 inches		
100		100			Clay, yellowish gray to dark gray		
105							
					Boring Termated @ 107 feet bgs		
110							

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CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-105	SHEET 1 OF 1

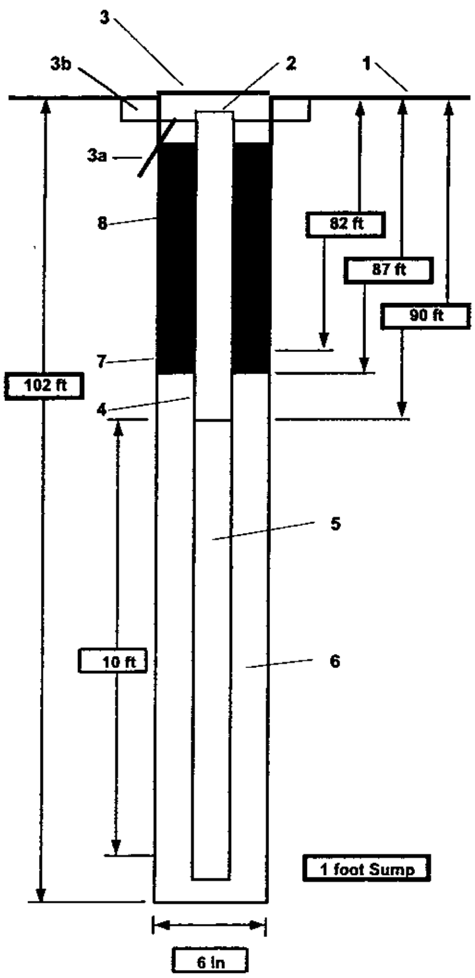
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 05/01/2002 — END: 05/01/2002 — LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 101 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

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CH2MHILL

PROJECT NUMBER	WELL NUMBER
170039	IW-1 SHEET 1 OF 1

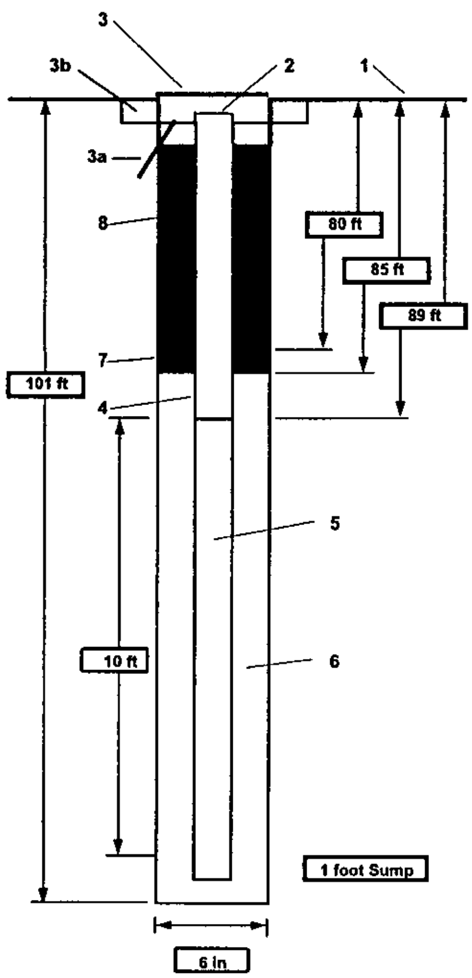
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/18/2002 END: 04/19/2002 LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 40-slot Schedule 40 PVC
6- Type screen filter	Sand, 1 ft of DSI #2 on top of 3 ft of Global #4
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	Surge and develop with stainless steel bailer
Development time	4.6 hour
Estimated purge volume	35 gallons
Comments	Total Depth (BGS) = 100 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-2

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/19/2002 END: 04/19/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Asphault, parking lot	
		100			Silt, brown, dry, stiff	0.0
5					Silty Clay, reddish brown, stiff, dry	0.0
10		100			Silty Clay, reddish brown, stiff, damp	0.0
15					Silty Clay, reddish brown, stiff, damp	0.0
					3 inch band of fine to coarse sand and gravel (>0.5 inches diameter)	
20		100			Silty Clay, reddish brown, stiff, damp	0.0
					Sand, light orange, fine grained, well sorted, loose	
25					Silty Sand, red with yellow mottling, fine to medium grained, stiff, dry	0.0
30		100			Silty Sand, red, fine to medium grained, poorly sorted, stiff, dry to damp	0.0
35					Sand, reddish orange, fine grained, stiff, dry to damp	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-2

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot
ELEVATION : — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : — START : 04/19/2002 — END: 04/19/2002 — LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
						0.0
					Sand, red to orange, fine grained, stiff, some medium grained quartz	
40		100				
					Sand, orange/yellow, fine to medium grained, well sorted, loose, dry	
					Sand, reddish white, fine grained, grading to medium grained, loose, dry	
						0.0
					Sand, orange, fine to medium grained, poorly sorted, grading to coarse grained, damp	
45						
					Pebble to cobble size	
					Sand, light orange yellow, fine grained, loose, dry, pebble	
						0.0
50		100				
					Sand, tan/white, fine to medium grained, loose, dry, pebbles	
						0.0
					Sand, tan/white, fine to medium grained grading to a coarse grain, loose, damp, pebbles	
55						
					Sand, orange, fine to medium grained, poorly sorted, damp, pebbles, subangular	
		100				0.0
60						
		100				0.0
					Sand, orange, fine to medium grained, poorly sorted, damp, pebble to cobble, subangular	
65						
					Same as above: Tan orange sand	
					Sand, light tan, fine grained, loose, well sorted, dry	
						0.0
70		100				
					Sand, tan to orange, fine grained, loose, well sorted, dry	
						0.0

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-2

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

ELEVATION : — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/19/2002 — END: 04/19/2002 — LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Silty sand, tan, fine grained, soft, some small gravel, damp	
					Sand, orange white, fine grained, well sorted, loose, dr	0.0
					damp	
80		100			Silty Clay, tan, stiff, wet	
						0.0
85					Silty Sand, tan, fine grained, soft, wet	
					Sand, white to light pink, fine grained, loose, dr	0.0
90		100				
					Sand, brown, fine grained, stiff, pea size gravel with subrounded cobbles	
					Sand, tan, fine to coarse grained, poorly sorted, gravel, subrounded to subangula pebbles to cobbles, loose dr	0.0
95					Sand, white/tan, fine to coarse grained, poorly sorted, loose, saturated @ 96 ft bgs, White/orange interbedded silty clay	
					Sand, orange/red, fine grained, loose, damp	Watertable @ approximately 96 feet bg
100					Gravelly Sand, tan, fine to coarse grained, poorly sorted, pebbles to cobbles Subangular to subrounded	
					Silty Clay, orange and gray mottled, wet, stif	
					Sand, gray, fine grained, wet @ 105: >1 inch bed of small brown angular gravel	
105					Clay, dark gray, massive	
					Boring Terminated @ 106 feet bgs	
110						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	IW-2	SHEET 1 OF 1

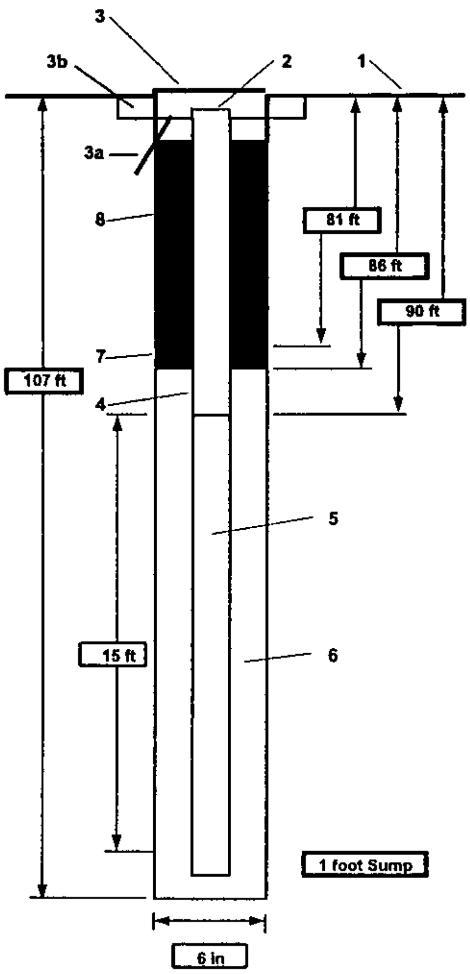
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/19/2002 — END: 04/19/2002 — LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 40-slot Schedule 40 PVC
6- Type screen filter	Sand, 1 ft of DSI #2 on top of 3 ft of Global #4
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	Surge and develop with stainless steel bailer
Development time	9 hour
Estimated purge volume	42 gallons
Comments	Total Depth (BGS) = 106 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 248

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-3

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/20/2002 END: 04/21/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
		100			Asphalt and gravel	0.0
5					Silt, brown, stiff, loess	0.0
10		100			Same as above, Silt	0.0
15						0.0
20		100			Same as above, Silt	
					Sand, orange, fine grained, loose, dry	0.0
25					Silty Sand, red, fine grained, stiff, damp	0.0
30		100				0.0
35					Sand, reddish orange, fine grained, loose, damp	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-3

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/20/2002 END: 04/21/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION — Corrected FID (ppm):
						2.6
40		100				
					Sand, tan to yellow, fine grained, loose, dry	0.0
					Sand, orange, fine to coarse grained, loose, dry	
45						
					Sand, orange, fine to coarse grained, loose, dry, pebbles >0.5 inch diameter angular to subangular	0.0
50		100			Sand, tan to reddish tan, fine to medium grained, loose dry, pebbles	
						0.0
55					Sand, orange, fine to medium grained, loose, dry pebble to cobble from 55 to 56 feet bgs	
		100				0.0
60					Sand, tan, fine to medium grained, loose, dry	
		100			Sand, grey, fine to coarse grained, loose, dry, pebble to cobble	0.0
					Sand, light tan, fine grained, loose, dry	
65					Silty Sand (some clay), fine grained, stiff, damp	
					Sand, orange to tan, fine grained, loose, dry	0.0
70		100				
						0.0

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-3

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/20/2002 END: 04/21/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75	75-85					
					Sand, tan, fine grained, pebbles to cobbles	0.0
80		100				
					Silty Clay, brown, stiff, pebbles to cobble, rounded, wet	
					Silty Clay, tan and orange, thin interbedding, stiff, we	0.0
					Sand, orange, fine to medium grained, gravel, subrounded, pebble to cobble	
85	85-95				Sand, reddish orange, fine grained, damp	
					Sand, white, fine grained, well sorted, loose	
						0.0
90		100				
					Sand, light tan to reddish tan, fine grained, well sorted, loose, dry	
						0.0
					Sand, tan, medium to coarse grained, poorly sorted, loose, damp	
95	95-105				Sand, orange, fine to coarse grained, poorly sorted, loose, wet gravel, subangular to subrounded, pebble to cobble	Watertable @ approximately 96 feet bgs
					Silty Sandy Clay, tannish gray, fine grained, well sorted, stiff, damp	
					Sand, white, fine grained, well sorted, loose wet	
100		100			Sand, orange, fine to coarse grained, gravel, pebble	
					Silty Clay, orange and gray mottled, stiff	
					Silty Sand, gray, wet	
					Sitly Sandy Clay, orange to gray mottling, stiff, we	
105					Boring Terminated @ 105 feet bgs	
110						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-4

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot
ELEVATION : — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : — START : 04/15/2002 — END: 04/16/2002 — LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm) *(Soil headspace)*
		100			Asphalt and gravel	
					Silt, brown, stiff, loess	2.5
5		100				3.1
10					Same as above, Silt	10.1
15		100				3.3
20					Same as above, Silt	
					Sand, orange, fine to medium grained, loose	0.0
25		100			Sandy Silt, brown	
					Sand, orange, fine toi medium grain, with silt, small less then 0.25 inch gravel	0.0
					Silty sand, red, dry, stiff, fine grain, up to 0.5 inch gravel, 1/8 inch tan sand and up to 0.5 inch laminations	
30					Sand, silt, orange to red, fine to medium grained, moist	0.0
35		100			Same as above	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-4

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/15/2002 END: 04/16/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Sand, orange, fine grain, loose	0.0
40					Sand, yellow to light yellow, medium grain, loose	
					Sand, orange, medium grained, with less then 1/8 inch yellow and tan fine grain laminations	
45		100			Sand, silty, red, stiff	0
					Sand, interbedded, yellow and light yellow, medium grain, up to 0.5 inch gravel	
					Sand, tan to white, medium grained, up to o.5 inch grave	0.0
50					Sand, yellow, medium grained, less then 1 inch gravel	
					Sand, orange, fine to medium grained, less then 1 inch gravel decreasing towards 60 feet	0.0
55		100			Sand, orange, fine to medium grain, up to 0.25 inch gravel	
						0.0
60					Same as above except brown in color	
					Silty sand, red, fine grained, stiff, 0.5 inch thick	
					Sand, tan, fine to medium grain, 6 inch thick orange medium grain sand	0.0
					Sand, tan to white, medium grain, up to 0.5 inch gravel throughout	
65		100			Sand, orange, fine grain, well sorted	
					Sand, white to tan, fine grain, well sorted	
					Sand, tan, fine grain, well sorted	0.0
70					Same as above except orange	
						0.0

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-4

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/15/2002 END: 04/16/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm).
75		100			Same as above	
					Sand, brown, medium grain, poorly sorted, with up to 0.5 inch grave	
					Sand, tan, fine grained, pebbles to cobbles	0.0
					Sand, orange, fine grain, well sorted, with fine grain white sand laminations	
80					Same as above	
					Sandy clay, some silt, brown, damp	0.0
					Sand, orange, medium grain, poorly sorted, damp, grave	
85		100			Sand, white, fine grain, well sorted	
90		100			Sand, white, fine grain, well sorted, a few up to 0.25 inch gravel	
					Sand, orange, fine grain, well sorted graded to a tan sand, fine to poorly sorted, grave from pebble to cobble size, damp	0.0
95		100			Sand, white, fine grain, well sorted, interbedded with silty clay	
					Sand, white, well sorted, fine grain	
					Sand, tan, fine to medium grained, poorly sorted, pebble to cobble size gravel, wet	Watertable @ approximately 97 feet bgs
100					Clay, light grey, stiff at 101 feet 1 inch layer of lithics and quartz gravel	
					Silty sand, orange, fine grain, well sorted	
					Sand, white, fine grain, well sorted, interbedded with 1mm tan silty clay, dam	
105		100			Clay, dark grey, massive, stiff, little silt, damp	
110						

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-4

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/15/2002 END: 04/16/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
115					Boring terminated at 115 feet bgs.	
120						
125						
130						
135						
140						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	IW-4	SHEET 1 OF 1

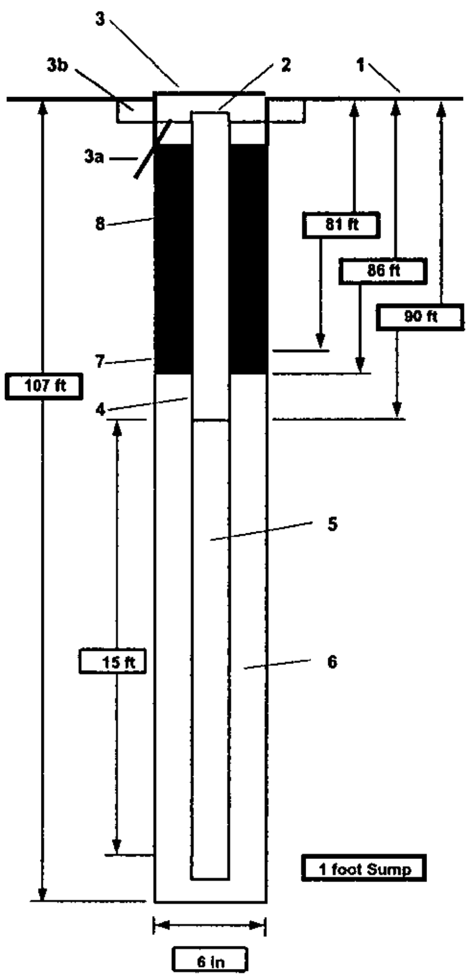
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/15/2002 END: 04/16/2002 LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 40-slot Schedule 40 PVC
6- Type screen filter	Sand, 1 ft of DSI #2 on top of 3 ft of Global #4
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 106 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-5

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

ELEVATION : — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/18/2002 — END: 04/19/2002 — LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Gravel (parking lot)	
		100			Silt, brown, moist, loess, stiff	0.0
5						0.0
10		100			Same as above	0.0
15						0.0
20		100				0.0
					Silt, brown, slight fine sand	
					Sandy clay, (some silt), brown grading to tan, dense, red and grey sandy clay inclusions	
25						0.0
30		100			Same as above, increase of fine sand, tan	0.0
					Clayey sand, tan increase of fine sand, firm	
					Sand, tan, fine grain, well sorted, moist, loose	
35						
					Clay, light grey with maroon mottles, dense, stiff	0.0

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-5

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/18/2002 END: 04/19/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Clay same as above	
40		100			Sand, golden to light yellow, fine grain, well sorted, loose	14.1
					Sand, brownish yellow, fine to medium grained poorly sorted, loose	
45					Sand, brownish, yellow, fine to coarse grained, poorly sorted, loose, gravel (<10%) subangular, <0.25 inches diameter	0.0
50		100				
					Sand, fine grain, well sorted, light yellow, loose	140.2 @52.3 ft bgs
55					Sand, fine to medium grain, poorly sorted, brownish yellow, pebbles (<20%), subangular <0.25 inches diameter	
						100.4 @57.5 ft bgs
60		100			Sand, brownish yellow, fine grain, well sorted, loose	
					Sand, brownish yellow, fine to medium grained, poorly sorted, loose gravel (10-20%), <0.5 inches diameter	
					Sand, brownish yellow, fine to medium grain, well sorted, loose	65 @62.5 ft bgs
65					Gravelly sand, poorly sorted, pebbles (20-30%) <1 inch diameter, loose	38.0
					Sand, brownish yellow, fine to medium grain, well sorted, loose	
70		100			Gravelly sand, brownish yellow, fine to coarse grained sand, subangular pebbles (30-40%), < 1 inch diameter	110.4

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-5

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/18/2002 END: 04/19/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Gravelly sand, same as above, brownish yellow	176
80		100				1476
85						165
90		100				306.0
95						Wet @ 95 ft bgs
100		100				
105						
					Sandy clay, light grey, wet, firm	
110		100			Gravelly sand, brownish yellow, fine to coarse grain, poorly sorted, loose	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-5

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot
ELEVATION : — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : — START : 04/18/2002 — END: 04/19/2002 — LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above	
					Clay, yellowish brown, dense, moist, stiff	
115						
					Color change from yellowish brown to yellowish grey to dark grey.	
120						
		100				
125						
130					Boring terminated at 130 ft bgs	
135						
140						

794 260

PROJECT NUMBER	WELL NUMBER	
170039	IW-5	SHEET 1 OF 1

CH2MHILL

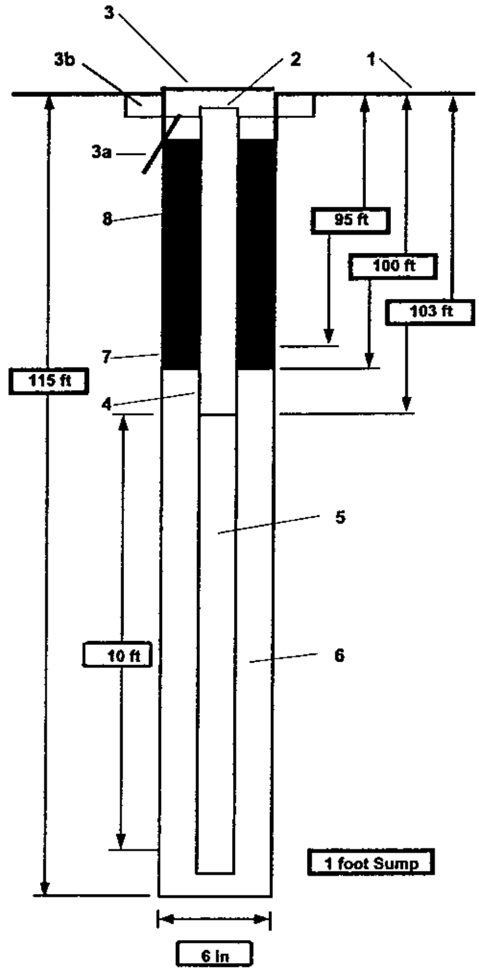
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/19/2002 — END: 04/19/2002 — LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 40-slot Schedule 40 PVC
6- Type screen filter	Sand, 1 ft of DSI #2 on top of 3 ft of Global #4
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	Surge and remove sediment with stainless ste bailer Developed using submersible pump
Development time	3 hour
Estimated purge volume	250 gallons
Comments	Total Depth (BGS) = 114 feet

Final field parameters collected during well development (/ /)

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	IW-6	SHEET 1 OF 1

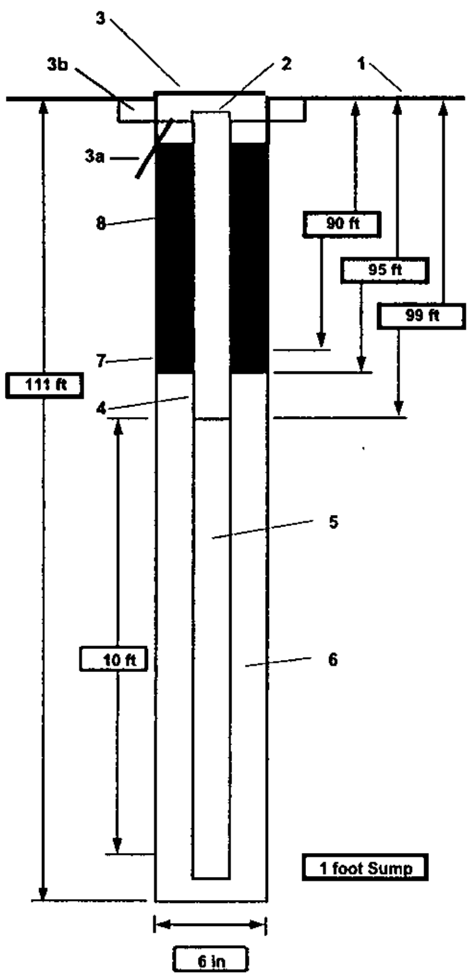
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 05/05/2002 END: 05/05/2002 LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 40-slot Schedule 40 PVC
6- Type screen filter	Sand, 1 ft of DSI #2 on top of 3 ft of Global #4
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol of well casing grout	
Development method	Surge and remove sediment with stainless ste bailer. Developed using submersible pump.
Development time	3 hour
Estimated purge volume	250 gallons
Comments	Total Depth (BGS) = 110 feet

Final field parameters collected during well development (/ /)

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 262

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-7

SOIL BORING LOG

PROJECT : EBT Treatability Study   LOCATION : Memphis Depot

ELEVATION :   DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS :   START : 05/05/2002   END: 05/05/2002   LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
0					Gravel (parking lot)	
					Silt, brown, moist, loess, stiff	
		100				0.0
5						
						0.0
10		100				
					Same as above	
						0.0
15						
					Sandy clay, (some silt), brown grading to tan, dense, red and grey sandy clay inclusions, stiff, moist	
						0.0
20		100				
						0.0
25						
					Clayey sand, red, fine grained, firm, moist	
						0.0
30		100				
					Sand (slight gravel), dark red, fine grained, well sorted, moist, firm to loose	Driller's sample bag: 151.0 Ziplock: 0.0
35						
					Clay, pink with light gray mottles, stiff, dense	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-7

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/05/2002 END: 05/05/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
						Driller's sample bag: 83.0 Ziplock: 0.0
40		100				
					Sand, golden to light yellow, fine grained, well sorted, loose, moist	
						Driller's sample bag: 172.0 Ziplock: 0.0
45						
					Gravel Sand, brownish yellow, fine to coarse grained, poorly sorted, loose, gravel (<10%), subangular, <0.25 inches diameter	
						Driller's sample bag: 312.0 Ziplock: 0.0
50		100				
					Sand, light yellow, fine grain, well sorted, loose	
						Driller's sample bag. 223.0 Ziplock 0.0
55						
					Gravelly Sand, brownish yellow, fine to medium grain, poorly sorted, pebbles (<20%), subangular, <0.25 inches diameter	
						Driller's sample bag: 188.0 Ziplock: 0.0
60		100				
					Sand, brownish yellow, fine grain, well sorted, loose	
					Gravelly Sand, brownish yellow, fine to medium grained, poorly sorted, loose pebbles (10-20%), <0 5 inches diameter	
					Sand, brownish yellow, fine to medium grain, well sorted, loose	Driller's sample bag 129.0 Ziplock: 0.0
65						
						Driller's sample bag: 184.0 Ziplock: 0.0
70		100				
					Gravelly sand, brownish yellow, fine to coarse grained sand, subangular pebbles (<30%), < 1 inch diameter	
						Driller's sample bag 195.0 Ziplock: 0.0

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-7

SOIL BORING LOG

PROJECT : EBT Treatability Study | LOCATION : Memphis Depot
ELEVATION : | DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : | START : 05/05/2002 | END: 05/05/2002 | LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Gravelly sand, same as above, brownish yellow	
						Driller's sample bag: 150.0 Ziplock: 0.0
80		100				
						Driller's sample bag. 143.0 Ziplock: 0.0
					Gravelly sand, same as above, brownish yellow	
85						
						Driller's sample bag: 113.0 Ziplock: 0.0
90		100				
						Driller's sample bag: 41.0 Ziplock: 0.0
95						Watertable @ approximately 93 feet bgs
					Gravelly sand, same as above, brownish yellow	
100						
105		100				
					Gravelly sand, same as above, brownish yellow	
110					Clay, yellowish brown, dense, moist, stiff	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-7

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/05/2002 END: 05/05/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above, Clay	
115					Boring terminated at 115 ft bgs	
120						
125						
130						
135						
140						

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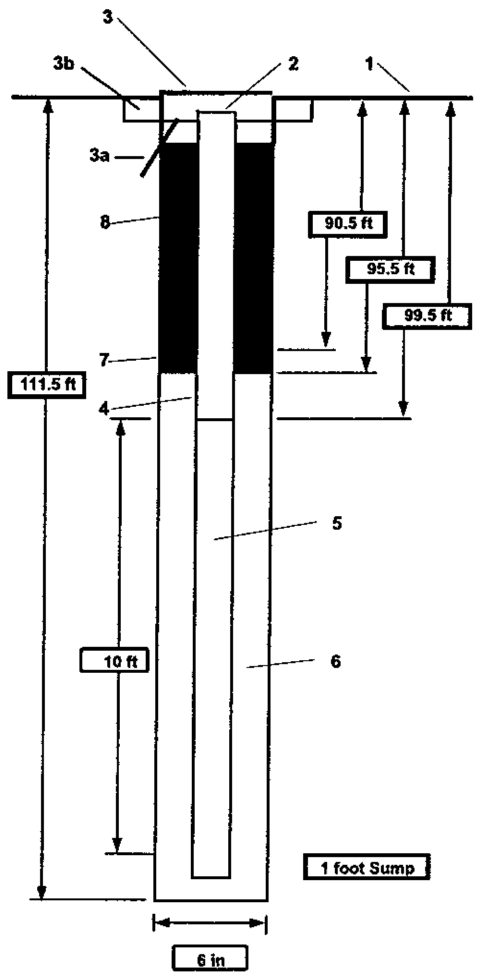
PROJECT NUMBER	WELL NUMBER	
170039	IW-7	SHEET 1 OF 1

CH2MHILL

WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/05/2002 END: 05/06/2002 LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 40-slot Schedule 40 PVC
6- Type screen filter	Sand, 1 ft of DSI #2 on top of 3 ft of Global #4
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	. bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol of well casing grout	
Development method	Surge and remove sediment with stainless ste bailer. Developed using submersible pump.
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 110.5 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Asphalt and gravel	
		100			Silt, brown, stiff, loess	0.0
5						
						0.0
10		100				
						0.0
15						
						0.0
20		100				
					Sand, orange, fine grained, loose, dry	0.0
					Silty Sand, reddish brown, fine to medium grained, poorly sorted, stiff	
25					Silty Sand, fine to medium grained, poorly sorted, stiff, dry	
						0.0
30		100				
						0.0
35						

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

ELEVATION : — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/30/2002 — END : 05/01/2002 — LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm)
					Sand, yellow, fine to medium grained, poorly sorted, loose, dry	0.0
40		100				
					Silty Clay, tan, stiff, dry	
					Sand, yellow, fine to coarse grained, poorly sorted, loose, dry	0.0
45						
					Sand, yellow to tan, fine to coarse grained, poorly sorted, some gravel, pebbles to cobble, loose, dry	
						11.2
50		100				
						0.0
55						
					Sand, orange, fine to coarse grained, gravel, pebbles to cobbles, loose, damp	
		100			Sand, reddish orange, fine to coarse grained, poorly sorted, loose, damp	0.0
60						
					Same as above	
		100			Sand, white, fine to coarse grained, poorly sorted, gravel, loose, damp	0.0
					Sand, white, fine grained, loose, dry	
65						
						0.0
70		100				
					Silty Sand, dark gray, fine grained, loose	
					Sand, white, fine grained, loose, dry	0.0
					Sandy Silty Clay, tan to red, fine grained, stiff, dry	
					Sand, white, loose, fine grained, dry	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm).
75					Clay, tan with light orange mottling, stiff, massive, damp	
						0.0
80		100				
						0.0
					Silty Sand, tan, fine grained, well sorted, damp	
85					Sand, white, fine grained, loose, dry	
						0.0
90		100				
						0.0
95					Sand, gray, fine grained, loose, wet	
					Sandy Clay, tan, stiff, wet	Water table @ 96 ft bgs
					Sand, gray, fine grained, loose, wet	
					Sand, orange, fine to coarse grained, gravel, wet	
100		100			Clay, some silt, stiff, gray, mottling, massive, wet	
105					Boring terminated at 105 ft bgs	
110						

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
115						
120						
125						
130						
135						
140						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
145						
150						
155						
160						
165						

794 272

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study　　LOCATION : Memphis Depot

ELEVATION :　　DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS :　　START : 04/30/2002　　END: 05/01/2002　　LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
170						
175						
180						
185						
190						
195						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
200						
205						
210						
215						
220						

794 274

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-106

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/17/2002 END: 04/18/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Asphalt and Gravel	0.0
		100			Brownish red, silty, clay	
5					Same as above	0.0
10		100			Same as above	0.0
15					Same as above	0.0
20		100			Sand, reddish orange, fine grain, well sorted	0.0
25					Sandy silt, some clay, white/grey mottled, stiff	
					Silty sand, orange, fine grain, well sortec	0.0
					Sand, red, fine to medium grain, poorly sorted, small pebbles	
30		100			Same as above	0.0
					Sand, orange, fine to medium grain, poorly sortec	
35					Sand, brown red, fine grain, well sorted	0.0
					Sand, yellow, well sorted, fine grain	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-106

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/17/2002 END: 04/18/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above except reddish orange	
40		100				
					Sand, tan, fine grain, well sorted	0.0
					Sand, orange yellow, fine to medium grain, poorly sorted, loose	
					Same as above except brown	
					Sand, orange, fine grain, well sorted, loose, dry	
					Sand, white, fine to medium grain, poorly sorted, loose	
					Same as above except orange	
45						
					Same as above except orange with gravel up to 0.5 inch diameter	0.0
					Same as above except white	
50		100				
					Sand, white, fine to medium grain, poorly sorted, loose, pebbles	12.1
					Sand, tan, fine to medium grain, poorly sorted, loose gravel up tp 0.25 inch diameter	
					Sand, orange, fine to medium grain, poorly sorted, loose	
					Sand, white, fine to medium grain, poorly sorted, loose, gravel up to 0.25 inch diameter	
55					Sand, orange, fine to medium grain, poorly sorted, loose, pebble to cobbles	
					Same as above except tan	0.0
					Same as above except orange	
60		100				
					Sand, interbedded tan and orange, fine to coarse grain, poorly sorted, gravel up to 0.5 inch diameter	0.0
65						
					Sand, tan, fine grain, well sorted	0.0
70		100				
					Same as above	0.0
					Sand, tan, fine to medium grain, poorly sorted, gravel up to 0.25 inch diameter	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-106

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/17/2002 END: 04/18/2002 LOGGER : Mike Karafa

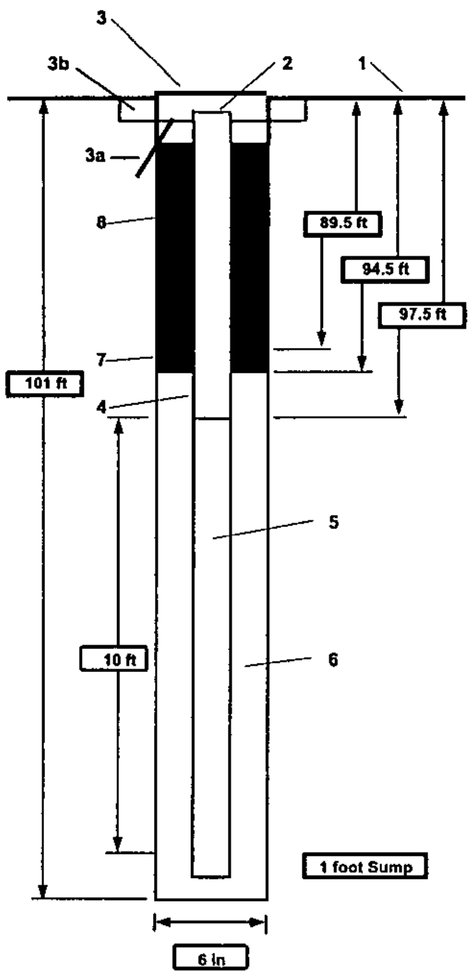
DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Sand, tan, fine grain, well sorted, loose	0.0
					Sand, orange, fine to medium grain, poorly sorted, gravel pebble to cobble 2 inch reddish brown layer, sand, fine to medium grain, up to 0.25 inch gravel	
					Sand, tan, fine to medium grain, poorly sorted, loose, pebble to cobble gravel, damp	
80		100			Same as above except orange	0.0
					Sand, tan to light grey, fine grain wet	
					Silty clay, orange, thin grey mottling, wet	
85					Sand, tan, fine grain, gravel up to 1 inch, wet	0.0
					Same as above except wet	
90		100			Sand, grey, fine to medium grain, gravel up to 1 inch, dam[p]	
95					Sand, some clay, fine to coarse grain, gravel, wet	0.0
						Water table @ 96 ft bgs
					Sand, orange, fine grain, damp	
100					Sand, orange, fine to coarse grain, gravel pebble to cobble size, wet	
					Silty clay, orange and grey mottling, wet	
		100			Silty sand, some clay, stiff, wet	
105					Sand, orange, some clay, fine grain, wet	
					Clay, dark grey, massive	
110					Boring terminated at 110 ft bgs	

CH2MHILL

PROJECT NUMBER	WELL NUMBER
170039	MW-106 SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : — START : 04/17/2002 — END: 04/17/2002 — LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	Surge and develop with stainless steel bailer to remove sediment. Submersible pump
Development time	8.3 hour
Estimated purge volume	42.5 gallons
Comments	Total Depth (BGS) = 100 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 278

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-109

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

ELEVATION : — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 05/01/2002 END: 05/02/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Asphalt and gravel	
		100			Silt, stiff, brown	0.0
5						
						9.1
10		100				
						5.4
15						
						0.0
20		100				
					Silty Sand, red, fine to medium grained, poorly sorted, loose	0.0
					Sandy Clay, reddish brown, fine grained, stiff, damp	
25					Sand, some silt, bright red, fine to medium grained, poorly sorted, stiff, dry	
		100				0.0
30						
		100				4.3
					Sand, red, fine to medium grained, poorly sorted, loose	
35					Silty Sand, red to brown, fine to medium grained, poorly sorted, stiff, damp	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-109

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/01/2002 END: 05/02/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Sand, orange yellow, fine grained, well sorted, loose	11.3
40		100				
					Sand, orange, fine to coarse grained, poorly sorted, loose, some gravel	16.2
45					Same as above except orange and yellow	
						0.5
50		100				
						0.8
55					Same as above, no gravel	
		100				0.0
60					Sand, tan, fine to coarse grained, poorly sorted, gravel, pebbles to cobbles, loose, dry	
		100			Sand, light yellow, fine grained, loose, dry	0.0
65					Sand, light yellow to orange, fine grained, well sorted, loose, dry	
						4.7
70		100				
						0.0

794 280

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-109

SOIL BORING LOG

PROJECT : EBT Treatability Study | LOCATION : Memphis Depot
ELEVATION : | DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : | START : 05/01/2002 | END 05/02/2002 | LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Sand, tan, fine to medium grained, loose, damp, some gravel	
						0.0
80		100			Sand, tan, fine grained, loose, dry	
					Sand, orange, fine to coarse grained, loose, dry	0.0
					Same as above, gravel, pebble to cobble	
85					Sand, white, fine grained, loose, dry	
					Same as above, orange	0.0
90		100				
					Sand, orange, fine to coarse grained, poorly sorted, loose, gravel, damp	0.0
					Sand, light tan, fine to coarse grained, poorly sorted, damp, pebble to cobbl	
95					Sand, some silt, tan, fine grained, stiff wet	
					Sand, tan, fine to medium grained, poorly sorted, loose, gravel, wet	Water table @ 96 ft bgs
					Silty Clay, tan, orange mottled, stiff, wet	
					Sand, gray, fine grained, well sorted, loose, wet	
100		100				
					Sand, brown, fine to medium grained, poorly sorted, loose, wet, gravel, pebble to cobble, subangular to subrounded	
					Clay, some silt, gray and orange mottling, massive, stiff, we	
105					Boring terminated at 105 ft bgs	
110						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-109	SHEET 1 OF 1

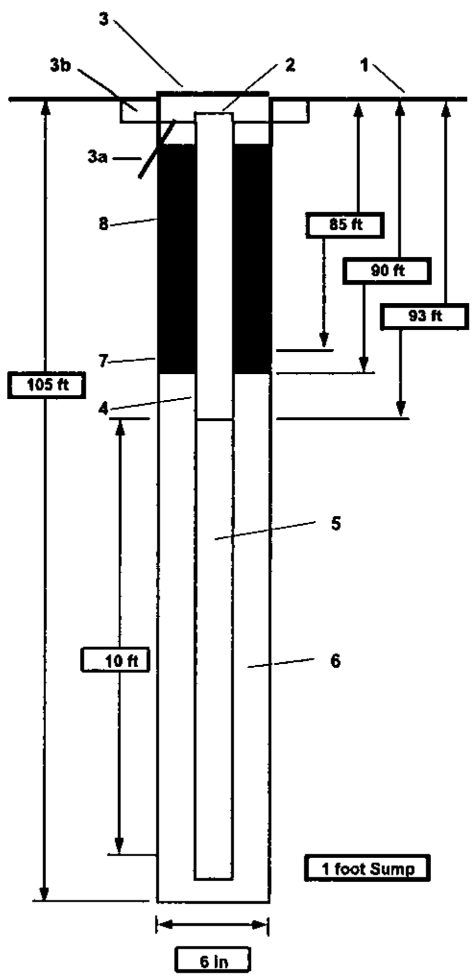
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/17/2002 — END: 04/17/2002 — LOGGER : Mike Karafa



Note: Diagram not to scale.

1-	Ground elevation at well	feet MSL
2-	Top of casing elevation	feet MSL
3-	Wellhead protection cover type	Flush-mount wellhead pad
	a) drain tube?	No
	b) concrete pad dimensions	3 by 3 feet
4-	Dia./type of well casing	2 inch Schedule 40 PVC
5-	Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6-	Type screen filter	Sand, DSI #2
	a) Quantity used	bags
7-	Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
	a) Quantity used	bags
8-	Grout	
	a) Grout mix used	90% grout / 10% bentonite powder
	b) Method of placement	Tremmie Method
	c) Vol of well casing grout	
	Development method	
	Development time	hour
	Estimated purge volume	gallons
	Comments	Total Depth (BGS) = 104 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 282

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-110

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/03/2002 END: 05/04/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Asphalt and gravel	
		100			Silt, brown, stiff (loess)	0.0
5						
						0.0
10		100				
						0.0
15						
						0.0
20		100				
						0.0
					Sand, orange, fine grained, loose, dry	
25					Silty Sand, red, fine to medium grained, poorly sorted, damp	
						1.2
30		100				
						0.0
35						

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-110

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/03/2002 END: 05/04/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Sand, yellow and orange, fine to coarse grained, poorly sorted, loose, dry	17.9
40		100				
						0.0
45					Silty Sand, some clay, brown, soft, fine to medium grained, poorly sorted, damp	
					Sand, orange, fine to coarse grained, poorly sorted, loose, dry, grave	
		100				7.8
50					Sand, tan to white, fine to medium grained, poorly sorted, loose, dry	
		100			Sand, tan to orange, fine to coarse grained, poorly sorted, loose, gravel, dry, pebbles to small cobbles	0.7
55					Sand, orange, fine to medium grained, poorly sorted, loose, dry	
		100				0.5
60					Sand, white and tan, fine to coarse grained, poorly sorted, gravel, pebble, subangular, damp	
		100				0.0
					Sand, white, fine grained, well sorted, loose, dry	
65					Sand, tan to orange, fine grained, well sorted, dry	
						14.4
					Silty Clay, gray, black and orange layering, fine grained, stiff, dry	
70		100				
					Sand, white to orange, fine grained, well sorted, loose dry	
					Silty Clay, some sand, tan, stiff, dry	0.0
					Sand, orange, fine grained, loose dry	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-110

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/03/2002 END: 05/04/2002 LOGGER : Mike Karafa

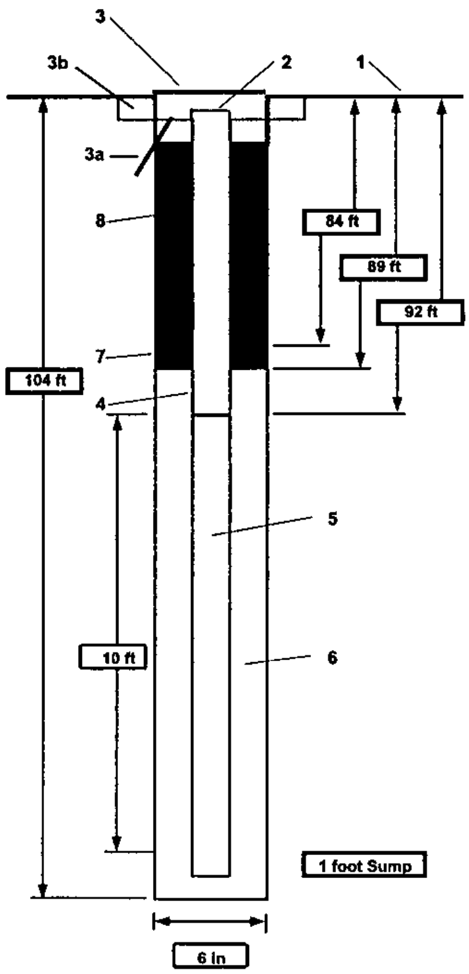
DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75	75-85				Sand, yellow to tan, fine grained, well sorted, loose, dry	
					Sand, white to tan, fine to coarse grained, poorly sorted, gravel, dr	0.0
80		100			Silty Clay, tan, fine grained, stiff, wet, gravel	
						0.5
85	85-90				Sand, fine grained, orange, well sorted, loose, dry	
		100			Silty Clay, tan, fine grained, stiff, wet, gravel	0.0
90	90-95				Sand, white to tan, loose, fine grained, dry	
		100			Sand, brown to orange, fine to coarse grained, poorly sorted, loose, gravel, pebble to cobble	0.0
95	95-105				Sand, white, fien grained, well sorted, loose, wet gravel	
					Sandy Silt, some clay, orange, stiff, fine grained, we	Water table @ 96.5 ft bgs
					Sand, white, fine grained, loose, wet gravel	
					Same as above, gravel percentage increasing with depth	
100		100				
					Clay, some silt, gray with orange mottling, stiff, wet, massiv	
105					Boring terminated at 105 ft bgs	
110						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-110	SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/04/2002 END: 05/04/2002 LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 103 feet

Final field parameters collected during well development (/ /)

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-111

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/22/2002 END: 04/23/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Asphalt and gravel	
		100			Silt, brown, stiff, damp, (loess)	0.0
5						
						1.5
10		100				
					Same as above, Silt	11.4
15						
						0.0
20		100				
						0.8
					Same as above, Silt	
25						
		100			Sand, orange, loose, fine grained	
		100			Silty Sand, reddish orange, fine to medium grained, stiff	10.5
30		100				
					Sand, bright red, fine to coarse grained, poorly sorted, stiff	0.0
		100			Sand, tan, fine grained, loose, damp	
					Sand, tan with red mottles, fine to medium grained, poorly sorted, stiff	
35						
					Sand, orange, fine to coarse grained, poorly sorted, loose, dry	
					Sand, dark brown, fine to medium grained, stiff, damp	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-111

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/22/2002 END: 04/23/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Sand, grayn very fine grained, loose, dry	
						0.0
					Sand, fine to medium grained, poorly sorted, loose, dry, some silt	
40		100				
					Sand, red, fine to medium grained, poorly sorted, stiff, some silt	
						0.0
					Sand, orange, fine to coarse grained, poorly sorted, loose, dry, pebbles	
45						
						0.0
50		100				
					Sand, tan, fine to medium grained, poorly sorted, loose, dry, slight gravel	
						0.0
55						
					Sand, orange, fine to coarse grained, poorloy sorted, loose, gravel, dry	
						0.0
60		100				
					Sand, tan, fine to medium grained, loose, poorly sorted, gravel	
						0.0
					Sand, tan, fine grained, loose dry, well sorted	
65						
					Sand, brown, fine to medium grained, loose, dry, poorly sorted	
					Sand, light tan, fine grained, loose, dry, well sorted	
						18.3
70		100				
					Sand, yellow, fine grained, well sorted	
					Silty Sand, some clay, gray/orange/red, fine grained, interbedding, stiff, damp to dry	
						0.0

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-111

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/22/2002 END: 04/23/2002 LOGGER : Mike Karafa

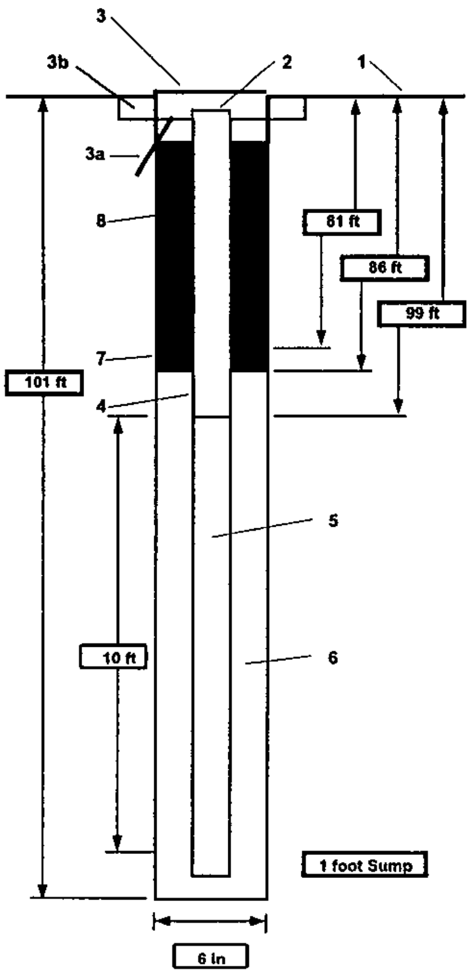
DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75	75-85	100			Sand, yellowish orange, fine grained, well sorted, loose dry Sand, orange and tan, fine to medium grained, poorly sorted, pebble to cobble, well rounded to angular, loose, dry	0.0
80					Clayey Silt, brown, fine grained, stiff,wet	0.0
85	85-95	100			Sand, white, fine grained, well sorted, loose,dry Sand, dark grey, fine grained, well sorted, loose, dry	0.0
90					Sand, orange to tan, fine grained, well sorted, loose, dry Same as above with gravel, pebble to cobble	0.0
95	95-105	100			Sand, brown, fine to coarse grained, poorly sorted, gravel, pebble to cobble, subangular to subrounded, loose Wet Sand, gray to white, fine grained, well sorted, subangular to subrounded, loose wet	Watertable @ approximately 96 feet bgs
100					Clay, some silt, gray with red mottling, stiff, massive	
105					Boring Terminated @ 105 feet bgs	
110						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-111	SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/22/2002 END: 04/23/2002 LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 100 feet

Final field parameters collected during well development (/ /)

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 290

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-112

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/21/2002 END: 04/21/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Asphalt and gravel	
		100			Silt, brown, stiff, damp, (loess)	0.0
5						
						6.9
10		100				
					Same as above, Silt	0.0
15						
						2.8
20		100				
					Same as above, Silt	0.0
					Sand, orange, fine grained, well sorted, dry	
25					Silty Sand, bright red, fine to medium grained, poorly sorted, stiff, damp	
		100				5.0
30						
		100				0.0
35						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-112

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/21/2002 END: 04/21/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above, Silty Sand	0.0
40		100			Silty Sand, brown, fine to medium grained, stiff, damp, poorly sorted	
					Silty Sand, red, fine grained, stiff, slightly damp	
					Sand, orange, fine grained, loose, dry	0.0
45					Sand, orange yellow, fine to coarse grained, poorly sorted, loose, gravel	
					Sand, tan, fine grained, well sorted, loose, dry	
		100			Sand, reddish orange, fine to coarse grained, poorly sorted, gravel and pebbles angular	0.0
50						
		100			Sand, tan, fine grained, loose, dry, well sorted	18.0
55						
		100				11.4
60					Sand, white to light tan, very fine grain, powdery, dry	
					Pebbles and cobbles from 61 to 62 feet bgs	
		100				1.6
65					Sand, tan, fine grained, well sorted, dry, loose	
		100				17.1
					Same as above except color changes from tan to orange	
70					Sand, fine to medium grained, poorly sorted, loose, dry	
		100				0.0
					Same as above, orange in color	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-112

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/21/2002 END: 04/21/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Sand, light gray, very fine grained, dry, loose	
					Sand, tan fine grained, well sorted, loose, dry	8.4
80		100			Sand, reddish tan, fine grained, loose, damp, pebbles to cobble, subangular	
					Sand, white to orange, fine to coarse grained, poorly sorted, pebble to cobble	
					Silty Sand, reddish tan, fine grained, trace gravel, soft damp	0.0
					Sandy Silt, reddish tan, mottled, stiff, fine grained, damp	
85					Sand, gray, fine grained, well sorted, loose, dry	
					Sand, tan, fine grained, well sorted, loose, dry	0.0
90		100			Sand, light tan, very fine grained, loose, dry, well sorted	
					Sand, orange, fine to medium grained, poorly sorted, gravel, pebble to cobble	17.8
95					Sand, gray to tan, fine to medium grained, poorly sorted, loose, wet	Watertable @ approximately 96 feet bgs
100		100			Clay with some silt, stiff, gray with red mottling, massive	
105					Boring Terminated @ 105 feet bgs	
110						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-112	SHEET 1 OF 1

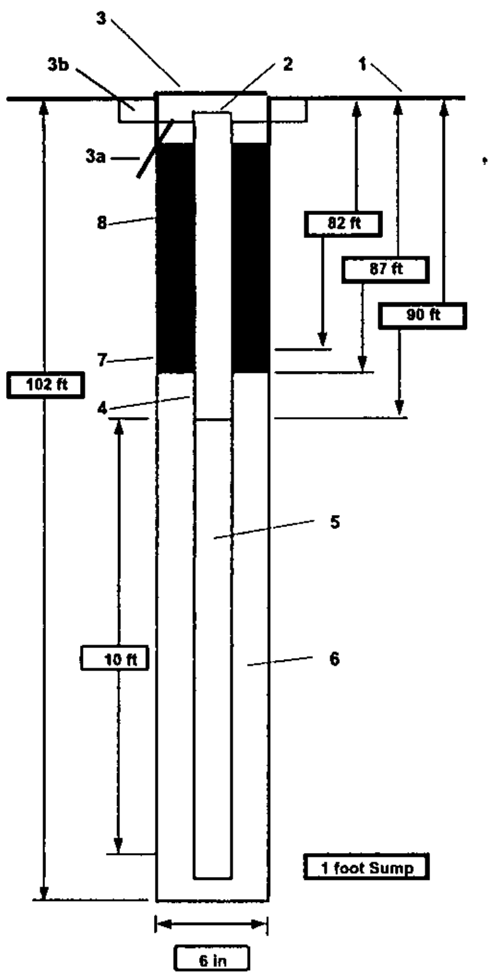
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/21/2002 — END: 04/22/2002 — LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 101 feet

Final field parameters collected during well development (/ /)

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 294

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study
LOCATION : Memphis Depot
ELEVATION :
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS :
START : 04/17/2002
END: 04/17/2002
LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Clay, brown, massive, very stiff, dry	
		100				
						5.0
5						
					Silty Clay, brown, stiff, organic material, damp	
						5.0
10		100				
					Silty Clay, brown, stiff, damp	
						0.0
15						
						0.0
					Sandy Clay, fine to coarse grained sand soft	
20		100				
					Sandy Clay, brown to reddish brown, very stiff, damp	
						0.0
25						
						0.0
					Sandy, Silty Clay, reddish browndf, with gray and yellow mottles, stiff fine to medium grained,	
30		100				
					Same as above, becomes red	
						0.0
35						
					Sand, gray to yellowish brown	
					Clay, brown, stiff, organic material	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot
ELEVATION : — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : — START : 04/17/2002 — END: 04/17/2002 — LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Sand (@37 ft), reddish brown, fine grained	0.0
					Sand, yellowish brown to tan, fine grained	
40		100				
					Sand, brown to reddish/yellowish brown, fine to medium grained, dry to moist, soft to loose	
						0.0
45						
						0.0
50		100				
					Sand, brown to yellowish brown, fine to medium grained, soft, gravel (<1 inch diam)	
					Sand, yellowish brown to buff, fine grained, gravel (15%)	
					Clayey Sand, orange brown, stiff, some gravel	16.2
					Gravelly Sand, gray/buff/brown, gravel (<1inch diam), subangular, soft, some thin clay lenses	
55						
					Gravelly Sand, brown/gray/buff/yellowish brown, fine grained, gravel (<1inch diam) subangular to subrounded @ 56 feet bgs, 3 inch zone of gravel	
						0.0
60		100				
					Sand, yellowish brown, fine to coarse grained, soft	
						0.0
					Sand, yellowish brown, fine grained, soft	
65						
						0.0
70		100				
					Same as above, Sand	
						0.0

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/17/2002 END: 04/17/2002 LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Clay, yellowish brown	
					Sand, yellowish brown, fine grained, soft	0.0
80		100			Sand, brown/grayish brown, fine to medium grained, cobbles (<30%), 2 inches diam.	0.0
85					Sand, grey/brown, fine grained, pebbles (3%), soft	0.0
90		100			Gravelly Sand, brown to grayish brown, medium grained, soft, dry	0.0
95					Sand, brown to grayish brown, fine to medium grained, soft, wet	Watertable @ approximately 96 feet bgs
					Same as above, some clay	
100		100			Gravelly Sand, tan, wet	
					Silty, Sandy Clay, orange brown to reddish brown, stiff, mottled	
105					Silty, Sandy Clay, orange brown to grey to light reddish brown, wet	
110		100			Clay, grey green, massive	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/17/2002 END: 04/17/2002 LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above, Clay	
115					Boring Terminated @ 115 feet bgs	
120						
125						
130						
135						
140						

794 298

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/17/2002 END: 04/17/2002 LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
145						
150						
155						
160						
165						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/17/2002 END: 04/17/2002 LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
170						
175						
180						
185						
190						
195						

794 300

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/17/2002 END: 04/17/2002 LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
200						
205						
210						
215						
220						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	IW-3	SHEET 1 OF 1

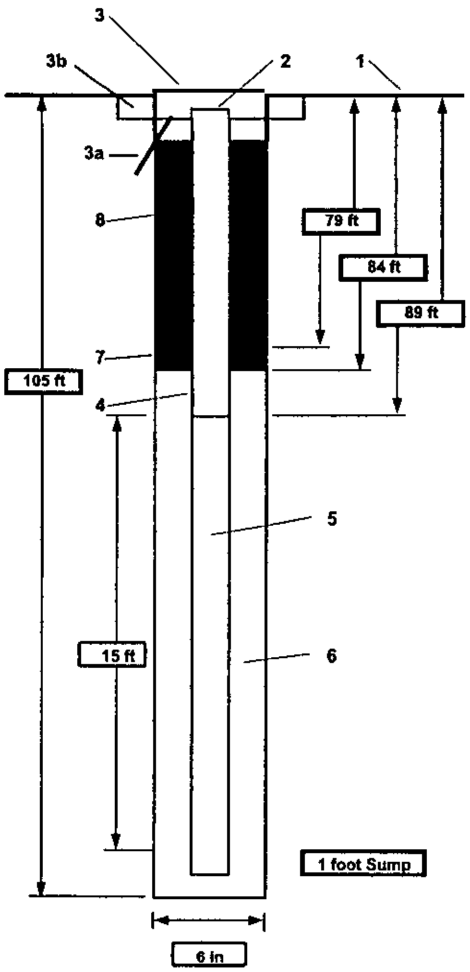
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/20/2002 — END: 04/21/2002 — LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 40-slot Schedule 40 PVC
6- Type screen filter	Sand, 1 ft of DSI #2 on top of 3 ft of Global #4
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	Surge and develop with stainless steel bailer
Development time	5.5 hour
Estimated purge volume	16 gallons
Comments	Total Depth (BGS) = 104 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 302

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-4

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

ELEVATION : — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/15/2002 — END: 04/16/2002 — LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
		100			Asphalt and gravel	
					Silt, brown, stiff, loess	2.5
5		100				3.1
10					Same as above, Silt	10.1
15		100				3.3
20					Same as above, Silt	
					Sand, orange, fine to medium grained, loose	0.0
25		100			Sandy Silt, brown	
					Sand, orange, fine to medium grain, with silt, small less then 0.25 inch gravel	0.0
					Silty sand, red, dry, stiff, fine grain, up to 0 5 inch gravel, 1/8 inch tan sand and up to 0.5 inch laminations	
30					Sand, silt, orange to red, fine to medium grained, moist	0.0
35		100			Same as above	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-4

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/15/2002 END: 04/16/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm).
					Sand, orange, fine grain, loose	0.0
40					Sand, yellow to light yellow, medium grain, loose	
					Sand, orange, medium grained, with less then 1/8 inch yellow and tan fine grain laminations	
45		100			Sand, silty, red, stiff	0
					Sand, interbedded, yellow and light yellow, medium grain, up to 0 5 inch gravel	
					Sand, tan to white, medium grained, up to o.5 inch grave	0.0
50					Sand, yellow, medium grained, less then 1 inch gravel	
					Sand, orange, fine to medium grained, less then 1 inch gravel decreasing towards 60 feet	0.0
55		100			Sand, orange, fine to medium grain, up to 0.25 inch gravel	
						0.0
60					Same as above except brown in color	
					Silty sand, red, fine grained, stiff, 0.5 inch thick	
					Sand, tan, fine to medium grain, 6 inch thick orange medium grain sand	0.0
					Sand, tan to white, medium grain, up to 0.5 inch gravel throughout	
65		100			Sand, orange, fine grain, well sorted	
					Sand, white to tan, fine grain, well sorted	
					Sand, tan, fine grain, well sorted	0.0
70					Same as above except orange	
						0.0

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-4

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/15/2002 END: 04/16/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75		100			Same as above	
					Sand, brown, medium grain, poorly sorted, with up to 0.5 inch grave	
					Sand, tan, fine grained, pebbles to cobble:	0.0
					Sand, orange, fine grain, well sorted, with fine grain white sand laminations	
80					Same as above	
					Sandy clay, some silt, brown, damp	0.0
85		100			Sand, orange, medium grain, poorly sorted, damp, grave	
					Sand, white, fine grain, well sorted	
90		100			Sand, white, fine grain, well sorted, a few up to 0.25 inch gravel	
					Sand, orange, fine grain, well sorted graded to a tan sand, fine to poorly sorted, grave from pebble to cobble size, damp	0.0
95		100			Sand, white, fine grain, well sorted, interbedded with silty clay	
					Sand, white, well sorted, fine grain	
					Sand, tan, fine to medium grained, poorly sorted, pebble to cobble size gravel, wet	Watertable @ approximately 97 feet bgs
100					Clay, light grey, stiff at 101 feet 1 inch layer of lithics and quartz gravel	
					Silty sand, orange, fine grain, well sorted	
					Sand, white, fine grain, well sorted, interbedded with 1mm tan silty clay, dam	
105		100			Clay, dark grey, massive, stiff, little silt, damp	
110						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-4

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/15/2002 END: 04/16/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION Corrected FID (ppm):
115					Boring terminated at 115 feet bgs.	
120						
125						
130						
135						
140						

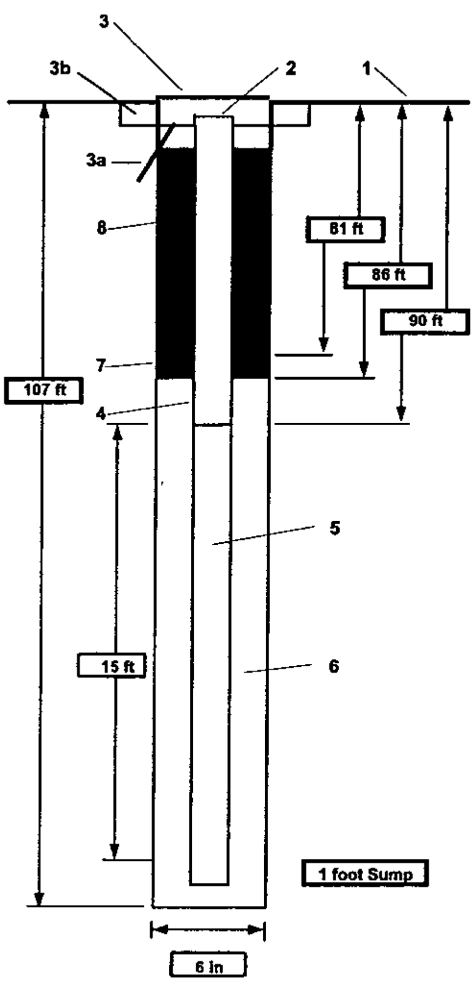
794 306

PROJECT NUMBER 170039	WELL NUMBER IW-4	SHEET 1 OF 1

CH2MHILL

WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : — START : 04/15/2002 — END: 04/16/2002 — LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 40-slot Schedule 40 PVC
6- Type screen filter	Sand, 1 ft of DSI #2 on top of 3 ft of Global #4
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 106 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-5

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

ELEVATION : — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/18/2002 — END: 04/19/2002 — LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm) *(Soil headspace)*
					Gravel (parking lot)	
		100			Silt, brown, moist, loess, stiff	0.0
5						0.0
10		100				0.0
					Same as above	
15						0.0
20		100				0.0
					Silt, brown, slight fine sand	
					Sandy clay, (some silt), brown grading to tan, dense, red and grey sandy clay inclusions	
25						0.0
30		100			Same as above, increase of fine sand, tan	
					Clayey sand, tan increase of fine sand, firm	0.0
					Sand, tan, fine grain, well sorted, moist, loose	
35						
					Clay, light grey with maroon mottles, dense, stiff	0.0

794 308

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-5

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/18/2002 END: 04/19/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Clay same as above	
					Sand, golden to light yellow, fine grain, well sorted, loose	
40		100				14.1
					Sand, brownish yellow, fine to medium grained poorly sorted, loose	
45					Sand, brownish, yellow, fine to coarse grained, poorly sorted, loose, gravel (<10%) subangular, <0.25 inches diameter	0.0
50		100				
					Sand, fine grain, well sorted, light yellow, loose	140.2 @52.3 ft bgs
55					Sand, fine to medium grain, poorly sorted, brownish yellow, pebbles (<20%), subangular <0.25 inches diameter	
						100.4 @57.5 ft bgs
60		100			Sand, brownish yellow, fine grain, well sorted, loose	
					Sand, brownish yellow, fine to medium grained, poorly sorted, loose gravel (10-20%), <0.5 inches diameter	
					Sand, brownish yellow, fine to medium grain, well sorted, loose	65 @62.5 ft bgs
65						
					Gravelly sand, poorly sorted, pebbles (20-30%) <1 inch diameter, loose	38.0
					Sand, brownish yellow, fine to medium grain, well sorted, loose	
70		100				
					Gravelly sand, brownish yellow, fine to coarse grained sand, subangular pebbles (30-40%), < 1 inch diameter	110.4

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-5

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/18/2002 END: 04/19/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm).
75					Gravelly sand, same as above, brownish yellow	176
80		100				1476
85						165
90		100				306.0
95						Wet @ 95 ft bgs
100		100				
105						
					Sandy clay, light grey, wet, firm	
110		100			Gravelly sand, brownish yellow, fine to coarse grain, poorly sorted, loose	

794 310

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-5

SOIL BORING LOG

PROJECT : EBT Treatability Study | LOCATION : Memphis Depot

ELEVATION : | DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : | START : 04/18/2002 | END: 04/19/2002 | LOGGER : Bryan Burkingstock

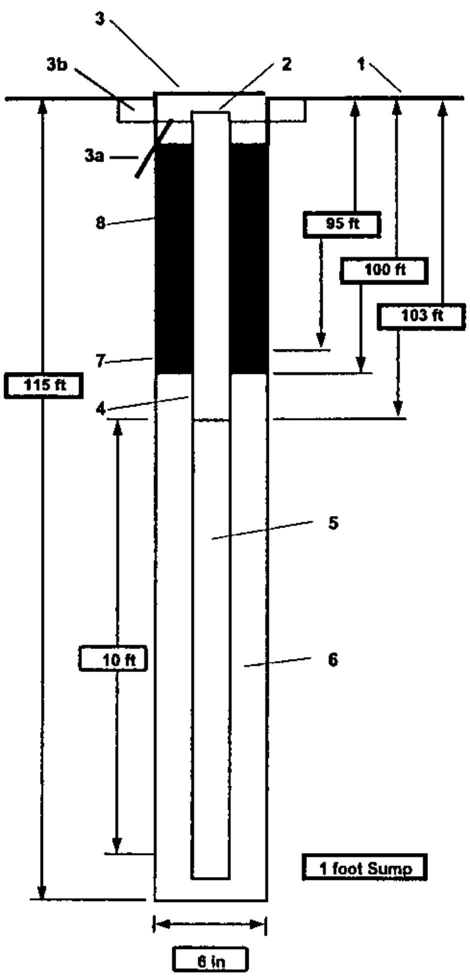
DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above	
					Clay, yellowish brown, dense, moist, stiff	
115						
					Color change from yellowish brown to yellowish grey to dark grey.	
120						
		100				
125						
130					Boring terminated at 130 ft bgs	
135						
140						

PROJECT NUMBER	WELL NUMBER	
170039	IW-5	SHEET 1 OF 1

CH2MHILL

WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : — START : 04/19/2002 — END: 04/19/2002 — LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 40-slot Schedule 40 PVC
6- Type screen filter	Sand, 1 ft of DSI #2 on top of 3 ft of Global #4
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	Surge and remove sediment with stainless ste bailer. Developed using submersible pump.
Development time	3 hour
Estimated purge volume	250 gallons
Comments	Total Depth (BGS) = 114 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

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PROJECT NUMBER	WELL NUMBER	
170039	IW-6	SHEET 1 OF 1

CH2MHILL

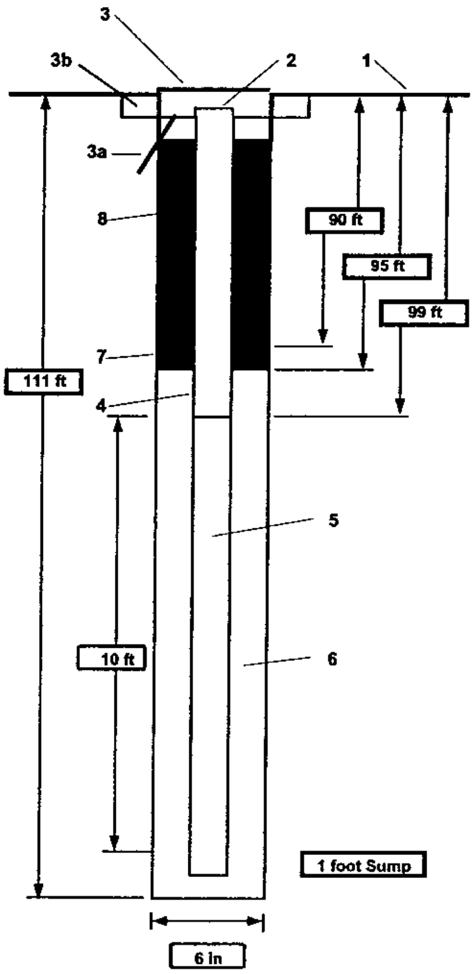
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 05/05/2002 — END: 05/05/2002 — LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 40-slot Schedule 40 PVC
6- Type screen filter	Sand, 1 ft of DSI #2 on top of 3 ft of Global #4
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	Surge and remove sediment with stainless ste bailer. Developed using submersible pump.
Development time	3 hour
Estimated purge volume	250 gallons
Comments	Total Depth (BGS) = 110 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-7

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/05/2002 END: 05/05/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
0					Gravel (parking lot)	
		100			Silt, brown, moist, loess, stiff	0.0
5						
						0.0
10		100			Same as above	
						0.0
15					Sandy clay, (some silt), brown grading to tan, dense, red and grey sandy clay inclusions, stiff, moist	
						0.0
20		100				
						0.0
25					Clayey sand, red, fine grained, firm, moist	
						0.0
30		100				
					Sand (slight gravel), dark red, fine grained, well sorted, moist, firm to loose	Driller's sample bag 151.0 Ziplock: 0.0
35					Clay, pink with light gray mottles, stiff, dense	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-7

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 05/05/2002 END: 05/05/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
						Driller's sample bag: 83.0 Ziplock: 0.0
40		100			Sand, golden to light yellow, fine grained, well sorted, loose, moist	
						Driller's sample bag: 172.0 Ziplock: 0.0
45					Gravel Sand, brownish yellow, fine to coarse grained, poorly sorted, loose, gravel (<10%), subangular, <0.25 inches diameter	
						Driller's sample bag. 312.0 Ziplock: 0.0
50		100				
					Sand, light yellow, fine grain, well sorted, loose	Driller's sample bag 223.0 Ziplock: 0.0
55					Gravelly Sand, brownish yellow, fine to medium grain, poorly sorted, pebbles (<20%), subangular, <0.25 inches diameter	
						Driller's sample bag 188.0 Ziplock: 0.0
60		100			Sand, brownish yellow, fine grain, well sorted, loose	
					Gravelly Sand, brownish yellow, fine to medium grained, poorly sorted, loose pebbles (10-20%), <0.5 inches diameter	
					Sand, brownish yellow, fine to medium grain, well sorted, loose	Driller's sample bag: 129.0 Ziplock: 0.0
65						
						Driller's sample bag: 184.0 Ziplock: 0.0
70		100				
					Gravelly sand, brownish yellow, fine to coarse grained sand, subangular pebbles (<30%), < 1 inch diameter	Driller's sample bag 195.0 Ziplock: 0.0

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-7

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION :
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/05/2002 END : 05/05/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Gravelly sand, same as above, brownish yellow	
						Driller's sample bag: 150.0 Ziplock: 0.0
80		100				
						Driller's sample bag: 143.0 Ziplock: 0.0
					Gravelly sand, same as above, brownish yellow	
85						
						Driller's sample bag. 113.0 Ziplock: 0.0
90		100				
						Driller's sample bag 41.0 Ziplock: 0.0
95						Watertable @ approximately 93 feet bgs
					Gravelly sand, same as above, brownish yellow	
100						
105		100				
					Gravelly sand, same as above, brownish yellow	
110					Clay, yellowish brown, dense, moist, stiff	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	IW-7

SOIL BORING LOG

PROJECT : EBT Treatability Study   LOCATION : Memphis Depot
ELEVATION :   DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS :   START : 05/05/2002   END: 05/05/2002   LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above, Clay	
115					Boring terminated at 115 ft bgs	
120						
125						
130						
135						
140						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	IW-7	SHEET 1 OF 1

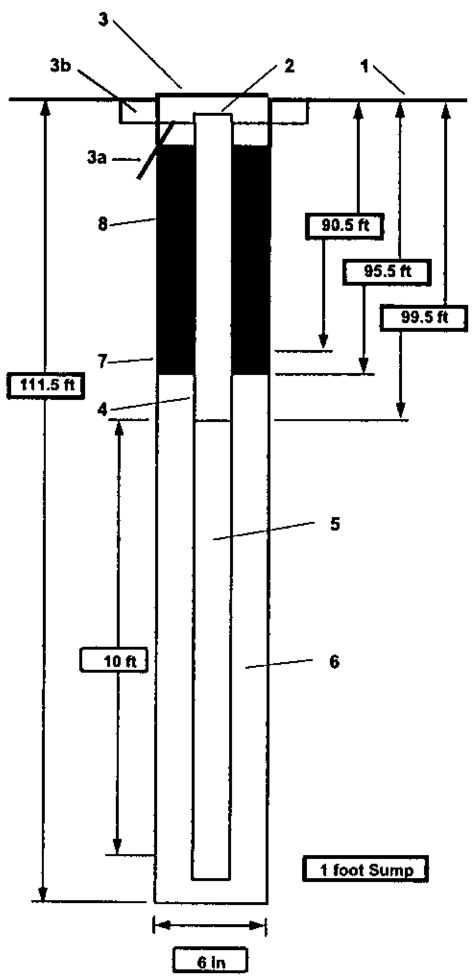
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 05/05/2002 — END: 05/06/2002 — LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 40-slot Schedule 40 PVC
6- Type screen filter	Sand, 1 ft of DSI #2 on top of 3 ft of Global #4
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	Surge and remove sediment with stainless ste bailer. Developed using submersible pump.
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 110 5 feet

Final field parameters collected during well development (/ /)

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Asphalt and gravel	
		100			Silt, brown, stiff, loess	0.0
5						
						0.0
10		100				
						0.0
15						
						0.0
20		100				
					Sand, orange, fine grained, loose, dry	0.0
					Silty Sand, reddish brown, fine to medium grained, poorly sorted, stiff	
25					Silty Sand, fine to medium grained, poorly sorted, stiff, dry	
						0.0
30		100				
						0.0
35						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm)
					Sand, yellow, fine to medium grained, poorly sorted, loose, dry	0.0
40		100				
					Silty Clay, tan, stiff, dry	
					Sand, yellow, fine to coarse grained, poorly sorted, loose, dry	0.0
45						
					Sand, yellow to tan, fine to coarse grained, poorly sorted, some gravel, pebbles to cobble, loose, dry	
						11.2
50		100				
						0.0
55						
					Sand, orange, fine to coarse grained, gravel, pebbles to cobbles, loose, damp	
		100			Sand, reddish orange, fine to coarse grained, poorly sorted, loose, dam	0.0
60						
					Same as above	
		100			Sand, white, fine to coarse grained, poorly sorted, gravel, loose, damp	0.0
					Sand, white, fine grained, loose, dry	
65						
						0.0
70		100				
					Silty Sand, dark gray, fine grained, loose	
					Sand, white, fine grained, loose, dry	0.0
					Sandy Silty Clay, tan to red, fine grained, stiff, dry	
					Sand, white, loose, fine grained, dry	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Clay, tan with light orange mottling, stiff, massive, damp	
						0.0
80		100				
					Silty Sand, tan, fine grained, well sorted, damp	0.0
85					Sand, white, fine grained, loose, dry	
						0.0
90		100				
						0.0
95					Sand, gray, fine grained, loose, wet	
					Sandy Clay, tan, stiff, wet	Water table @ 96 ft bgs
					Sand, gray, fine grained, loose, wet	
					Sand, orange, fine to coarse grained, gravel, wet	
100		100			Clay, some silt, stiff, gray, mottling, massive, wet	
105					Boring terminated at 105 ft bgs	
110						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
115						
120						
125						
130						
135						
140						

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study   LOCATION : Memphis Depot

ELEVATION :   DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 Inch sample casing / 6 inch outer casing)

WATER LEVELS :   START : 04/30/2002   END: 05/01/2002   LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
145						
150						
155						
160						
165						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
170						
175						
180						
185						
190						
195						

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-105

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
200						
205						
210						
215						
220						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-106

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot
ELEVATION : — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : — START : 04/17/2002 — END: 04/18/2002 — LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Asphalt and Gravel	0.0
		100			Brownish red, silty, clay	
5					Same as above	0.0
10		100			Same as above	0.0
15					Same as above	0.0
20		100			Sand, reddish orange, fine grain, well sorted	0.0
					Sandy silt, some clay, white/grey mottled, stiff	
25					Silty sand, orange, fine grain, well sortec	0.0
					Sand, red, fine to medium grain, poorly sorted, small pebbles	
30		100			Same as above	0.0
					Sand, orange, fine to medium grain, poorly sortec	
35					Sand, brown red, fine grain, well sorted	0.0
					Sand, yellow, well sorted, fine grain	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-106

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/17/2002 END: 04/18/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION — Corrected FID (ppm):
					Same as above except reddish orange	
40		100				
					Sand, tan, fine grain, well sorted	0.0
					Sand, orange yellow, fine to medium grain, poorly sorted, loose	
					Same as above except brown	
					Sand, orange, fine grain, well sorted, loose, dry	
					Sand, white, fine to medium grain, poorly sorted, loose	
					Same as above except orange	
45						
					Same as above except orange with gravel up to 0.5 inch diameter	0.0
					Same as above except white	
50		100				
					Sand, white, fine to medium grain, poorly sorted, loose, pebbles	12.1
					Sand, tan, fine to medium grain, poorly sorted, loose gravel up tp 0.25 inch diameter	
					Sand, orange, fine to medium grain, poorly sorted, loose	
					Sand, white, fine to medium grain, poorly sorted, loose, gravel up to 0.25 inch diameter	
55					Sand, orange, fine to medium grain, poorly sorted, loose, pebble to cobbles	
					Same as above except tan	0.0
					Same as above except orange	
60		100				
					Sand, interbedded tan and orange, fine to coarse grain, poorly sorted, gravel up to 0.5 inch diameter	0 0
65						
					Sand, tan, fine grain, well sorted	0.0
70		100				
					Same as above	0.0
					Sand, tan, fine to medium grain, poorly sorted, gravel up to 0.25 inch diameter	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-106

SOIL BORING LOG

PROJECT : EBT Treatability Study   LOCATION : Memphis Depot

ELEVATION :   DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS :   START : 04/17/2002   END: 04/18/2002   LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Sand, tan, fine grain, well sorted, loose	0.0
					Sand, orange, fine to medium grain, poorly sorted, gravel pebble to cobble 2 inch reddish brown layer, sand, fine to medium grain, up to 0.25 inch gravel	
					Sand, tan, fine to medium grain, poorly sorted, loose, pebble to cobble gravel, damp	
80		100			Same as above except orange	0.0
					Sand, tan to light grey, fine grain wet	
					Silty clay, orange, thin grey mottling, wet	
85					Sand, tan, fine grain, gravel up to 1 inch, wet	0.0
					Same as above except wet	
90		100			Sand, grey, fine to medium grain, gravel up to 1 inch, dam	
95					Sand, some clay, fine to coarse grain, gravel, wet	0.0
						Water table @ 96 ft bgs
					Sand, orange, fine grain, damp	
100					Sand, orange, fine to coarse grain, gravel pebble to cobble size, wet	
					Silty clay, orange and grey mottling, wet	
		100			Silty sand, some clay, stiff, wet	
105					Sand, orange, some clay, fine grain, wet	
					Clay, dark grey, massive	
110					Boring terminated at 110 ft bgs	

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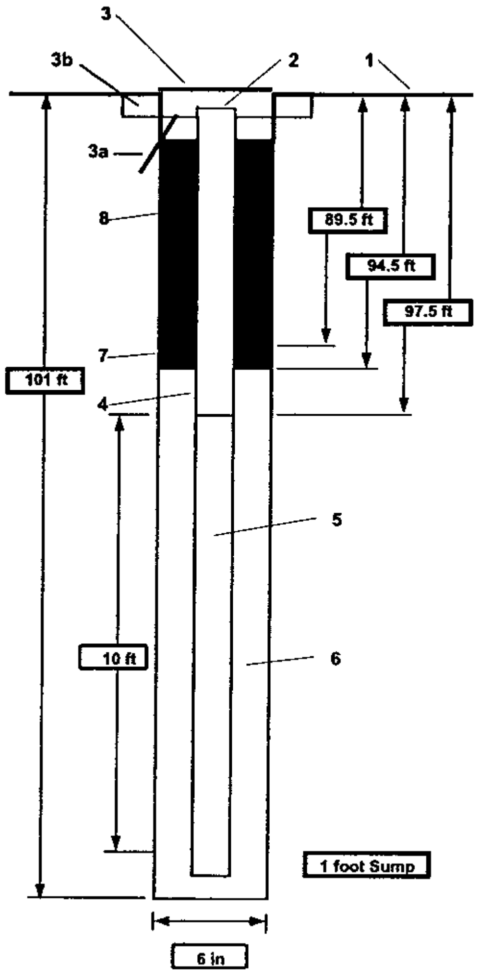
CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-106	SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : — START : 04/17/2002 — END: 04/17/2002 — LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	Surge and develop with stainless steel bailer to remove sediment. Submersible pump.
Development time	8.3 hour
Estimated purge volume	42.5 gallons
Comments	Total Depth (BGS) = 100 feet

Final field parameters collected during well development (/ /)

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-109

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/01/2002 END: 05/02/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm) (Soil headspace)
					Asphalt and gravel	
		100			Silt, stiff, brown	0.0
5						
						9.1
10		100				
						5.4
15						
						0.0
20		100				
					Silty Sand, red, fine to medium grained, poorly sorted, loose	0.0
25					Sandy Clay, reddish brown, fine grained, stiff, damp	
					Sand, some silt, bright red, fine to medium grained, poorly sorted, stiff, dry	
		100				0.0
30						
		100				4.3
					Sand, red, fine to medium grained, poorly sorted, loose	
35					Silty Sand, red to brown, fine to medium grained, poorly sorted, stiff, damp	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-109

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/01/2002 END: 05/02/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Sand, orange yellow, fine grained, well sorted, loose	11.3
40		100				
					Sand, orange, fine to coarse grained, poorly sorted, loose, some gravel	16.2
45					Same as above except orange and yellow	
						0.5
50		100				
						0.8
55					Same as above, no gravel	
		100				0.0
60					Sand, tan, fine to coarse grained, poorly sorted, gravel, pebbles to cobbles, loose, dry	
		100			Sand, light yellow, fine grained, loose, dry	0.0
65					Sand, light yellow to orange, fine grained, well sorted, loose, dry	
						4.7
70		100				
						0.0

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-109

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 05/01/2002 END: 05/02/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Sand, tan, fine to medium grained, loose, damp, some gravel	
						0.0
80		100			Sand, tan, fine grained, loose, dry	
					Sand, orange, fine to coarse grained, loose, dry	0.0
					Same as above, gravel, pebble to cobble	
85					Sand, white, fine grained, loose, dry	
					Same as above, orange	0.0
90		100				
					Sand, orange, fine to coarse grained, poorly sorted, loose, gravel, damp	0.0
					Sand, light tan, fine to coarse grained, poorly sorted, damp, pebble to cobbl	
95					Sand, some silt, tan, fine grained, stiff wet	
					Sand, tan, fine to medium grained, poorly sorted, loose, gravel, wet	Water table @ 96 ft bgs
					Silty Clay, tan, orange mottled, stiff, wet	
					Sand, gray, fine grained, well sorted, loose, wet	
100		100				
					Sand, brown, fine to medium grained, poorly sorted, loose, wet, gravel, pebble to cobble, subangular to subrounded	
					Clay, some silt, gray and orange mottling, massive, stiff, we	
105					Boring terminated at 105 ft bgs	
110						

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CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-109	SHEET 1 OF 1

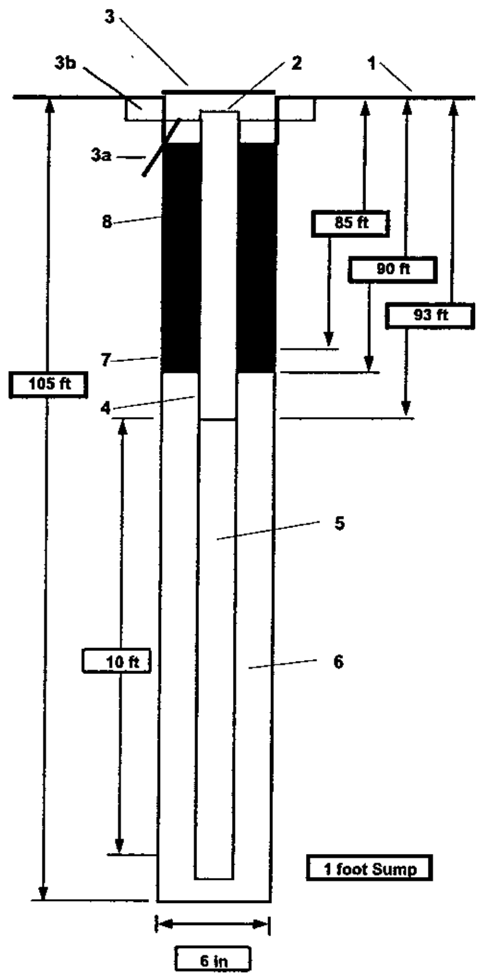
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/17/2002 — END: 04/17/2002 — LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 104 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-110

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/03/2002 END: 05/04/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Asphalt and gravel	
		100			Silt, brown, stiff (loess)	0.0
5						
						0.0
10		100				
						0.0
15						
						0.0
20		100				
						0.0
					Sand, orange, fine grained, loose, dry	
25					Silty Sand, red, fine to medium grained, poorly sorted, damp	
						1.2
30		100				
						0.0
35						

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-110

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 05/03/2002 END: 05/04/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Sand, yellow and orange, fine to coarse grained, poorly sorted, loose, dry	17.9
40		100				
						0.0
45					Silty Sand, some clay, brown, soft, fine to medium grained, poorly sorted, damp	
		100			Sand, orange, fine to coarse grained, poorly sorted, loose, dry, grave	7.8
50					Sand, tan to white, fine to medium grained, poorly sorted, loose, dry	
		100			Sand, tan to orange, fine to coarse grained, poorly sorted, loose, gravel, dry, pebbles to small cobbles	0.7
55					Sand, orange, fine to medium grained, poorly sorted, loose, dry	
		100				0.5
60					Sand, white and tan, fine to coarse grained, poorly sorted, gravel, pebble, subangular, damp	
		100				0.0
65					Sand, white, fine grained, well sorted, loose, dry	
					Sand, tan to orange, fine grained, well sorted, dry	14.4
					Silty Clay, gray, black and orange layering, fine grained, stiff, dry	
70		100				
					Sand, white to orange, fine grained, well sorted, loose dry	0.0
					Silty Clay, some sand, tan, stiff, dry	
					Sand, orange, fine grained, loose dry	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-110

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

ELEVATION : — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 05/03/2002 — END: 05/04/2002 — LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Sand, yellow to tan, fine grained, well sorted, loose, dry	
					Sand, white to tan, fine to coarse grained, poorly sorted, gravel, dr	0.0
80		100			Silty Clay, tan, fine grained, stiff, wet, gravel	0.5
85					Sand, fine grained, orange, well sorted, loose, dry	
		100			Silty Clay, tan, fine grained, stiff, wet, gravel	0.0
90					Sand, white to tan, loose, fine grained, dry	
		100			Sand, brown to orange, fine to coarse grained, poorly sorted, loose, gravel, pebble to cobble	0.0
95					Sand, white, fien grained, well sorted, loose, wet gravel	
					Sandy Silt, some clay, orange, stiff, fine grained, we	Water table @ 96.5 ft bgs
					Sand, white, fine grained, loose, wet gravel	
					Same as above, gravel percentage increasing with depth	
100		100				
					Clay, some silt, gray with orange mottling, stiff, wet, massiv	
105					Boring terminated at 105 ft bgs	
110						

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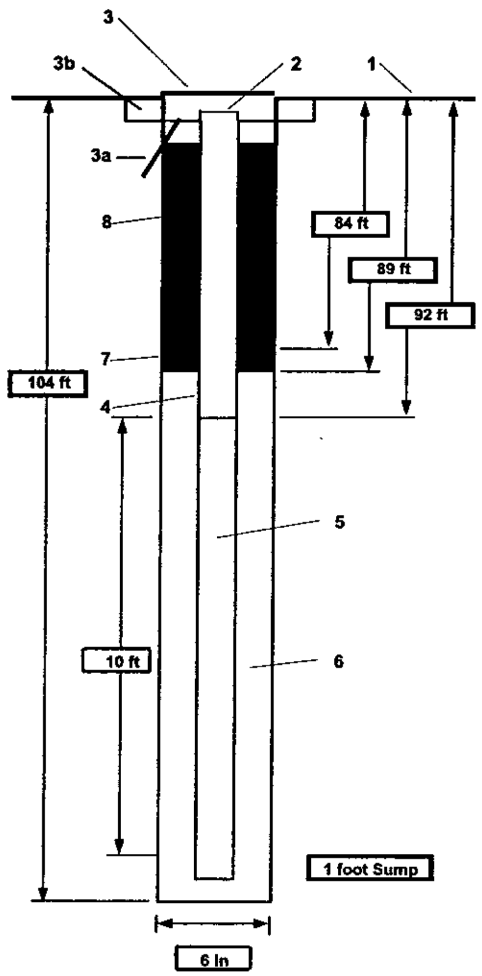
PROJECT NUMBER	WELL NUMBER	
170039	MW-110	SHEET 1 OF 1

CH2MHILL

WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/04/2002 END: 05/04/2002 LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 103 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-111

SOIL BORING LOG

PROJECT : EBT Treatability Study | LOCATION : Memphis Depot
ELEVATION : | DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : | START : 04/22/2002 | END: 04/23/2002 | LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Asphalt and gravel	
		100			Silt, brown, stiff, damp, (loess)	0.0
5						
						1.5
10		100				
					Same as above, Silt	11.4
15						
						0.0
20		100				
					Same as above, Silt	0.8
25						
		100			Sand, orange, loose, fine grained	
		100			Silty Sand, reddish orange, fine to medium grained, stiff	10.5
30		100				
					Sand, bright red, fine to coarse grained, poorly sorted, stiff	0.0
		100			Sand, tan, fine grained, loose, damp	
					Sand, tan with red mottles, fine to medium grained, poorly sorted, stiff	
35					Sand, orange, fine to coarse grained, poorly sorted, loose, dry	
					Sand, dark brown, fine to medium grained, stiff, damp	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-111

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/22/2002 END: 04/23/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Sand, grayn very fine grained, loose, dry	0.0
					Sand, fine to medium grained, poorly sorted, loose, dry, some silt	
40		100			Sand, red, fine to medium grained, poorly sorted, stiff, some silt	
					Sand, orange, fine to coarse grained, poorly sorted, loose, dry, pebbles	0.0
45						
						0.0
50		100			Sand, tan, fine to medium grained, poorly sorted, loose, dry, slight gravel	
						0.0
55					Sand, orange, fine to coarse grained, poorloy sorted, loose, gravel, dry	
						0.0
60		100				
					Sand, tan, fine to medium grained, loose, poorly sorted, gravel	0.0
					Sand, tan, fine grained, loose dry, well sorted	
65					Sand, brown, fine to medium grained, loose, dry, poorly sorted	
					Sand, light tan, fine grained, loose, dry, well sorted	18.3
70		100				
					Sand, yellow, fine grained, well sorted	
					Silty Sand, some clay, gray/orange/red, fine grained, interbedding, stiff, damp to dry	0.0

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-111

SOIL BORING LOG

PROJECT : EBT Treatability Study   LOCATION : Memphis Depot
ELEVATION :   DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS :   START : 04/22/2002   END: 04/23/2002   LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Sand, yellowish orange, fine grained, well sorted, loose dry Sand, orange and tan, fine to medium grained, poorly sorted, pebble to cobble, well rounded to angular, loose, dry	0.0
80		100			Clayey Silt, brown, fine grained, stiff,wet	0.0
85					Sand, white, fine grained, well sorted, loose,dry	0.0
90		100			Sand, dark grey, fine grained, well sorted, loose, dry Sand, orange to tan, fine grained, well sorted, loose, dry Same as above with gravel, pebble to cobble	0.0
95					Sand, brown, fine to coarse grained, poorly sorted, gravel, pebble to cobble, subangular to subrounded, loose Wet Sand, gray to white, fine grained, well sorted, subangular to subrounded, loose wet	Watertable @ approximately 96 feet bgs
100		100			Clay, some silt, gray with red mottling, stiff, massive	
105					Boring Terminated @ 105 feet bgs	
110						

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CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-111	SHEET 1 OF 1

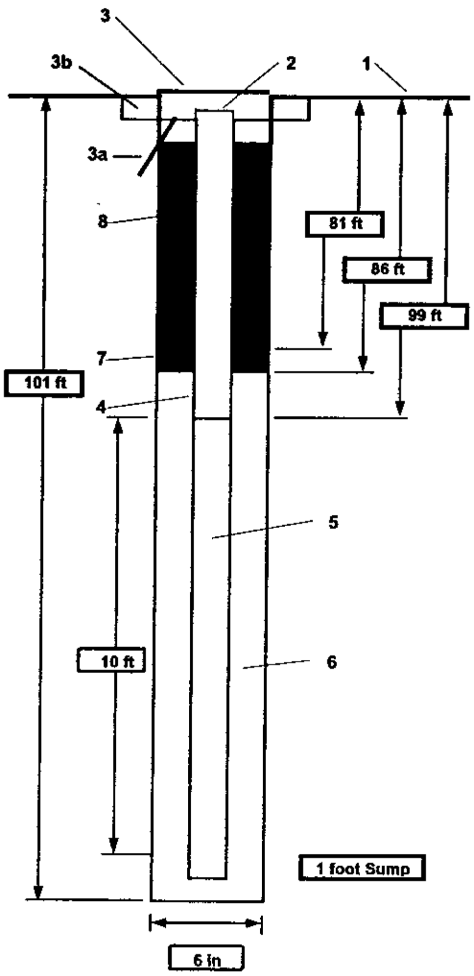
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/22/2002 — END: 04/23/2002 — LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well: feet MSL

2- Top of casing elevation: feet MSL

3- Wellhead protection cover type: Flush-mount wellhead pad
- a) drain tube?: No
- b) concrete pad dimensions: 3 by 3 feet

4- Dia./type of well casing: 2 inch Schedule 40 PVC

5- Type/slot size of screen: 2 inch 10-slot Schedule 40 PVC

6- Type screen filter: Sand, DSI #2
- a) Quantity used: bags

7- Type of seal: Bentonite pellets, DSI Shur-plug 3/8"
- a) Quantity used: bags

8- Grout
- a) Grout mix used: 90% grout / 10% bentonite powder
- b) Method of placement: Tremmie Method
- c) Vol. of well casing grout:

Development method:

Development time: hour

Estimated purge volume: gallons

Comments: Total Depth (BGS) = 100 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-112

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START · 04/21/2002 END: 04/21/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Asphalt and gravel	
		100			Silt, brown, stiff, damp, (loess)	0.0
5						
						6.9
10		100				
					Same as above, Silt	0.0
15						
						2.8
20		100				
					Same as above, Silt	0.0
					Sand, orange, fine grained, well sorted, dry	
25					Silty Sand, bright red, fine to medium grained, poorly sorted, stiff, damp	
		100				5.0
30						
		100				0.0
35						

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-112

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION :
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/21/2002 END: 04/21/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above, Silty Sand	0.0
40		100				
					Silty Sand, brown, fine to medium grained, stiff, damp, poorly sorted	
					Silty Sand, red, fine grained, stiff, slightly damp	
					Sand, orange, fine grained, loose, dry	0.0
					Sand, orange yellow, fine to coarse grained, poorly sorted, loose, gravel	
45						
					Sand, tan, fine grained, well sorted, loose, dry	
					Sand, reddish orange, fine to coarse grained, poorly sorted, gravel and pebbles angular	0.0
		100				
50						
					Sand, tan, fine grained, loose, dry, well sorted	18.0
		100				
55						
		100				11.4
60						
					Sand, white to light tan, very fine grain, powdery, dry	
					Pebbles and cobbles from 61 to 62 feet bgs	
		100				1.6
65						
					Sand, tan, fine grained, well sorted, dry, loose	
		100				17.1
					Same as above except color changes from tan to orange	
					Sand, fine to medium grained, poorly sorted, loose, dry	
70						
		100				0.0
					Same as above, orange in color	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-112

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/21/2002 END: 04/21/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm).
75					Sand, light gray, very fine grained, dry, loose	
					Sand, tan fine grained, well sorted, loose, dry	8.4
80		100			Sand, reddish tan, fine grained, loose, damp, pebbles to cobble, subangular	
					Sand, white to orange, fine to coarse grained, poorly sorted, pebble to cobble	
					Silty Sand, reddish tan, fine grained, trace gravel, soft damp	0.0
					Sandy Silt, reddish tan, mottled, stiff, fine grained, damp	
85					Sand, gray, fine grained, well sorted, loose, dry	
					Sand, tan, fine grained, well sorted, loose, dry	0.0
90		100				
					Sand, light tan, very fine grained, loose, dry, well sorted	
					Sand, orange, fine to medium grained, poorly sorted, gravel, pebble to cobble	17.8
95					Sand, gray to tan, fine to medium grained, poorly sorted, loose, wet	
						Watertable @ approximately 96 feet bgs
100		100			Clay with some silt, stiff, gray with red mottling, massive	
105					Boring Terminated @ 105 feet bgs	
110						

794 344

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-112	SHEET 1 OF 1

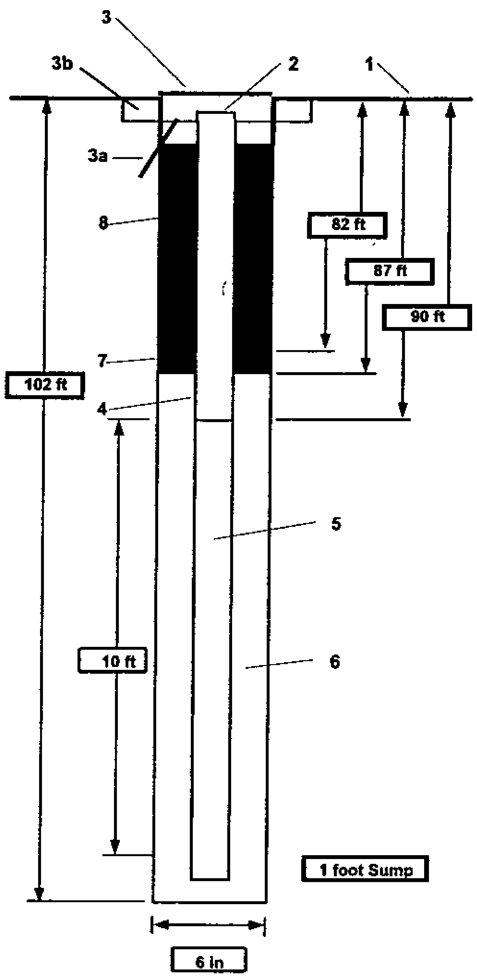
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/21/2002 — END: 04/22/2002 — LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 101 feet

Final field parameters collected during well development (/ /)

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/17/2002 END: 04/17/2002 LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Clay, brown, massive, very stiff, dry	
		100				5.0
5					Silty Clay, brown, stiff, organic material, damp	
						5.0
10		100			Silty Clay, brown, stiff, damp	
						0.0
15						
						0.0
					Sandy Clay, fine to coarse grained sand soft	
20		100			Sandy Clay, brown to reddish brown, very stiff, damp	
						0.0
25						
						0.0
					Sandy, Silty Clay, reddish browndf, with gray and yellow mottles, stiff fine to medium grained.	
30		100				
					Same as above, becomes red	0.0
35					Sand, gray to yellowish brown	
					Clay, brown, stiff, organic material	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/17/2002 END: 04/17/2002 LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm)
					Sand (@37 ft), reddish brown, fine grained	
					Sand, yellowish brown to tan, fine grained	0.0
40		100			Sand, brown to reddish/yellowish brown, fine to medium grained, dry to moist, soft to loose	
						0.0
45						
						0.0
50		100			Sand, brown to yellowish brown, fine to medium grained, soft, gravel (<1 inch diam)	
					Sand, yellowish brown to buff, fine grained, gravel (15%)	
					Clayey Sand, orange brown, stiff, some gravel	
					Gravelly Sand, gray/buff/brown, gravel (<1inch diam), subangular, soft, some thin clay lenses	16.2
55					Gravelly Sand, brown/gray/buff/yellowish brown, fine grained, gravel (<1inch diam) subangular to subrounded @ 56 feet bgs, 3 inch zone of gravel	
						0.0
60		100			Sand, yellowish brown, fine to coarse grained, soft	
					Sand, yellowish brown, fine grained, soft	0.0
65						
						0.0
70		100			Same as above, Sand	
						0.0

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot
ELEVATION : — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : — START : 04/17/2002 — END: 04/17/2002 — LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Clay, yellowish brown	
					Sand, yellowish brown, fine grained, soft	0.0
80		100			Sand, brown/grayish brown, fine to medium grained, cobbles (<30%), 2 inches diam.	0.0
85					Sand, grey/brown, fine grained, pebbles (3%), soft	0.0
90		100			Gravelly Sand, brown to grayish brown, medium grained, soft, dry	0.0
95					Sand, brown to grayish brown, fine to medium grained, soft, wet	Watertable @ approximately 96 feet bgs
					Same as above, some clay	
100		100			Gravelly Sand, tan, wet	
					Silty, Sandy Clay, orange brown to reddish brown, stiff, mottled	
105					Silty, Sandy Clay, orange brown to grey to light reddish brown, wet	
110		100			Clay, grey green, massive	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/17/2002 END: 04/17/2002 LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above, Clay	
115					Boring Terminated @ 115 feet bgs	
120						
125						
130						
135						
140						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/17/2002 END: 04/17/2002 LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm).
145						
150						
155						
160						
165						

794 350

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/17/2002 END: 04/17/2002 LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
170						
175						
180						
185						
190						
195						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-113

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/17/2002 END: 04/17/2002 LOGGER : David Nelson

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
200						
205						
210						
215						
220						

794 352

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-113	SHEET 1 OF 1

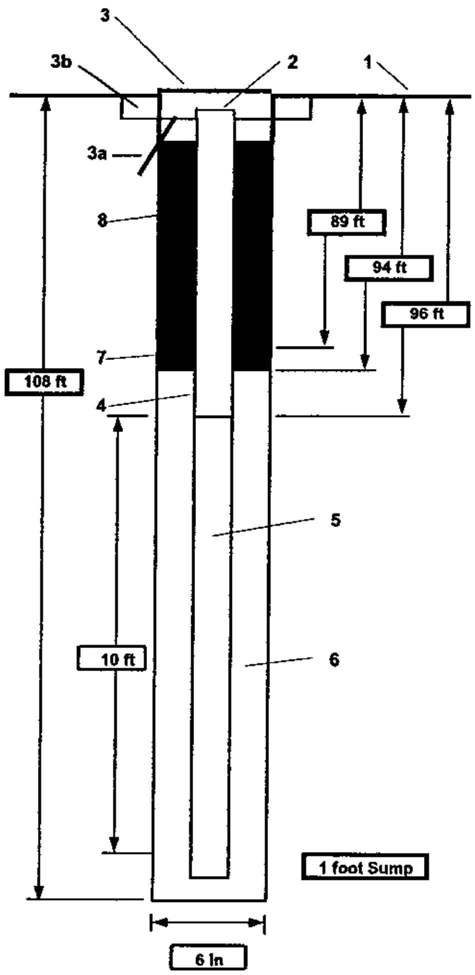
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/17/2002 — END: 04/17/2002 — LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol of well casing grout	
Development method	Surge and develop with stainless steel bailer
Development time	9 hour
Estimated purge volume	37 gallons
Comments	Total Depth (BGS) = 107 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-114

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/23/2002 END: 04/30/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Asphalt and gravel	
		100			Silt, brown, stiff, damp, (loess)	6.1
5						
						0.0
10		100				
					Same as above, Silt	7.1
15						
						0.0
20		100				
					Sand, orange, loose, fine grained, well sorted, dry	0.0
25					Silty Sand, red, fine to coarse grained, poorly sorted, stiff, dry	
						6.2
30		100				
						6.3
35					Sand, reddish orange, fine grained, well sorted, loose, dry	

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-114

SOIL BORING LOG

PROJECT : EBT Treatability Study   LOCATION : Memphis Depot
ELEVATION :   DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS :   START : 04/23/2002   END: 04/30/2002   LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
						0.0
40		100				
						0.0
45					Sand, yellow to orange, fine to coarse grained, loose, dry, pebbles	
		100				0.0
50					Sand, orange, fine grained, well sorted, loose, dry	
		100			Sand, white, fine grained, loose, well sorted	
					Sand, orange, fine to coarse grained, poorly sorted, gravel, < 1 inch diameter	0.0
55					Same as above, except gravel <0.75 inch diameter	
						0.0
60		100			Sand, orange, fine to coarse grained, poorly sorted, loose	
						0.0
65					Sand, yellowish orange to tan, fine grained, loose, dry, well sorted	
						0.0
70		100				
					Silty Sand, brown	
						0.0

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-114

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/23/2002 END: 04/30/2002 LOGGER : Mike Karafa

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75	75-85				Sand, white to yellowish orange, fine grained, loose, dry	
						0.0
80		100			Sand, yellow to tan, fine to coarse grained, loose, dry to damp, gravel, pebble to cobble	
						0.0
85	85-95				Sand, white to orange, fine grained, loose, dry	
						1.2
90		100			Sand, orange, medium to coarse grained, poorly sorted, gravel	
						0.0
95	95-105				Sand, fine to medium grained, poorly sorted, gravel, loose, wet	
						Watertable @ approximately 96 feet bgs
					Sand, white, fine grained, well sorted, loose, wet	
100		100			Sand, orange, fine to medium grained, poorly sorted, loose, gravel, pebbles to cobbles, subangular, we	
					Clay, some silt, orange and gray mottling, stiff, massive	
105					Boring Terminated @ 105 feet bgs	
110						

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CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-114	SHEET 1 OF 1

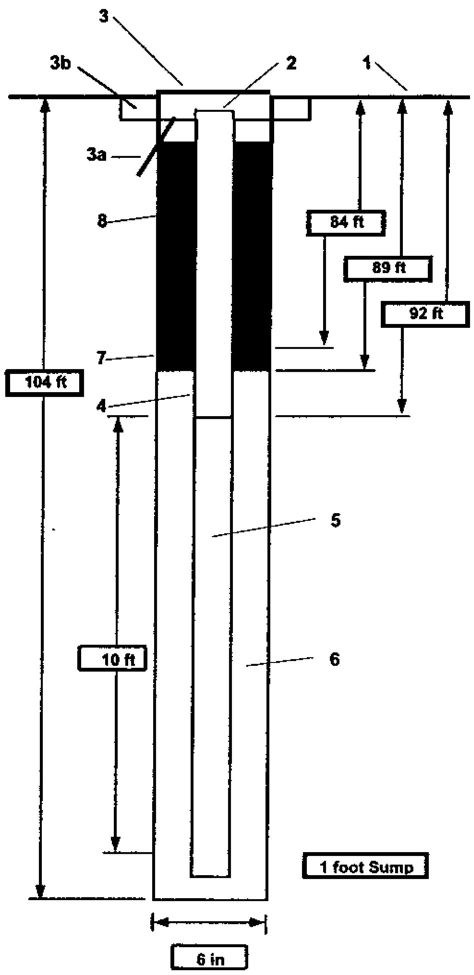
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED · Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/30/2002 END: 04/30/2002 LOGGER : Mike Karafa



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 103 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	**MW-115** (Clustered with MW-116)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/22/2002 END: 04/22/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Gravel (parking lot)	
					Silt, brown, moist, firm (loess)	
		100				
						0.0
5						
						0.0
10		100			Silt, brown, moist, (loess)	
						0.0
15						
						0.0
20		100				
					Silt, brown, moist, (loess)	
					Sandy Clay, tan, moist, fine grained, stiff Dark yellow and light gray mottles	0.0
					Increase fine grained sand with depth	
25					Color grading from tan to brownish red to dark red	
						0.0
30		100			Clayey Sand, dark red, fine grained, well sorted, moist, dense	
						50.1
					Sand, dark red, fine grained, well sorted, mois	
35						
					Clay, pink with light gray mottles, dense, massive, moist	

794 358

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-115 (Clustered with MW-116)

SOIL BORING LOG

PROJECT : EBT Treatability Study   LOCATION : Memphis Depot

ELEVATION :   DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS :   START : 04/22/2002   END: 04/22/2002   LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above, Clay	110.0
40		100			Sand, light yellow, fine grained, dry, loose, well sorted	
						Driller's sample bag: 340.0 Ziplock: 0.0 *see logbook for details
45					Gravelly Sand, brownish yellow, fine to coarse grained, poorly sorted, loose, moist pebbles (<10%), <0.25 inches diameter, subangular	
						Driller's sample bag: 270.0 Ziplock: 0.0
50		100				
						Driller's sample bag. 1203.0 Ziplock. 0.0
55					Same as above, Gravelly Sand	
		100				Driller's sample bag: 860.0 Ziplock: 0.2
60						
					Sand, yellow, loose, dry, fine to medium grained, well sorted	Driller's sample bag 776.0 Ziplock: 0.0
65					Gravelly Sand, brownish yellow, fine to coarse grained, poorly sorted, loose, moist pebbles (<10%), <1 inch diameter, subangular	
						Driller's sample bag. 245.0 Ziplock: 0.0
70		100				
						Driller's sample bag 113.0 Ziplock: 0.0

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-115 (Clustered with MW-116)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/22/2002 END: 04/22/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Same as above, Gravelly Sand	
						Driller's sample bag: 134.0 Ziplock: 0.0
80		100				
						Driller's sample bag: 125.0 Ziplock: 0.0
85					Same as above, Gravelly Sand	
						Driller's sample bag 97.0 Ziplock: 0.0
90		100				
						Driller's sample bag: 107.0 Ziplock: 0.0
95						Watertable @ approximately 95 feet bgs
		100				
100					Same as above, Gravelly Sand	
					Boring Terminated @ 101 feet bgs	
105						
110						

794 360

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	**MW-115** (Clustered with MW-116)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/22/2002 END: 04/22/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
115						
120						
125						
130						
135						
140						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-115 (Clustered with MW-116)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/22/2002 END: 04/22/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
145						
150						
155						
160						
165						

794 362

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-115 (Clustered with MW-116)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/22/2002 END 04/22/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
170						
175						
180						
185						
190						
195						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	**MW-115** (Clustered with MW-116)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/22/2002 END: 04/22/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
200						
205						
210						
215						
220						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-115	SHEET 1 OF 1

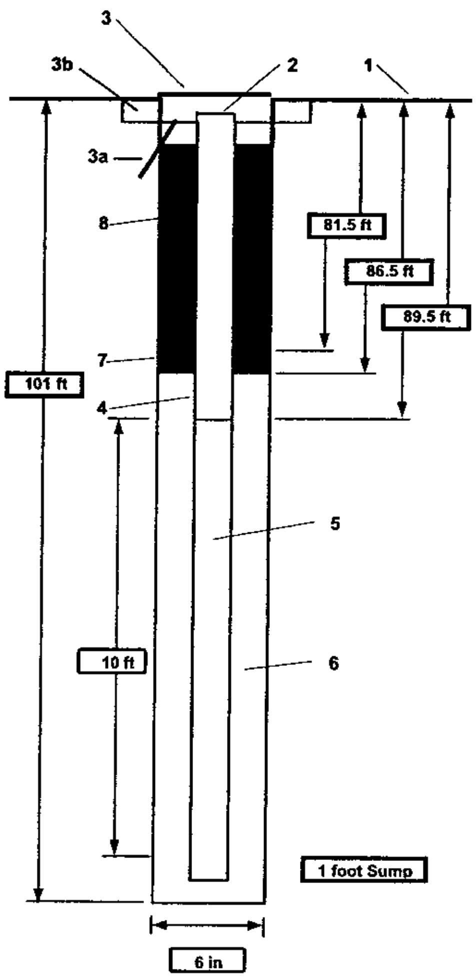
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/22/2002 — END: 04/23/2002 — LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	Surge and remove sediment with stainless ste bailer Developed using submersible pump.
Development time	1.8 hour
Estimated purge volume	130 gallons
Comments	Total Depth (BGS) = 100.5 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	**MW-116** (Clustered with MW-115)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/21/2002 END: 04/21/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Gravel (parking lot)	
					Silt, brown, moist, (loess)	
		100				0.0
5						
						0.0
10		100			Silt, brown, moist, (loess)	
						0.0
15						
						0.0
20		100				
					Silt, brown, moist, (loess)	
					Sandy Clay, tan, moist, fine grained, stiff Dark yellow and light gray mottles	0.0
25						
					Color grading from tan to brownish red to dark red Increase fine grained sand with depth	
						0.0
30		100			Clayey Sand, dark red, fine grained, well sorted, moist, dense	
						10.0
					Sand, dark red, fine grained, well sorted, mois	
35						

794 366

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-116 (Clustered with MW-115)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/21/2002 END: 04/21/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Clay, pink with light gray mottles, dense, moist, massive (@37 feet bgs)	0.0
40		100				
					Sand, golden to light yellow, loose, fine grained, well sorted	
						0.0
45						
					Gravelly Sand, brownish yellow, loose, fine to coarse grained, poorly sorted, pebbles (<20%), <0.25 inches diameter	
						1371.0
50		100				
						126.0
55						
					Sand, brownish yellow, fine to medium grained, well sorted, loose	
		100				130.0
60						
		100				123.0
65						
						315.0
					Gravelly Sand, brownish yellow, loose, fine to coarse grained, poorly sorted, pebbles (20-30%), <0.75 inches diameter	
70		100				
					Sand, brownish yellow, fine grained, well sorted, loose, moist	38.0

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	**MW-116** (Clustered with MW-115)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/21/2002 END: 04/21/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Gravelly Sand, brownish yellow, loose, fine to medium grained, well sorted, pebbles (<10%), <1 inch diameter, subangular	
						380.0
80		100			Gravelly Sand, same as above	
						96.0
85					Gravelly Sand, same as above	
						110.0
90		100			Gravelly Sand, same as above	
						150.0
95						Watertable @ approximately 95 feet bgs
					Gravelly Sand, same as above	
100						
105		100			Gravelly Sand, same as above	
					Clay, yellowish gray to gray, dense, massive	
110						

794 368

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-116 (Clustered with MW-115)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/21/2002 END: 04/21/2002 LOGGER : Bryan Burkingstock

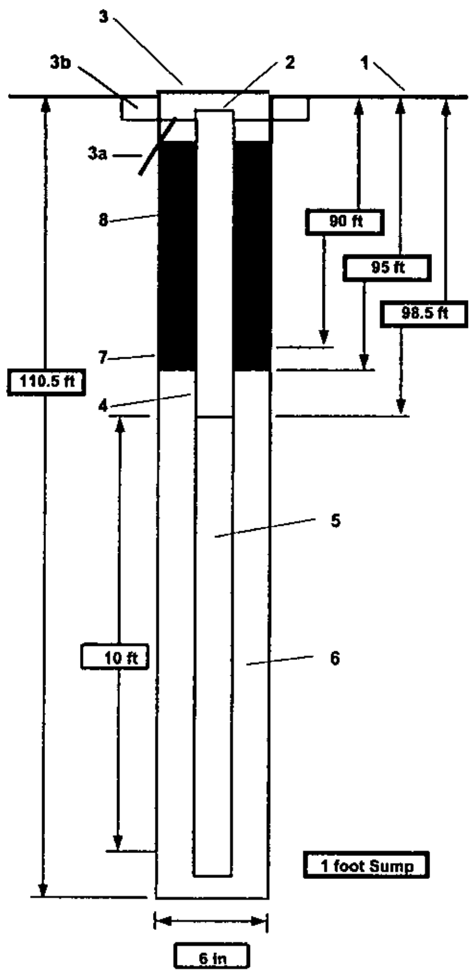
DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm)
					Clay, same as above	
115					Boring Terminated @ 103 feet bgs	
120						
125						
130						
135						
140						

PROJECT NUMBER	WELL NUMBER	
170039	MW-116	SHEET 1 OF 1

CH2MHILL

WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/21/2002 END: 04/22/2002 LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	Surge and remove sediment with stainless ste bailer. Developed using submersible pump.
Development time	1 7 hour
Estimated purge volume	150 gallons
Comments	Total Depth (BGS) = 109.5 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 370

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-117

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot
ELEVATION : — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Gravel (parking lot)	
					Silt, brown, moist, (loess)	
		100				0.0
5						
						0.0
10		100			Silt, brown, moist, (loess)	
						0.0
15						
						0.0
20		100				
					Silt, brown, moist, (loess)	
					Sandy Clay, reddish brown with red and gray mottles, moist, fine grained, stiff	
					Color grading from tan to brownish red to orange, red Increase fine grained sand with depth	0.0
25						
					Clayey Sand, orange to dark red, fine grained, well sorted, moist, firm	
						0.0
					Sand, brownish red to orange, fine grained, slight clay well sorted, moist, loos	
30		100				
					Sand with gravel, orange red, fine grained, well sorted, moist, loose, pebbles (<10%) subangular, <0.25 inches diameter	Driller's sample bag: 65.0 Ziplock: 0.0
35						
					Clay, pink with light gray sandy clay inclusions, dense, massive, moist	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-117

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot
ELEVATION : — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : — START : 04/30/2002 — END: 05/01/2002 — LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above, Clay	Driller's sample bag: 155.0 Ziplock: 0.0
40		100			Gravelly Sand, tan, fine grained, well sorted, moist, loose, pebbles (<10%), <0.25 inch diameter, subangular	
					Sand, light yellow, well sorted, fine grained, loose	Driller's sample bag: 194.0 Ziplock: 0.0
45					Gravelly Sand, brownish yellow to light yellow, fine to coarse grained, poorly sorted, loose, moist, pebbles (<20%), <0.5 inches diameter, subangular	
						Driller's sample bag: 236.0 Ziplock: 0.0
50		100				
					Same as above, Gravelly Sand	Driller's sample bag: 241.0 Ziplock: 0.0
55						
					Same as above, Gravelly Sand	Driller's sample bag: 169.0 Ziplock: 0.0
60		100				
					Sand, brownish yellow, medium grained, well sorted, moist, loose	Driller's sample bag: 124.0 Ziplock: 0.0
65						
						Driller's sample bag 157.0 Ziplock: 0.0
70		100			Same as above, Sand	
						Driller's sample bag: 174.0 Ziplock: 0.0

794 372

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-117

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Gravelly Sand, brownish yellow, fine to coarse grained, poorly sorted, pebbles (<20%) <1 inch diameter, subangular, mois	
					Same as above, some gravel 2 inches in diametei	Driller's sample bag 185.0 Ziplock: 0.0
80		100				
						Driller's sample bag 161.0 Ziplock: 0.0
85						
						Driller's sample bag 92.0 Ziplock: 0.0
90		100			Same as above, Gravelly Sand	
						Driller's sample bag 63.0 Ziplock: 0.0
						Watertable @ approximately 93 feet bg:
95						
100						
					Same as above, Gravelly Sand	
105		100				
110					Clay, yellowish gray, stiff, massive, damp	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-117

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/30/2002 END: 05/01/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above, Clay	
115					Boring Terminated @ 115 feet bgs	
120						
125						
130						
135						
140						

794 374

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-117	SHEET 1 OF 1

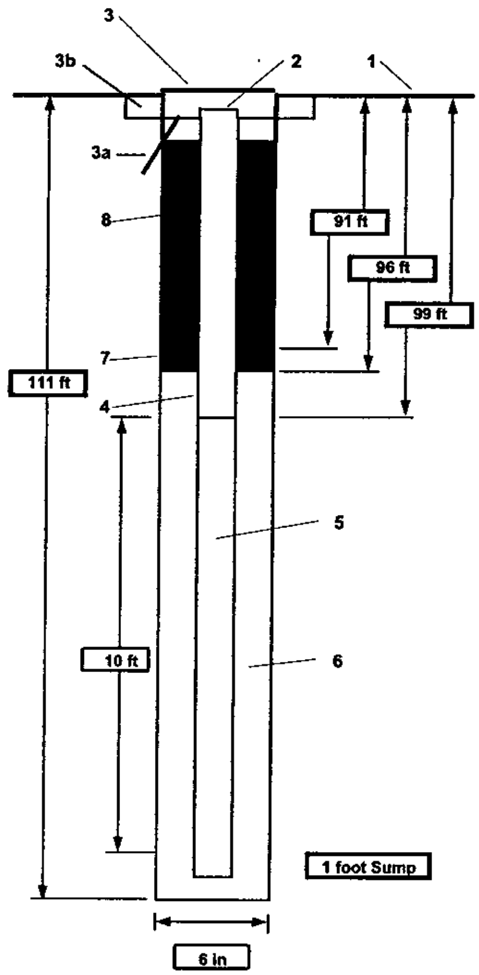
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION · Memphis Depot

DRILLING CONTRACTOR ·Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 05/01/2002 — END: 05/01/2002 — LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 110 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-118

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/01/2002 END: 05/01/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm) *(Soil headspace)*
					Gravel (parking lot)	
					Silt, brown, moist, (loess)	
		100				0.0
5						
						0.0
10		100			Silt, brown, moist, (loess)	
						0.0
15						
						0.0
20		100				
					Silt, brown, moist, (loess)	
					Sandy Clay, reddish brown with red and gray mottles, moist, fine grained, stiff	
					Color grading from tan to brownish red to orange, red Increase fine grained sand with depth	0.0
25						
					Clayey Sand, orange to dark red, fine grained, well sorted, moist, firm	
						0.0
30		100				
					Sand with gravel, orange to dark red, medium grained, well sorted, moist, loose, pebbles (<10%), subangular, <0.25 inches diameter	
						Driller's sample bag: 42.0 Ziplock: 0.0
35						
					Clay, pink with light gray sandy clay inclusions, dense, massive, moist	

794 376

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-118

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 05/01/2002 END: 05/01/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm)
					Same as above, Clay	Driller's sample bag: 161.0 Ziplock: 0.0
40		100			Gravelly Sand, tan, fine grained, well sorted, moist, loose, pebbles (<10%), <0.25 inch diameter, subangular	
					Sand, light yellow, well sorted, fine grained, loose	Driller's sample bag: 245.0 Ziplock: 0.0
45					Gravelly Sand, brownish yellow to light yellow, fine to coarse grained, poorly sorted, loose, moist, pebbles (<20%), <0.5 inches diameter, subangular	
						Driller's sample bag: 250.0 Ziplock: 0.0
50		100				
					Same as above, Gravelly Sand	Driller's sample bag: 241.0 Ziplock: 0.0
55						
					Same as above, Gravelly Sand	Driller's sample bag: 160.0 Ziplock: 0.0
60		100				
					Sand, brownish yellow, medium grained, well sorted, moist, loose	Driller's sample bag: 138.0 Ziplock: 0.0
65						
						Driller's sample bag: 144.0 Ziplock: 0.0
70		100			Same as above, Sand	
						Driller's sample bag: 174.0 Ziplock: 0.0

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-118

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/01/2002 END: 05/01/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Gravelly Sand, brownish yellow, fine to coarse grained, poorly sorted, pebbles (<20%) <1 inch diameter, subangular, mois	
					Same as above, some gravel 2 inches in diameter	Driller's sample bag: 194.0 Ziplock: 0.0
80		100				
						Driller's sample bag. 182.0 Ziplock: 0.0
85						
						Driller's sample bag: 119.0 Ziplock: 0.0
90		100			Same as above, Gravelly Sand	
						Driller's sample bag: 72.0 Ziplock: 0.0
						Watertable @ approximately 93 feet bgs
95						
		100				
100						
					Boring Terminated @ 101 feet bgs	
105						
110						

794 378

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-118

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/01/2002 END: 05/01/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Gravel (parking lot)	
					Silt, brown, moist, (loess)	
		100				0.0
5						
						0.0
10		100			Silt, brown, moist, (loess)	
						0.0
15						
						0.0
20		100				
					Silt, brown, moist, (loess)	
					Sandy Clay, reddish brown with red and gray mottles, moist, fine grained, stiff	
					Color grading from tan to brownish red to orange, red Increase fine grained sand with depth	0.0
25						
					Clayey Sand, orange to dark red, fine grained, well sorted, moist, firm	
						0.0
30		100				
					Sand with gravel, orange to dark red, medium grained, well sorted, moist, loose, pebbles (<10%), subangular, <0.25 inches diameter	
						Driller's sample bag: 42.0 Ziplock: 0.0
35						
					Clay, pink with light gray sandy clay inclusions, dense, massive, moist	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-118

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/01/2002 END: 05/01/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above, Clay	Driller's sample bag: 161.0 Ziplock: 0.0
40		100			Gravelly Sand, tan, fine grained, well sorted, moist, loose, pebbles (<10%), <0.25 inch diameter, subangular	
					Sand, light yellow, well sorted, fine grained, loose	Driller's sample bag: 245.0 Ziplock: 0.0
45					Gravelly Sand, brownish yellow to light yellow, fine to coarse grained, poorly sorted, loose, moist, pebbles (<20%), <0.5 inches diameter, subangular	
						Driller's sample bag 250.0 Ziplock: 0.0
50		100				
					Same as above, Gravelly Sand	Driller's sample bag: 241.0 Ziplock: 0.0
55						
					Same as above, Gravelly Sand	Driller's sample bag 160.0 Ziplock: 0.0
60		100				
					Sand, brownish yellow, medium grained, well sorted, moist, loose	Driller's sample bag 138.0 Ziplock: 0.0
65						
						Driller's sample bag: 144.0 Ziplock: 0.0
70		100			Same as above, Sand	
						Driller's sample bag: 174.0 Ziplock: 0.0

794 380

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-118

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

ELEVATION : — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 05/01/2002 — END: 05/01/2002 — LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Gravelly Sand, brownish yellow, fine to coarse grained, poorly sorted, pebbles (<20%) <1 inch diameter, subangular, mois	
					Same as above, some gravel 2 inches in diamete	Driller's sample bag. 194.0 Ziplock: 0.0
80		100				
						Driller's sample bag 182.0 Ziplock: 0.0
85						
						Driller's sample bag: 119.0 Ziplock: 0.0
90		100			Same as above, Gravelly Sand	
						Driller's sample bag 72.0 Ziplock: 0.0
						Watertable @ approximately 93 feet bg
95						
		100				
100						
					Boring Terminated @ 101 feet bgs	
105						
110						

PROJECT NUMBER	WELL NUMBER	
170039	MW-118	SHEET 1 OF 1

CH2MHILL

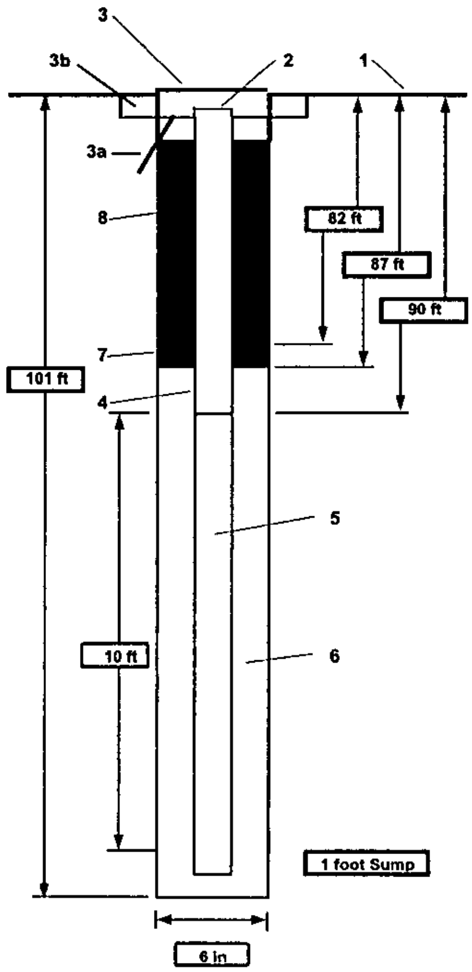
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 05/01/2002 — END: 05/02/2002 — LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 101 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 382

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-119

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/02/2002 END: 05/02/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm). *(Soil headspace)*
0					Gravel (parking lot)	
					Silt, brown, moist, (loess)	
		100				
						0.0
5						
						0.0
10		100			Silt, brown, moist, (loess)	
						0.0
15						
						0.0
20		100				
					Silt, brown, moist, (loess)	
					Sandy Clay, reddish brown with red and gray mottles, moist, fine grained, stiff	0.0
					Color grading from tan to brownish red to orange, red Increase fine grained sand with depth	
25						
					Clayey Sand, orange to dark red, fine grained, well sorted, moist, firm	
						0.0
30		100				
					Sand with gravel, orange to dark red, medium grained, well sorted, moist, loose, pebbles (<10%), subangular, <0.25 inches diameter	
						Driller's sample bag: 36.0 Ziplock: 0.0
35						
					Clay, pink with light gray sandy clay inclusions, dense, massive, moist	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-119

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/02/2002 END : 05/02/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm)
					Same as above, Clay	Driller's sample bag 10.0 Ziplock: 0.0
40		100				
					Same as above, Clay	
					Gravelly Sand, tan, fine grained, well sorted, moist, loose, pebbles (<10%), <0.25 inch diameter, subangular	
					Sand, light yellow, well sorted, fine grained, loose	Driller's sample bag 230.0 Ziplock: 0.0
45						
					Gravelly Sand, brownish yellow to light yellow, fine to coarse grained, poorly sorted, loose, moist, pebbles (<20%), <0.5 inches diameter, subangular	
						Driller's sample bag 264.0 Ziplock: 0.0
50		100				
					Same as above, Gravelly Sand	Driller's sample bag 241.0 Ziplock: 0.0
55						
					Same as above, Gravelly Sand	Driller's sample bag 174.0 Ziplock: 0.0
60		100				
					Sand, brownish yellow, medium grained, well sorted, moist, loose	Driller's sample bag 141.0 Ziplock: 0.0
65						
						Driller's sample bag 157.0 Ziplock: 0.0
					Same as above, Sand	
70		100				
					Gravelly Sand, brownish yellow, fine to coarse grained, poorly sorted, pebbles (<20%) <1 inch diameter, subangular, mois	Driller's sample bag 163.0 Ziplock: 0.0

794 384

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-119

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/02/2002 END: 05/02/2002 LOGGER : Bryan Burkingstock

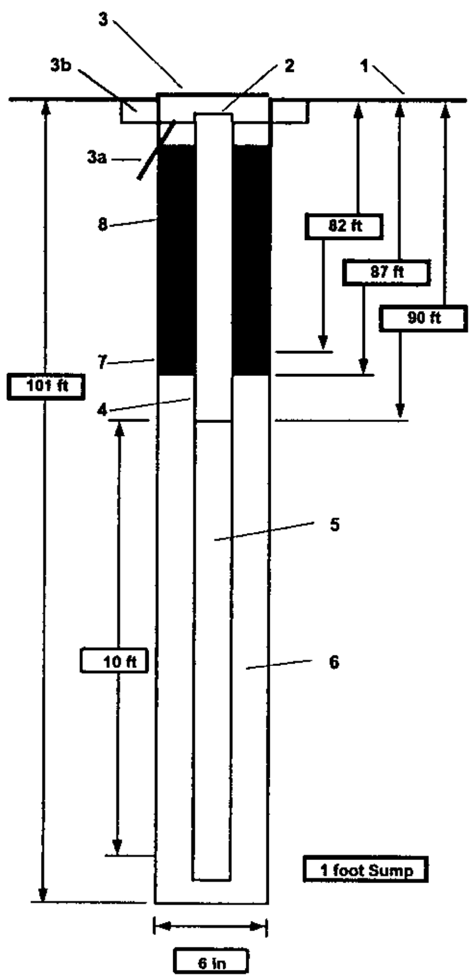
DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75						
					Same as above, some gravel 2 inches in diamete	Driller's sample bag: 181.0 Ziplock: 0.0
80		100				
						Driller's sample bag: 134.0 Ziplock: 0.0
85						
						Driller's sample bag: 104.0 Ziplock: 0.0
90		100			Same as above, Gravelly Sand	
						Driller's sample bag 37.0 Ziplock: 0.0
						Watertable @ approximately 93 feet bg:
95						
		100				
100						
					Boring Terminated @ 101 feet bgs	
105						
110						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-119	SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study   LOCATION : Memphis Depot
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS :   START : 05/02/2002   END: 05/03/2002   LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1-	Ground elevation at well	feet MSL
2-	Top of casing elevation	feet MSL
3-	Wellhead protection cover type	Flush-mount wellhead pad
	a) drain tube?	No
	b) concrete pad dimensions	3 by 3 feet
4-	Dia./type of well casing	2 inch Schedule 40 PVC
5-	Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6-	Type screen filter	Sand, DSI #2
	a) Quantity used	bags
7-	Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
	a) Quantity used	bags
8-	Grout	
	a) Grout mix used	90% grout / 10% bentonite powder
	b) Method of placement	Tremmie Method
	c) Vol. of well casing grout	
	Development method	
	Development time	hour
	Estimated purge volume	gallons
	Comments	Total Depth (BGS) = 101 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 386

PROJECT NUMBER	BORING NUMBER
170039	**MW-120** (Clustered with MW-121)

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot
ELEVATION : — DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : — START : 04/19/2002 — END. 04/20/2002 — LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Gravel (parking lot)	
					Silt, brown, moist, (loess)	
		100				0.0
5						
						0.0
10		100			Silt, brown, moist, (loess)	
						0.0
15						
						0.0
20		100				
					Silt, brown, moist, (loess)	
					Sandy Clay(some silt), tan to reddish brown, dense, moist, fine grained	0.0
25						
					Color grading from tan to brownish red to dark red Increase fine grained sand with depth	
						0.0
					Clayey Sand, dark red, fine grained, well sorted, moist, firm	
30		100				
						10.0
					Sand (slight clay), dark red, fine to medium grained, well sorted, moist, firr	
35						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-120 (Clustered with MW-121)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/19/2002 END: 04/20/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
						79.0
40					Sand, tan, fine to medium grained, well sorted, pebbles (<10%), < 0.25 inch diameter	
					Clay, pink with light gray sandy clay inclusions, dense, massive, moist	175.0
45		100				
					Gravelly Sand, brownish yellow, fine to coarse grained, poorly sorted, loose, moist, pebbles (<20%), <1 inch diameter, subangular	
						280.0
50						
						376.0
55						
					Same as above, Gravelly Sand	
						233.0
60		100				
						483.0
65					Same as above, Gravelly Sand	
						425.0
70		100				
						394.0

794 388

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-120 (Clustered with MW-121)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/19/2002 END: 04/20/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm)
75					Same as above, Gravelly Sand	
		100				384.0
80						
						276.0
85						
		100				143.0
90					Same as above, Gravelly Sand	
						290.0
95						Watertable @ approximately 95 feet bgs
100						
					Same as above, Gravelly Sand	
105						
		100				
					Clay, dense, yellowish gray, massive	
110						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-120	SHEET 1 OF 1

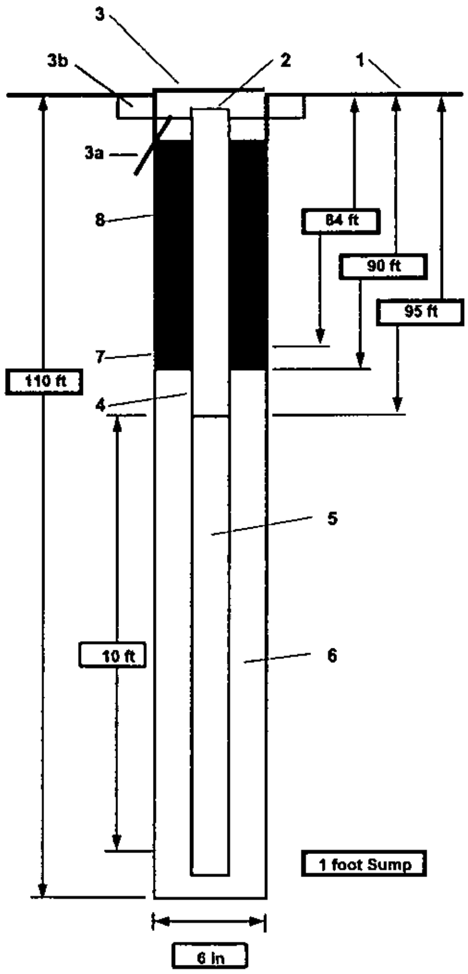
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/20/2002 — END: 04/20/2002 — LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	Surge and remove sediment with stainless ste bailer. Developed using submersible pump.
Development time	1.8 hour
Estimated purge volume	130 gallons
Comments	Total Depth (BGS) = 109 feet

Final field parameters collected during well development (/ /)

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 390

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-121 (Clustered with MW-120)

SOIL BORING LOG

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

ELEVATION : — DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/20/2002 — END: 04/20/2002 — LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Gravel (parking lot)	
					Silt, brown, moist, (loess)	
		100				0.0
5						
						0.0
10		100			Silt, brown, moist, (loess)	
						0.0
15						
						0.0
20		100				
					Silt, brown, moist, (loess)	
					Sandy Clay, tan, dense, moist, fine grained	
						0.0
25						
					Color grading from tan to brownish red to dark red Increase fine grained sand with depth	
						0.0
					Clayey Sand, dark red, fine grained, well sorted, moist	
30		100				
						110.0
					Sand, dark red, fine grained, well sorted, mois	
35						
					Clayey Sand, brownish red, fine grained, moist	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-121 (Clustered with MW-120)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/20/2002 END: 04/20/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Clayey Sand, brownish red, fine grained, moist	300.0
					Sand, brown, fine grained, well sorted, pebbles (<10%), < 1 inch diameter, moist	
40		100				
					Clay, pink with light gray sandy clay inclusions, dense, massive, moist	
						240.0
					Sand, brownish yellow, fine grained, well sorted, loose, moist	
45						
					Gravelly Sand, brownish yellow to light yellow, fine to coarse grained, poorly sorted, loose, moist, pebbles (10 to 20%), <0.25 inches diameter, subangular	
						507.0
50		100				
						390.0
55						
					Sand, brownish yellow, medium grained, well sorted, moist	
		100				157.0
60						
		100				203.0
65						
					Gravelly Sand, brownish yellow, fine to coarse grained, poorly sorted, pebbles (<10%) <0.25 inches diameter, subangular, mois	
						247.0
70		100				
						109.0

794 392

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	**MW-121** (Clustered with MW-120)

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/20/2002 END: 04/20/2002 LOGGER : Bryan Burkingstock

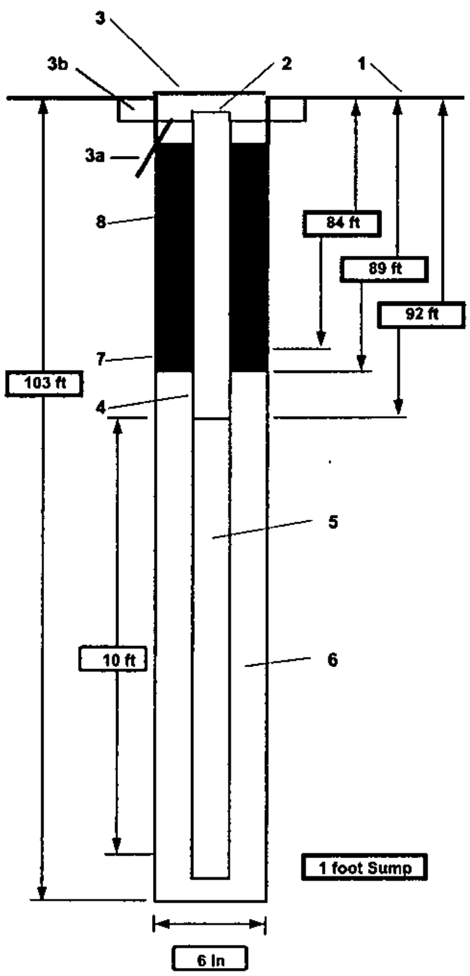
DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Same as above, Gravelly Sand	
						150.0
80		100				
						234.0
85						
						126.0
90		100			Same as above, Gravelly Sand	
						80.0
95						Watertable @ approximately 95 feet bgs
100						
					Same as above, Gravelly Sand	
					Boring Terminated @ 103 feet bgs	
105						
110						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-121	SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/20/2002 END: 04/21/2002 LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	Surge and remove sediment with stainless ste bailer. Developed using submersible pump.
Development time	1.5 hour
Estimated purge volume	100 gallons
Comments	Total Depth (BGS) = 103 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 394

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-122

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 05/04/2002 END: 05/04/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Gravel (parking lot)	
		100			Silt, brown, moist, (loess)	0.0
5						
						0.0
10		100			Silt, brown, moist, (loess)	
						0.0
15						
						0.0
20		100				
					Silt, brown, moist, (loess)	
					Sandy Clay, reddish brown with red and gray mottles, moist, fine grained, stiff	0.0
					Color grading from tan to brownish red to orange, red Increase fine grained sand with depth	
25						
					Clayey Sand, orange to dark red, fine grained, well sorted, moist, firm	
						0.0
30		100				
					Sand with gravel, orange to dark red, medium grained, well sorted, moist, loose, pebbles (<10%), subangular, <0.25 inches diameter	
						Driller's sample bag 45.0 Ziplock: 0.0
35						

794 395

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-122

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/04/2002 END: 05/04/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Clay, pink with light gray sandy clay inclusions, dense, massive, moist	Driller's sample bag: 22.0 Ziplock: 0.0
40		100				
					Gravelly Sand, tan, fine grained, well sorted, moist, loose, pebbles (<10%), <0.25 inch diameter, subangular	Driller's sample bag: 217.0 Ziplock: 0.0
					Sand, light yellow, well sorted, fine grained, loose	
45					Gravelly Sand, brownish yellow to light yellow, fine to coarse grained, poorly sorted, loose, moist, pebbles (<20%), <0.5 inches diameter, subangular	
						Driller's sample bag: 245.0 Ziplock: 0.0
50		100				
					Same as above, Gravelly Sand	Driller's sample bag: 231.0 Ziplock: 0.0
55						
					Same as above, Gravelly Sand	Driller's sample bag: 183.0 Ziplock: 0.0
60		100				
					Sand, brownish yellow, medium grained, well sorted, moist, loose	
						Driller's sample bag: 169.0 Ziplock: 0.0
65						
						Driller's sample bag: 158.0 Ziplock: 0.0
70		100			Same as above, Sand	
					Gravelly Sand, brownish yellow, fine to coarse grained, poorly sorted, pebbles (<20%) <1 inch diameter, subangular, moist, loose	Driller's sample bag: 160.0 Ziplock: 0.0

794 396

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-122

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

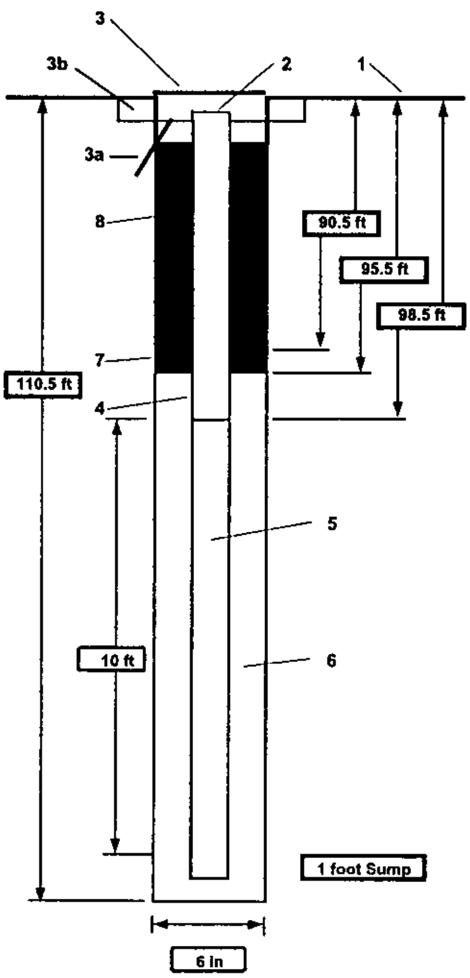
WATER LEVELS : START · 05/04/2002 END: 05/04/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75						
					Same as above, some gravel 2 inches in diamete	Driller's sample bag 186.0 Ziplock: 0.0
80		100				
						Driller's sample bag 121.0 Ziplock: 0.0
85						
						Driller's sample bag 111.0 Ziplock: 0.0
90		100			Same as above, Gravelly Sand	
						Driller's sample bag 45.0 Ziplock: 0.0
						Watertable @ approximately 93 feet bg
95						
		100				
100						
105						
110						

PROJECT NUMBER	WELL NUMBER	
170039	MW-122	SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/04/2002 END: 05/05/2002 LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 109.5 feet

Final field parameters collected during well development (/ /):

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 398

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-123

SOIL BORING LOG

PROJECT : EBT Treatability Study   LOCATION : Memphis Depot

ELEVATION :   DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS :   START : 04/29/2002   END: 04/29/2002   LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
	0-5	100			Gravel (parking lot)	
					Silt, brown, moist, (loess)	0.0
5	5-15					0.0
10		100			Silt, brown, moist, (loess)	
						0.0
15	15-25					0.0
20		100			Silt, brown, moist, (loess)	
					Sandy Clay, brownish tan with red and gray mottles, moist, fine grained, stiff	
					Color grading from tan to brownish red to orange, red Increase fine grained sand with depth	0.0
25	25-35				Clayey Sand, dark red, fine grained, well sorted, moist, firm	
					Sand, dark red, fine grained, well sorted, moist, loose	0.0
30		100				
						Driller's sample bag: 42.0 Ziplock: 0.0
					Sand with gravel, orange red, fine grained, well sorted, moist, loose, pebbles (<10%) subangular, <0.25 inches diameter	
35	35-					
					Clay, pink with light gray sandy clay inclusions, dense, massive, moist	

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-123

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/29/2002 END: 04/29/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above, Clay	Driller's sample bag: 134.0 Ziplock: 0.0
40		100			Gravelly Sand, tan, fine grained, well sorted, moist, loose, pebbles (<10%), <0.25 inch diameter, subangular	
					Sand, light yellow, well sorted, fine grained, loose	Driller's sample bag: 192.0 Ziplock: 0.0
45						
					Gravelly Sand, brownish yellow to light yellow, fine to coarse grained, poorly sorted, loose, moist, pebbles (<20%), <0.5 inches diameter, subangular	Driller's sample bag 259.0 Ziplock: 0.0
50		100				
					Same as above, Gravelly Sand	Driller's sample bag 243.0 Ziplock: 0.0
55						
					Same as above, Gravelly Sand	Driller's sample bag. 177.0 Ziplock: 0.0
60		100				
					Sand, brownish yellow, medium grained, well sorted, moist, loose	Driller's sample bag 119.0 Ziplock: 0.0
65						
					Gravelly Sand, brownish yellow, fine to coarse grained, poorly sorted, pebbles (<20%) <0.5 inches diameter, subangular, mois	Driller's sample bag 206.0 Ziplock: 0.0
70		100				
					Same as above, Gravelly Sand	Driller's sample bag: 187.0 Ziplock: 0.0

794 400

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-123

SOIL BORING LOG

PROJECT : EBT Treatability Study   LOCATION : Memphis Depot

ELEVATION :   DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS :   START : 04/29/2002   END: 04/29/2002   LOGGER : Bryan Burkingstock

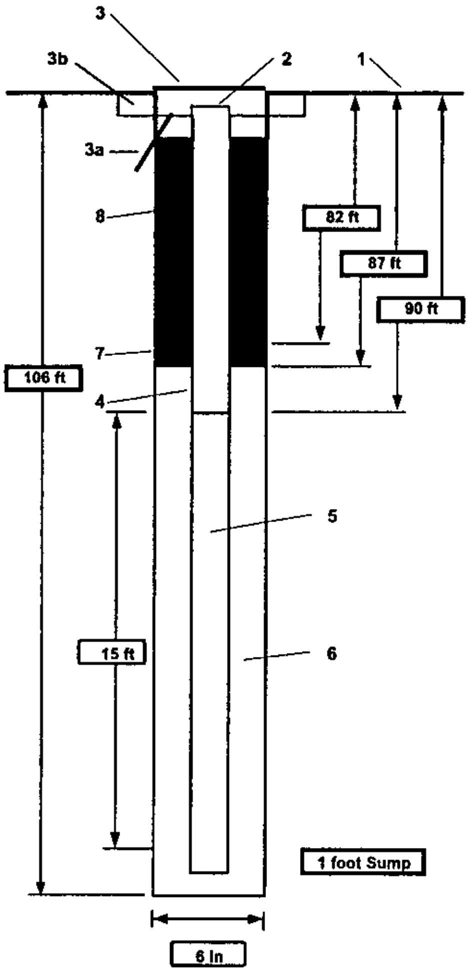
DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Same as above, Gravelly Sand	
						Driller's sample bag: 177.0 Ziplock: 0.0
80		100				
						Driller's sample bag: 143.0 Ziplock: 0.0
85						
						Driller's sample bag: 106.0 Ziplock: 0.0
90		100			Same as above, Gravelly Sand	
						Driller's sample bag: 73.0 Ziplock: 0.0
95						Watertable @ approximately 93 feet bgs
100		100				
					Same as above, Gravelly Sand	
105						
					Boring Terminated @ 106 feet bgs	
110						

CH2MHILL

PROJECT NUMBER	WELL NUMBER
170039	MW-123 SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/29/2002 END: 04/30/2002 LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well: feet MSL

2- Top of casing elevation: feet MSL

3- Wellhead protection cover type: Flush-mount wellhead pad
   a) drain tube?: No
   b) concrete pad dimensions: 3 by 3 feet

4- Dia./type of well casing: 2 inch Schedule 40 PVC

5- Type/slot size of screen: 2 inch 10-slot Schedule 40 PVC

6- Type screen filter: Sand, DSI #2
   a) Quantity used: bags

7- Type of seal: Bentonite pellets, DSI Shur-plug 3/8"
   a) Quantity used: bags

8- Grout
   a) Grout mix used: 90% grout / 10% bentonite powder
   b) Method of placement: Tremmie Method
   c) Vol. of well casing grout:

Development method:

Development time: hour

Estimated purge volume: gallons

Comments: Total Depth (BGS) = 106 feet

Final field parameters collected during well development (/ /):

pH =		
conductivity =		mS/cm
temperature =		°C
Dissolved Oxygen =		mg/l
Turbidity =		NTU

794 402

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-124

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot

ELEVATION : DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : START : 05/03/2002 END: 05/03/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Gravel (parking lot)	
					Silt, brown, moist, (loess)	
		100				0.0
5						
						0.0
10		100			Silt, brown, moist, (loess)	
						0.0
15						
						0.0
20		100				
					Silt, brown, moist, (loess)	
					Sandy Clay, brownish red, moist, fine grained, stiff	
						0.0
25						
					Color grading from tan to brownish red to dark red Increase fine grained sand with depth	
						0.0
					Clayey Sand, red, fine grained, well sorted, moist	
30		100				
						Driller's sample bag: 21.0 Ziplock 0.0
					Sand, dark red, fine grained, well sorted, mois	
35						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-124

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 05/03/2002 END: 05/03/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
					Same as above, Sand	Driller's sample bag 118.0 Ziplock: 0.0
					Clay, pink with light gray sandy clay mottles, dense, massive, moist	
40		100				
						Driller's sample bag 167.0 Ziplock: 0.0
					Sand, brownish yellow, fine to medium grained, well sorted, loose, moist	
45						
					Gravelly Sand, brownish yellow to light yellow, fine to coarse grained, poorly sorted, loose, moist, pebbles (<10%), <0.25 inches diameter, subangular	
						Driller's sample bag 432.0 Ziplock: 0.0
50		100				
						Driller's sample bag 295.0 Ziplock: 0.0
55					Sand, brownish yellow, medium grained, well sorted, moist, loose	
						Driller's sample bag: 164.0 Ziplock: 0.0
60		100				
						Driller's sample bag 124.0 Ziplock: 0.0
65						
						Driller's sample bag: 279.0 Ziplock: 0.0
					Gravelly Sand, brownish yellow, fine to coarse grained, poorly sorted, pebbles (<20%) <1 inches diameter, subangular, mois	
70		100				
						Driller's sample bag 209.0 Ziplock: 0.0

794 404

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-124

SOIL BORING LOG

PROJECT : EBT Treatability Study   LOCATION : Memphis Depot

ELEVATION :   DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS :   START : 05/03/2002   END: 05/03/2002   LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm)
75					Same as above, Gravelly Sand	
						Driller's sample bag. 154.0 Ziplock: 0.0
80		100				
						Driller's sample bag: 213.0 Ziplock: 0.0
85						
						Driller's sample bag: 113.0 Ziplock: 0.0
90		100			Same as above, Gravelly Sand	
						Driller's sample bag. 71.0 Ziplock: 0.0
95						Watertable @ approximately 93 feet bgs
100		100				
					Same as above, Gravelly Sand	
105						
					Boring Terminated @ 115 feet bgs	
110						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-124	SHEET 1 OF 1

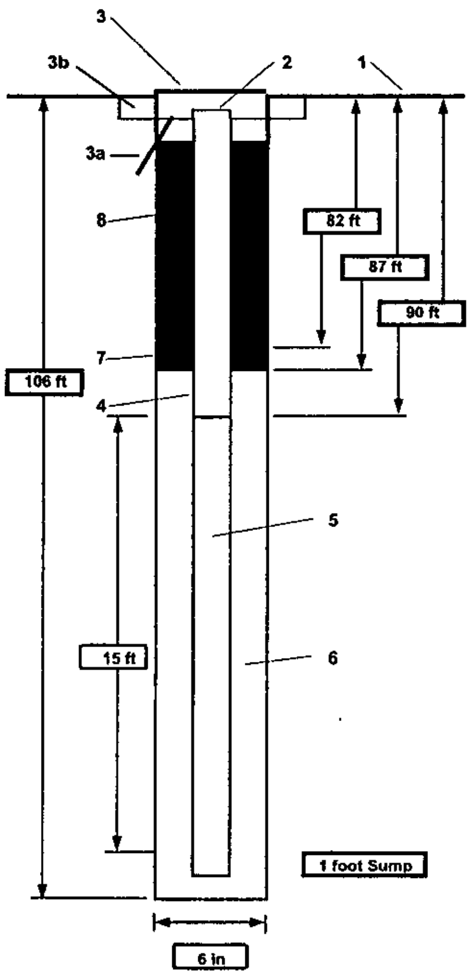
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 05/03/2002 — END: 05/04/2002 — LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well	feet MSL
2- Top of casing elevation	feet MSL
3- Wellhead protection cover type	Flush-mount wellhead pad
a) drain tube?	No
b) concrete pad dimensions	3 by 3 feet
4- Dia./type of well casing	2 inch Schedule 40 PVC
5- Type/slot size of screen	2 inch 10-slot Schedule 40 PVC
6- Type screen filter	Sand, DSI #2
a) Quantity used	bags
7- Type of seal	Bentonite pellets, DSI Shur-plug 3/8"
a) Quantity used	bags
8- Grout	
a) Grout mix used	90% grout / 10% bentonite powder
b) Method of placement	Tremmie Method
c) Vol. of well casing grout	
Development method	
Development time	hour
Estimated purge volume	gallons
Comments	Total Depth (BGS) = 106 feet

Final field parameters collected during well development (/ /)

pH =	
conductivity =	mS/cm
temperature =	°C
Dissolved Oxygen =	mg/l
Turbidity =	NTU

794 406

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-125

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/22/2002 END: 04/22/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm): *(Soil headspace)*
					Gravel (parking lot)	
					Silt, brown, moist, (loess)	
		100				0.0
5						
						0.0
10		100			Silt, brown, moist, (loess)	
						0.0
15						
						0.0
20		100				
					Silt, brown, moist, (loess)	
					Sandy Clay, brownish tan, moist, fine grained, stiff	
						0.0
25						
					Color grading from tan to brownish red to dark red Increase fine grained sand with depth	
						0.0
30		100			Clayey Sand, dark red, fine grained, well sorted, moist	
						Driller's sample bag: 110.0 Ziplock: 0.0
					Sand, dark red, fine grained, well sorted, mois	
35						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-125

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/22/2002 END: 04/22/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm)
					Same as above, Sand	Driller's sample bag 117.0 Ziplock: 0.0
40		100				
					Clay, pink with light gray sandy clay inclusions, dense, massive, moist	
					Sand, tan to brownish yellow, fine to medium grained, well sorted, loose, moist	Driller's sample bag 150.0 Ziplock: 0.0
45						
					Gravelly Sand, brownish yellow to light yellow, fine to coarse grained, poorly sorted, loose, moist, pebbles (<10%), <0.25 inches diameter, subangular	
						Driller's sample bag 320.0 Ziplock: 0.0
50		100				
						Driller's sample bag 276.0 Ziplock: 0.0
55						
					Sand, brownish yellow, medium grained, well sorted, moist, loose	
						Driller's sample bag 136.0 Ziplock 0.0
60		100				
						Driller's sample bag 113.0 Ziplock: 0.0
65						
						Driller's sample bag 326.0 Ziplock: 0.0
70		100			Gravelly Sand, brownish yellow, fine to coarse grained, poorly sorted, pebbles (<20%) <1 inches diameter, subangular, moist	
						Driller's sample bag 193.0 Ziplock: 0.0

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CH2MHILL

PROJECT NUMBER	BORING NUMBER
170039	MW-125

SOIL BORING LOG

PROJECT : EBT Treatability Study LOCATION : Memphis Depot
ELEVATION : DRILLING CONTRACTOR : Boart Longyear
DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)
WATER LEVELS : START : 04/22/2002 END 04/22/2002 LOGGER : Bryan Burkingstock

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (%)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Corrected FID (ppm):
75					Same as above, Gravelly Sand	
						Driller's sample bag. 160.0 Ziplock: 0.0
80		100				
						Driller's sample bag 227.0 Ziplock: 0.0
85						
						Driller's sample bag 93.0 Ziplock: 0.0
90		100			Same as above, Gravelly Sand	
						Driller's sample bag 82.0 Ziplock: 0.0
95						Watertable @ approximately 93 feet bgs
100						
					Same as above, Gravelly Sand	
105						
		100				
					Clay, yellowish gray, dense, massive	
110						

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
170039	MW-125	SHEET 1 OF 1

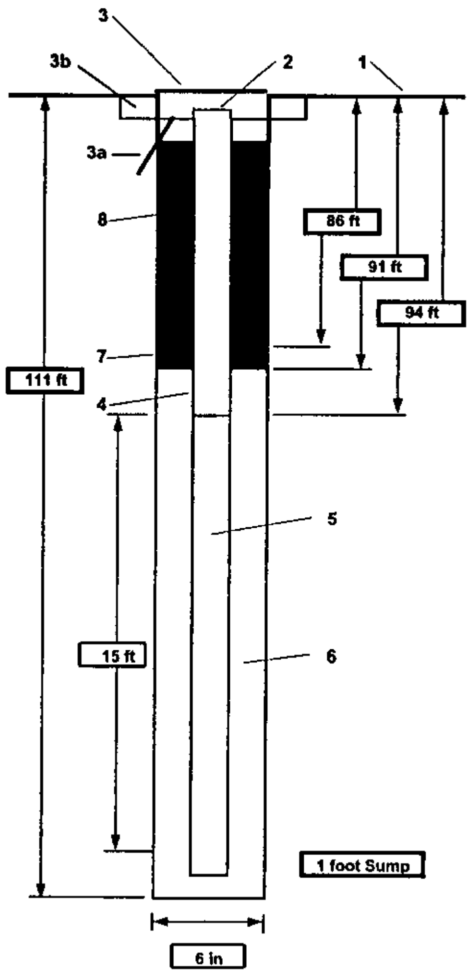
WELL COMPLETION DIAGRAM

PROJECT : EBT Treatability Study — LOCATION : Memphis Depot

DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT USED : Rotasonic rig (4 inch sample casing / 6 inch outer casing)

WATER LEVELS : — START : 04/23/2002 — END: 04/24/2002 — LOGGER : Bryan Burkingstock



Note: Diagram not to scale.

1- Ground elevation at well: feet MSL

2- Top of casing elevation: feet MSL

3- Wellhead protection cover type: Flush-mount wellhead pad
- a) drain tube? No
- b) concrete pad dimensions: 3 by 3 feet

4- Dia./type of well casing: 2 inch Schedule 40 PVC

5- Type/slot size of screen: 2 inch 10-slot Schedule 40 PVC

6- Type screen filter: Sand, DSI #2
- a) Quantity used: bags

7- Type of seal: Bentonite pellets, DSI Shur-plug 3/8"
- a) Quantity used: bags

8- Grout
- a) Grout mix used: 90% grout / 10% bentonite powder
- b) Method of placement: Tremmie Method
- c) Vol of well casing grout:

Development method:

Development time: hour

Estimated purge volume: gallons

Comments: Total Depth (BGS) = 110 feet

Final field parameters collected during well development (/ /):

pH =

conductivity = mS/cm

temperature = °C

Dissolved Oxygen = mg/l

Turbidity = NTU

ATTACHMENT B

Summary of Sample Information

Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
IW-1 (Area 2)	IW1-97.5	16-Apr-2002	Soil					x														
	IW1-EBT-B-97-99	20-May-2002	Water	x																		
	IW1-EBT-B	21-May-2002	Water		x	x	x		x	x	x		x	x								
	IW1-EBT-TS7-97-99	20-Jan-2003	Water	x																		
	IW1-EBT-TS7	23-Jan-2003	Water		x	x	x		x	x	x		x	x								
IW-2 (Area 2)	IW2-104	19-Apr-2002	Soil					x														
	IW2-EBT-B-98-103	20-May-2002	Water	x																		
	IW2-EBT-B	22-May-2002	Water		x		x		x	x	x		x	x								
	IW2-EBT-TS7-98-103	20-Jan-2003	Water	x																		
	IW2-EBT-TS7	23-Jan-2003	Water		x		x		x	x	x		x	x								
IW-3 (Area 2)	IW3-103'	20-Apr-2002	Soil					x														
	IW3-EBT-B-99-101	20-May-2002	Water	x																		
	IW3-EBT-B	21-May-2002	Water		x		x		x	x	x		x	x								
	IW3-EBT-TS7-99-101	20-Jan-2003	Water	x																		
	IW3-EBT-TS7	23-Jan-2003	Water		x		x		x	x	x		x	x								
IW-4 (Area 2)	IW-4 100-105	16-Apr-2002	Soil					x														
	IW4-EBT-B-99-104	20-May-2002	Water	x																		
	IW4-EBT-B	21-May-2002	Water		x	x	x		x	x	x		x	x								
	IW4-EBT-TS7-99-104	20-Jan-2003	Water	x																		
	IW4-EBT-TS7	23-Jan-2003	Water		x	x	x		x	x	x		x	x								
IW-5 (Area 1)	IW5-100	18-Apr-2002	Soil					x														
	IW5-82.5soil	18-Apr-2002	Soil	x																		
	IW5-EBT-B-105-110	21-May-2002	Water	x																		
	IW5-EBT-B	21-May-2002	Water		x		x		x	x	x		x	x								
	IW5-EBT-TS7-105-110	20-Jan-2003	Water	x																		
	IW5-EBT-TS7	23-Jan-2003	Water		x		x		x	x	x		x	x								
	IW5-EBT-TS7-OIL	23-Jan-2003	Water	x																		
IW-6 (Area 1)	IW6-97	05-May-2002	Soil					x														
	IW6-EBT-B-101-106	21-May-2002	Water	x																		
	IW6-EBT-B	21-May-2002	Water		x	x	x		x	x	x		x	x								
	IW6-EBT-TS7-101-106	20-Jan-2003	Water	x																		
	IW6-EBT-TS7	23-Jan-2003	Water		x	x	x		x	x	x		x	x								
	IW6-EBT-TS7-OIL	23-Jan-2003	Water	x																		
IW-7 (Area 1)	IW7-108	05-May-2002	Soil					x														
	IW7-EBT-B-102-107	21-May-2002	Water	x																		
	IW7-EBT-B	21-May-2002	Water		x	x	x		x	x	x		x	x								
	IW7-EBT-TS7-102-107	20-Jan-2003	Water	x																		
	IW7-EBT-TS7	23-Jan-2003	Water		x	x	x		x	x	x		x	x								
	IW7-EBT-TS7-OIL	23-Jan-2003	Water	x																		
MW-21 (Area 1)	MW21_98-103BL	20-Mar-2002	Water	x																		
	MW-21-BL	21-Mar-2002	Water		x		x		x	x	x				x							
	MW21-EBT-B	23-May-2002	Water											x								
	MW21-EBT-TS1-98.5-103.5	08-Jul-2002	Water	x																		
	MW21-EBT-TS1	09-Jul-2002	Water		x		x		x	x	x		x	x								
	MW21-EBT-TS2-98.5-103.5	29-Jul-2002	Water	x																		
	MW21-EBT-TS2-98.5-103.5D	29-Jul-2002	Water	x																		

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Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-21 (Area 1)	MW21-EBT-TS2	29-Jul-2002	Water		X		X		X	X	X		X	X								
	MW21-EBT-TS3-98.5-103.5	03-Sep-2002	Water	X																		
	MW21-EBT-TS3	03-Sep-2002	Water		X		X		X	X	X		X	X		X						
	MW21-EBT-TS4-98.5-103.5	07-Oct-2002	Water	X																		
	MW21-EBT-TS4	07-Oct-2002	Water		X		X		X	X	X		X	X		X						
	MW21-EBT-TS5-98.5-103.5	11-Nov-2002	Water	X																		
	MW21-EBT-TS5	11-Nov-2002	Water		X		X		X	X	X		X	X								
	MW21-EBT-TS6-98.5-103.5	16-Dec-2002	Water	X																		
	MW21-EBT-TS6	16-Dec-2002	Water		X		X		X	X	X		X	X								
	MW21-EBT-TS7-98.5-103.5	20-Jan-2003	Water	X																		
	MW21-EBT-TS7	20-Jan-2003	Water		X		X		X	X	X		X	X								
	MW21-EBT-TS8-98.5-103.5	24-Feb-2003	Water	X																		
	MW21-EBT-TS8	24-Feb-2003	Water		X		X		X	X	X		X	X								
	MW21-EBT-TS9-98.5-103.5	24-Mar-2003	Water	X																		
	MW21-EBT-TS9	24-Mar-2003	Water		X		X		X	X	X		X	X								
	MW21-EBT-TS10-98.5-103.5	21-Apr-2003	Water	X																		
	MW21-EBT-TS10	21-Apr-2003	Water		X		X		X	X	X		X	X								
	MW21-EBT-TS11-98.5-103.5	19-May-2003	Water	X																		
	MW21-EBT-TS11	19-May-2003	Water		X		X		X	X	X		X	X								
	MW21-EBT-TS12-98.5-103.5	23-Jun-2003	Water	X																		
	MW21-EBT-TS12	23-Jun-2003	Water		X		X		X	X	X		X	X								
	MW21-EBT-TS13-98.5-103.5	21-Jul-2003	Water	X																		
	MW21-EBT-TS13	21-Jul-2003	Water		X		X		X	X	X		X	X								
MW-26 (Area 2)	MW26-EBT-TS13	24-Jul-2003	Water	X	X		X		X	X	X		X	X								
	MW26-EBT-TS14	18-Aug-2003	Water	X	X		X		X	X	X		X	X								
MW-85 (Area 2)	MW-85-1**	30-Nov-2001	Water	X																		
	MW-85_102-BL	19-Mar-2002	Water		X				X	X	X				X							
	MW-85_BAIL-BL	21-Mar-2002	Water				X															
	MW85-EBT-B	23-May-2002	Water											X								
MW-86 (Area 2)	MW-86-1***	30-Nov-2001	Water	X																		
	MW-86_105-BL	20-Mar-2002	Water		X		X		X	X	X				X							
	MW86-EBT-B	23-May-2002	Water											X								
	MW86-EBT-TS1-100-105	08-Jul-2002	Water	X																		
	MW86-EBT-TS1	09-Jul-2002	Water		X		X		X	X	X		X	X								
	MW86-EBT-TS2-100-105	29-Jul-2002	Water	X																		
	MW86-EBT-TS2	30-Jul-2002	Water		X		X		X	X	X		X	X								
	MW86-EBT-TS3-100-105	03-Sep-2002	Water	X																		
	MW86-EBT-TS3	04-Sep-2002	Water		X		X		X	X	X		X	X								
	MW86-EBT-TS4-100-105	07-Oct-2002	Water	X																		
	MW86-EBT-TS4	08-Oct-2002	Water		X		X		X	X	X		X	X								
	MW86-EBT-TS5-100-105	11-Nov-2002	Water	X																		
	MW86-EBT-TS5	12-Nov-2002	Water		X		X		X	X	X		X	X								
	MW86-EBT-TS6-100-105	16-Dec-2002	Water	X																		
	MW86-EBT-TS6	17-Dec-2002	Water		X		X		X	X	X		X	X								
	MW86-EBT-TS7-100-105	20-Jan-2003	Water	X																		
	MW86-EBT-TS7	21-Jan-2003	Water		X		X		X	X	X		X	X								
	MW86-EBT-TS9-100-105	24-Mar-2003	Water	X																		
	MW86-EBT-TS9	25-Mar-2003	Water		X		X		X	X	X	X	X	X								
	MW86-EBT-TS10-100-105	21-Apr-2003	Water	X																		

Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	O2 in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-86 (Area 2)	MW86-EBT-TS10	22-Apr-2003	Water		x		x		x	x	x	x	x	x								
	MW86-EBT-TS11-100-105	19-May-2003	Water	x																		
	MW86-EBT-TS11	20-May-2003	Water		x		x		x	x	x	x	x	x								
	MW86-EBT-TS12-100-105	23-Jun-2003	Water	x																		
	MW86-EBT-TS12	24-Jun-2003	Water		x		x		x	x	x		x	x								
	MW86-EBT-TS13-100-105	21-Jul-2003	Water	x																		
	MW86-EBT-TS13	22-Jul-2003	Water		x		x		x	x	x		x	x								
	MW86-EBT-TS14-100-105	18-Aug-2003	Water	x																		
	MW86-EBT-TS14	19-Aug-2003	Water		x		x		x	x	x		x	x			x					
MW-88 (Area 2)	MW-88-1***	30-Nov-2001	Water	x																		
	MW-88-BL	21-Mar-2002	Water		x		x		x	x	x				x							
	MW88-EBT-TS1-90-95	03-Jul-2002	Water	x																		
	MW88-EBT-TS1	11-Jul-2002	Water		x		x		x	x	x											
	MW88-EBT-TS2-90-95	29-Jul-2002	Water	x																		
	MW88-EBT-TS2	01-Aug-2002	Water		x		x		x	x	x		x	x								
	MW88-EBT-TS3-90-95	03-Sep-2002	Water	x																		
	MW88-EBT-TS3	06-Sep-2002	Water		x		x		x	x	x		x	x								
	MW88-EBT-TS4-90-95	07-Oct-2002	Water	x																		
	MW88-EBT-TS4	10-Oct-2002	Water		x		x		x	x	x		x	x								
	MW88-EBT-TS5-90-95	11-Nov-2002	Water	x																		
	MW88-EBT-TS5	14-Nov-2002	Water		x		x		x	x	x		x	x								
	MW88-EBT-TS6-90-95	16-Dec-2002	Water	x																		
	MW88-EBT-TS6	19-Dec-2002	Water		x		x		x	x	x		x	x								
	MW88-EBT-TS7-90-95	20-Jan-2003	Water	x																		
	MW88-EBT-TS7	24-Jan-2003	Water		x		x		x	x	x		x	x								
	MW88-EBT-TS9-90-95	24-Mar-2003	Water	x																		
	MW88-EBT-TS9	27-Mar-2003	Water		x		x		x	x	x		x	x								
	MW88-EBT-TS10-90-95	21-Apr-2003	Water	x																		
	MW88-EBT-TS10	24-Apr-2003	Water		x		x		x	x	x		x	x								
	MW88-EBT-TS11-90-95	19-May-2003	Water	x																		
	MW88-EBT-TS11	22-May-2003	Water		x		x		x	x	x		x	x								
	MW88-EBT-TS12-90-95	23-Jun-2003	Water	x																		
	MW88-EBT-TS12	26-Jun-2003	Water		x		x		x	x	x		x	x								
	MW88-EBT-TS13-90-95	21-Jul-2003	Water	x																		
	MW88-EBT-TS13	24-Jul-2003	Water		x		x		x	x	x		x	x								
	MW88-EBT-TS14-90-95	18-Aug-2003	Water	x																		
	MW88-EBT-TS14	21-Aug-2003	Water		x		x		x	x	x		x	x								
MW-100B (Area 1)	MW-100-1*	11-Dec-2001	Water	x																		
	MW100B_117-BL	22-Mar-2002	Water		x		x		x	x	x				x							
	MW100B-EBT-B	23-May-2002	Water											x								
	MW100B-EBT-TS1-110-115	08-Jul-2002	Water	x																		
	MW100B-EBT-TS1	09-Jul-2002	Water		x		x		x	x	x		x	x								
	MW100B-EBT-TS2-110-115	29-Jul-2002	Water	x																		
	MW100B-EBT-TS2	29-Jul-2002	Water		x		x		x	x	x		x	x								
	MW100B-EBT-TS3-110-115	03-Sep-2002	Water	x																		
	MW100B-EBT-TS3	03-Sep-2002	Water		x		x		x	x	x		x	x		x						
	MW100B-EBT-TS4-110-115	07-Oct-2002	Water	x																		
	MW100B-EBT-TS4-110-115D	07-Oct-2002	Water	x																		
	MW100B-EBT-TS4	07-Oct-2002	Water		x		x		x	x	x		x	x		x						
	MW100B-EBT-TS5-110-115	11-Nov-2002	Water	x																		

Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-100B (Area 1)	MW100B-EBT-TS5	11-Nov-2002	Water		x		x		x	x	x		x	x		x						
	MW100B-EBT-TS6-110-115	16-Dec-2002	Water	x																		
	MW100B-EBT-TS6	19-Dec-2002	Water		x		x		x	x	x		x	x		x						
	MW100B-EBT-TS7-110-115	20-Jan-2003	Water	x																		
	MW100B-EBT-TS7	20-Jan-2003	Water		x		x		x	x	x		x	x		x						
	MW100B-EBT-TS8-110-115	24-Feb-2003	Water	x																		
	MW100B-EBT-TS8	26-Feb-2003	Water		x		x		x	x	x		x	x		x						
	MW100B-EBT-TS9-110-115	24-Mar-2003	Water	x																		
	MW100B-EBT-TS9	24-Mar-2003	Water		x		x		x	x	x		x	x		x						
	MW100B-EBT-TS10-110-115	21-Apr-2003	Water	x																		
	MW100B-EBT-TS10	21-Apr-2003	Water		x		x		x	x	x		x	x		x						
	MW100B-EBT-TS11-110-115	19-May-2003	Water	x																		
	MW100B-EBT-TS11	19-May-2003	Water		x		x		x	x	x		x	x		x						
	MW100B-EBT-TS12-110-115	23-Jun-2003	Water	x																		
	MW100B-EBT-TS12	25-Jun-2003	Water		x		x		x	x	x		x	x		x						
	MW100B-EBT-TS13-110-115	21-Jul-2003	Water	x																		
	MW100B-EBT-TS13	23-Jul-2003	Water		x		x		x	x	x		x	x		x						
	MW100B-EBT-TS14	21-Aug-2003	Water														x					
MW-105 (Area 2)	MW-105-97	01-May-2002	Soil					x														
	MW-105-EBT-B-97.5-99.5	20-May-2002	Water	x																		
	MW105-EBT-B	23-May-2002	Water		x		x		x	x	x		x	x								
	MW105-EBT-TS1-97.5-99.5	08-Jul-2002	Water	x																		
	MW105-EBT-TS1	10-Jul-2002	Water		x		x		x	x	x		x	x								
	MW105-EBT-TS2-97.5-99.5	29-Jul-2002	Water	x																		
	MW105-EBT-TS2	31-Jul-2002	Water		x		x		x	x	x		x	x								
	MW105-EBT-TS3-97.5-99.5	03-Sep-2002	Water	x																		
	MW105-EBT-TS3	05-Sep-2002	Water		x		x		x	x	x		x	x								
	MW105-EBT-TS4-97.5-99.5	07-Oct-2002	Water	x																		
	MW105-EBT-TS4	09-Oct-2002	Water		x		x		x	x	x		x	x								
	MW105-EBT-TS5-97.5-99.5	11-Nov-2002	Water	x																		
	MW105-EBT-TS5	13-Nov-2002	Water		x		x		x	x	x		x	x								
	MW105-EBT-TS6-97.5-99.5	16-Dec-2002	Water	x																		
	MW105-EBT-TS6	18-Dec-2002	Water		x		x		x	x	x		x	x								
	MW105-EBT-TS7-97.5-99.5	20-Jan-2003	Water	x																		
	MW105-EBT-TS7	22-Jan-2003	Water		x		x		x	x	x		x	x								
	MW105-EBT-TS9-97.5-99.5	24-Mar-2003	Water	x																		
	MW105-EBT-TS9	26-Mar-2003	Water		x		x		x	x	x	x	x	x								
	MW105-EBT-TS10-97.5-99.5	21-Apr-2003	Water	x																		
	MW105-EBT-TS10	23-Apr-2003	Water		x		x		x	x	x		x	x								
	MW105-EBT-TS11-97.5-99.5	19-May-2003	Water	x																		
	MW105-EBT-TS11	21-May-2003	Water		x		x		x	x	x		x	x								
	MW105-EBT-TS12-97.5-99.5	23-Jun-2003	Water	x																		
	MW105-EBT-TS12	25-Jun-2003	Water		x		x		x	x	x		x	x								
	MW105-EBT-TS13-97.5-99.5	21-Jul-2003	Water	x																		
	MW105-EBT-TS13	23-Jul-2003	Water		x		x		x	x	x		x	x								
	MW105-EBT-TS14-97.5-99.5	18-Aug-2003	Water	x																		
	MW105-EBT-TS14	20-Aug-2003	Water		x		x		x	x	x		x	x								
MW-106 (Area 2)	MW-106 104'	17-Apr-2002	Soil					x														
	MW106-EBT-B-100-105	20-May-2002	Water	x																		
	MW106-EBT-B-100-105D	20-May-2002	Water	x																		

Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-106 (Area 2)	MW106-EBT-B	21-May-2002	Water		x		x		x	x	x		x	x								
	MW106-EBT-TS1-100-106	08-Jul-2002	Water	x																		
	MW106-EBT-TS1	11-Jul-2002	Water		x		x		x	x	x		x	x								
	MW106-EBT-TS2-100-106	29-Jul-2002	Water	x																		
	MW106-EBT-TS2	29-Jul-2002	Water		x		x		x	x	x		x	x								
	MW106-EBT-TS3-100-106	03-Sep-2002	Water	x																		
	MW106-EBT-TS3	03-Sep-2002	Water		x		x		x	x	x		x	x								
	MW106-EBT-TS4-100-106	07-Oct-2002	Water	x																		
	MW106-EBT-TS4	07-Oct-2002	Water		x		x		x	x	x		x	x								
	MW106-EBT-TS5-100-106	11-Nov-2002	Water	x																		
	MW106-EBT-TS5	11-Nov-2002	Water		x		x		x	x	x		x	x								
	MW106-EBT-TS6-100-106	16-Dec-2002	Water	x																		
	MW106-EBT-TS6	16-Dec-2002	Water		x		x		x	x	x		x	x								
	MW106-EBT-TS7-100-106	20-Jan-2003	Water	x																		
	MW106-EBT-TS7	20-Jan-2003	Water		x		x		x	x	x		x	x								
	MW106-EBT-TS8-100-106	24-Mar-2003	Water	x																		
	MW106-EBT-TS8	25-Mar-2003	Water		x		x		x	x	x		x	x								
	MW106-EBT-TS10-100-106	21-Apr-2003	Water	x																		
	MW106-EBT-TS10	22-Apr-2003	Water		x		x		x	x	x		x	x								
	MW106-EBT-TS11-100-106	19-May-2003	Water	x																		
	MW106-EBT-TS11	20-May-2003	Water		x		x		x	x	x		x	x								
	MW106-EBT-TS12-100-106	23-Jun-2003	Water	x																		
	MW106-EBT-TS12	20-Jan-2003	Water		x		x		x	x	x		x	x								
	MW106-EBT-TS13-100-106	21-Jul-2003	Water	x																		
	MW106-EBT-TS13	22-Jul-2003	Water		x		x		x	x	x		x	x								
	MW106-EBT-TS14-100-106	18-Aug-2003	Water	x																		
	MW106-EBT-TS14	19-Aug-2003	Water		x		x		x	x	x		x	x								
MW-109 (Area 2)	MW-109-87	02-May-2002	Soil					x														
	MW-109-EBT-99-101	20-May-2002	Water	x																		
	MW-109-EBT-B	20-May-2002	Water		x		x		x	x	x		x	x								
	MW109-EBT-TS1-99-101	08-Jul-2002	Water	x																		
	MW109-EBT-TS1	08-Jul-2002	Water		x		x		x	x	x		x	x								
	MW109-EBT-TS2-99-101	29-Jul-2002	Water	x																		
	MW109-EBT-TS2	30-Jul-2002	Water		x		x		x	x	x		x	x								
	MW109-EBT-TS3-99-101	03-Sep-2002	Water	x																		
	MW109-EBT-TS3	04-Sep-2002	Water		x		x		x	x	x		x	x								
	MW109-EBT-TS4-99-101	07-Oct-2002	Water	x																		
	MW109-EBT-TS4	08-Oct-2002	Water		x		x		x	x	x		x	x								
	MW109-EBT-TS5-99-101	11-Nov-2002	Water	x																		
	MW109-EBT-TS5	12-Nov-2002	Water		x		x		x	x	x		x	x								
	MW109-EBT-TS6-99-101	16-Dec-2002	Water	x																		
	MW109-EBT-TS6	17-Dec-2002	Water		x		x		x	x	x		x	x								
	MW109-EBT-TS7-99-101	20-Jan-2003	Water	x																		
	MW109-EBT-TS7	21-Jan-2003	Water		x		x		x	x	x		x	x								
	MW109-EBT-TS8-99-101	24-Mar-2003	Water	x																		
	MW109-EBT-TS8	25-Mar-2003	Water		x		x		x	x	x	x	x	x								
	MW109-EBT-TS10-99-101	21-Apr-2003	Water	x																		
	MW109-EBT-TS10	22-Apr-2003	Water		x		x		x	x	x	x	x	x								
	MW109-EBT-TS11-99-101	19-May-2003	Water	x																		
	MW109-EBT-TS11	20-May-2003	Water		x		x		x	x	x	x	x	x								

Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selinium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-109 (Area 2)	MW109-EBT-TS12-00-101	23-Jun-2003	Water	X																		
	MW109-EBT-TS12	24-Jun-2003	Water		X		X		X	X	X		X	X								
	MW109-EBT-TS13-00-101	21-Jul-2003	Water	X																		
	MW109-EBT-TS13	22-Jul-2003	Water		X		X		X	X	X		X	X								
	MW109-EBT-TS14-00-101	18-Aug-2003	Water	X																		
	MW109-EBT-TS14	19-Aug-2003	Water		X		X		X	X	X		X	X								
MW-110 (Area 2)	MW-110-SS	04-May-2002	Soil					X														
	MW-110-SSD	04-May-2002	Soil					X														
	MW-110-EBT-00-101	20-May-2002	Water	X																		
	MW-110-EBT-S	20-May-2002	Water		X	X	X		X	X	X		X	X								
	MW-110-EBT-S-D	20-May-2002	Water		X	X	X		X	X	X		X	X								
	MW110-EBT-TS1-00-101	08-Jul-2002	Water	X																		
	MW110-EBT-TS1-00-101D	08-Jul-2002	Water	X																		
	MW110-EBT-TS1	09-Jul-2002	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS1-D	09-Jul-2002	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS2-00-101	29-Jul-2002	Water	X																		
	MW110-EBT-TS2-00-101D	29-Jul-2002	Water	X																		
	MW110-EBT-TS2	30-Jul-2002	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS2-D	30-Jul-2002	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS3-00-101	03-Sep-2002	Water	X																		
	MW110-EBT-TS3-00-101D	03-Sep-2002	Water	X																		
	MW110-EBT-TS3	04-Sep-2002	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS3D	04-Sep-2002	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS4-00-101	07-Oct-2002	Water	X																		
	MW110-EBT-TS4-00-101D	07-Oct-2002	Water	X																		
	MW110-EBT-TS4	08-Oct-2002	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS4D	08-Oct-2002	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS5-00-101	11-Nov-2002	Water	X																		
	MW110-EBT-TS5-00-101D	11-Nov-2002	Water	X																		
	MW110-EBT-TS5	12-Nov-2002	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS5D	12-Nov-2002	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS6-00-101	16-Dec-2002	Water	X																		
	MW110-EBT-TS6-00-101D	16-Dec-2002	Water	X																		
	MW110-EBT-TS6	17-Dec-2002	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS6D	17-Dec-2002	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS7-00-101	20-Jan-2003	Water	X																		
	MW110-EBT-TS7-00-101D	20-Jan-2003	Water	X																		
	MW110-EBT-TS7	21-Jan-2003	Water		X	X	X		X	X	X		X	X								
	MW110-EBT-TS7D	21-Jan-2003	Water		X	X	X		X	X	X		X	X								
	MW110-EBT-TS8-00-101	24-Mar-2003	Water	X																		
	MW110-EBT-TS8-00-101D	24-Mar-2003	Water	X																		
	MW110-EBT-TS8	24-Mar-2003	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS8D	24-Mar-2003	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS10-00-101	21-Apr-2003	Water	X																		
	MW110-EBT-TS10-00-101D	21-Apr-2003	Water	X																		
	MW110-EBT-TS10	21-Apr-2003	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS10D	21-Apr-2003	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS11-00-101	19-May-2003	Water	X																		
	MW110-EBT-TS11-00-101D	19-May-2003	Water	X																		
	MW110-EBT-TS11	19-May-2003	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS11D	19-May-2003	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS12-00-101	23-Jun-2003	Water	X																		

Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Fe2 TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-110 (Area 2)	MW110-EBT-TS12-99-101D	23-Jun-2003	Water	X																		
	MW110-EBT-TS12	23-Jun-2003	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS12D	23-Jun-2003	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS13-99-101	21-Jul-2003	Water	X																		
	MW110-EBT-TS13-99-101D	21-Jul-2003	Water	X																		
	MW110-EBT-TS13	21-Jul-2003	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS13D	21-Jul-2003	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS14-99-101	18-Aug-2003	Water	X																		
	MW110-EBT-TS14-99-101D	18-Aug-2003	Water	X																		
	MW110-EBT-TS14	18-Aug-2003	Water		X		X		X	X	X		X	X								
	MW110-EBT-TS14D	18-Aug-2003	Water		X		X		X	X	X		X	X								
MW-111 (Area 2)	MW-111-98	23-Apr-2002	Soil					X														
	MW111-EBT-B-97.5-99.5	20-May-2002	Water	X																		
	MW111-EBT-B	22-May-2002	Water		X		X		X	X	X		X	X								
	MW111-EBT-TS1-97.5-99.5	08-Jul-2002	Water	X																		
	MW111-EBT-TS1	09-Jul-2002	Water		X		X		X	X	X		X	X								
	MW111-EBT-TS2-97.5-99.5	29-Jul-2002	Water	X																		
	MW111-EBT-TS2	31-Jul-2002	Water		X		X		X	X	X		X	X								
	MW111-EBT-TS3-97.5-99.5	03-Sep-2002	Water	X																		
	MW111-EBT-TS3	05-Sep-2002	Water		X		X		X	X	X		X	X								
	MW111-EBT-TS4-97.5-99.5	07-Oct-2002	Water	X																		
	MW111-EBT-TS4	09-Oct-2002	Water		X		X		X	X	X		X	X								
	MW111-EBT-TS5-97.5-99.5	11-Nov-2002	Water	X																		
	MW111-EBT-TS5	13-Nov-2002	Water		X		X		X	X	X		X	X								
	MW111-EBT-TS6-97.5-99.5	16-Dec-2002	Water	X																		
	MW111-EBT-TS6	18-Dec-2002	Water		X		X		X	X	X		X	X								
	MW111-EBT-TS7-97.5-99.5	20-Jan-2003	Water	X																		
	MW111-EBT-TS7	22-Jan-2003	Water		X		X		X	X	X		X	X								
	MW111-EBT-TS9-97.5-99.5	24-Mar-2003	Water	X																		
	MW111-EBT-TS9	26-Mar-2003	Water		X		X		X	X	X		X	X								
	MW111-EBT-TS10-97.5-99.5	21-Apr-2003	Water	X																		
	MW111-EBT-TS10	23-Apr-2003	Water		X		X		X	X	X		X	X								
	MW111-EBT-TS11-97.5-99.5	19-May-2003	Water	X																		
	MW111-EBT-TS11	21-May-2003	Water		X		X		X	X	X		X	X								
	MW111-EBT-TS12-97.5-99.5	23-Jun-2003	Water	X																		
	MW111-EBT-TS12	25-Jun-2003	Water		X		X		X	X	X		X	X								
	MW111-EBT-TS13-97.5-99.5	21-Jul-2003	Water	X																		
	MW111-EBT-TS13	23-Jul-2003	Water		X		X		X	X	X		X	X								
	MW111-EBT-TS14-97.5-99.5	18-Aug-2003	Water	X																		
	MW111-EBT-TS14	20-Aug-2003	Water		X		X		X	X	X		X	X			X					
MW-112 (Area 2)	MW112-98	21-Apr-2002	Soil					X														
	MW-112-EBT-98-100	20-May-2002	Water	X																		
	MW-112-EBT-B	20-May-2002	Water		X		X		X	X	X		X	X								
	MW112-EBT-TS1-98-100	08-Jul-2002	Water	X																		
	MW112-EBT-TS1	10-Jul-2002	Water		X		X		X	X	X		X	X								
	MW112-EBT-TS2-98-100	29-Jul-2002	Water	X																		
	MW112-EBT-TS2	31-Jul-2002	Water		X		X		X	X	X		X	X								
	MW112-EBT-TS3-98-100	03-Sep-2002	Water	X																		
	MW112-EBT-TS3	05-Sep-2002	Water		X		X		X	X	X		X	X								
	MW112-EBT-TS4-98-100	07-Oct-2002	Water	X																		
	MW112-EBT-TS4	09-Oct-2002	Water		X		X		X	X	X		X	X								
	MW112-EBT-TS5-98-100	11-Nov-2002	Water	X																		

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Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

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Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-112 (Area 2)	MW112-EBT-TS5	13-Nov-2002	Water		x		x		x	x	x		x	x								
	MW112-EBT-TS6-98-100	16-Dec-2002	Water	x																		
	MW112-EBT-TS6	18-Dec-2002	Water		x		x		x	x	x		x	x								
	MW112-EBT-TS7-98-100	20-Jan-2003	Water	x																		
	MW112-EBT-TS7	22-Jan-2003	Water		x		x		x	x	x		x	x								
	MW112-EBT-TS9-98-100	24-Mar-2003	Water	x																		
	MW112-EBT-TS9	26-Mar-2003	Water		x		x		x	x	x		x	x								
	MW112-EBT-TS10-98-100	21-Apr-2003	Water	x																		
	MW112-EBT-TS10	23-Apr-2003	Water		x		x		x	x	x		x	x								
	MW112-EBT-TS11-98-100	19-May-2003	Water	x																		
	MW112-EBT-TS11	21-May-2003	Water		x		x		x	x	x		x	x								
	MW112-EBT-TS12-98-100	23-Jun-2003	Water	x																		
	MW112-EBT-TS12	25-Jun-2003	Water		x		x		x	x	x		x	x								
	MW112-EBT-TS13-98-100	21-Jul-2003	Water	x																		
	MW112-EBT-TS13	23-Jul-2003	Water		x		x		x	x	x		x	x								
	MW112-EBT-TS14-98-100	18-Aug-2003	Water	x																		
	MW112-EBT-TS14	20-Aug-2003	Water		x		x		x	x	x		x	x								
MW-113 (Area 2)	MW-133 106'	17-Apr-2002	Soil					x														
	MW113-EBT-B-99.5-104.5	20-May-2002	Water	x																		
	MW113-EBT-B	22-May-2002	Water		x		x		x	x	x		x	x								
	MW113-EBT-TS1-99.5-104.5	08-Jul-2002	Water	x																		
	MW113-EBT-TS1	10-Jul-2002	Water		x		x		x	x	x		x	x								
	MW113-EBT-TS2-99.5-104.5	29-Jul-2002	Water	x																		
	MW113-EBT-TS2	31-Jul-2002	Water		x		x		x	x	x		x	x								
	MW113-EBT-TS3-99.5-104.5	03-Sep-2002	Water	x																		
	MW113-EBT-TS3	05-Sep-2002	Water		x		x		x	x	x		x	x								
	MW113-EBT-TS4-99.5-104.5	07-Oct-2002	Water	x																		
	MW113-EBT-TS4	09-Oct-2002	Water		x		x		x	x	x		x	x								
	MW113-EBT-TS5-99.5-104.5	11-Nov-2002	Water	x																		
	MW113-EBT-TS5	13-Nov-2002	Water		x		x		x	x	x		x	x								
	MW113-EBT-TS6-99.5-104.5	16-Dec-2002	Water	x																		
	MW113-EBT-TS6	18-Dec-2002	Water		x		x		x	x	x		x	x								
	MW113-EBT-TS7-99.5-104.5	20-Jan-2003	Water	x																		
	MW113-EBT-TS7	22-Jan-2003	Water		x		x		x	x	x		x	x								
	MW113-EBT-TS9-99.5-104.5	24-Mar-2003	Water	x																		
	MW113-EBT-TS9	26-Mar-2003	Water		x		x		x	x	x	x	x	x								
	MW113-EBT-TS10-99.5-104.5	21-Apr-2003	Water	x																		
	MW113-EBT-TS10	23-Apr-2003	Water		x		x		x	x	x		x	x								
	MW113-EBT-TS11-99.5-104.5	19-May-2003	Water	x																		
	MW113-EBT-TS11	21-May-2003	Water		x		x		x	x	x		x	x								
	MW113-EBT-TS12-99.5-104.5	23-Jun-2003	Water	x																		
	MW113-EBT-TS12	25-Jun-2003	Water		x		x		x	x	x		x	x								
	MW113-EBT-TS13-99.5-104.5	21-Jul-2003	Water	x																		
	MW113-EBT-TS13	23-Jul-2003	Water		x		x		x	x	x		x	x								
	MW113-EBT-TS14-99.5-104.5	18-Aug-2003	Water	x																		
	MW113-EBT-TS14	20-Aug-2003	Water		x		x		x	x	x		x	x								
MW-114 (Area 2)	MW-114-102	30-Apr-2002	Soil					x														
	MW114-EBT-B-99-101	20-May-2002	Water	x																		
	MW114-EBT-B	22-May-2002	Water		x	x	x		x	x	x		x	x								
	MW114-EBT-TS1-99-101	08-Jul-2002	Water	x																		
	MW114-EBT-TS1	09-Jul-2002	Water		x		x		x	x	x		x	x								
	MW114-EBT-TS2-99-101	29-Jul-2002	Water	x																		

Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / OC)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-114 (Area 2)	MW114-EBT-TS2	30-Jul-2002	Water		x		x		x	x	x		x	x								
	MW114-EBT-TS3-09-101	03-Sep-2002	Water	x																		
	MW114-EBT-TS3	04-Sep-2002	Water		x		x		x	x	x		x	x								
	MW114-EBT-TS4-09-101	07-Oct-2002	Water	x																		
	MW114-EBT-TS4	08-Oct-2002	Water		x		x		x	x	x		x	x								
	MW114-EBT-TS5-09-101	11-Nov-2002	Water	x																		
	MW114-EBT-TS5	12-Nov-2002	Water		x		x		x	x	x		x	x								
	MW114-EBT-TS6-09-101	16-Dec-2002	Water	x																		
	MW114-EBT-TS6	17-Dec-2002	Water		x		x		x	x	x		x	x								
	MW114-EBT-TS7-09-101	20-Jan-2003	Water	x																		
	MW114-EBT-TS7	21-Jan-2003	Water		x	x	x		x	x	x		x	x								
	MW114-EBT-TS9-09-101	24-Mar-2003	Water	x																		
	MW114-EBT-TS9	25-Mar-2003	Water		x		x		x	x	x		x	x								
	MW114-EBT-TS10-09-101	21-Apr-2003	Water	x																		
	MW114-EBT-TS10	22-Apr-2003	Water		x		x		x	x	x		x	x								
	MW114-EBT-TS11-09-101	19-May-2003	Water	x																		
	MW114-EBT-TS11	20-May-2003	Water		x		x		x	x	x		x	x								
	MW114-EBT-TS12-09-101	23-Jun-2003	Water	x																		
	MW114-EBT-TS12	24-Jun-2003	Water		x		x		x	x	x		x	x								
	MW114-EBT-TS13-09-101	21-Jul-2003	Water	x																		
	MW114-EBT-TS13	22-Jul-2003	Water		x		x		x	x	x		x	x								
	MW114-EBT-TS14-09-101	18-Aug-2003	Water	x																		
	MW114-EBT-TS14	19-Aug-2003	Water		x		x		x	x	x		x	x								
MW-115 (Area 1)	MW115-07	22-Apr-2002	Soil					x														
	MW115-EBT-B-04-09	21-May-2002	Water	x																		
	MW115-EBT-B	21-May-2002	Water		x		x		x	x	x		x	x								
	MW115-EBT-TS1-04-09	08-Jul-2002	Water	x																		
	MW115-EBT-TS1	03-Jul-2002	Water		x		x		x	x	x		x	x								
	MW115-EBT-TS2-04-09	29-Jul-2002	Water	x																		
	MW115-EBT-TS2	31-Jul-2002	Water		x		x		x	x	x		x	x								
	MW115-EBT-TS3-04-09	03-Sep-2002	Water	x																		
	MW115-EBT-TS3	06-Sep-2002	Water		x		x		x	x	x		x	x		x						
	MW115-EBT-TS4-04-09	07-Oct-2002	Water	x																		
	MW115-EBT-TS4	08-Oct-2002	Water		x		x		x	x	x		x	x		x						
	MW115-EBT-TS5-04-09	11-Nov-2002	Water	x																		
	MW115-EBT-TS5	12-Nov-2002	Water		x		x		x	x	x		x	x		x						
	MW115-EBT-TS6-04-09	16-Dec-2002	Water	x																		
	MW115-EBT-TS6	17-Dec-2002	Water		x		x		x	x	x		x	x		x						
	MW115-EBT-TS7-04-09	20-Jan-2003	Water	x																		
	MW115-EBT-TS7	22-Jan-2003	Water		x		x		x	x	x		x	x		x						
	MW115-EBT-TS8-04-09	24-Feb-2003	Water	x																		
	MW115-EBT-TS8	24-Feb-2003	Water		x		x		x	x	x		x	x		x						
	MW115-EBT-TS9-04-09	24-Mar-2003	Water	x																		
	MW115-EBT-TS9	26-Mar-2003	Water		x		x		x	x	x		x	x		x						
	MW115-EBT-TS10-04-09	21-Apr-2003	Water	x																		
	MW115-EBT-TS10	22-Apr-2003	Water		x		x		x	x	x		x	x		x						
	MW115-EBT-TS11-04-09	19-May-2003	Water	x																		
	MW115-EBT-TS11	21-May-2003	Water		x		x		x	x	x		x	x		x						
	MW115-EBT-TS12-04-09	23-Jun-2003	Water	x																		
	MW115-EBT-TS12	25-Jun-2003	Water		x		x		x	x	x		x	x		x						
	MW115-EBT-TS13-04-09	21-Jul-2003	Water	x																		
	MW115-EBT-TS13	23-Jul-2003	Water		x		x		x	x	x		x	x		x						

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Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-116 (Area 1)	MW116-100	21-Apr-2002	Soil					x														
	MW116-62.5	21-Apr-2002	Soil	x																		
	MW116-62.5D	21-Apr-2002	Soil	x																		
	MW116-EBT-B-101-106	21-May-2002	Water	x																		
	MW116-EBT-B-101-106D	21-May-2002	Water	x																		
	MW116-EBT-B	22-May-2002	Water		x		x		x	x	x		x	x								
	MW116-EBT-TS1-101-106	06-Jul-2002	Water	x																		
	MW116-EBT-TS1	09-Jul-2002	Water		x		x		x	x	x		x	x								
	MW116-EBT-TS2-101-106	29-Jul-2002	Water	x																		
	MW116-EBT-TS2	31-Jul-2002	Water		x		x		x	x	x		x	x								
	MW116-EBT-TS3-101-106	03-Sep-2002	Water	x																		
	MW116-EBT-TS3-101-106D	03-Sep-2002	Water	x																		
	MW116-EBT-TS3	06-Sep-2002	Water		x		x		x	x	x		x	x		x						
	MW116-EBT-TS4-101-106	07-Oct-2002	Water	x																		
	MW116-EBT-TS4	09-Oct-2002	Water		x		x		x	x	x		x	x		x						
	MW116-EBT-TS5-101-106	11-Nov-2002	Water	x																		
	MW116-EBT-TS5-101-106D	11-Nov-2002	Water	x																		
	MW116-EBT-TS5	13-Nov-2002	Water		x		x		x	x	x		x	x		x						
	MW116-EBT-TS6-101-106	16-Dec-2002	Water	x																		
	MW116-EBT-TS6-101-106D	16-Dec-2002	Water	x																		
	MW116-EBT-TS6	17-Dec-2002	Water		x		x		x	x	x		x	x								
	MW116-EBT-TS7-101-106	20-Jan-2003	Water	x																		
	MW116-EBT-TS7-101-106D	20-Jan-2003	Water	x																		
	MW116-EBT-TS7	22-Jan-2003	Water		x		x		x	x	x		x	x		x						
	MW116-EBT-TS8-101-106	24-Feb-2003	Water	x																		
	MW116-EBT-TS8-101-106D	24-Feb-2003	Water	x																		
	MW116-EBT-TS8	25-Feb-2003	Water		x		x		x	x	x		x	x		x						
	MW116-EBT-TS9-101-106	24-Mar-2003	Water	x																		
	MW116-EBT-TS9-101-106D	24-Mar-2003	Water	x																		
	MW116-EBT-TS9	25-Mar-2003	Water		x		x		x	x	x		x	x		x						
	MW116-EBT-TS10-101-106	21-Apr-2003	Water	x																		
	MW116-EBT-TS10-101-106D	21-Apr-2003	Water	x																		
	MW116-EBT-TS10	22-Apr-2003	Water		x		x		x	x	x		x	x		x						
	MW116-EBT-TS11-101-106	19-May-2003	Water	x																		
	MW116-EBT-TS11-101-106D	19-May-2003	Water	x																		
	MW116-EBT-TS11	20-May-2003	Water		x		x		x	x	x		x	x		x						
	MW116-EBT-TS12-101-106	23-Jun-2003	Water	x																		
	MW116-EBT-TS12-101-106D	23-Jun-2003	Water	x																		
	MW116-EBT-TS12	24-Jun-2003	Water		x		x		x	x	x		x	x		x						
	MW116-EBT-TS13-101-106	21-Jul-2003	Water	x																		
	MW116-EBT-TS13-101-106D	21-Jul-2003	Water	x																		
	MW116-EBT-TS13	22-Jul-2003	Water		x		x		x	x	x		x	x		x						
MW-117 (Area 1)	MW117-95	01-May-2002	Soil					x														
	MW117-EBT-B-101-106	21-May-2002	Water	x																		
	MW117-EBT-B	22-May-2002	Water		x		x		x	x	x		x	x								
	MW117-EBT-TS1-101-106	06-Jul-2002	Water	x																		
	MW117-EBT-TS1	06-Jul-2002	Water													x						
	MW117-EBT-TS1	11-Jul-2002	Water	x	x		x		x	x	x		x	x								
	MW117-EBT-TS2-101-106	29-Jul-2002	Water	x																		
	MW117-EBT-TS2	30-Jul-2002	Water		x		x		x	x	x		x	x		x						x
	MW117-EBT-TS3-101-106	03-Sep-2002	Water	x																		
	MW117-EBT-TS3	05-Sep-2002	Water		x		x		x	x	x		x	x		x						
	MW117-EBT-TS3-oil	05-Sep-2002	Oil	x																		

Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-117 (Area 1)	MW117-EBT-TS4-101-106	07-Oct-2002	Water	x																		
	MW117-EBT-TS4	09-Oct-2002	Water		x		x		x	x	x		x	x		x						
	MW117-EBT-TS4-oil	09-Oct-2002	Oil	x																		
	MW117-EBT-TS5-101-106	11-Nov-2002	Water	x																		
	MW117-EBT-TS5	14-Nov-2002	Water		x		x		x	x	x		x	x		x						
	MW117-EBT-TS5-oil	13-Nov-2002	Oil	x																		
	MW117-EBT-TS6-101-106	16-Dec-2002	Water	x																		
	MW117-EBT-TS6	18-Dec-2002	Water		x		x		x	x	x		x	x		x						
	MW117-EBT-TS6-oil	18-Dec-2002	Oil	x																		
	MW117-EBT-TS7-101-106	20-Jan-2003	Water	x																		
	MW117-EBT-TS7	23-Jan-2003	Water		x		x		x	x	x		x	x		x						
	MW117-EBT-TS8-101-106	24-Feb-2003	Water	x																		
	MW117-EBT-TS8	26-Feb-2003	Water		x		x		x	x	x		x	x								
	MW117-EBT-TS8	27-Feb-2003	Water													x						
	MW117-EBT-TS9-101-106	24-Mar-2003	Water	x																		
	MW117-EBT-TS9	26-Mar-2003	Water		x		x		x	x	x		x	x		x						
	MW117-EBT-TS10-101-106	21-Apr-2003	Water	x																		
	MW117-EBT-TS10	23-Apr-2003	Water		x		x		x	x	x		x	x		x						
	MW117-EBT-TS11-101-106	19-May-2003	Water	x																		
	MW117-EBT-TS11	21-May-2003	Water		x		x		x	x	x		x	x		x						
	MW117-EBT-TS12-101-106	23-Jun-2003	Water	x																		
	MW117-EBT-TS12	25-Jun-2003	Water		x		x		x	x	x		x	x		x						
	MW117-EBT-TS13	21-Jul-2003	Water	x	x		x		x	x	x		x	x		x						
MW-118 (Area 1)	MW-118-100	01-May-2002	Soil					x														
	MW118-EBT-B-84-89	21-May-2002	Water	x																		
	MW118-EBT-B	22-May-2002	Water		x		x		x	x	x		x	x								
	MW118-EBT-TS1-84-89	08-Jul-2002	Water	x																		
	MW118-EBT-TS1	09-Jul-2002	Water		x		x		x	x	x		x	x								
	MW118-EBT-TS2-84-89	29-Jul-2002	Water	x																		
	MW118-EBT-TS2	30-Jul-2002	Water		x		x		x	x	x		x	x								
	MW118-EBT-TS3-84-89	03-Sep-2002	Water	x																		
	MW118-EBT-TS3	06-Sep-2002	Water		x		x		x	x	x		x	x		x						
	MW118-EBT-TS4-84-89	07-Oct-2002	Water	x																		
	MW118-EBT-TS4	08-Oct-2002	Water		x		x		x	x	x		x	x		x						
	MW118-EBT-TS5-84-89	11-Nov-2002	Water	x																		
	MW118-EBT-TS5	12-Nov-2002	Water		x		x		x	x	x		x	x		x						
	MW118-EBT-TS6-84-89	16-Dec-2002	Water	x																		
	MW118-EBT-TS6	17-Dec-2002	Water		x		x		x	x	x		x	x		x						
	MW118-EBT-TS7-84-89	20-Jan-2003	Water	x																		
	MW118-EBT-TS7	21-Jan-2003	Water		x		x		x	x	x		x	x		x						
	MW118-EBT-TS8-84-89	24-Feb-2003	Water	x																		
	MW118-EBT-TS8	25-Feb-2003	Water		x		x		x	x	x		x	x		x						
	MW118-EBT-TS9-84-89	24-Mar-2003	Water	x																		
	MW118-EBT-TS9	25-Mar-2003	Water		x		x		x	x	x		x	x		x						
	MW118-EBT-TS10-84-89	21-Apr-2003	Water	x																		
	MW118-EBT-TS10	22-Apr-2003	Water		x		x		x	x	x		x	x		x						
	MW118-EBT-TS11-84-89	19-May-2003	Water	x																		
	MW118-EBT-TS11	20-May-2003	Water		x		x		x	x	x		x	x		x						
	MW118-EBT-TS12-84-89	23-Jun-2003	Water	x																		
	MW118-EBT-TS12	24-Jun-2003	Water		x		x		x	x	x		x	x		x						
	MW118-EBT-TS13-84-89	21-Jul-2003	Water	x																		
	MW118-EBT-TS13	22-Jul-2003	Water		x		x		x	x	x		x	x		x						

Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selinium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-119 (Area 1)	MW-119-88	02-May-2002	Soil					x														
	MW119-EBT-B-84-89	21-May-2002	Water	x																		
	MW119-EBT-B	22-May-2002	Water		x		x		x	x	x		x	x								
	MW119-EBT-TS1-84-89	08-Jul-2002	Water	x																		
	MW119-EBT-TS1	09-Jul-2002	Water		x		x		x	x	x		x	x								
	MW119-EBT-TS2-84-89	29-Jul-2002	Water	x																		
	MW119-EBT-TS2-84-89D	29-Jul-2002	Water	x																		
	MW119-EBT-TS2	30-Jul-2002	Water		x		x		x	x	x		x	x								
	MW119-EBT-TS2D	30-Jul-2002	Water		x		x		x	x	x		x	x								
	MW119-EBT-TS3-84-89	03-Sep-2002	Water	x																		
	MW119-EBT-TS3-84-89D	03-Sep-2002	Water	x																		
	MW119-EBT-TS3	05-Sep-2002	Water		x		x		x	x	x		x	x		x						
	MW119-EBT-TS3D	05-Sep-2002	Water		x		x		x	x	x		x	x		x						
	MW119-EBT-TS4-84-89	07-Oct-2002	Water	x																		
	MW119-EBT-TS4	08-Oct-2002	Water		x		x		x	x	x		x	x		x						
	MW119-EBT-TS5-84-89	11-Nov-2002	Water	x																		
	MW119-EBT-TS5	13-Nov-2002	Water		x		x		x	x	x		x	x		x						
	MW119-EBT-TS6-84-89	16-Dec-2002	Water	x																		
	MW119-EBT-TS6	16-Dec-2002	Water		x		x		x	x	x		x	x		x						
	MW119-EBT-TS7-84-89	20-Jan-2003	Water	x																		
	MW119-EBT-TS7	21-Jan-2003	Water		x		x		x	x	x		x	x		x						
	MW119-EBT-TS8-84-89	24-Feb-2003	Water	x																		
	MW119-EBT-TS8	26-Feb-2003	Water		x		x		x	x	x		x	x								
	MW119-EBT-TS8	27-Feb-2003	Water													x						
	MW119-EBT-TS9-84-89	24-Mar-2003	Water	x																		
	MW119-EBT-TS9	26-Mar-2003	Water		x		x		x	x	x		x	x		x						
	MW119-EBT-TS10-84-89	21-Apr-2003	Water	x																		
	MW119-EBT-TS10	23-Apr-2003	Water		x		x		x	x	x		x	x								
	MW119-EBT-TS11-84-89	19-May-2003	Water	x																		
	MW119-EBT-TS11	21-May-2003	Water		x		x		x	x	x		x	x		x						
	MW119-EBT-TS12-84-89	23-Jun-2003	Water	x																		
	MW119-EBT-TS12	24-Jun-2003	Water		x		x		x	x	x		x	x		x						
	MW119-EBT-TS13-84-89	21-Jul-2003	Water	x																		
	MW119-EBT-TS13	23-Jul-2003	Water		x		x		x	x	x		x	x		x						
MW-120 (Area 1)	MW120-100	20-Apr-2002	Soil					x														
	MW120-62.8soil	19-Apr-2002	Soil	x																		
	MW120-EBT-B-101-106	21-May-2002	Water	x																		
	MW120-EBT-B	22-May-2002	Water		x		x		x	x	x		x	x								
	MW120-EBT-TS1-101-106	08-Jul-2002	Water	x																		
	MW120-EBT-TS1	10-Jul-2002	Water		x		x		x	x	x		x	x		x						
	MW120-EBT-TS2-101-106	29-Jul-2002	Water	x																		
	MW120-EBT-TS2	30-Jul-2002	Water		x		x		x	x	x		x	x								
	MW120-EBT-TS3-101-106	03-Sep-2002	Water	x																		
	MW120-EBT-TS3	06-Sep-2002	Water				x															
	MW120-EBT-TS3	06-Sep-2002	Water		x				x	x	x		x	x		x						
	MW120-EBT-TS4-101-106	07-Oct-2002	Water	x																		
	MW120-EBT-TS4	08-Oct-2002	Water		x		x		x	x	x		x	x		x						
	MW120-EBT-TS5-101-106	11-Nov-2002	Water	x																		
	MW120-EBT-TS5	13-Nov-2002	Water		x		x		x	x	x		x	x		x						
	MW120-EBT-TS6-101-106	16-Dec-2002	Water	x																		
	MW120-EBT-TS6	17-Dec-2002	Water		x		x		x	x	x		x	x		x						
	MW120-EBT-TS6D	17-Dec-2002	Water		x		x		x	x	x		x	x		x						
	MW120-EBT-TS7-101-106	20-Jan-2003	Water	x																		

Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / OC)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-120 (Area 1)	MW120-EBT-TS7	22-Jan-2003	Water		X		X		X	X	X		X	X		X						
	MW120-EBT-TS7D	22-Jan-2003	Water		X		X		X	X	X		X	X		X						
	MW120-EBT-TS8-101-106	24-Feb-2003	Water	X																		
	MW120-EBT-TS8	25-Feb-2003	Water		X		X		X	X	X		X	X		X						
	MW120-EBT-TS8D	25-Feb-2003	Water		X		X		X	X	X		X	X		X						
	MW120-EBT-TS9-101-106	24-Mar-2003	Water	X																		
	MW120-EBT-TS9	25-Mar-2003	Water		X		X		X	X	X		X	X		X						
	MW120-EBT-TS9D	25-Mar-2003	Water		X		X		X	X	X		X	X		X						
	MW120-EBT-TS10-101-106	21-Apr-2003	Water	X																		
	MW120-EBT-TS10	22-Apr-2003	Water		X		X		X	X	X		X	X		X						
	MW120-EBT-TS10D	22-Apr-2003	Water		X		X		X	X	X		X	X		X						
	MW120-EBT-TS11-101-106	19-May-2003	Water	X																		
	MW120-EBT-TS11	20-May-2003	Water		X		X		X	X	X		X	X		X						
	MW120-EBT-TS11D	20-May-2003	Water		X		X		X	X	X		X	X		X						
	MW120-EBT-TS12-101-106	23-Jun-2003	Water	X																		
	MW120-EBT-TS12	23-Jun-2003	Water		X		X		X	X	X		X	X		X						
	MW120-EBT-TS12D	23-Jun-2003	Water		X		X		X	X	X		X	X		X						
	MW120-EBT-TS13-101-106	21-Jul-2003	Water	X																		
	MW120-EBT-TS13	22-Jul-2003	Water		X		X		X	X	X		X	X		X						
	MW120-EBT-TS13D	22-Jul-2003	Water		X		X		X	X	X		X	X		X						
MW-121 (Area 1)	MW121-102	20-Apr-2002	Soil					X														
	MW121-102D	20-Apr-2002	Soil					X														
	MW121-EBT-B-96-100	21-May-2002	Water	X																		
	MW121-EBT-B	22-May-2002	Water		X	X	X		X	X	X		X	X								
	MW121-EBT-B-D	22-May-2002	Water		X	X	X		X	X	X		X	X								
	MW121-EBT-TS1-96-100	08-Jul-2002	Water	X																		
	MW121-EBT-TS1	10-Jul-2002	Water		X		X		X	X	X		X	X								
	MW121-EBT-TS2-96-100	29-Jul-2002	Water	X																		
	MW121-EBT-TS2	31-Jul-2002	Water		X		X		X	X	X		X	X								
	MW121-EBT-TS3-96-100	03-Sep-2002	Water	X																		
	MW121-EBT-TS3	05-Sep-2002	Water				X															
	MW121-EBT-TS3	06-Sep-2002	Water		X				X	X	X		X	X		X						
	MW121-EBT-TS4-96-100	07-Oct-2002	Water	X																		
	MW121-EBT-TS4	08-Oct-2002	Water		X		X		X	X	X		X	X		X						
	MW121-EBT-TS5-96-100	11-Nov-2002	Water	X																		
	MW121-EBT-TS5	12-Nov-2002	Water		X		X		X	X	X		X	X		X						
	MW121-EBT-TS6-96-100	16-Dec-2002	Water	X																		
	MW121-EBT-TS6	18-Dec-2002	Water		X		X		X	X	X		X	X		X						
	MW121-EBT-TS7-96-100	20-Jan-2003	Water	X																		
	MW121-EBT-TS7	22-Jan-2003	Water		X	X	X		X	X	X		X	X		X						
	MW121-EBT-TS8-96-100	24-Feb-2003	Water	X																		
	MW121-EBT-TS8	27-Feb-2003	Water		X		X		X	X	X		X	X		X						
	MW121-EBT-TS9-96-100	24-Mar-2003	Water	X																		
	MW121-EBT-TS9	24-Mar-2003	Water		X		X		X	X	X		X	X		X						
	MW121-EBT-TS10-96-100	21-Apr-2003	Water	X																		
	MW121-EBT-TS10	24-Apr-2003	Water		X		X		X	X	X		X	X		X						
	MW121-EBT-TS11-96-100	19-May-2003	Water	X																		
	MW121-EBT-TS11	21-May-2003	Water		X		X		X	X	X		X	X		X						
	MW121-EBT-TS12-96-100	23-Jun-2003	Water	X																		
	MW121-EBT-TS12	26-Jun-2003	Water		X		X		X	X	X		X	X		X						
	MW121-EBT-TS13-96-100	21-Jul-2003	Water	X																		
	MW121-EBT-TS13	23-Jul-2003	Water		X		X		X	X	X		X	X		X						

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Summary of Sample Information
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Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-122 (Area 1)	MW122-102	04-May-2002	Soil					x														
	MW122-EBT-B-101-106	21-May-2002	Water	x																		
	MW122-EBT-B	23-May-2002	Water		x		x		x	x	x		x	x								
	MW122-EBT-TS1-101-106	08-Jul-2002	Water	x																		
	MW122-EBT-TS1-101-106D	08-Jul-2002	Water	x																		
	MW122-EBT-TS1	11-Jul-2002	Water		x		x		x	x	x		x	x								
	MW122-EBT-TS2-101-106	29-Jul-2002	Water	x																		
	MW122-EBT-TS2	31-Jul-2002	Water		x		x		x	x	x		x	x								
	MW122-EBT-TS3-101-106	03-Sep-2002	Water	x																		
	MW122-EBT-TS3	06-Sep-2002	Water		x		x		x	x	x		x	x		x						
	MW122-EBT-TS4-101-106	07-Oct-2002	Water	x																		
	MW122-EBT-TS4-101-106D	07-Oct-2002	Water	x																		
	MW122-EBT-TS4	09-Oct-2002	Water		x		x		x	x	x		x	x		x						
	MW122-EBT-TS5	13-Nov-2002	Water	x	x		x		x	x	x		x	x		x						
	MW122-EBT-TS6-101-106	16-Dec-2002	Water	x																		
	MW122-EBT-TS6	18-Dec-2002	Water		x		x		x	x	x		x	x		x						
	MW122-EBT-TS7-101-106	20-Jan-2003	Water	x																		
	MW122-EBT-TS7	21-Jan-2003	Water		x		x		x	x	x		x	x		x						
	MW122-EBT-TS8-101-106	24-Feb-2003	Water	x																		
	MW122-EBT-TS8	25-Feb-2003	Water		x		x		x	x	x		x	x		x						
	MW122-EBT-TS9-101-106	24-Mar-2003	Water	x																		
	MW122-EBT-TS9	26-Mar-2003	Water		x		x		x	x	x		x	x		x						
	MW122-EBT-TS10-101-106	21-Apr-2003	Water	x																		
	MW122-EBT-TS10	22-Apr-2003	Water		x		x		x	x	x		x	x		x						
	MW122-EBT-TS11-101-106	19-May-2003	Water	x																		
	MW122-EBT-TS11	20-May-2003	Water		x		x		x	x	x		x	x		x						
	MW122-EBT-TS12-101-106	23-Jun-2003	Water	x																		
	MW122-EBT-TS12	24-Jun-2003	Water		x		x		x	x	x		x	x		x						
	MW122-EBT-TS13-101-106	21-Jul-2003	Water	x																		
	MW122-EBT-TS13	22-Jul-2003	Water		x		x		x	x	x		x	x		x						
MW-123 (Area 1)	MW123-100	29-Apr-2002	Soil					x														
	MW123-EBT-B-96-101	21-May-2002	Water	x																		
	MW123-EBT-B	23-May-2002	Water		x	x	x		x	x	x		x	x								
	MW123-EBT-TS1-96-101	08-Jul-2002	Water	x																		
	MW123-EBT-TS1	10-Jul-2002	Water		x		x		x	x	x		x	x								
	MW123-EBT-TS2-96-101	29-Jul-2002	Water	x																		
	MW123-EBT-TS2	30-Jul-2002	Water		x		x		x	x	x		x	x								
	MW123-EBT-TS3-96-101	03-Sep-2002	Water	x																		
	MW123-EBT-TS3	05-Sep-2002	Water		x		x		x	x	x		x	x		x						
	MW123-EBT-TS3-oil	05-Sep-2002	Oil	x																		
	MW123-EBT-TS4-96-101	07-Oct-2002	Water	x																		
	MW123-EBT-TS4	10-Oct-2002	Water		x		x		x	x	x		x	x		x						
	MW123-EBT-TS4D	10-Oct-2002	Water		x		x		x	x	x		x	x		x						
	MW123-EBT-TS5-96-101	11-Nov-2002	Water	x																		
	MW123-EBT-TS5	13-Nov-2002	Water		x		x		x	x	x		x	x		x						
	MW123-EBT-TS6-96-101	16-Dec-2002	Water	x																		
	MW123-EBT-TS6	18-Dec-2002	Water		x		x		x	x	x		x	x		x						
	MW123-EBT-TS7-96-101	20-Jan-2003	Water	x																		
	MW123-EBT-TS7	22-Jan-2003	Water		x	x	x		x	x	x		x	x		x						
	MW123-EBT-TS8-96-101	24-Feb-2003	Water	x																		
	MW123-EBT-TS8	25-Feb-2003	Water		x		x		x	x	x		x	x		x						
	MW123-EBT-TS9-96-101	24-Mar-2003	Water	x																		
	MW123-EBT-TS9	27-Mar-2003	Water		x		x		x	x	x		x	x		x						

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Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	FID TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-123 (Area 1)	MW123-EBT-TS10-06-101	21-Apr-2003	Water	X																		
	MW123-EBT-TS10	23-Apr-2003	Water		X		X		X	X	X		X	X		X						
	MW123-EBT-TS11-06-101	19-May-2003	Water	X																		
	MW123-EBT-TS11	21-May-2003	Water		X		X		X	X	X		X	X		X						
	MW123-EBT-TS12-06-101	23-Jun-2003	Water	X																		
	MW123-EBT-TS12	25-Jun-2003	Water		X		X		X	X	X		X	X		X						
	MW123-EBT-TS13-06-101	21-Jul-2003	Water	X																		
	MW123-EBT-TS13	23-Jul-2003	Water		X		X		X	X	X		X	X		X						
MW-124 (Area 1)	MW124-100	03-May-2002	Soil					X														
	MW124-100D	03-May-2002	Soil					X														
	MW124-EBT-B-06-101	21-May-2002	Water	X																		
	MW124-EBT-B	23-May-2002	Water		X		X		X	X	X		X	X								
	MW124-EBT-TS1-06-101	06-Jul-2002	Water	X																		
	MW124-EBT-TS1	10-Jul-2002	Water		X		X		X	X	X		X	X								
	MW124-EBT-TS1-D	10-Jul-2002	Water		X		X		X	X	X		X	X								
	MW124-EBT-TS2-06-101	29-Jul-2002	Water	X																		
	MW124-EBT-TS2	31-Jul-2002	Water		X		X		X	X	X		X	X								
	MW124-EBT-TS3-06-101	03-Sep-2002	Water	X																		
	MW124-EBT-TS3	03-Sep-2002	Water		X		X		X	X	X		X	X		X						
	MW124-EBT-TS4-06-101	07-Oct-2002	Water	X																		
	MW124-EBT-TS4	09-Oct-2002	Water		X		X		X	X	X		X	X		X						
	MW124-EBT-TS5-06-101	11-Nov-2002	Water	X																		
	MW124-EBT-TS5	12-Nov-2002	Water		X		X		X	X	X		X	X		X						
	MW124-EBT-TS6-06-101	16-Dec-2002	Water	X																		
	MW124-EBT-TS6	17-Dec-2002	Water		X		X		X	X	X		X	X		X						
	MW124-EBT-TS7-06-101	20-Jan-2003	Water	X																		
	MW124-EBT-TS7	21-Jan-2003	Water		X		X		X	X	X		X	X		X						
	MW124-EBT-TS8-06-101	24-Feb-2003	Water	X																		
	MW124-EB-TS8	25-Feb-2003	Water		X		X		X	X	X		X	X		X						
	MW124-EBT-TS9-06-101	24-Mar-2003	Water	X																		
	MW124-EB-TS9	25-Mar-2003	Water		X		X		X	X	X		X	X		X						
	MW124-EBT-TS10-06-101	21-Apr-2003	Water	X																		
	MW124-EB-TS10	23-Apr-2003	Water		X		X		X	X	X		X	X		X						
	MW124-EBT-TS11-06-101	19-May-2003	Water	X																		
	MW124-EB-TS11	20-May-2003	Water		X		X		X	X	X		X	X		X						
	MW124-EBT-TS12-06-101	23-Jun-2003	Water	X																		
	MW124-EBT-TS12	24-Jun-2003	Water		X		X		X	X	X		X	X		X						
	MW124-EBT-TS13-06-101	21-Jul-2003	Water	X																		
	MW124-EBT-TS13	22-Jul-2003	Water		X		X		X	X	X		X	X		X						
MW-125 (Area 1)	MW125-105	23-Apr-2002	Soil					X														
	MW125-EBT-B-09-104	21-May-2002	Water	X																		
	MW125-EBT-B-09-104D	21-May-2002	Water	X																		
	MW125-EBT-B	23-May-2002	Water		X		X		X	X	X		X	X								
	MW125-EBT-TS1-09-104	06-Jul-2002	Water	X																		
	MW125-EBT-TS1	10-Jul-2002	Water		X		X		X	X	X		X	X		X						
	MW125-EBT-TS2-09-104	29-Jul-2002	Water	X																		
	MW125-EBT-TS2	30-Jul-2002	Water		X		X		X	X	X		X	X								
	MW125-EBT-TS3-09-104	03-Sep-2002	Water	X																		
	MW125-EBT-TS3	05-Sep-2002	Water		X		X		X	X	X		X	X		X						
	MW125-EBT-TS4-09-104	07-Oct-2002	Water	X																		
	MW125-EBT-TS4	09-Oct-2002	Water		X		X		X	X	X		X	X		X						

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Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
MW-125 (Area 1)	MW125-EBT-TS5-89-104	11-Nov-2002	Water	X																		
	MW125-EBT-TS5-89-104D	11-Nov-2002	Water	X																		
	MW125-EBT-TS5	12-Nov-2002	Water		X		X		X	X	X		X	X		X						
	MW125-EBT-TS6-89-104	16-Dec-2002	Water	X																		
	MW125-EBT-TS6-89-104D	16-Dec-2002	Water	X																		
	MW125-EBT-TS6	18-Dec-2002	Water		X		X		X	X	X		X	X		X						
	MW125-EBT-TS7-89-104	20-Jan-2003	Water	X																		
	MW125-EBT-TS7-89-104D	20-Jan-2003	Water	X																		
	MW125-EBT-TS7	21-Jan-2003	Water		X		X		X	X	X		X	X		X						
	MW125-EBT-TS8-89-104	24-Feb-2003	Water	X																		
	MW125-EBT-TS8	26-Feb-2003	Water		X		X		X	X	X		X	X		X						
	MW125-EBT-TS9-89-104	24-Mar-2003	Water	X																		
	MW125-EBT-TS9-89-104D	24-Mar-2003	Water	X																		
	MW125-EBT-TS9	26-Mar-2003	Water		X		X		X	X	X		X	X		X						
	MW125-EBT-TS10-89-104	21-Apr-2003	Water	X																		
	MW125-EBT-TS10-89-104D	21-Apr-2003	Water	X																		
	MW125-EBT-TS10	23-Apr-2003	Water		X		X		X	X	X		X	X		X						
	MW125-EBT-TS11-89-104	19-May-2003	Water	X																		
	MW125-EBT-TS11-89-104D	19-May-2003	Water	X																		
	MW125-EBT-TS11	22-May-2003	Water		X		X		X	X	X		X	X		X						
	MW125-EBT-TS12-89-104	23-Jun-2003	Water	X																		
	MW125-EBT-TS12-89-104D	23-Jun-2003	Water	X																		
	MW125-EBT-TS12	25-Jun-2003	Water		X		X		X	X	X		X	X		X						
	MW125-EBT-TS13-89-104	21-Jul-2003	Water	X																		
	MW125-EBT-TS13-89-104D	21-Jul-2003	Water	X																		
	MW125-EBT-TS13	23-Jul-2003	Water		X		X		X	X	X		X	X		X						
Source Blank	Source Blank	20-Feb-2002	Water	X																		
	EBT-8-SB	07-May-2002	Water	X																		
	EBT-vegoil-Pre	12-Jun-2002	Oil	X																		
	EBT-vegoil-Post	13-Jun-2002	Oil	X																		
	LACTATE 2	17-Jun-2002	Oil	X																		
	HYD-AREA 1	21-Jun-2002	Water	X																		
	HYD-AREA 2	21-Jun-2002	Water	X																		
	FTANK-AREA2	20-Jun-2002	Oil/Water	X																	X	
	Source-EBT-062202	22-Jun-2002	Water	X																		
	MW108-EBT-TS2-SB	29-Jul-2002	Water	X																		
	MW108-EBT-TS3-SB	03-Sep-2002	Water	X																		
	MW108-EBT-TS4-SB	07-Oct-2002	Water	X																		
	MW108-EBT-TS5-SB	11-Nov-2002	Water	X																		
	MW108-EBT-TS6-SB	16-Dec-2002	Water	X																		
	MW124-EBT-TS7-SB	23-Jan-2003	Water	X																		
	MW21-EBT-TS8-88.5-103.5-SB	24-Feb-2003	Water	X																		
	MI-EBT-Injfluid_EXT	26-Feb-2003	Water	X																		
	MI-EBT-Lactate_EXT	26-Feb-2003	Oil	X																		
	MW110-EBT-TS9-SB	24-Mar-2003	Water	X																		
	MW110-EBT-TS10-SB	21-Apr-2003	Water	X																		
	Sodium Lactate - EBT3INJ	29-Apr-2003	Oil	X																		
	Injection Mix - EBT3INJ	30-Apr-2003	Water	X																		
	MW21-EBT-TS11-88.5-103.5-SB	19-May-2003	Water	X																		
	Sodium Lactate - EBT4INJ	28-May-2003	Oil	X																		

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Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	FuG TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
Source Blank	Injection Mix - EBT40U	23-May-2003	Water	X																		
	MW119-EBT-TS12-SB	23-Jun-2003	Water	X																		
	MW119-EBT-TS13-SB	21-Jul-2003	Water	X																		
Equipment Blank	E BLK-01	20-Feb-2002	Water	X																		
	EB-SL	20-Mar-2002	Water	X																		
	EBT-B-EB	07-May-2002	Water	X																		
	MW121-EBT-B-EB	22-May-2002	Water		X	X	X		X	X	X		X	X								
	MW121-EBT-TS1-EB	10-Jul-2002	Water		X	X	X		X	X	X		X	X								
	MW106-EBT-TS2-EB	29-Jul-2002	Water	X																		
	MW121-EBT-TS2-EB	31-Jul-2002	Water		X		X		X	X	X		X	X								
	MW106-EBT-TS3-EB	03-Sep-2002	Water	X																		
	MW121-EBT-TS3-EB	05-Sep-2002	Water				X															
	MW121-EBT-TS3-EB	06-Sep-2002	Water		X				X	X	X		X	X		X						
	MW106-EBT-TS4-EB	07-Oct-2002	Water	X																		
	MW121-EBT-TS4-EB	08-Oct-2002	Water		X		X		X	X	X		X	X		X						
	MW106-EBT-TS5-EB	11-Nov-2002	Water	X																		
	MW121-EBT-TS5-EB	12-Nov-2002	Water		X		X		X	X	X		X	X		X						
	MW106-EBT-TS6-EB	16-Dec-2002	Water	X																		
	MW121-EBT-TS6-EB	18-Dec-2002	Water		X		X		X	X	X		X	X		X						
	MW121-EBT-TS7-EB	22-Jan-2003	Water		X	X	X		X	X	X		X	X		X						
	MW124-EBT-TS7-EB	23-Jan-2003	Water	X																		
	MW21-EBT-TS8-98.5-103.5-EB	24-Feb-2003	Water	X																		
	MW121-EBT-TS8-EB	27-Feb-2003	Water		X		X		X	X	X					X						
	MW119-EBT-TS9-EB	24-Mar-2003	Water	X																		
	MW121-EBT-TS9-EB	25-Mar-2003	Water		X		X		X	X	X					X						
	MW119-EBT-TS10-EB	21-Apr-2003	Water	X																		
	MW121-EBT-TS10-EB	24-Apr-2003	Water		X		X		X	X	X					X						
	MW21-EBT-TS11-98.5-103.5-EB	19-May-2003	Water	X																		
	MW121-EBT-TS11-EB	21-May-2003	Water		X		X		X	X	X					X						
	MW119-EBT-TS12-EB	23-Jun-2003	Water	X																		
	MW121-EBT-TS12-EB	26-Jun-2003	Water		X		X		X	X	X					X						
	MW119-EBT-TS13-EB	21-Jul-2003	Water	X																		
	MW121-EBT-TS13-EB	23-Jul-2003	Water		X		X		X	X	X					X						
	MW89-EBT-TS14-EB	19-Aug-2003	Water		X		X		X	X	X											
Trip Blank	Trip Blank	20-Feb-2002	Water	X																		
	Trip Blank	20-Feb-2002	Water	X																		
	Trip Blank	24-Apr-2002	Water	X																		
	Trip Blank	07-May-2002	Water	X																		
	Trip Blank	20-May-2002	Water	X																		
	Trip Blank	13-Jun-2002	Water	X																		
	Trip Blank	22-Jun-2002	Water	X																		
	Trip Blank	08-Jul-2002	Water	X																		
	Trip Blank	29-Jul-2002	Water	X										X								
	Trip Blank	03-Sep-2002	Water	X																		
	Trip Blank	06-Sep-2002	Water											X								
	Trip Blank - 021007	07-Oct-2002	Water	X																		
	Trip Blank - 021010	10-Oct-2002	Water											X								
	Trip Blank - 021111	11-Nov-2002	Water	X																		
	Trip Blank - 021113	13-Nov-2002	Water	X																		

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Attachment B
Summary of Sample Information
Main Installation, Memphis Depot

Well	Sample ID	Sample Date	Matrix (Soil / Water / Oil)	Volatile Organic Carbons (8260B)	Manganese (6010B)	Arsenic/ Selenium (6020)	Nitrate, Nitrite, Sulfate, Chloride, Bromide (9056)	Total Organic Carbon (9060)	Dissolved Organic Carbon (9060)	Sulfide (376.1)	Alkalinity (310.1)	Metabolic Acids	Volatile Fatty Acids (AM21G)	Methane, Ethane, Ethene (AM18)	Methane, Ethane, Ethene (RSK 175)	Oil in Water (1664)	Q-PCR Dehalo	Full TCLP (TCLP)	pH	Flash Point	Ignitability	Hexane Extractable Material (HEA)
Trip Blank	Trip Blank - 021114	14-Nov-2002	Water											x								
	Trip Blank - 021216	16-Dec-2002	Water	x																		
	Trip Blank - 021218	18-Dec-2002	Water	x																		
	Trip Blank - 021118	19-Dec-2002	Water											x								
	Trip Blank - 030120	20-Jan-2003	Water	x																		
	Trip Blank - 030123	23-Jan-2003	Water	x																		
	Trip Blank - 030124	24-Jan-2003	Water											x								
	Trip Blank - 030224	24-Feb-2003	Water	x																		
	TRIPBLANK030227	27-Feb-2003	Water	x																		
	Trip Blank - 030324	24-Mar-2003	Water	x																		
	Trip Blank - 032104	21-Apr-2003	Water	x																		
	Trip Blank - 030501	21-Apr-2003	Water	x																		
	TRIPBLANK030519	19-May-2003	Water	x																		
	TRIPBLANK030520	20-May-2003	Water	x																		
	Trip Blank - 032808	28-May-2003	Water	x																		
	Trip Blank - 030623	23-Jun-2003	Water	x																		
	Trip Blank - 030721	21-Jul-2003	Water	x																		
	Trip Blank - 030724	24-Jul-2003	Water	x																		
	Trip Blank - 030818	18-Aug-2003	Water	x																		
IDW	EBT-IDW-05072002	07-May-2002	Soil	x														x				
	EBT-IDW-05072002	07-May-2002	Water																x	x		

Notes:
BL or B = Baseline value
* A total of 10 samples were collected: MW-100-1 through MW-100-10.
** A total of 6 samples were collected: MW-85-1 through MW-85-6.
*** A total of 9 samples were collected: MW-86-1 through MW-86-9.
**** A total of 8 samples were collected: MW-88-1 through MW-88-8.

ATTACHMENT C

Water Level Measurements

Attachment C.3
Summary of Water Level Measurements
Study Areas
Main Installation, Memphis Depot

Identification	Ground Elevation (feet MSL)	TOC Elevation (feet MSL)	Clay Elevation (feet MSL)	Depth to Water (feet BTOC) Baseline	Depth to Water (feet BTOC) Sampling Event 1	Depth to Water (feet BTOC) Sampling Event 2	Depth to Water (feet BTOC) Sampling Event 3	Depth to Water (feet BTOC) Sampling Event 4	Depth to Water (feet BTOC) Sampling Event 5	Depth to Water (feet BTOC) Sampling Event 6	Depth to Water (feet BTOC) Sampling Event 7
AREA 1				05/24/2002	07/08/2002	08/01/2002	09/06/2002	10/10/2002	11/11/2002	12/16/2002	01/23/2003
IW-5	292.43	292.17	179.43	93.31	NM	NM	NM	NM	NM	NM	NM
IW-6	292.27	291.94	183.27	93.20	NM	NM	NM	NM	NM	NM	NM
IW-7	292.29	292.00	182.78	93.23	NM	NM	NM	NM	NM	NM	NM
MW-21	295.21	295.00	NA	94.94	NM	94.80	94.74	NM	94.85	94.74	94.81
MW-100B	291.50	290.90	184.10	92.61	92.98	92.50	92.60	92.62	92.71	92.81	92.52
MW-115	291.92	291.67	NA	92.89	NM*	92.87	92.64	92.91	92.69	92.75	92.96
MW-116	291.92	291.67	183.42	92.87	NM*	92.87	92.85	92.91	93.05	92.74	92.89
MW-117	291.57	291.38	182.57	92.74	NM*	92.96	NM*	NM*	94.90	NM*	92.69
MW-118	291.54	291.17	NA	92.52	NM*	92.44	92.39	92.90	92.94	92.35	92.42
MW-119	291.74	291.50	NA	92.83	NM*	92.25	92.72	92.78	92.87	92.64	92.65
MW-120	291.72	291.58	183.72	92.88	NM*	92.77	92.84	92.96	93.31	92.75	92.82
MW-121	291.83	291.63	NA	92.85	NM*	92.65	92.83	92.87	92.87	92.72	92.84
MW-122	291.76	291.62	183.26	92.97	NM*	93.36	NM*	NM*	93.07	92.76	92.96
MW-123	291.36	291.08	NA	92.47	92.47	93.70	NM*	NM*	92.83	92.40	92.42
MW-124	291.58	291.33	NA	92.74	NM*	92.63	92.63	92.69	92.78	92.55	92.75
MW-125	291.47	291.36	182.47	92.72	93.14	92.61	92.53	92.68	92.75	92.52	92.71
AREA 2				05/24/2002	07/08/2002	07/29/2002	09/04/2002	10/08/2002	11/12/2002	12/16/2002	01/21/2003
IW-1	304.29	304.05	205.29	96.19	NM	NM	NM	NM	NM	95.60	95.54
IW-2	304.49	304.21	199.49	96.18	NM	NM	NM	NM	NM	95.55	95.55
IW-3	304.47	304.21	201.47	96.47	NM	NM	NM	NM	NM	95.85	95.88
IW-4	304.86	304.53	199.68	96.73	NM	NM	NM	NM	NM	96.19	96.17
MW-86	304.78	304.29	187.89	96.98	96.66	96.63	96.58	96.87	97.00	96.46	96.51
MW-88	305.47	305.15	203.47	80.43	80.07	80.83	80.39	79.90	80.09	79.74	79.84
MW-105	304.42	304.25	205.42	96.92	96.27	96.33	96.26	96.12	96.58	96.06	96.03
MW-106	304.65	304.44	197.65	96.81	96.41	96.85	96.49	96.36	96.60	96.12	96.31
MW-109	304.75	304.57	201.79	96.87	96.70	96.70	96.59	96.56	96.61	96.40	96.54
MW-110	304.82	304.64	202.82	97.12	96.85	96.69	96.77	96.69	97.10	96.56	96.57
MW-111	304.87	304.66	205.67	97.41	97.15	97.18	97.09	96.95	97.40	96.64	96.91
MW-112	304.77	304.57	204.77	97.17	96.69	96.94	96.84	96.71	96.97	96.60	96.67
MW-113	304.92	304.61	199.82	97.71	97.38	97.48	97.38	97.22	97.70	97.20	97.20
MW-114	304.84	304.66	202.84	97.31	96.87	97.04	96.94	96.95	97.21	96.71	96.79

Identification	Depth to Water (feet BTOC) Sampling Event 8	Depth to Water (feet BTOC) Sampling Event 9	Depth to Water (feet BTOC) Sampling Event 10	Depth to Water (feet BTOC) Sampling Event 11	Depth to Water (feet BTOC) Sampling Event 12	Depth to Water (feet BTOC) Sampling Event 13	Depth to Water (feet BTOC) Sampling Event 14	Groundwater Elevation (feet MSL) Baseline
AREA 1	02/24/2003	03/27/2003	04/24/2003	05/22/2003	06/25/2003	07/21/2003	No Event	05/24/2002
IW-5	NM	NM	NM	NM	NM	NM	NM	198.81
IW-6	NM	NM	NM	NM	NM	NM	NM	198.74
IW-7	NM	NM	NM	NM	NM	NM	NM	198.77
MW-21	94.53	94.38	94.11	94.18	94.01	93.80	NM	200.06
MW-100B	92.91	92.11	91.90	91.92	91.74	91.58	NM	198.29
MW-115	92.94	92.42	92.17	92.18	92.02	91.80	NM	198.62
MW-116	93.01	92.40	92.10	92.20	92.03	91.75	NM	198.70
MW-117	92.78	92.15	91.95	91.94	91.61	91.51	NM	198.64
MW-118	92.59	92.01	91.71	91.78	91.60	91.35	NM	198.65
MW-119	92.82	92.29	92.02	92.08	91.83	91.62	NM	198.67
MW-120	92.89	92.28	91.69	92.08	91.69	91.61	NM	198.70
MW-121	92.98	92.38	92.03	92.17	92.00	91.72	NM	198.63
MW-122	93.02	92.39	92.11	92.20	92.05	91.74	NM	198.65
MW-123	92.56	91.62	91.61	91.71	91.50	91.25	NM	198.62
MW-124	92.81	92.20	91.91	92.00	91.84	91.52	NM	198.65
MW-125	92.70	92.15	91.85	91.83	91.78	91.43	NM	198.63
AREA 2	02/28/2003	03/24/2003	04/21/2003	05/19/2003	06/23/2003	07/21/2003	08/18/2003	05/24/2002
IW-1	NM	NM	NM	NM	NM	NM	NM	207.84
IW-2	NM	NM	NM	NM	NM	NM	NM	208.03
IW-3	NM	NM	NM	NM	NM	NM	NM	207.74
IW-4	NM	NM	NM	NM	NM	NM	NM	207.80
MW-86	96.35	96.41	96.34	96.37	96.12	96.07	95.95	207.31
MW-88	79.69	79.75	79.77	80.10	79.80	80.15	79.71	224.72
MW-105	95.58	95.99	95.93	95.82	95.77	95.56	95.44	207.33
MW-106	96.33	96.06	96.00	95.96	95.78	95.53	95.51	207.63
MW-109	96.38	96.34	96.26	96.74	96.65	96.50	96.09	207.80
MW-110	96.51	96.54	96.48	96.45	96.24	95.95	95.89	207.52
MW-111	96.62	96.80	96.73	96.72	96.52	96.35	96.27	207.25
MW-112	96.55	96.55	96.50	96.49	96.30	96.07	96.03	207.40
MW-113	97.13	97.08	97.06	97.07	96.66	96.65	96.68	207.10
MW-114	96.67	96.68	96.60	96.59	96.46	96.21	96.12	207.35

Identification	Groundwater Elevation (feet MSL) Sampling Event 1	Groundwater Elevation (feet MSL) Sampling Event 2	Groundwater Elevation (feet MSL) Sampling Event 3	Groundwater Elevation (feet MSL) Sampling Event 4	Groundwater Elevation (feet MSL) Sampling Event 5	Groundwater Elevation (feet MSL) Sampling Event 6	Groundwater Elevation (feet MSL) Sampling Event 7	Groundwater Elevation (feet MSL) Sampling Event 8	Groundwater Elevation (feet MSL) Sampling Event 9	Groundwater Elevation (feet MSL) Sampling Event 10	Groundwater Elevation (feet MSL) Sampling Event 11	Groundwater Elevation (feet MSL) Sampling Event 12	Groundwater Elevation (feet MSL) Sampling Event 13	Groundwater Elevation (feet MSL) Sampling Event 14	Average Fluvial Aquifer Thickness (feet)
AREA 1	07/08/2002	08/01/2002	09/06/2002	10/10/2002	11/11/2002	12/16/2002	01/23/2003	02/24/2003	03/27/2003	04/24/2003	05/22/2003	06/25/2003	07/21/2003	No Event	
IW-5	NM*	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	18.4
IW-6	NM*	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	15.5
IW-7	NM*	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	16.0
MW-21	NM*	200.20	200.26	NM	200.15	200.26	200.19	200.12	200.64	200.69	200.84	200.89	201.20	NM	NA
MW-100B	198.34	198.40	198.30	198.28	198.19	198.29	198.38	197.99	198.79	199.00	198.94	199.16	199.34	NM	34.5
MW-115	NM*	198.80	198.83	198.76	198.98	198.92	198.72	198.73	199.25	199.50	199.49	199.65	199.87	NM	NA
MW-116	NM*	198.80	198.62	198.76	198.62	198.93	198.65	198.66	199.27	199.57	199.47	199.64	199.92	NM	15.6
MW-117	NM*	198.42	NM*	NM*	196.66	NM*	198.69	198.60	199.23	199.43	199.44	199.57	199.87	NM	16.3
MW-118	NM*	198.73	198.78	198.67	198.63	198.82	198.75	198.58	199.16	199.46	199.39	199.37	199.82	NM	NA
MW-119	NM*	199.25	198.78	198.72	198.63	198.86	198.65	198.56	199.21	199.48	199.42	199.57	199.88	NM	NA
MW-120	NM*	198.79	198.72	198.60	198.25	198.81	198.74	198.67	199.23	199.57	199.50	199.67	199.95	NM	15.3
MW-121	NM*	198.78	198.80	198.76	198.66	198.91	198.63	198.65	199.27	199.58	199.46	199.63	199.91	NM	NA
MW-122	NM*	198.24	NM*	NM*	198.55	198.86	198.66	198.60	199.23	199.51	199.42	199.57	199.83	NM	15.8
MW-123	198.62	197.39	NM*	NM*	198.16	198.69	198.57	198.53	199.17	199.48	199.38	199.53	199.84	NM	NA
MW-124	NM*	198.76	198.78	198.70	198.81	198.84	198.64	198.58	199.19	199.48	199.39	199.55	199.87	NM	NA
MW-125	198.21	198.74	198.78	198.69	198.60	198.83	198.64	198.57	199.20	199.50	199.47	199.56	199.88	NM	16.5
AREA 2	07/08/2002	07/22/2002	09/04/2002	10/08/2002	11/12/2002	12/16/2002	01/21/2003	02/28/2003	03/24/2003	04/21/2003	05/19/2003	06/23/2003	07/21/2003	08/18/2003	
IW-1	NM	NM	NM	NM	NM	208.43	208.49	NM	NM	NM	NM	NM	NM	NM	3.0
IW-2	NM	NM	NM	NM	NM	208.66	208.66	NM	NM	NM	NM	NM	NM	NM	9.0
IW-3	NM	NM	NM	NM	NM	208.36	208.33	NM	NM	NM	NM	NM	NM	NM	6.7
IW-4	NM	NM	NM	NM	NM	208.34	208.41	NM	NM	NM	NM	NM	NM	NM	8.5
MW-86	207.63	207.60	207.31	207.62	207.29	207.83	207.78	207.94	207.88	207.95	207.92	208.17	208.22	208.34	18.9
MW-88	225.08	224.32	224.76	225.25	225.08	225.41	225.31	225.46	225.40	225.38	225.05	225.35	225.00	225.44	16.7
MW-105	207.98	207.88	207.99	208.13	207.67	208.19	208.22	208.67	208.27	208.32	208.33	208.48	208.69	208.81	2.8
MW-106	208.03	207.59	207.95	208.08	207.84	208.32	208.13	208.11	208.38	208.44	208.48	208.66	208.91	208.93	10.8
MW-109	207.87	207.87	207.98	208.01	207.79	208.17	208.03	208.21	208.23	208.31	207.83	207.92	208.07	208.48	6.3
MW-110	207.79	207.75	207.87	207.95	207.54	208.09	208.07	208.13	208.10	208.16	208.19	208.40	208.69	208.65	5.2
MW-111	207.51	207.48	207.57	207.71	207.26	207.82	207.75	207.94	207.86	207.93	207.94	208.14	208.31	208.39	1.9
MW-112	207.88	207.63	207.73	207.86	207.60	207.97	207.90	208.02	208.02	208.07	208.08	208.27	208.50	208.54	3.2
MW-113	207.43	207.36	207.45	207.59	207.11	207.41	207.41	207.48	207.72	207.75	207.74	207.95	207.96	208.15	7.7
MW-114	207.69	207.62	207.72	207.71	207.45	207.95	207.87	207.99	208.00	208.06	208.07	208.20	208.45	208.54	5.1

Notes:
NM Not Measured.
NA Not Available.
* Not measured due to oil coating probe
Red indicates free product in monitoring well.

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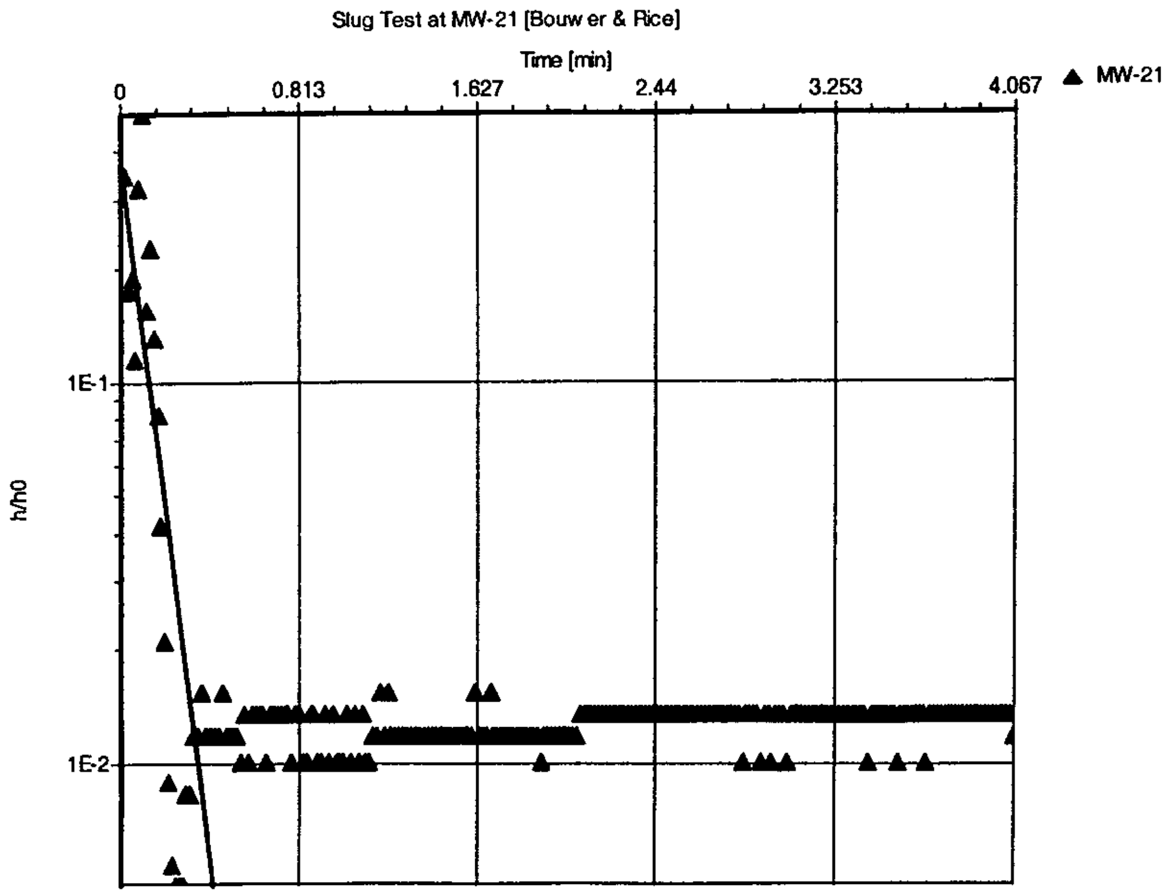
ATTACHMENT D

Slug Test and 72-Hour Aquifer Test Analysis Reports

Slug Test Analysis Reports

CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346
CH2MHILL Phone: 770-604-9182 * 545

Slug Test Analysis Report	
Project:	Memphis Depot
Number:	175430.FV.DF
Client:	Huntsville Alabama COE 170039



Slug Test: **Slug Test at MW-21**

Analysis Method: **Bouwer & Rice**

Analysis Results: Conductivity: 1.99E-2 [cm/s]

Test parameters:				
Test Well:	MW-21		Aquifer Thickness:	17.89 [ft]
Casing radius:	0.0833 [ft]		Gravel Pack Porosity (%)	25
Screen length:	9.42 [ft]			
Boring radius:	0.333 [ft]			
r(eff):	0.181 [ft]			

Comments: AquiferTest v.3.5 (Waterloo Hydrogeologic) & Benchmark Datum, Partially Penetrating Well.
Static Water Level = 205.949 (m) * 3.28 (ft/m) = 675.513 ft.
Water Level at t=0: 673.52 ft.
r(eff) was used.

Evaluated by: Jim Huang
Evaluation Date: 09/22/2003

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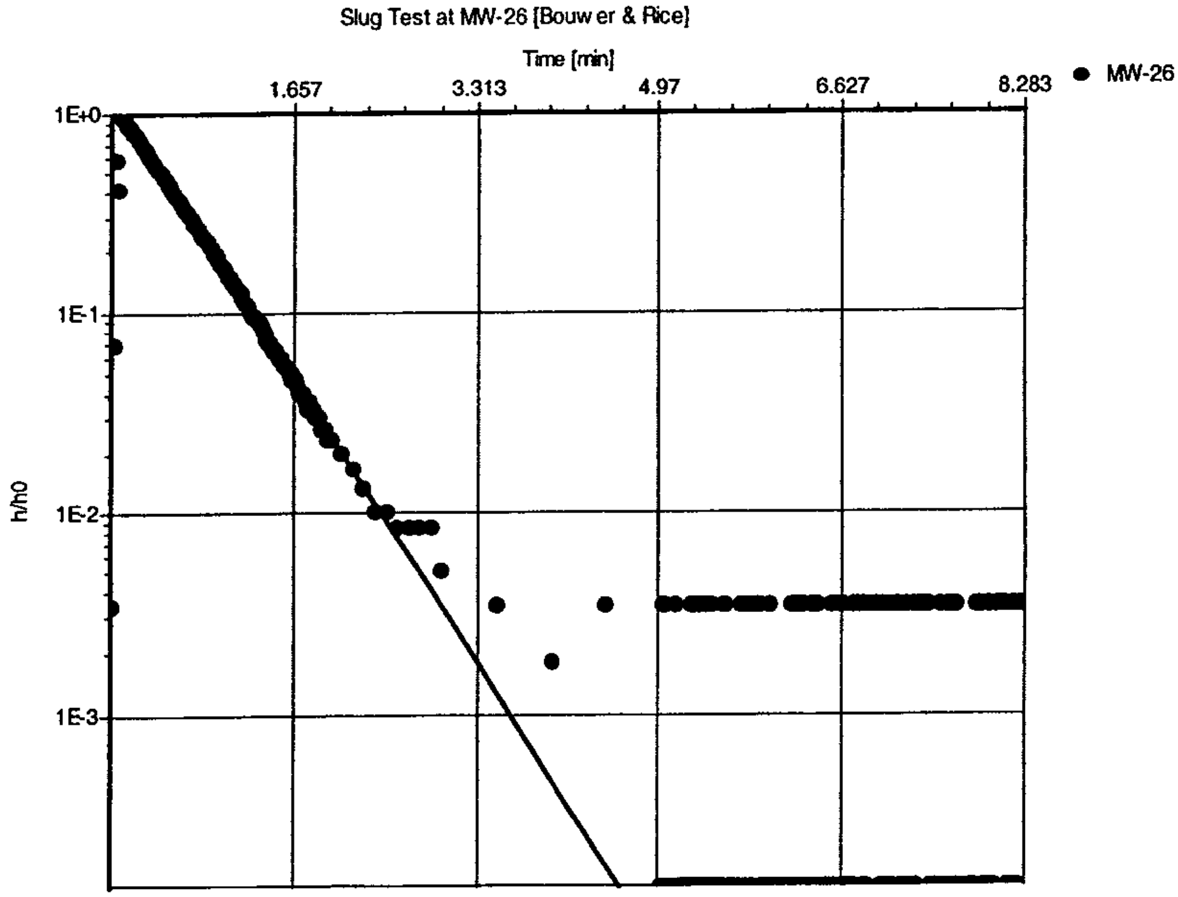
CH2M HILL 115 Perimeter Center Place NE, Suite 700 Atlanta, GA 30346 CH2MHILL Phone: 770-604-9182 * 545	**Slug Test Analysis Report**
	Project: Memphis Depot
	Number: 175430.FV.DF
	Client: Huntsville Alabama COE 170039



Slug Test: **Slug Test at MW-26**

Analysis Method: **Bouwer & Rice**

Analysis Results: Conductivity: 4.80E-3 [cm/s]

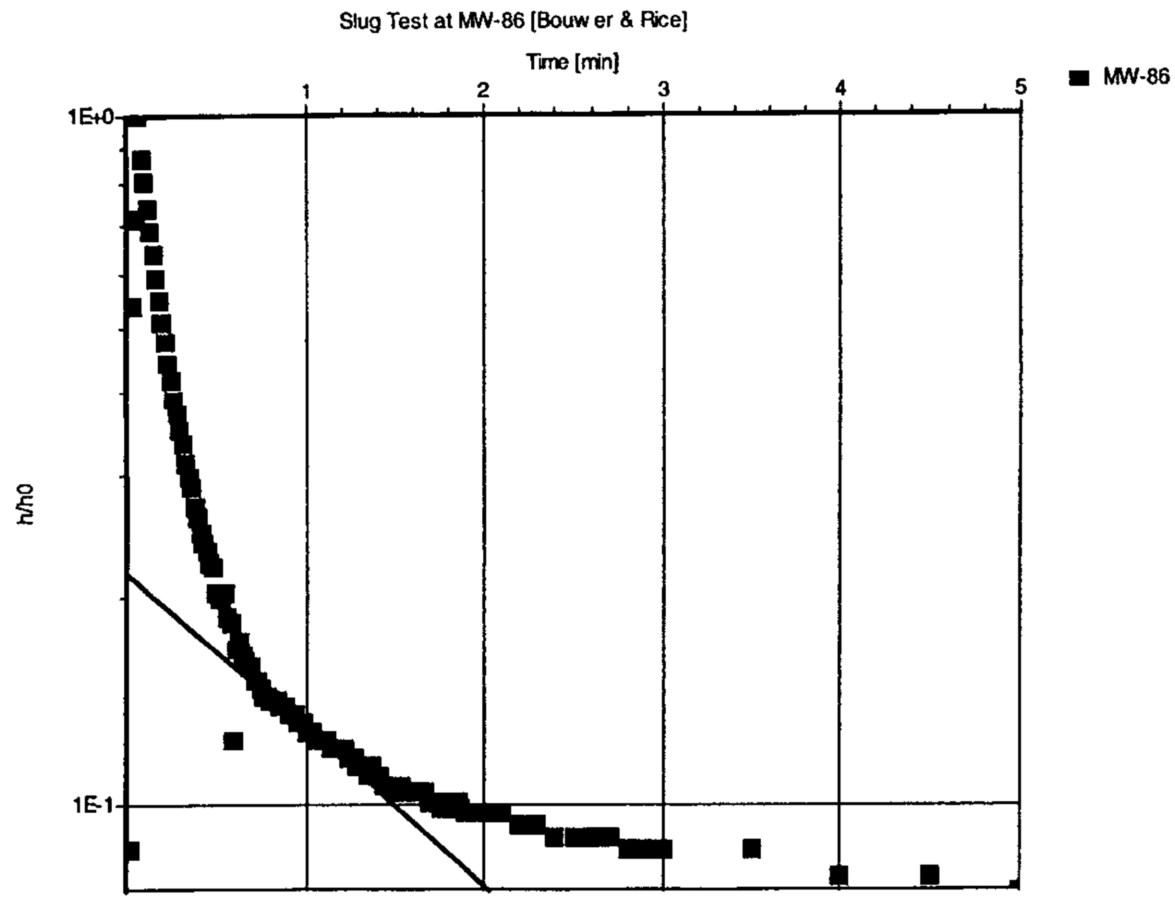
Test parameters:				
	Test Well:	MW-26	Aquifer Thickness:	9.14 [ft]
	Casing radius:	0.0833 [ft]	Gravel Pack Porosity (%)	25
	Screen length:	6.93 [ft]		
	Boring radius:	0.333 [ft]		
	r(eff):	0.181 [ft]		

Comments: AquiferTest v.3.5 (Waterloo Hydrogeologic) & Benchmark Datum, Partially Penetrating Well.
Static Water Level = 205.949 (m) * 3.28 (ft/m) = 675.513 ft.
Water Level at t=0: 673.52 ft.
r(eff) was used.

Evaluated by: Jim Huang
Evaluation Date: 09/22/2003

CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346
CH2MHILL Phone: 770-604-9182 * 545

Slug Test Analysis Report	
Project:	Memphis Depot
Number:	175430.FV.DF
Client:	Huntsville Alabama COE 170039



Slug Test: **Slug Test at MW-86**

Analysis Method: **Bouwer & Rice**

Analysis Results: Conductivity: 6.92E-4 [cm/s]

Test parameters:

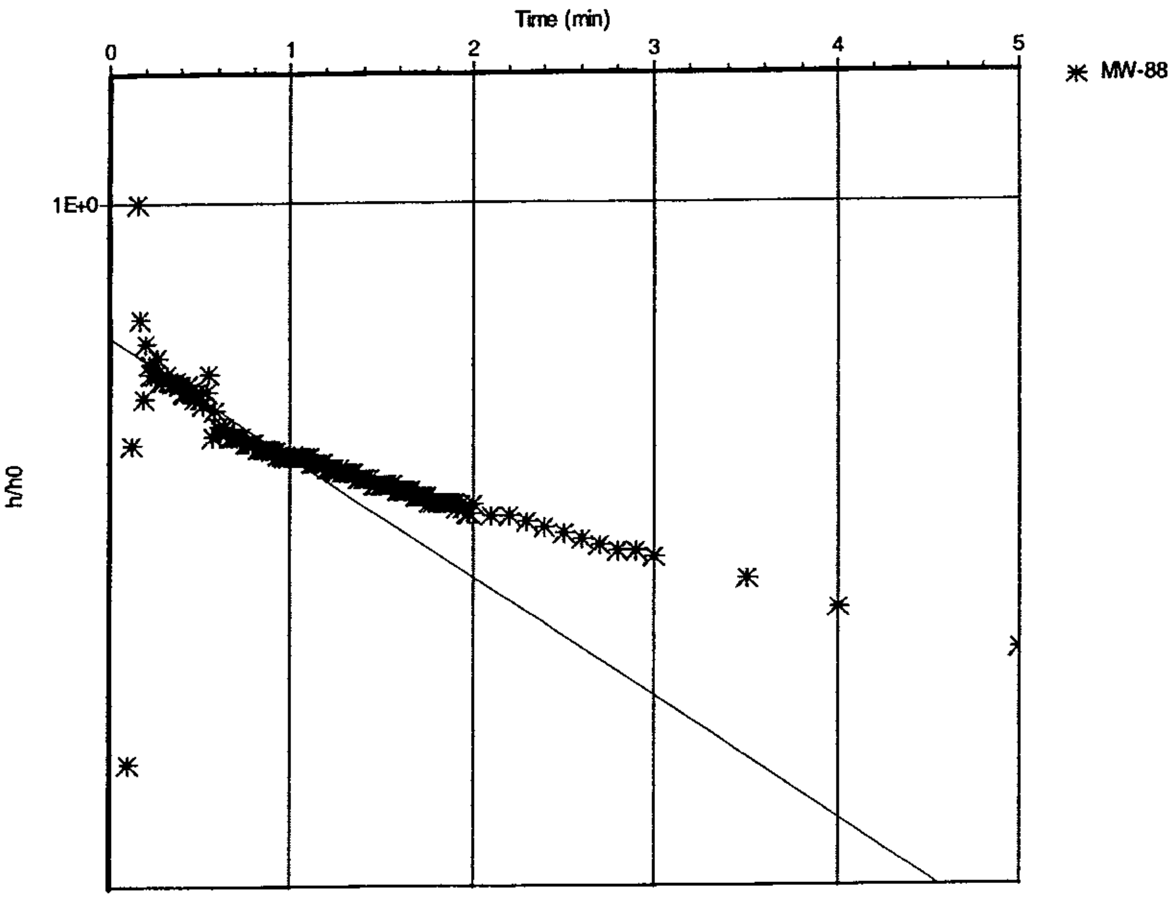
Test Well:	MW-86	Aquifer Thickness:	19.74 [ft]
Casing radius:	0.0833 [ft]	Gravel Pack Porosity (%)	25
Screen length:	20 [ft]		
Boring radius:	0.333 [ft]		
r(eff):	0.181 [ft]		

Comments: AquiferTest v.3.5 (Waterloo Hydrogeologic) & Benchmark Datum, Fully Penetrating Well.
Static Water Level = 205.949 (m) * 3.28 (ft/m = 675.513 ft.
Water Level at t=0: 673.68 ft.
r(eff) was used.

Evaluated by: Jim Huang
Evaluation Date: 09/22/2003

794 437

CH2M HILL 115 Perimeter Center Place NE, Suite 700 Atlanta, GA 30346 CH2MHILL Phone: 770-604-9182 * 545	**Slug Test Analysis Report** Project: Memphis Depot Number: 175430.FV.DF Client: Huntsville Alabama COE 170039



Slug Test: **Slug Test at MW-88**

Analysis Method: **Bouwer & Rice**

Analysis Results: Conductivity: 1.50E-4 [cm/s]

Test parameters:				
	Test Well:	MW-88	Aquifer Thickness:	16.61 [ft]
	Casing radius:	0.0833 [ft]	Gravel Pack Porosity (%)	25
	Screen length:	15 [ft]		
	Boring radius:	0.333 [ft]		
	r(eff):	0.181 [ft]		

Comments: AquiferTest v.3.5 (Waterloo Hydrogeologic) & Benchmark Datum, Fully Penetrating Well.
Static Water Level = 205.949 (m) * 3.28 (ft/m) = 675.513 ft.
Water Level at t=0: 673.620 ft.
r(eff) was used.

Evaluated by: Jim Huang
Evaluation Date: 09/22/2003

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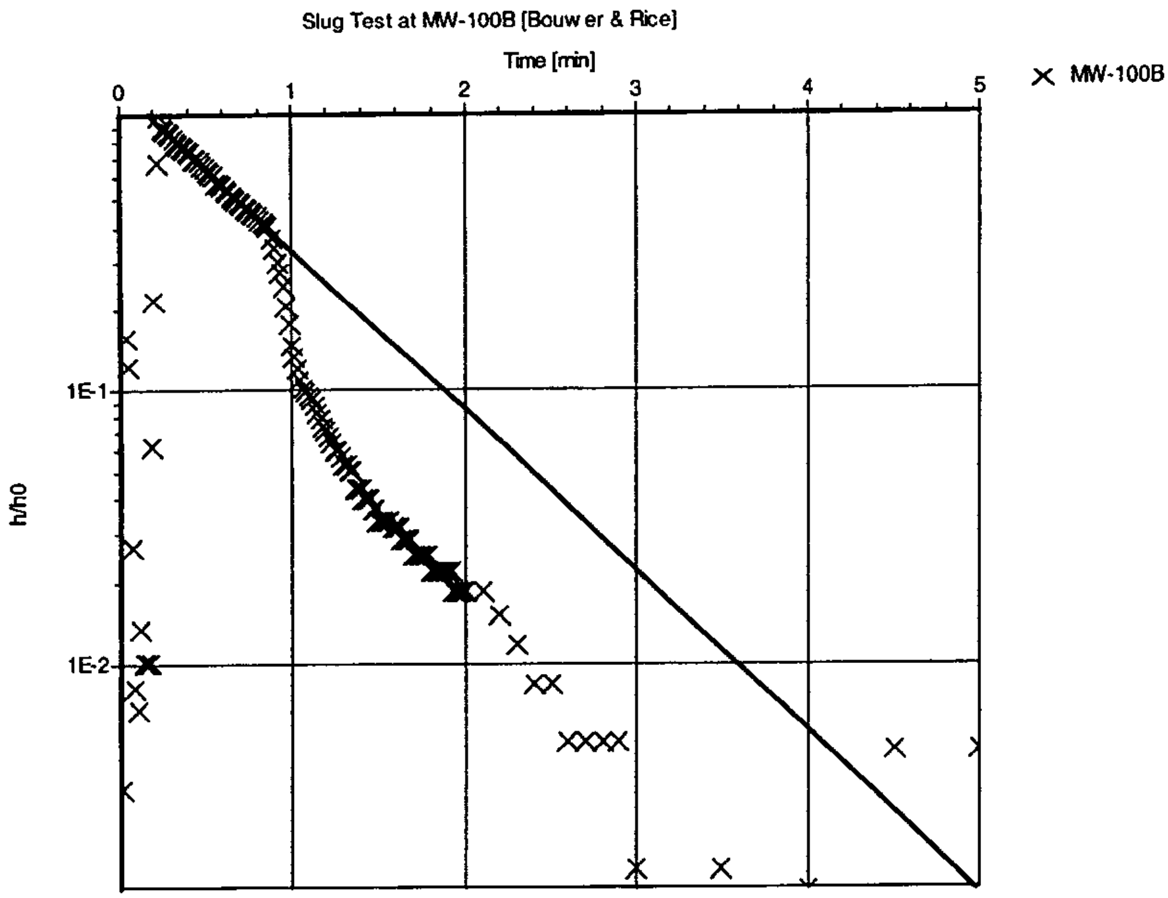
CH2MHILL Phone: 770-604-9182 * 545

Slug Test Analysis Report

Project:	Memphis Depot
Number:	175430.FV.DF
Client:	Huntsville Alabama COE 170039



Slug Test: **Slug Test at MW-100B**

Analysis Method: **Bouwer & Rice**

Analysis Results: Conductivity: 4.13E-4 [cm/s]

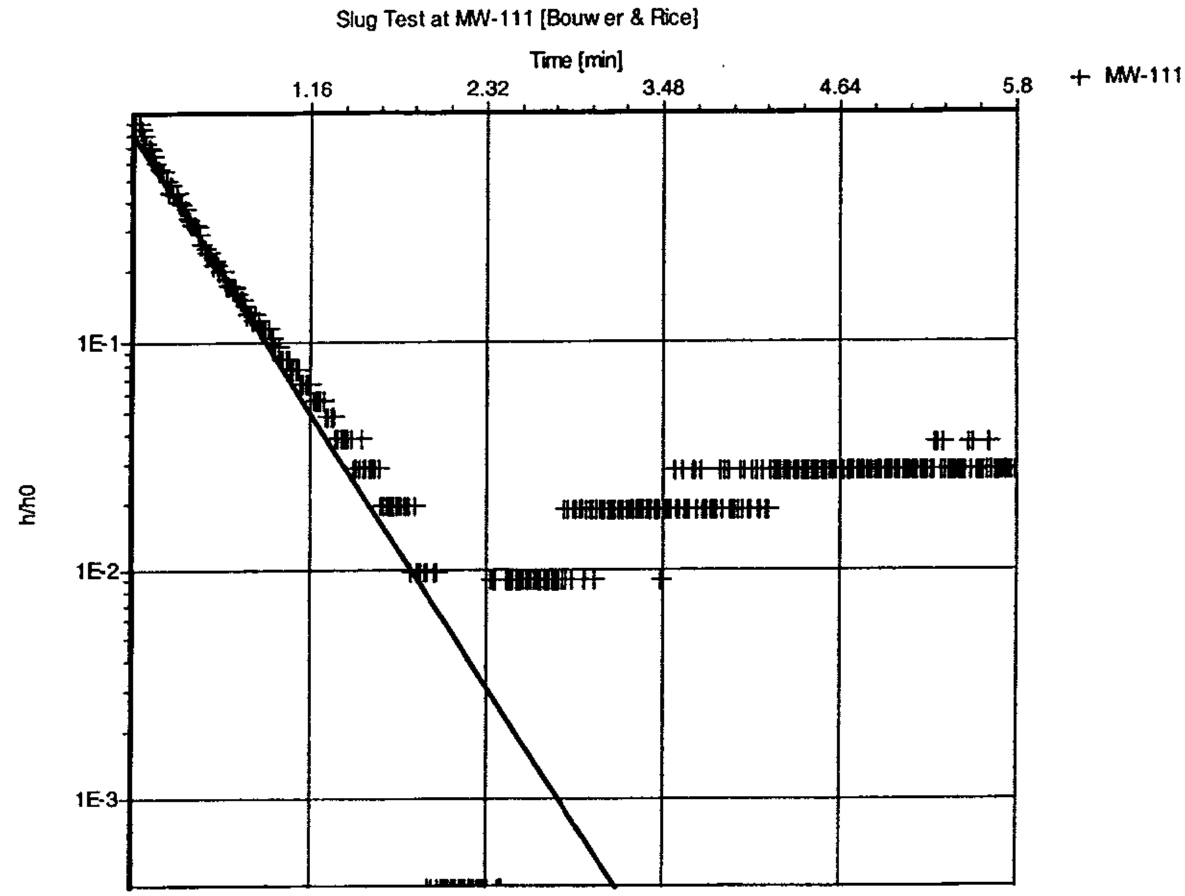
Test parameters:				
Test Well:	MW-100B	Aquifer Thickness:	34.8 [ft]
Casing radius:	0.0833 [ft]	Gravel Pack Porosity (%)	25
Screen length:	20 [ft]		
Boring radius:	0.292 [ft]		
r(eff):	0.163 [ft]		

Comments: AquiferTest v.3.5 (Waterloo Hydrogeologic) & Benchmark Datum, Partially Penetrating Well.
Static Water Level = 205.949 (m) * 3.28 (ft/m) = 675.513 ft.
Water Level at t=0: 673.55 ft.
Well casing radius was used.

Evaluated by: Jim Huang
Evaluation Date: 09/22/2003

794 439

CH2M HILL 115 Perimeter Center Place NE, Suite 700 Atlanta, GA 30346 CH2MHILL Phone: 770-604-9182 * 545	**Slug Test Analysis Report**
	Project: Memphis Depot
	Number: 175430.FV.DF
	Client: Huntsville Alabama COE 170039



Slug Test: **Slug Test at MW-111**

Analysis Method: **Bouwer & Rice**

Analysis Results: Conductivity: 1.12E-2 [cm/s]

Test parameters:				
	Test Well:	MW-111	Aquifer Thickness:	1.64 [ft]
	Casing radius:	0.0833 [ft]	Gravel Pack Porosity (%)	25
	Screen length:	1.81 [ft]		
	Boring radius:	0.292 [ft]		
	r(eff):	0.163 [ft]		

Comments: AquiferTest v.3.5 (Waterloo Hydrogeologic) & Benchmark Datum, Fully Penetrating Well.
Static Water Level = 205.949 (m) * 3.28 (ft/m) = 675.513 ft.
Water Level at t=0: 674.82 ft.
r(eff) was used.

Evaluated by: Jim Huang
Evaluation Date: 09/22/2003

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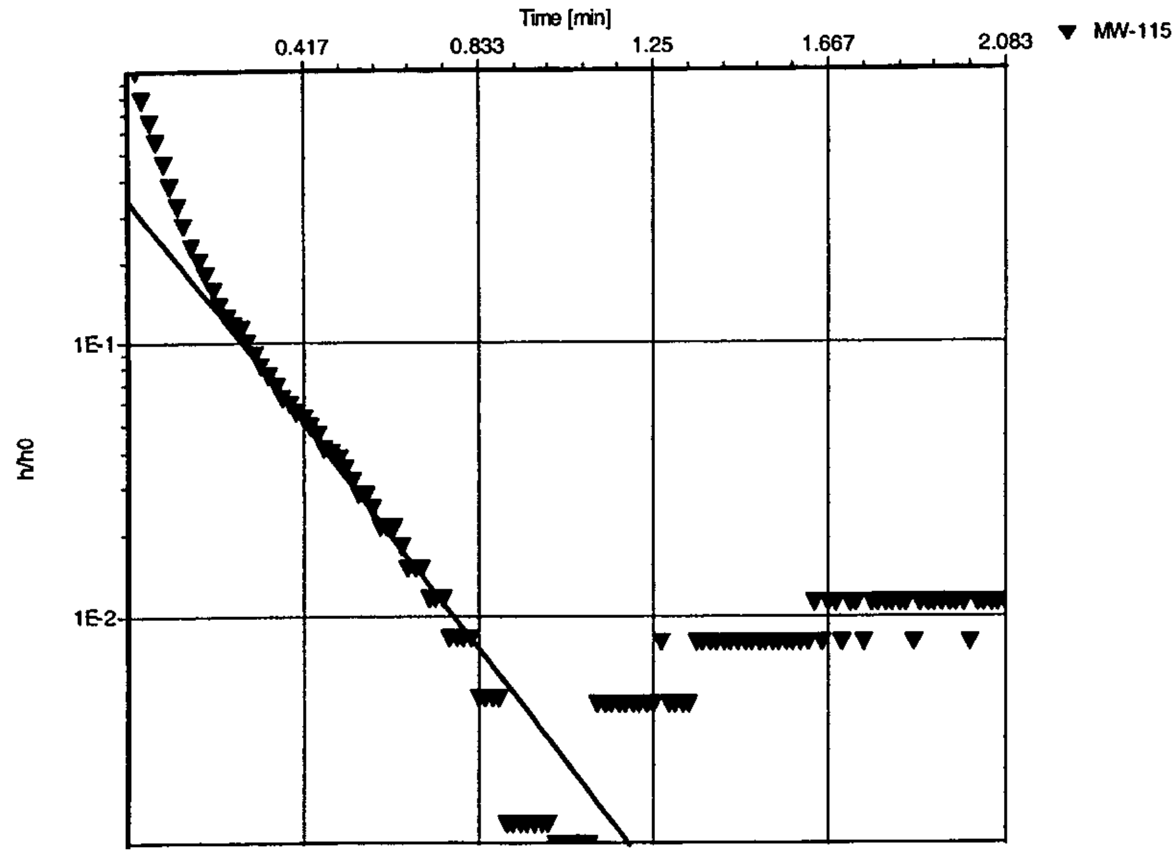
Slug Test Analysis Report	
Project:	Memphis Depot
Number:	175430.FV.DF
Client:	Huntsville Alabama COE 170039

Slug Test at MW-115 [Bouwer & Rice]



Slug Test: **Slug Test at MW-115**

Analysis Method: **Bouwer & Rice**

Analysis Results: Conductivity: 9.33E-3 [cm/s]

Test parameters:				
Test Well:	MW-115	Aquifer Thickness:	15.38 [ft]
Casing radius:	0.0833 [ft]	Gravel Pack Porosity (%)	25
Screen length:	6.6 [ft]		
Boring radius:	0.292 [ft]		
r(eff):	0.163 [ft]		

Comments: AquiferTest v.3.5 (Waterloo Hydrogeologic) & Benchmark Datum, Partially Penetrating Well.
Static Water Level = 205.949 (m) * 3.28 (ft/m) = 675.513 ft.
Water Level at t=0: 673.51 ft.
r(eff) was used.

Evaluated by: Jim Huang
Evaluation Date: 09/22/2003

794 441

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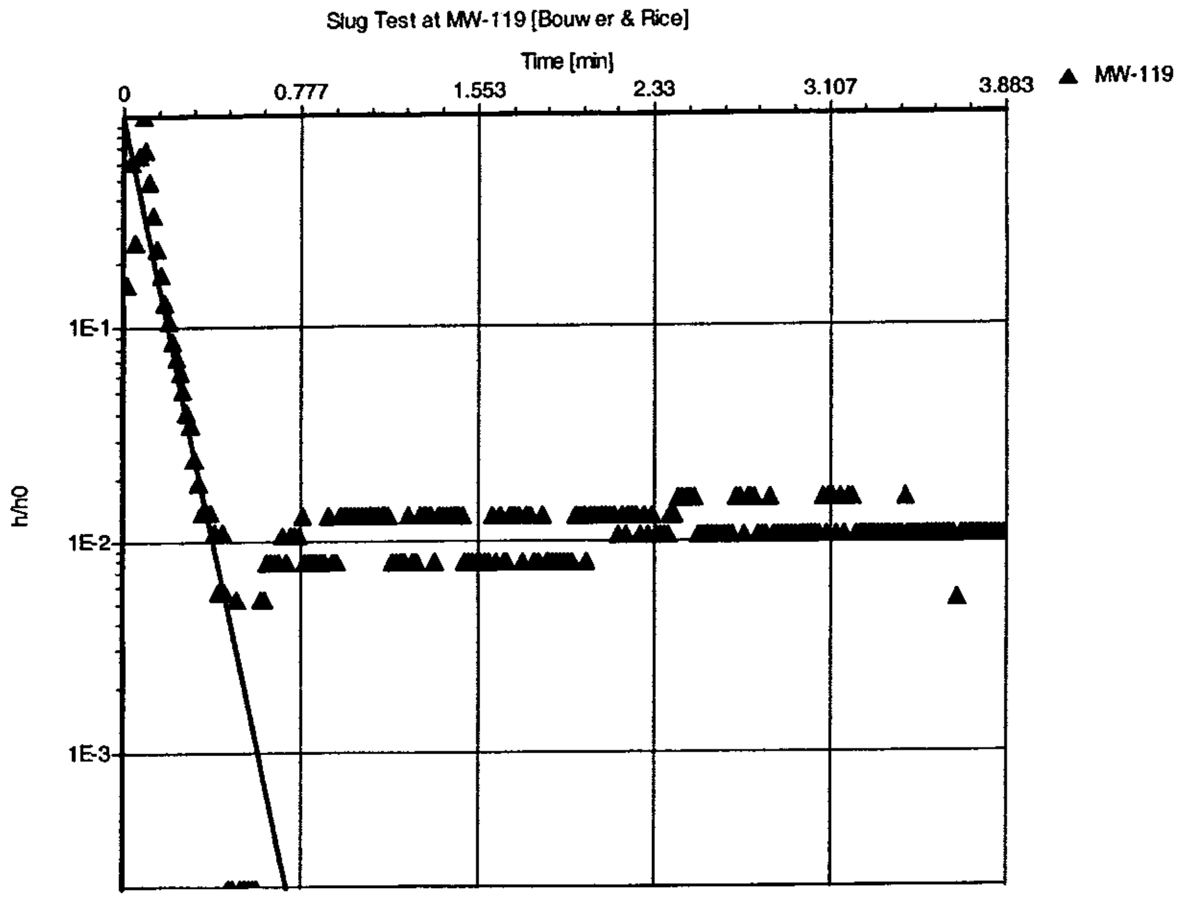
Slug Test Analysis Report	
Project:	Memphis Depot
Number:	175430.FV.DF
Client:	Huntsville Alabama COE 170039



Slug Test: **Slug Test at MW-119**

Analysis Method: **Bouwer & Rice**

Analysis Results: Conductivity: 2.27E-2 [cm/s]

Test parameters:

Test Well:	MW-119	Aquifer Thickness:	15.49 [ft]
Casing radius:	0.0833 [ft]	Gravel Pack Porosity (%)	25
Screen length:	7.25 [ft]		
Boring radius:	0.292 [ft]		
r(eff):	0.163 [ft]		

Comments: AquiferTest v.3.5 (Waterloo Hydrogeologic) & Benchmark Datum, Partially Penetrating Well.
Static Water Level = 205.949 (m) * 3.28 (ft/m) = 675.513 ft.
r(eff) was used.
Water Level at t=0: 205.949 (m) * 3.28 (ft/m) = 675.51 ft.

Evaluated by: Jim Huang
Evaluation Date: 09/22/2003

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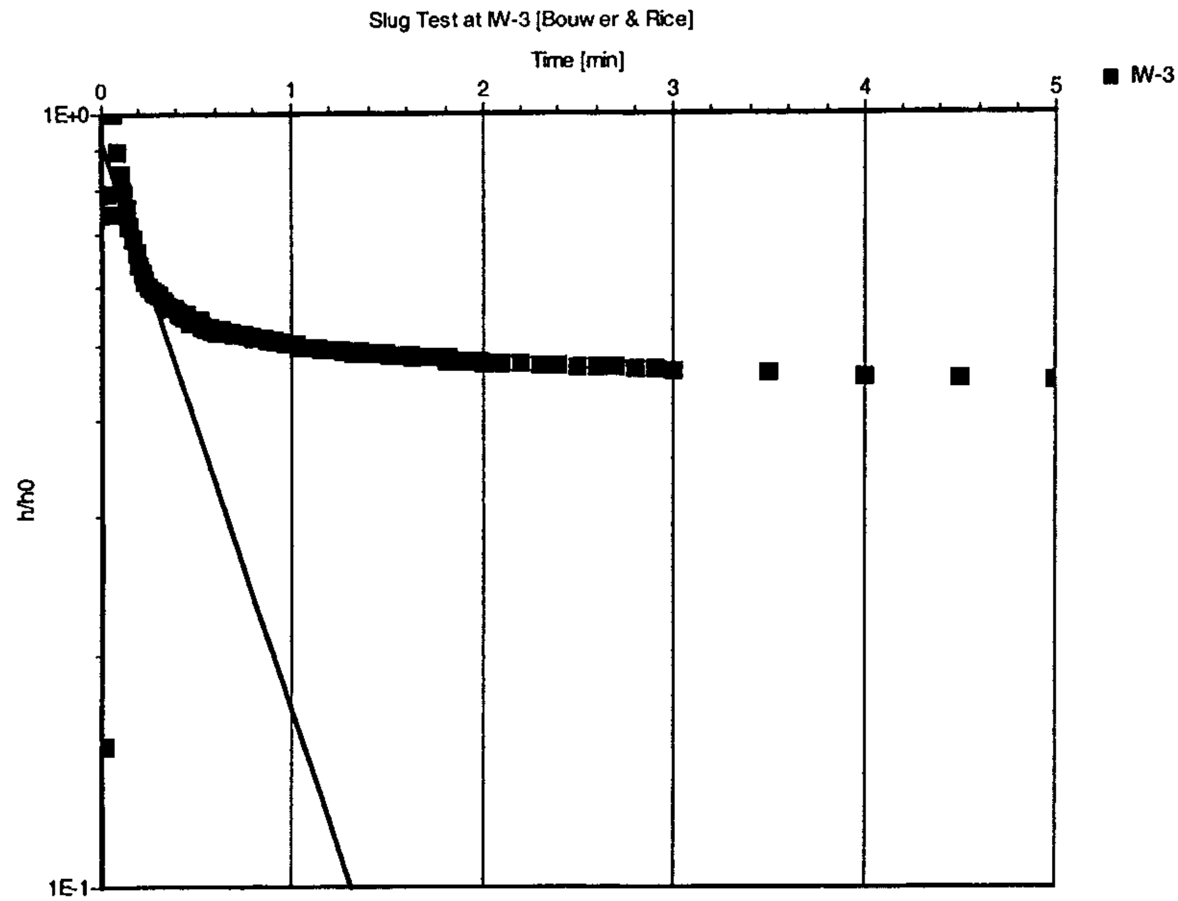
Slug Test Analysis Report

Project:	Memphis Depot
Number:	175430.FV.DF
Client:	Huntsville Alabama COE 170039



Slug Test: **Slug Test at IW-3**

Analysis Method: **Bouwer & Rice**

Analysis Results: Conductivity: 4.05E-3 [cm/s]

Test parameters:

Test Well:	IW-3	Aquifer Thickness:	6.33 [ft]
Casing radius:	0.0833 [ft]	Gravel Pack Porosity (%)	25
Screen length:	6.6 [ft]		
Boring radius:	0.292 [ft]		
r(eff):	0.163 [ft]		

Comments: AquiferTest v.3.5 (Waterloo Hydrogeologic) & Benchmark Datum, Fully Penetrating Well.
Static Water Level = 205.949 (m) * 3.28 (ft/m) = 675.513 ft.
Water Level at t=0: 673.59 ft.
r(eff) was used.

Evaluated by: Jim Huang
Evaluation Date: 09/22/2003

794 443

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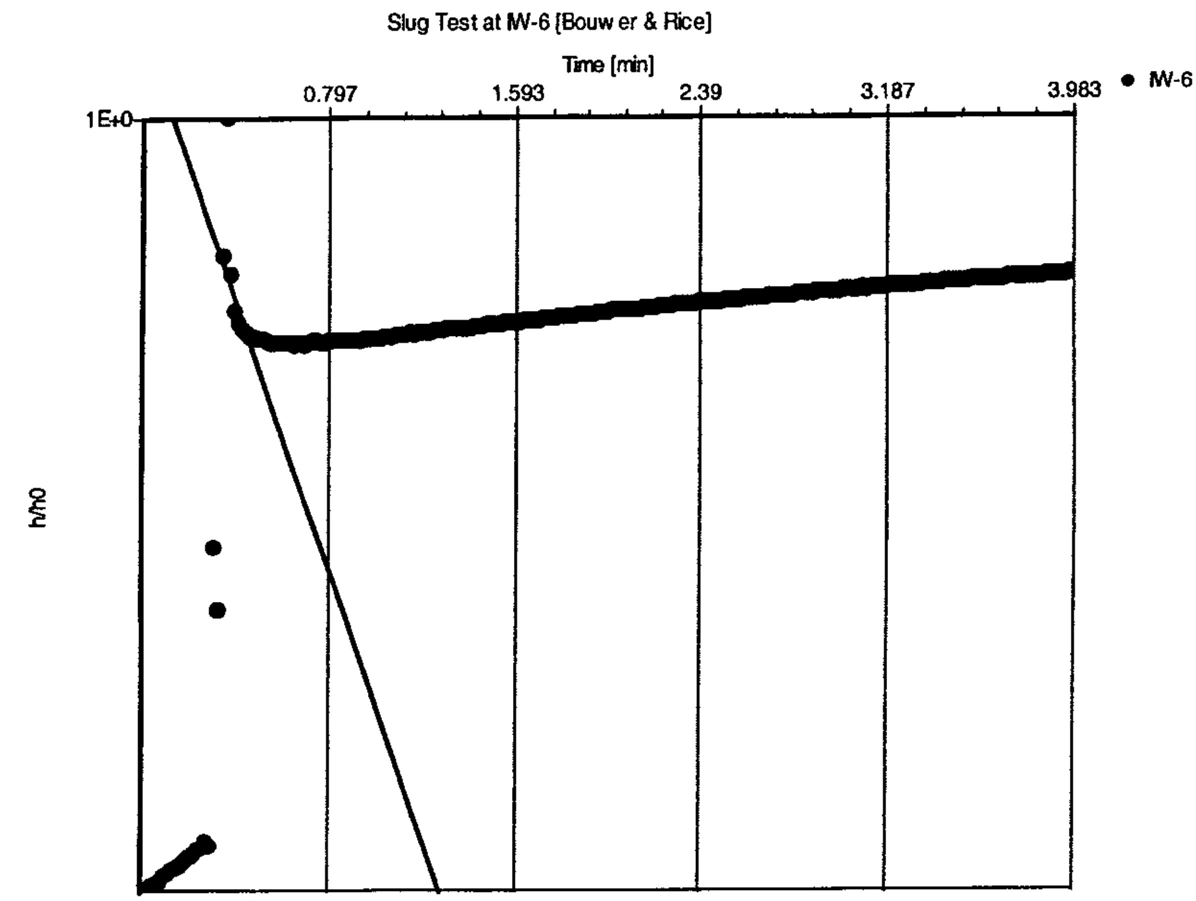
Slug Test Analysis Report

Project:	Memphis Depot
Number:	175430.FV.DF
Client:	Huntsville Alabama COE 170039



Slug Test: **Slug Test at IW-6**

Analysis Method: **Bouwer & Rice**

Analysis Results: Conductivity: 6.55E-4 [cm/s]

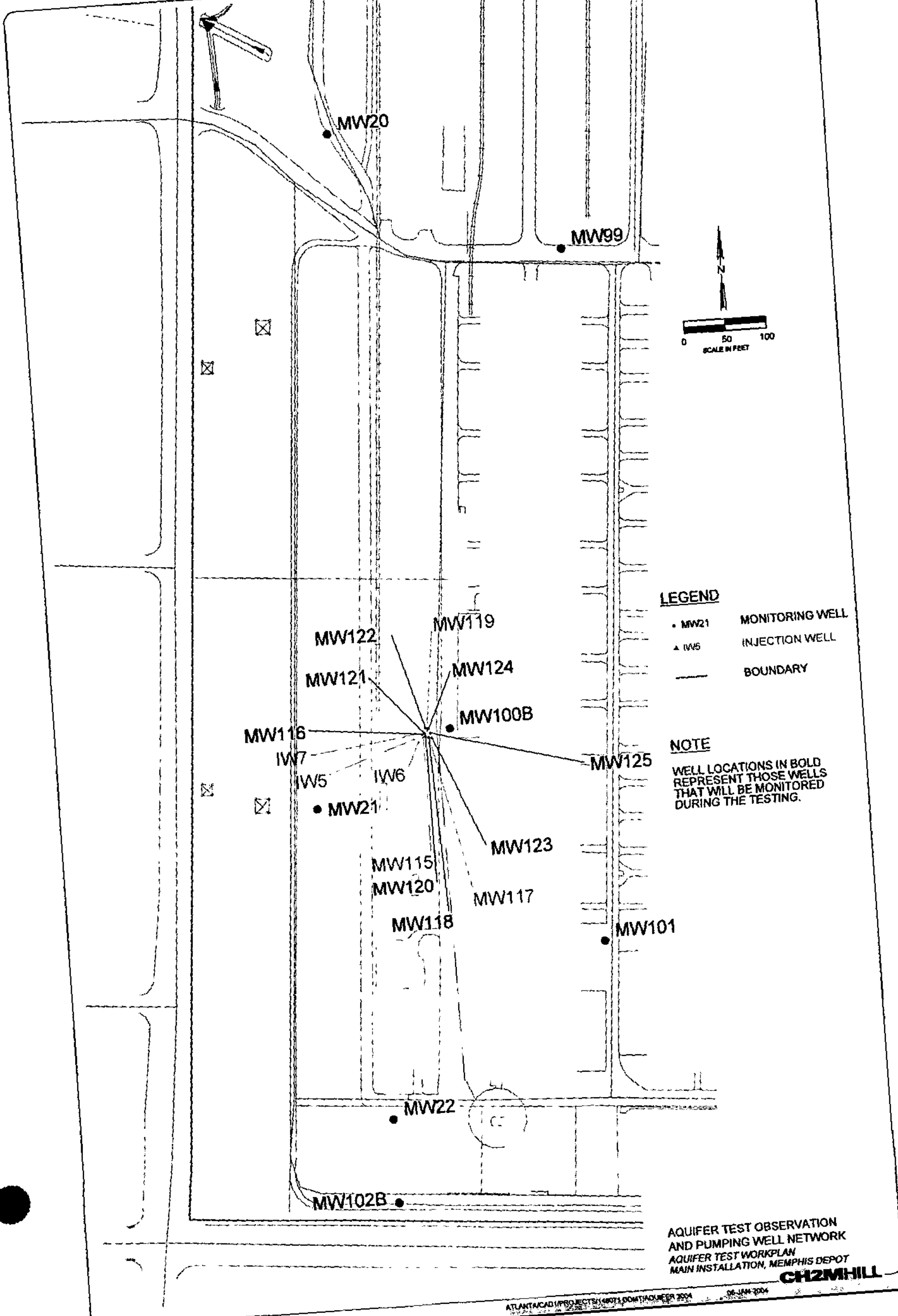
Test parameters:

Test Well:	IW-6	Aquifer Thickness:	15.78 [ft]
Casing radius:	0.0833 [ft]	Gravel Pack Porosity (%)	25
Screen length:	10 [ft]		
Boring radius:	0.292 [ft]		
r(eff):	0.163 [ft]		

Comments: AquiferTest v.3.5 (Waterloo Hydrogeologic) & Benchmark Datum, Partially Penetrating Well.
Static Water Level = 205.949 (m) * 3.28 (ft/m) = 675.513 ft.
Water Level at t=0: 670.23 ft.
Well casing radius was used.

Evaluated by: Jim Huang
Evaluation Date: 09/22/2003

72-Hour Aquifer Test Analysis Reports



AQUIFER TEST OBSERVATION AND PUMPING WELL NETWORK
AQUIFER TEST WORKPLAN
MAIN INSTALLATION, MEMPHIS DEPOT
CH2MHILL

794 446

Attachment D
Summary of Input Parameters Used for Aquifer Test Analyses
Main Installation, Memphis Depot

Well ID	Distance from Pumping Well (MW-120) (ft)	Fully or Partially Penetrating Well	Well Screen Radius (r, ft)	Borehole Radius (R, ft)	Elevation of Top of Screen (MSL)	Elevation of Bottom of Screen (MSL)	Well Screen Length + sand (L, ft)	Top of Casing Elevation (MSL)	Depth to Static Water Level (ft)	GW Elevation (MSL)	Clay / rock Elevation (MSL)	Saturated Aquifer Thickness (D, ft)	Total Depth of Well (ft)	Height of the Stagnant Water Column (b, ft)	Static GW Elevation from the Reference Point
MW-120	0	Fully	0 0833	0.333	193.6	183.56	10	291.56	92.82	198 74	183.56	15.18	108.50	15.18	12.7448
MW-121	5.08	Fully	0.0833	0.333	199.6	189.63	10	291.63	92.94	198.69	189.63	9.06	102.50	9.06	9.5804
MW-122	14.79	Fully	0.0833	0 333	193.1	183 12	10	291 62	92.96	198.66	183.12	15 54	109.00	15.54	15.9246
MW-123	11 46	Fully	0 0833	0.333	201.1	186.09	15	291.09	92.42	198 67	186.09	12.58	105.50	12.58	10.6103
MW-124	15.27	Fully	0.0833	0 333	201.4	186 39	15	291.39	92.75	198.64	186.39	12.25	105.50	12.25	13.1790
MW-125	10.59	Fully	0.0833	0.333	197.4	182 35	15	291.35	92.71	198.64	182.35	16.29	109.50	16.29	15.9838

Notes:

1. Saturated Aquifer Thickness = groundwater elevation - clay elevation
2 Height of the stagnant water column = total depth - depth to water
3. For fully penetrating wells (the entire aquifer thickness was screened): saturated aquifer thickness D = height of the stagnant water column b
4. Pressure Heads were measured in MW-21, MW-99, MW-100B, and MW-101 using MiniTroll Pros manufactured by In-Situ Inc. Pressure Heads were measured in the rest of wells using Hermit Dataloggers
5. AquiferTest (by Waterloo Hydrogeologic, Inc.) software was used to determine the analysis results.
6. The depths to groundwater were recorded in January 2001 and January 2003.
7. The static groundwater elevation was recorded prior to the pumping test.

ft: feet
MSL: mean sea level

Attachment D
Summary of Results from Aquifer Test Analyses
Main Installation, Memphis Depot

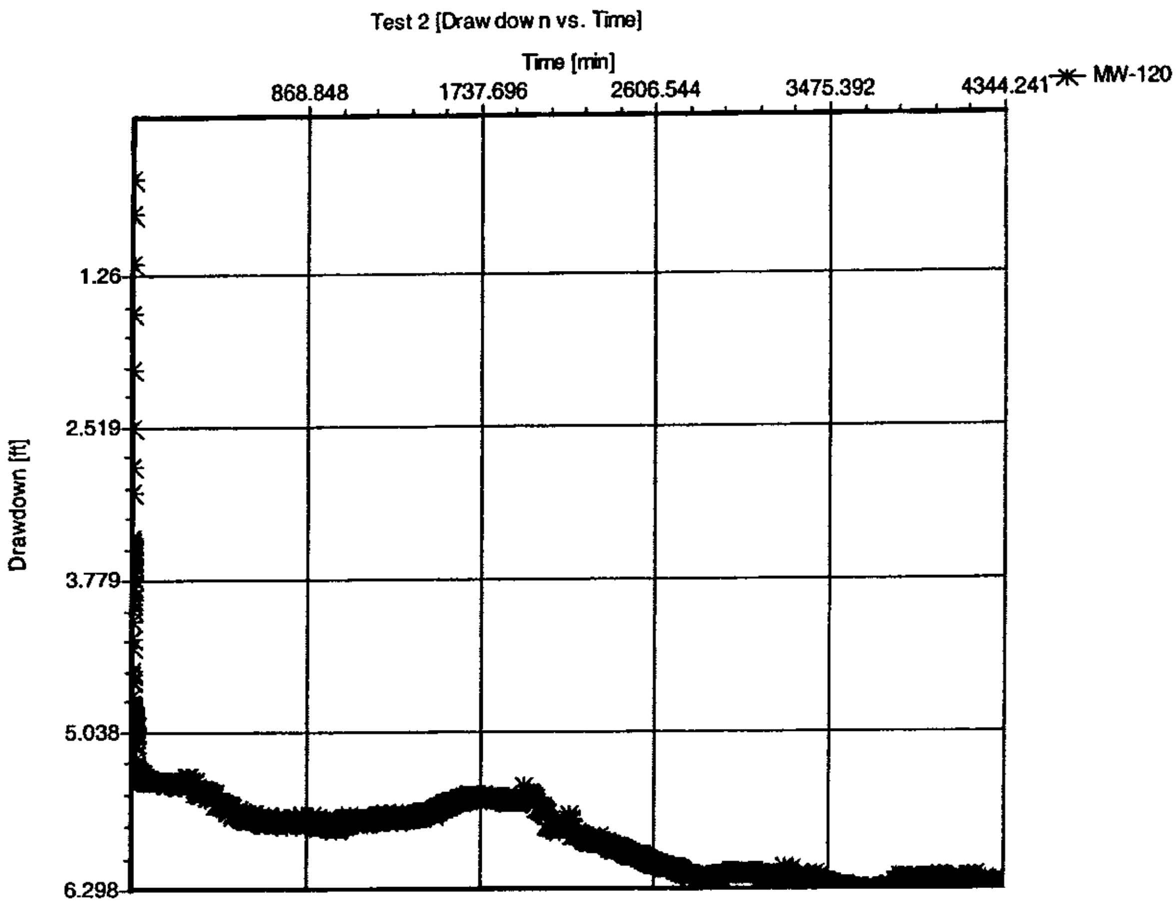
Well ID	Neuman Method		Cooper-Jacob Time-Drawdown Method with Unconfined Aquifer Correction		Theis Recovery Method with Unconfined Aquifer Correction		Cooper-Jacob Distance-Drawdown Method with Unconfined Aquifer Correction		Geomean		Specific Capacity (ft^2/min)
	K (cm/s)	T (cm^2/s)	K (cm/s)	T (cm^2/s)	K (cm/s)	T (cm^2/s)	K (cm/s)	T (cm^2/s)	K (cm/s)	T (cm^2/s)	
MW-120	5.52E-04	2.56E-01	1.48E-03	6.87E-01	4.84E-02	2.24E+01	2.01E-02	9.29E+00	3.41E-03	1.58E+00	1.34E-01
MW-121	8.17E-03	3.78E+00	2.25E-02	1 04E+01	1.61E-02	7.46E+00			1.44E-02	6.64E+00	
MW-122	1.87E-02	8.66E+00	3.46E-02	1.60E+01	3.43E-02	1.59E+01			2.81E-02	1.30E+01	
MW-123	---	---	---	---	6.80E-02	3.15E+01			6.80E-02	3.15E+01	
MW-124	6.64E-04	3.07E-01	4.85E-02	2.24E+01	2.96E-02	1.37E+01			9.84E-03	4.55E+00	
MW-125	4.59E-04	2.13E-01	3.03E-02	1.40E+01	2.97E-02	1.37E+01			7.45E-03	3.44E+00	
Geomean:	1.91E-03	8.87E-01	1.76E-02	8.15E+00	3.42E-02	1.58E+01	2.01E-02	9.29E+00	1.38E-02	6.38E+00	

1. Aquifer test analyses were conducted using AquiferTest software, distributed by Waterloo Hydrogeologic
   Software and aquifer test analyses are described at the following website: http://www waterloohydrogeologic.com/software/aquifertest/aquifertest_ov.htm.
2. The specific capacity was calculated for the pump well: MW-120
3. Monitoring wells MW-21, -99, -100B, -101S, -116, and -118 observed no response during the aquifer test as recorded by the data logger.

---: Test data could not be matched to the type curve or straight line

CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346
CH2MHILL Phone: 770-604-9182 * 545

Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



Pumping Test: **Test 2**

Analysis Method: **Drawdown vs. Time**

Analysis Results:

Test parameters:				
	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]		
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		

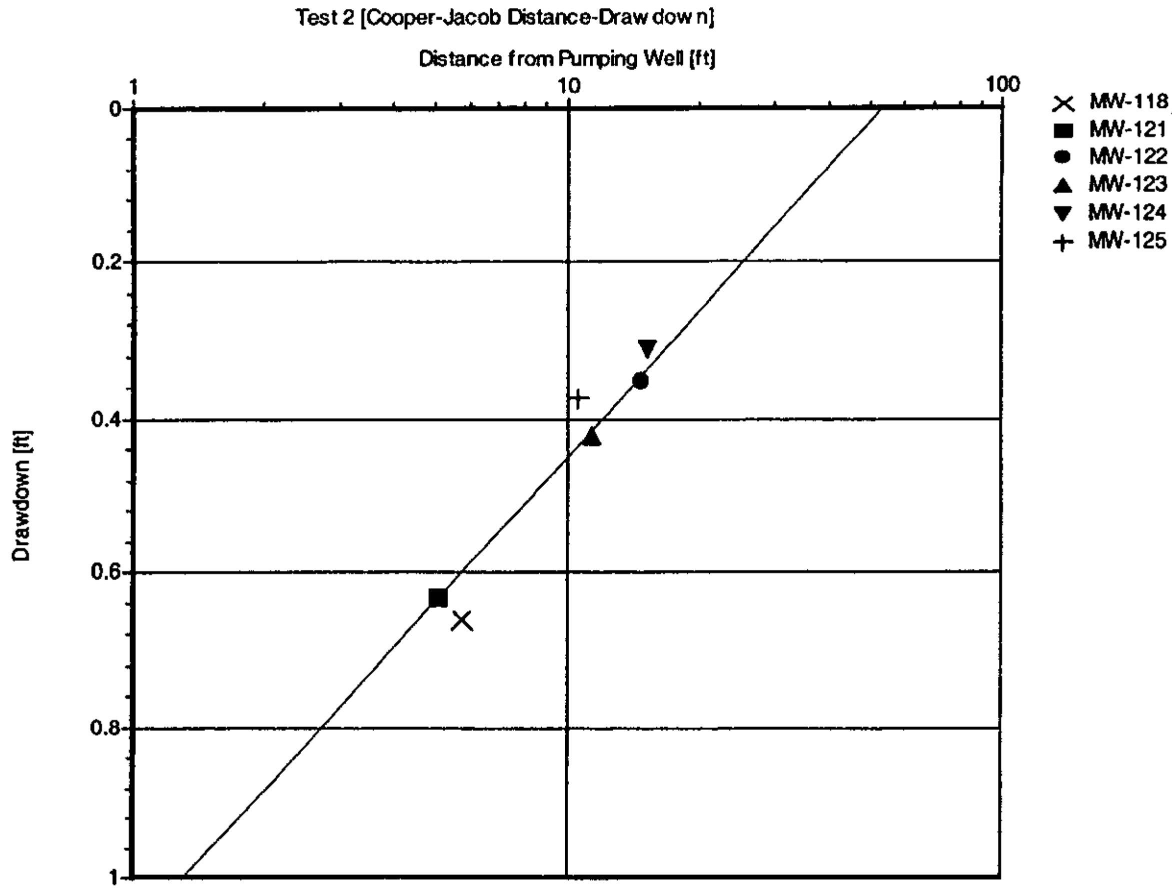
Comments:

Evaluated by:
Evaluation Date: 02/11/2004

CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346
CH2MHILL Phone: 770-604-9182 * 545

Pumping Test Analysis Report

Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



Pumping Test: **Test 2**

Analysis Method: **Cooper-Jacob Distance-Drawdown**

Analysis Results: Transmissivity: 9.29E+0 [cm²/s] Conductivity: 2.01E-2 [cm/s]

Test parameters:

Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
Casing radius:	0.0833 [ft]	Unconfined Aquifer	
Screen length:	10 [ft]		
Boring radius:	0.333 [ft]		
Discharge Rate:	7.6 [U.S. gal/min]		
Calculation Time:	1000 [min]		

Comments:

Evaluated by:
Evaluation Date: 02/11/2004

794 450

CH2M HILL
115 Perimeter Center Place NE, Suite 700
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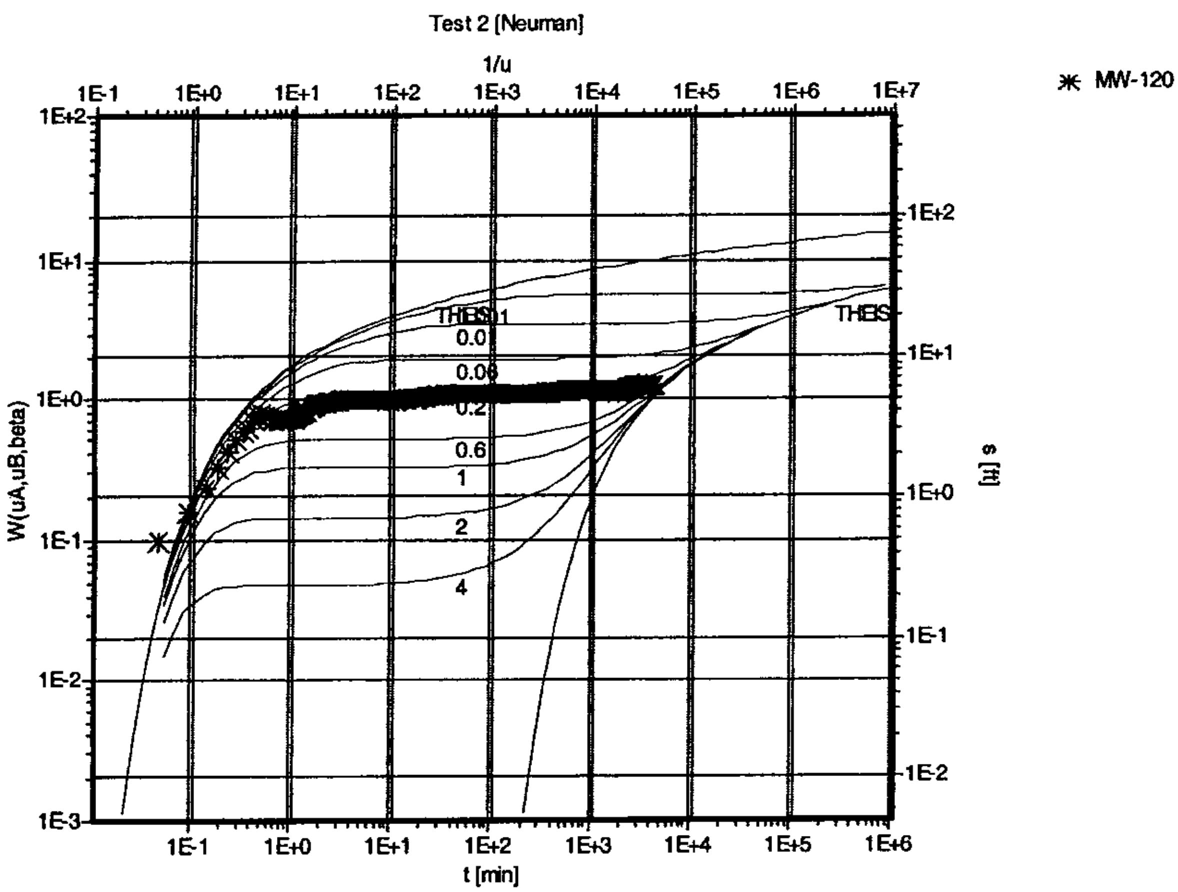
CH2MHILL Phone: 770-604-9182 * 545

Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



<u>Pumping Test:</u> **Test 2**

<u>Analysis Method:</u> **Neuman**

<u>Analysis Results:</u> Transmissivity: 2.56E-1 [cm²/s] Conductivity: 5.52E-4 [cm/s]

<u>Test parameters:</u>

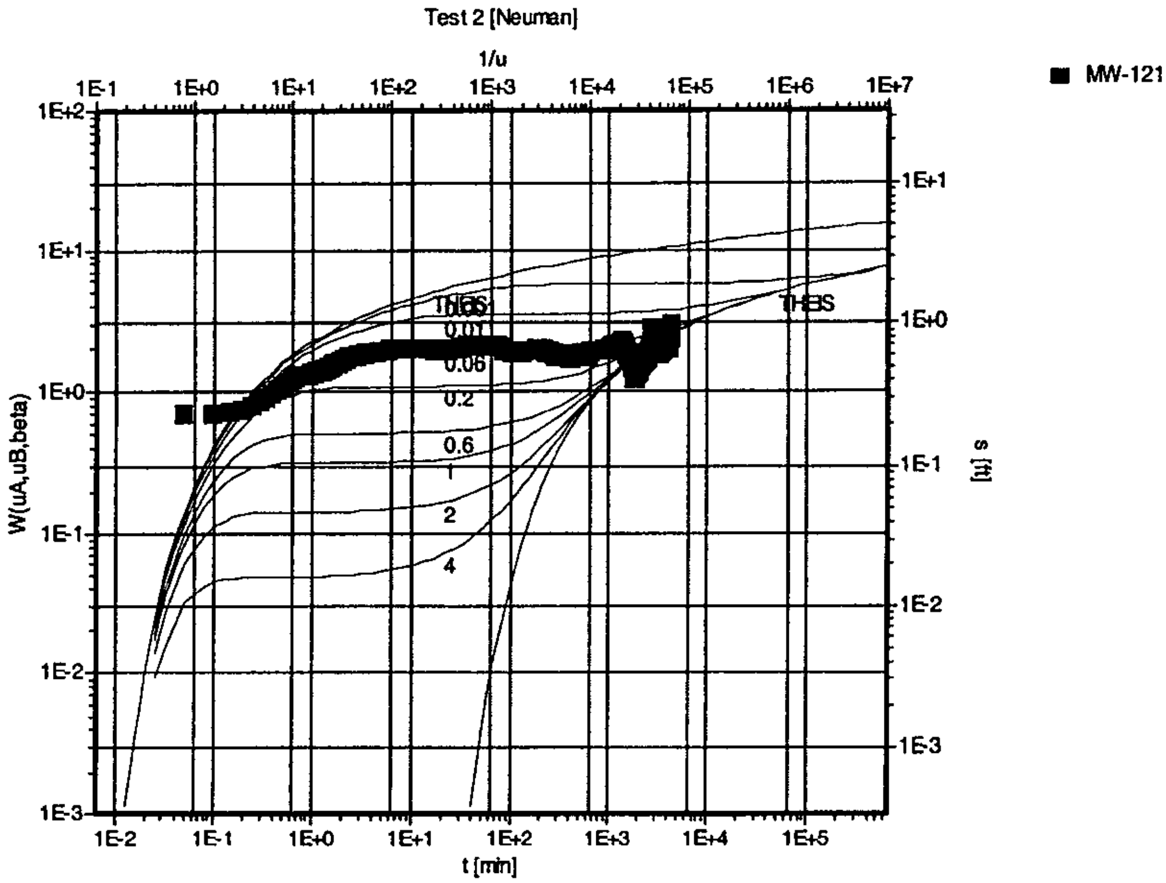
Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
Casing radius:	0.0833 [ft]	Beta:	0.2
Screen length:	10 [ft]		
Boring radius:	0.333 [ft]		
Discharge Rate:	7.6 [U.S. gal/min]		
LOG(Sy/S):	4		

<u>Comments:</u>

Evaluated by: Jim Huang
Evaluation Date: 02/09/2004

CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346
CH2MHILL Phone: 770-604-9182 * 545

Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



Pumping Test: **Test 2**

Analysis Method: **Neuman**

Analysis Results:	Transmissivity:	3.78E+0 [cm²/s]	Conductivity:	8.17E-3 [cm/s]

Test parameters:				
	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]	Beta:	0.06
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		
	LOG(Sy/S):	3.5		

Comments:

Evaluated by: Jim Huang
Evaluation Date: 02/09/2004

794 452

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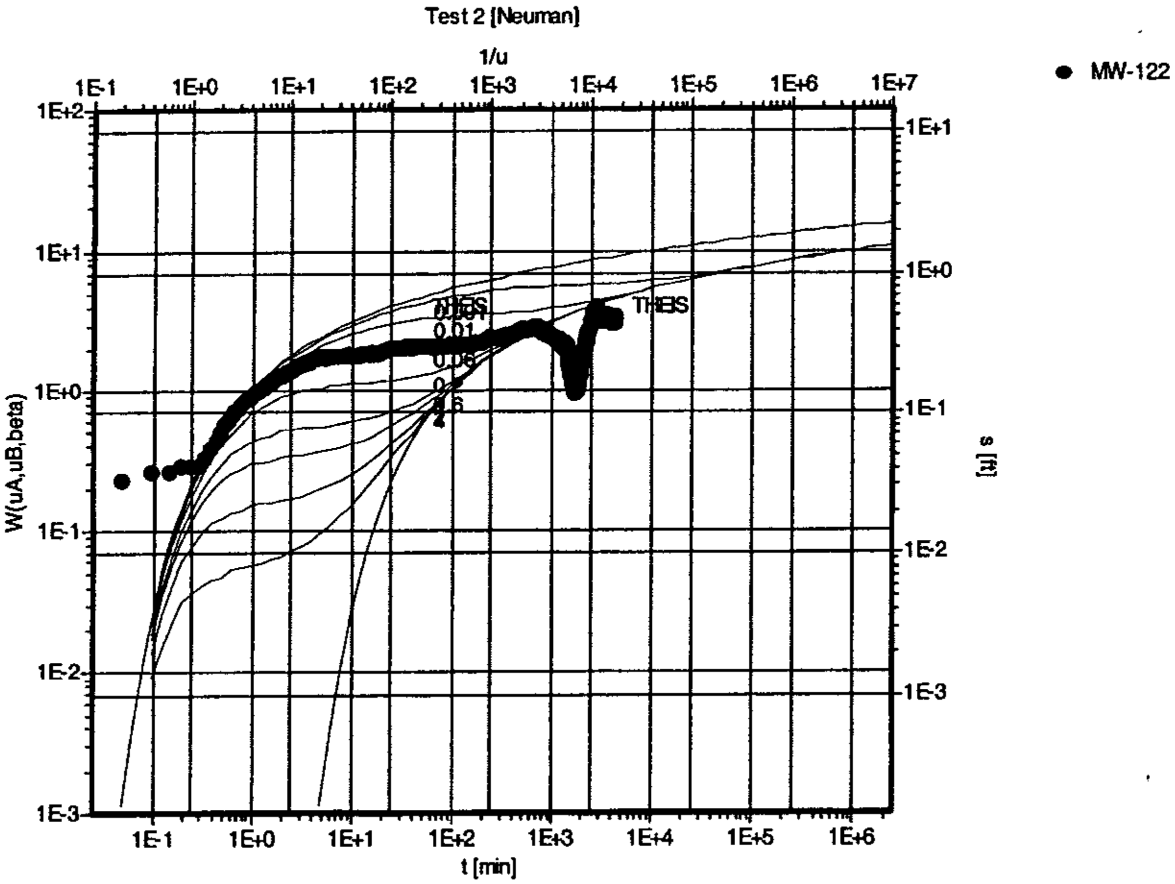
Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



Pumping Test: **Test 2**

Analysis Method: **Neuman**

Analysis Results:	Transmissivity:	8.66E+0 [cm²/s]	Conductivity:	1.87E-2 [cm/s]
Test parameters:	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]	Beta:	0.06
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		
	LOG(Sy/S):	2		

Comments:

Evaluated by: Jim Huang
Evaluation Date: 02/09/2004

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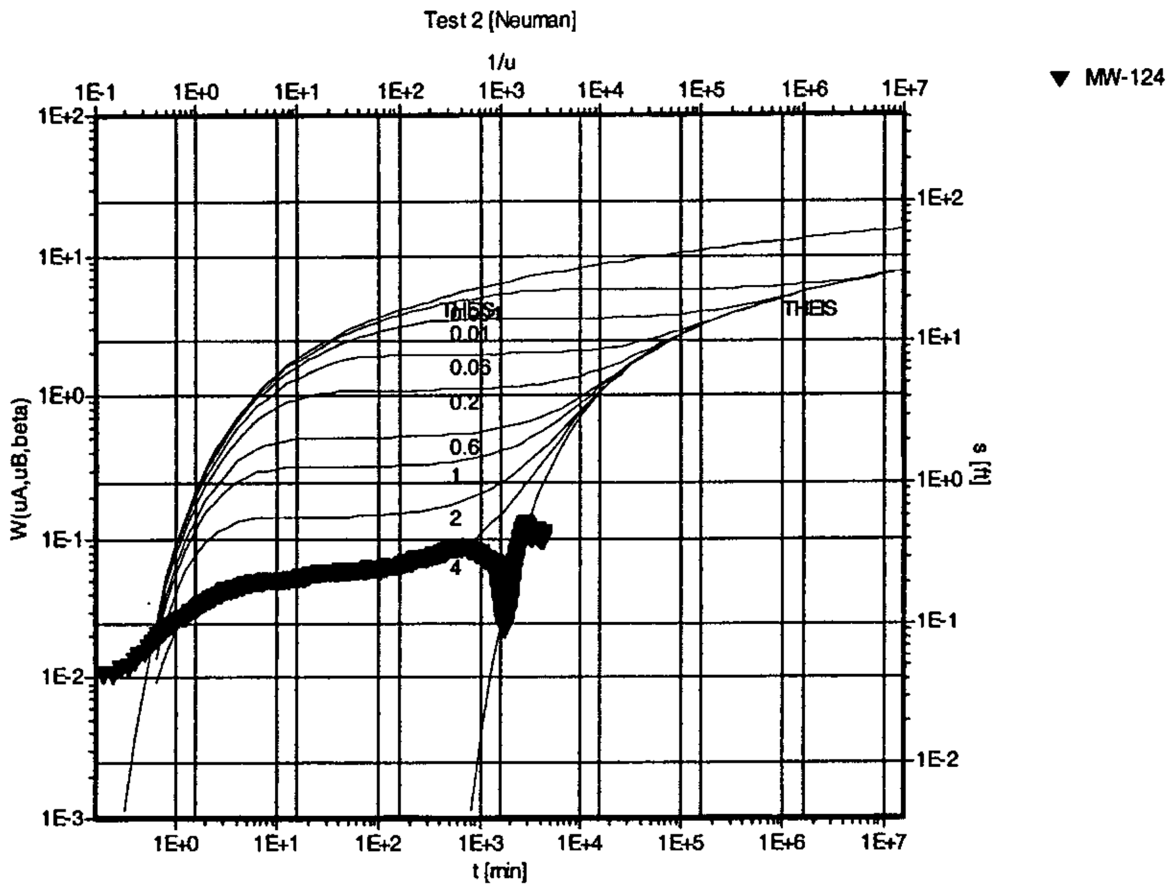
Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



Pumping Test: **Test 2**

Analysis Method: **Neuman**

Analysis Results: Transmissivity: 3.07E-1 [cm²/s] Conductivity: 6.64E-4 [cm/s]

Test parameters:

Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
Casing radius:	0.0833 [ft]	Beta:	4
Screen length:	10 [ft]		
Boring radius:	0.333 [ft]		
Discharge Rate:	7.6 [U.S. gal/min]		
LOG(Sy/S):	3.4		

Comments:

Evaluated by: Jim Huang
Evaluation Date: 02/09/2004

794 454

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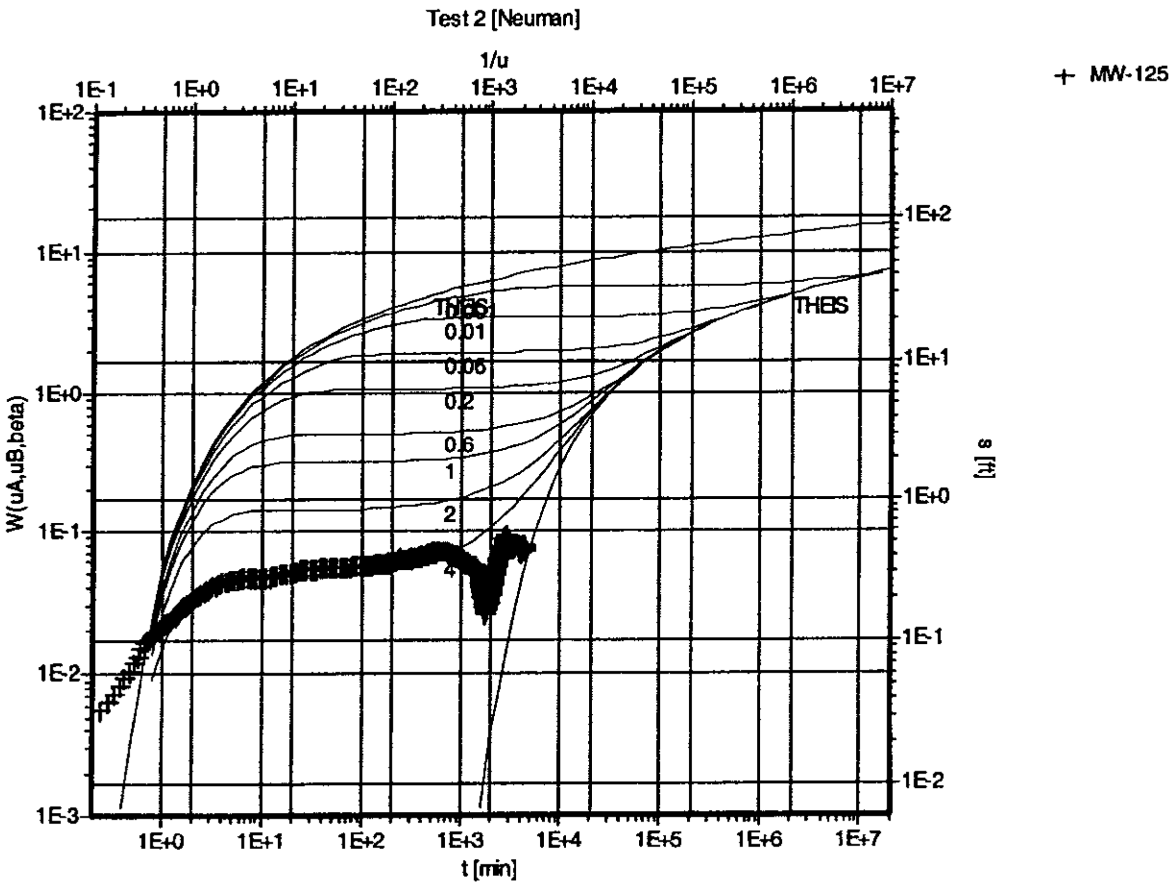
Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



Pumping Test: **Test 2**

Analysis Method: **Neuman**

Analysis Results:

Transmissivity:	2.13E-1 [cm²/s]	Conductivity:	4.59E-4 [cm/s]

Test parameters:

Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
Casing radius:	0.0833 [ft]	Beta:	4
Screen length:	10 [ft]		
Boring radius:	0.333 [ft]		
Discharge Rate:	7.6 [U.S. gal/min]		
LOG(Sy/S):	3.6		

Comments:

Evaluated by: Jim Huang
Evaluation Date: 02/09/2004

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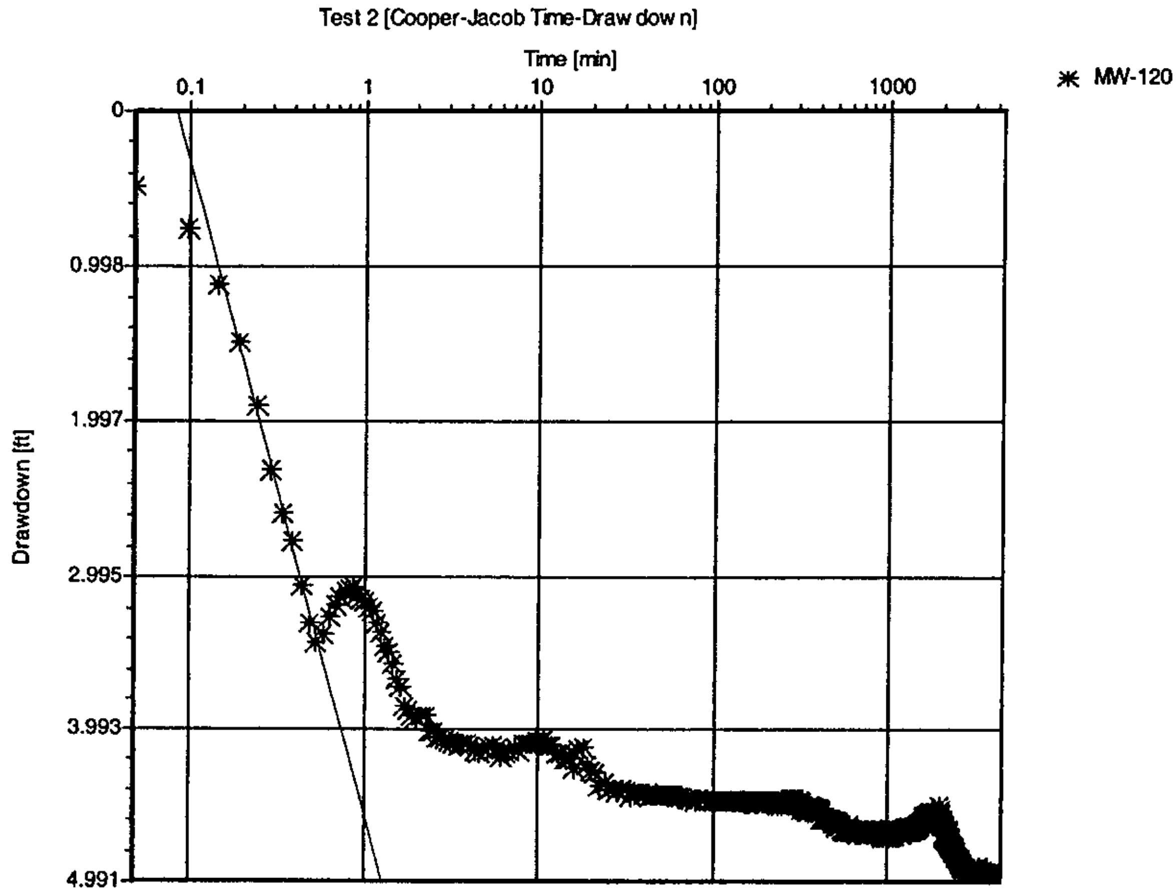
Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



Pumping Test: **Test 2**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	6.87E-1 [cm²/s]	Conductivity:	1.48E-3 [cm/s]
Test parameters:	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]	Unconfined Aquifer	
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		

Comments:

Evaluated by:
Evaluation Date: 02/11/2004

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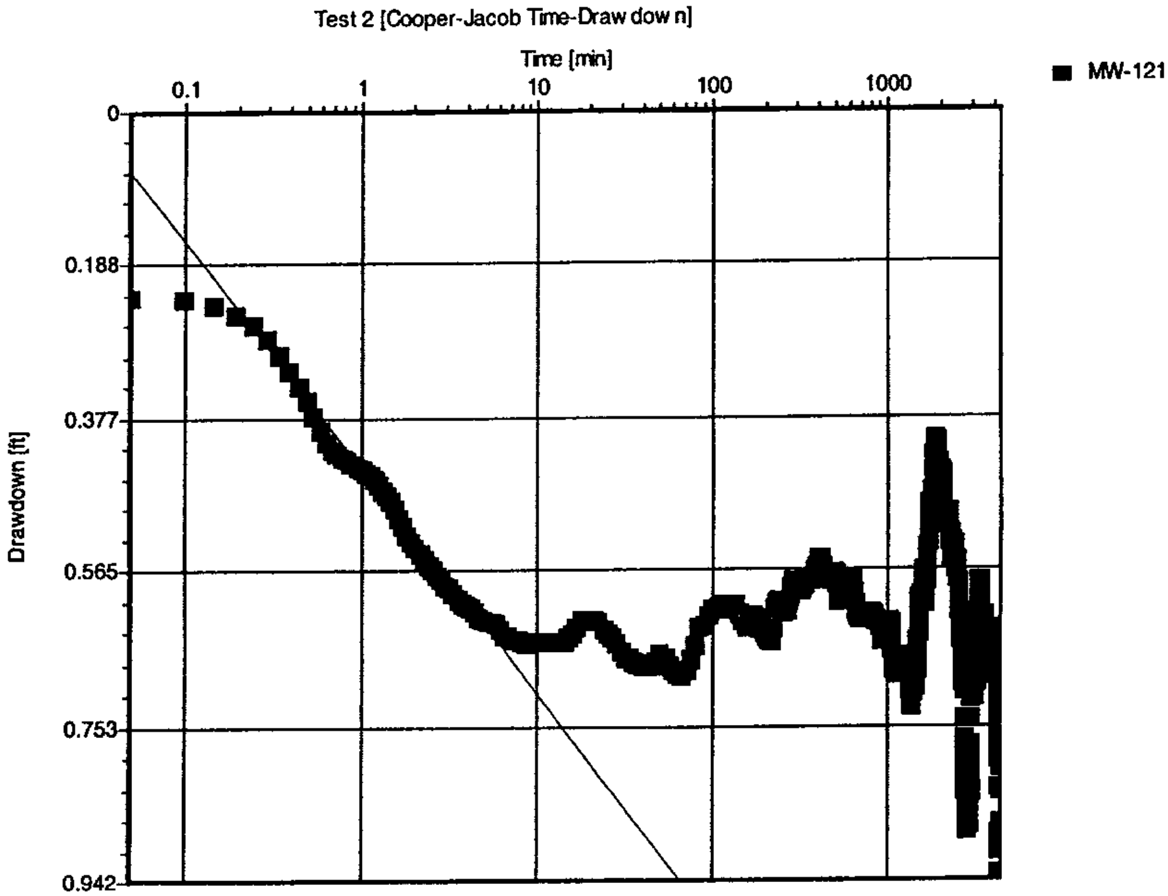
CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346
CH2MHILL Phone: 770-604-9182 * 545

Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



Pumping Test: **Test 2**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results: Transmissivity: 1.04E+1 [cm²/s] Conductivity: 2.25E-2 [cm/s]

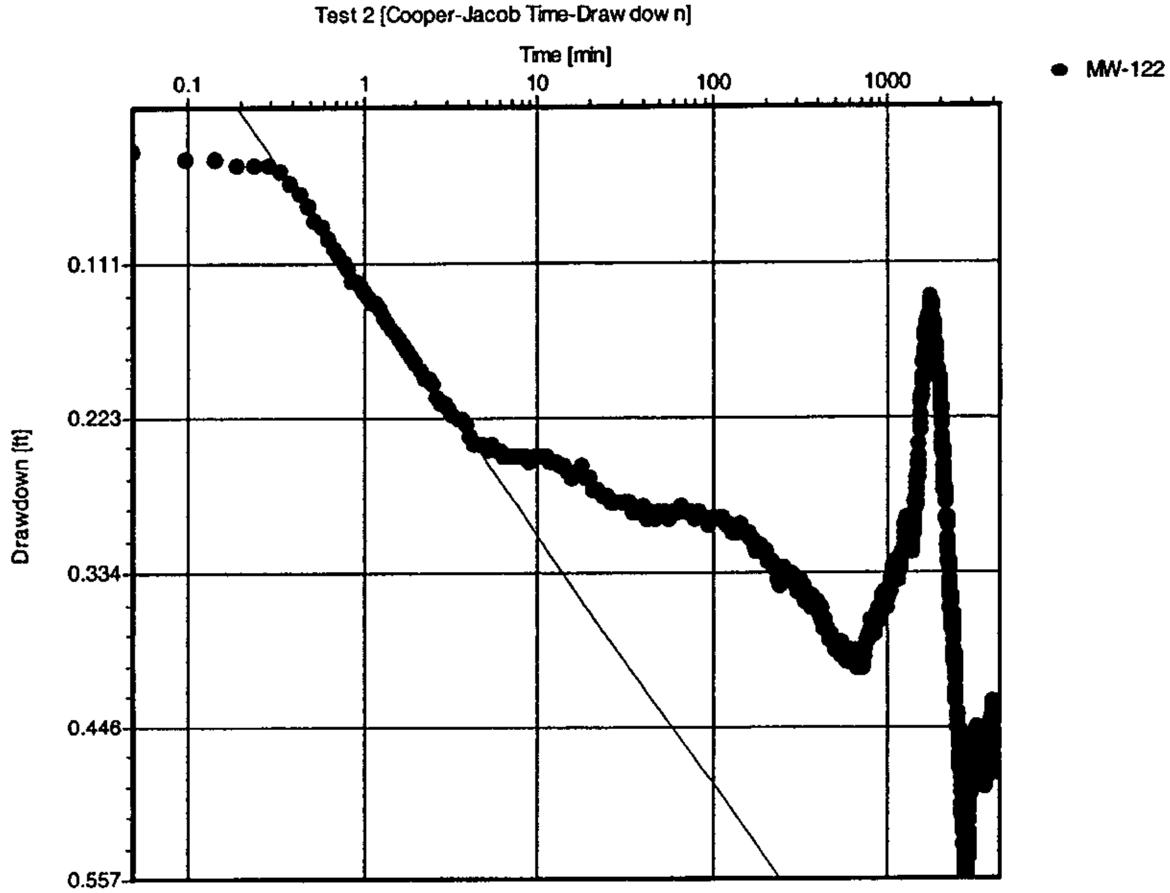
Test parameters:				
	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]	Unconfined Aquifer	
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		

Comments:

Evaluated by: Jim Huang
Evaluation Date: 02/11/2004

CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346
CH2MHILL Phone: 770-604-9182 * 545

Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



Pumping Test: **Test 2**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	1.60E+1 [cm²/s]	Conductivity:	3.46E-2 [cm/s]

Test parameters:	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]	Unconfined Aquifer	
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		

Comments:

Evaluated by: Jim Huang
Evaluation Date: 02/11/2004

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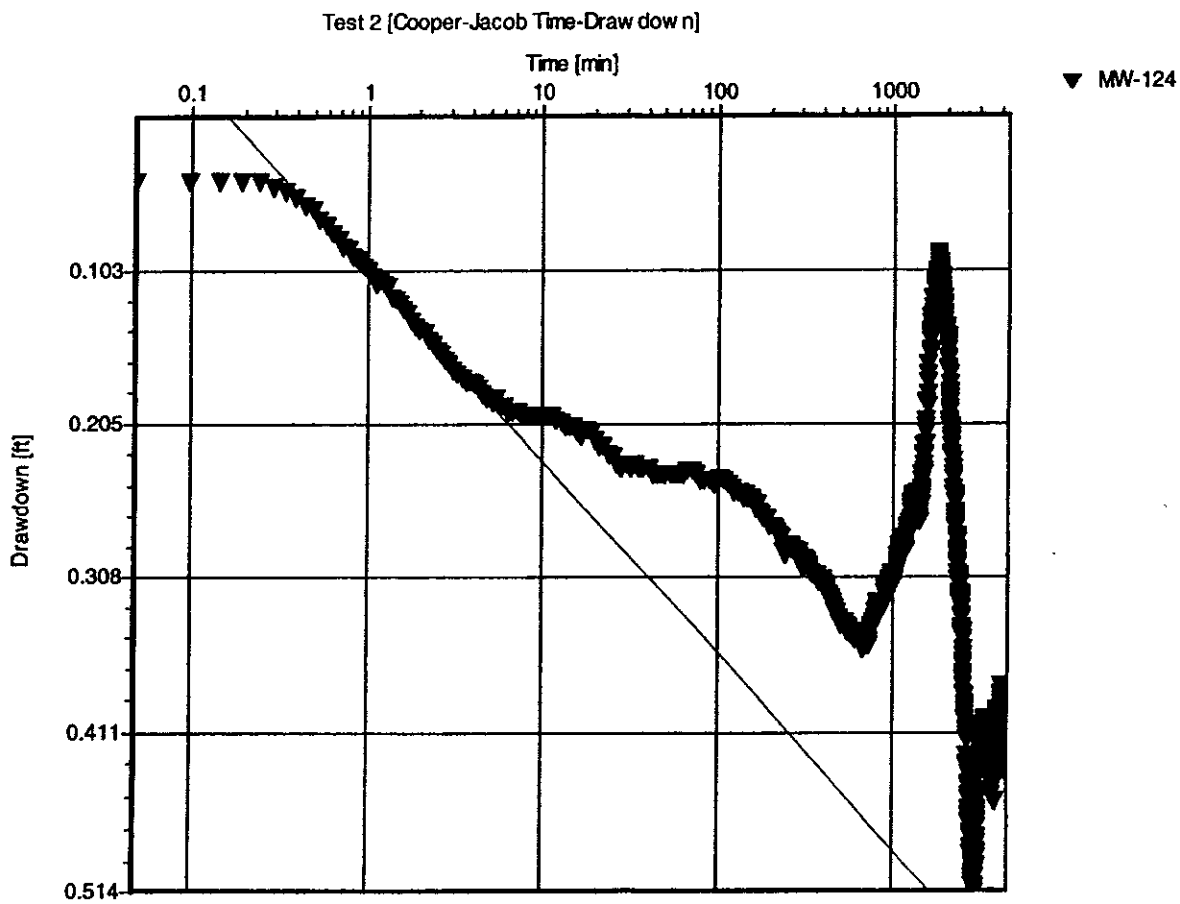
CH2M HILL 115 Perimeter Center Place NE, Suite 700 Atlanta, GA 30346 CH2MHILL Phone: 770-604-9182 * 545	**Pumping Test Analysis Report**	
	Project:	Main Installation Pumping Tests
	Number:	170039.TS.S2
	Client:	Huntsville Alabama COE



Pumping Test: **Test 2**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	2.24E+1 [cm²/s]	Conductivity:	4.85E-2 [cm/s]

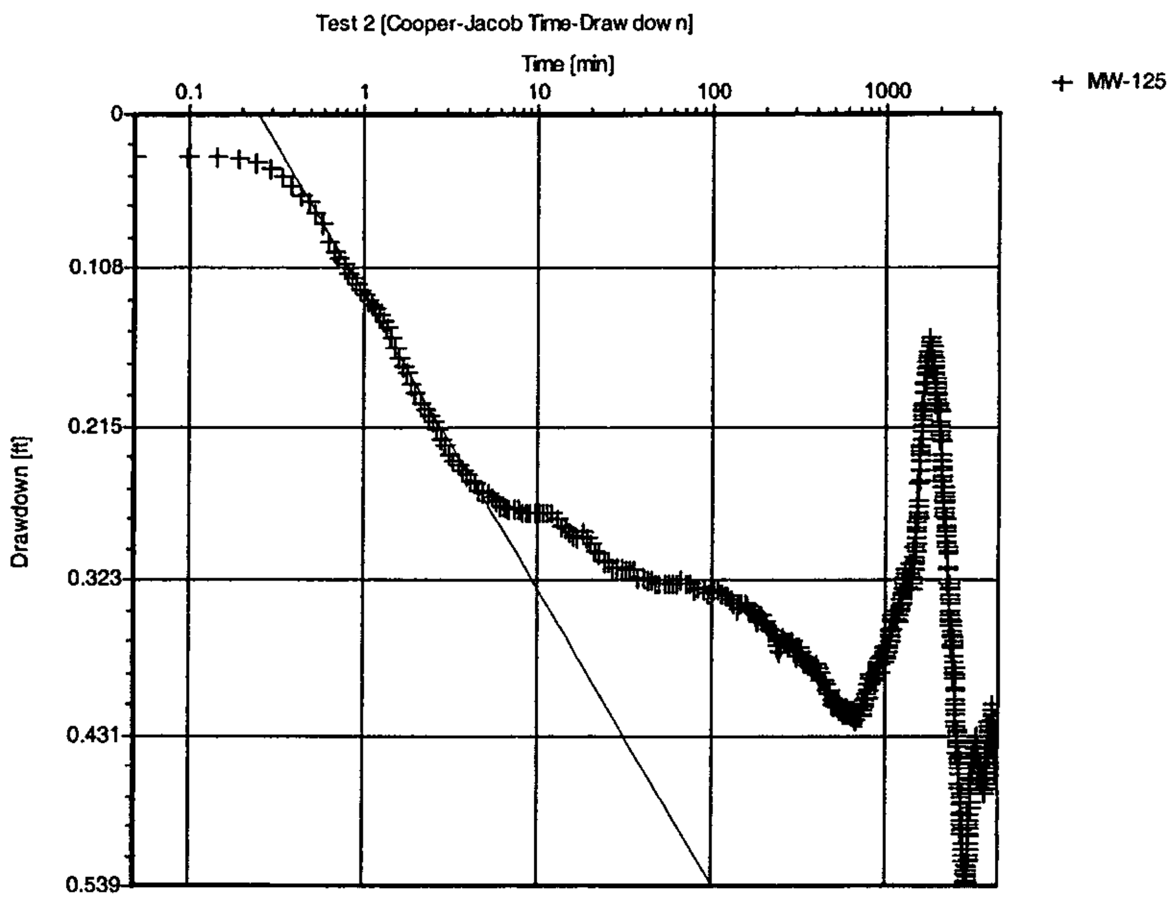
Test parameters:	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]	Unconfined Aquifer	
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		

Comments:

Evaluated by: Jim Huang
Evaluation Date: 02/11/2004

CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346
CH2MHILL Phone: 770-604-9182 * 545

Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



Pumping Test: **Test 2**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	1.40E+1 [cm²/s]	Conductivity:	3.03E-2 [cm/s]

Test parameters:				
	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]	Unconfined Aquifer	
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		

Comments:

Evaluated by: Jim Huang
Evaluation Date: 02/11/2004

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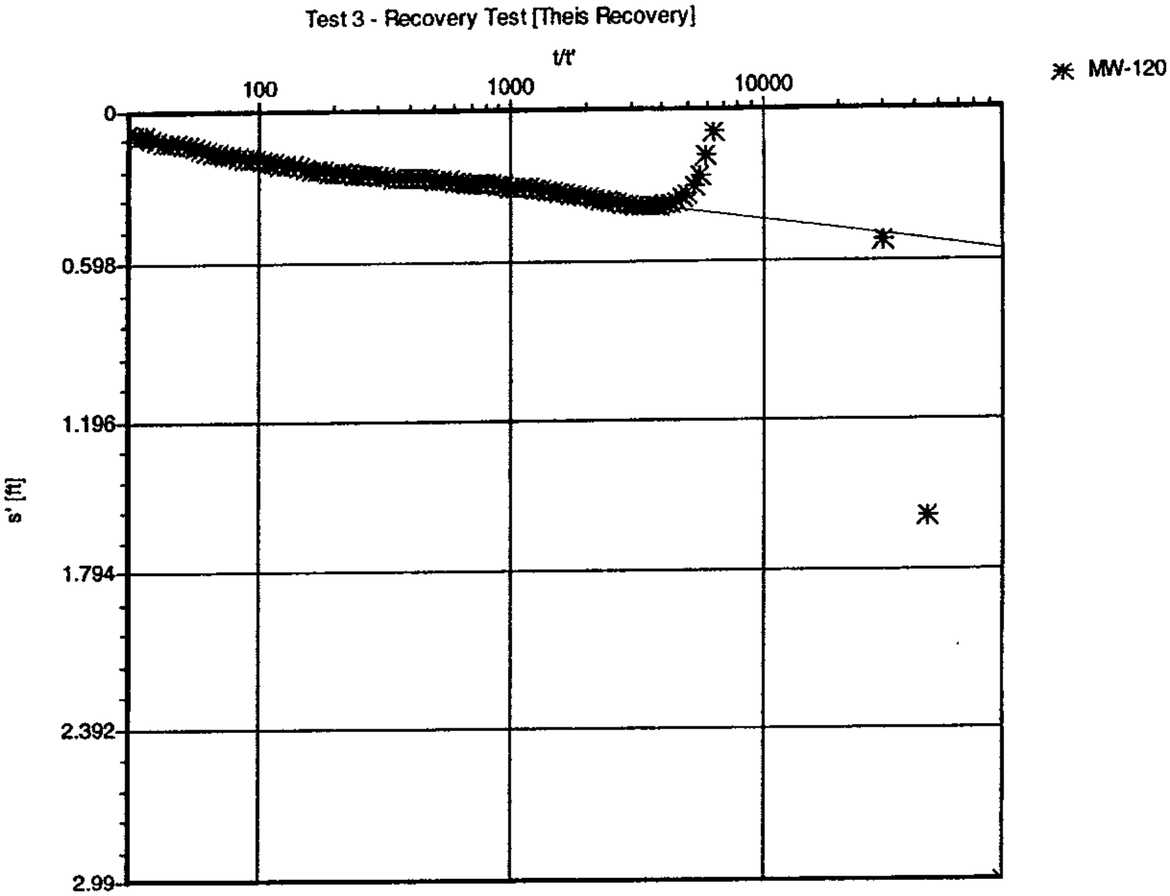
CH2M HILL 115 Perimeter Center Place NE, Suite 700 Atlanta, GA 30346 CH2MHILL Phone: 770-604-9182 * 545	**Pumping Test Analysis Report**	
	Project:	Main Installation Pumping Tests
	Number:	170039.TS.S2
	Client:	Huntsville Alabama COE



Pumping Test:	**Test 3 - Recovery Test**			
Analysis Method:	**Theis Recovery**			
Analysis Results:	Transmissivity:	2.24E+1 [cm²/s]	Conductivity:	4.84E-2 [cm/s]
Test parameters:	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]	Unconfined Aquifer	
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		
	Pumping Time	4344 [min]		

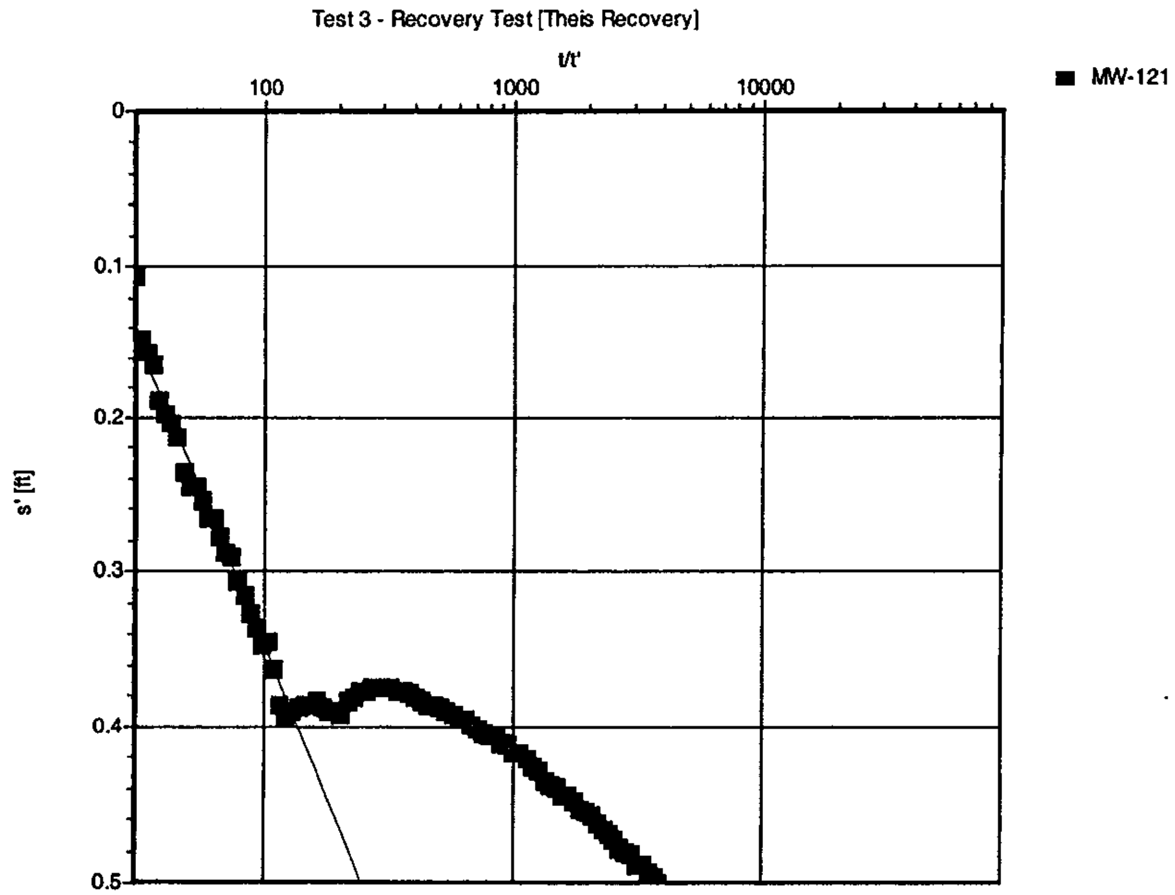
Comments:

Evaluated by:

Evaluation Date: 02/11/2004

CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346
CH2MHILL Phone: 770-604-9182 * 545

Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



Pumping Test: **Test 3 - Recovery Test**

Analysis Method: **Theis Recovery**

Analysis Results:	Transmissivity:	7.46E+0 [cm²/s]	Conductivity:	1.61E-2 [cm/s]

Test parameters:	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]	Unconfined Aquifer	
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		
	Pumping Time	4344 [min]		

Comments:

Evaluated by: Jim Huang
Evaluation Date: 02/11/2004

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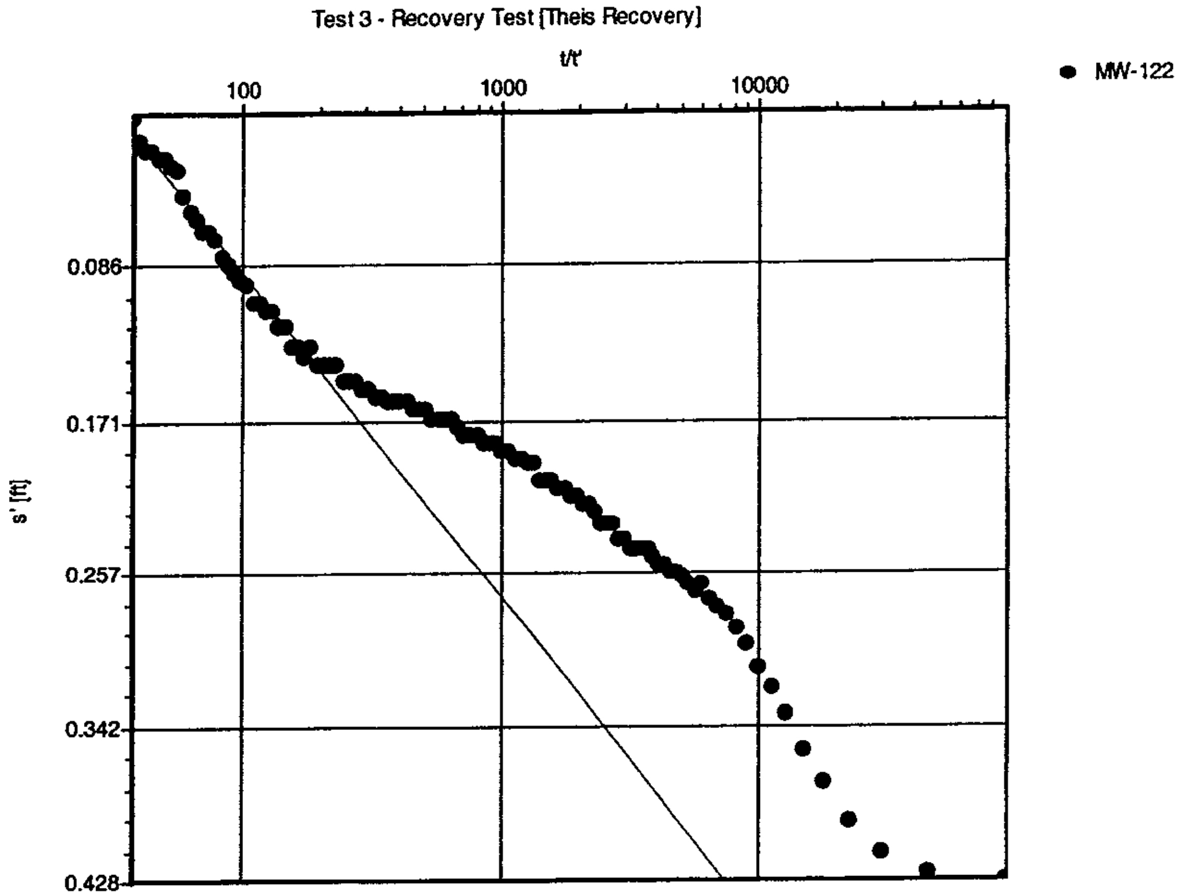
CH2M HILL 115 Perimeter Center Place NE, Suite 700 Atlanta, GA 30346 CH2MHILL Phone: 770-604-9182 * 545	**Pumping Test Analysis Report**	
	Project:	Main Installation Pumping Tests
	Number:	170039.TS.S2
	Client:	Huntsville Alabama COE



Pumping Test: **Test 3 - Recovery Test**

Analysis Method: **Theis Recovery**

Analysis Results:	Transmissivity:	1.59E+1 [cm²/s]	Conductivity:	3.43E-2 [cm/s]

Test parameters:	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]	Unconfined Aquifer	
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		
	Pumping Time	4344 [min]		

Comments:

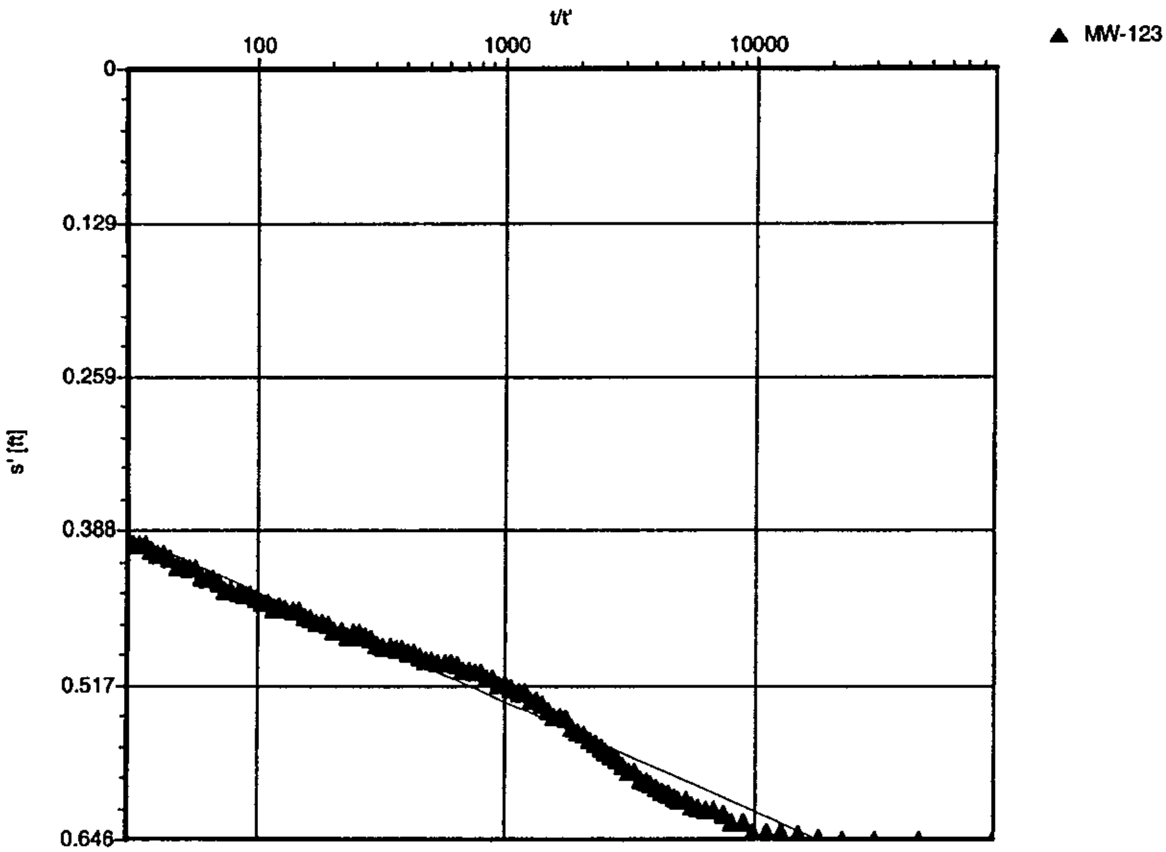
Evaluated by: Jim Huang

Evaluation Date: 02/11/2004

CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346
CH2MHILL Phone: 770-604-9182 * 545

Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE

Test 3 - Recovery Test [Theis Recovery]



Pumping Test: **Test 3 - Recovery Test**

Analysis Method: **Theis Recovery**

Analysis Results:	Transmissivity:	3.15E+1 [cm²/s]	Conductivity:	6.80E-2 [cm/s]

Test parameters:	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]	Unconfined Aquifer	
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		
	Pumping Time	4344 [min]		

Comments:

Evaluated by: Jim Huang
Evaluation Date: 02/11/2004

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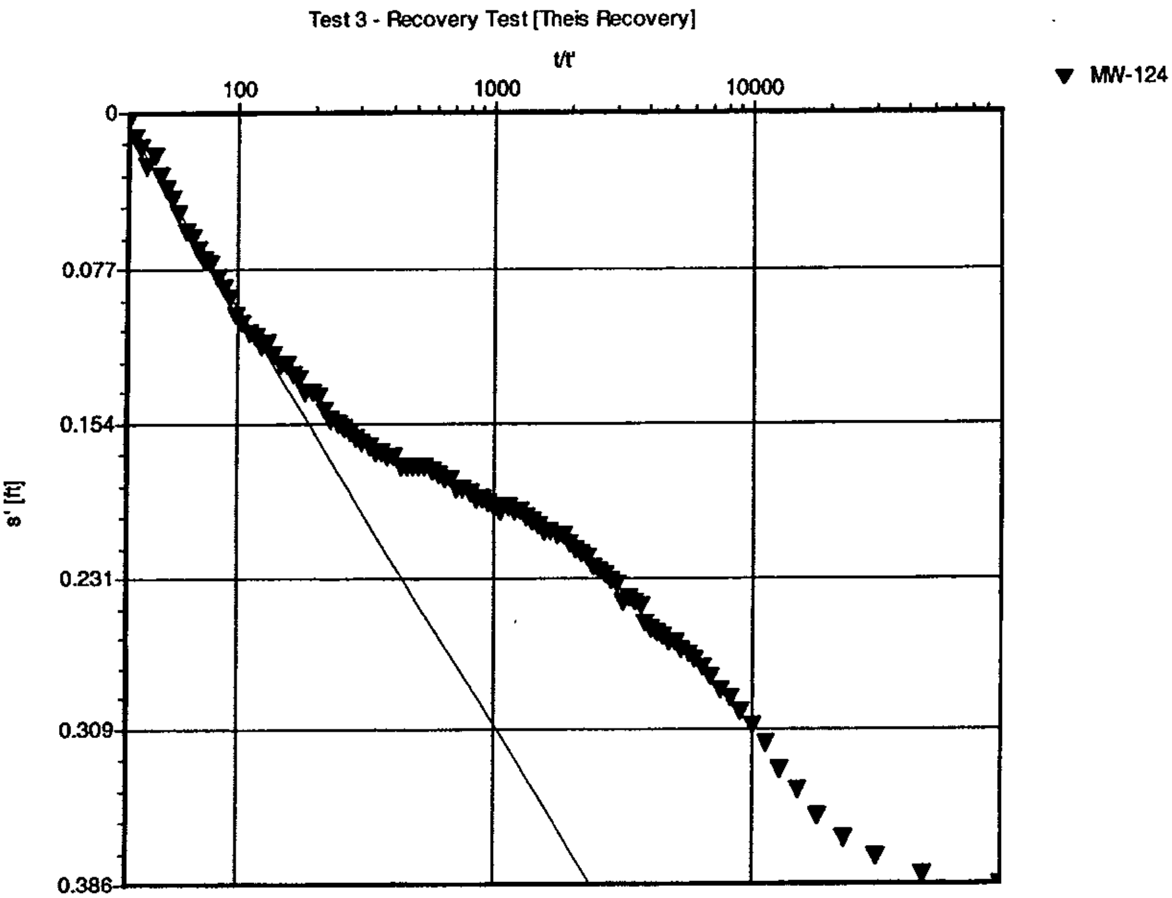
CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346
CH2MHILL Phone: 770-604-9182 * 545

Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



Pumping Test: **Test 3 - Recovery Test**

Analysis Method: **Theis Recovery**

Analysis Results:	Transmissivity:	1.37E+1 [cm²/s]	Conductivity:	2.96E-2 [cm/s]

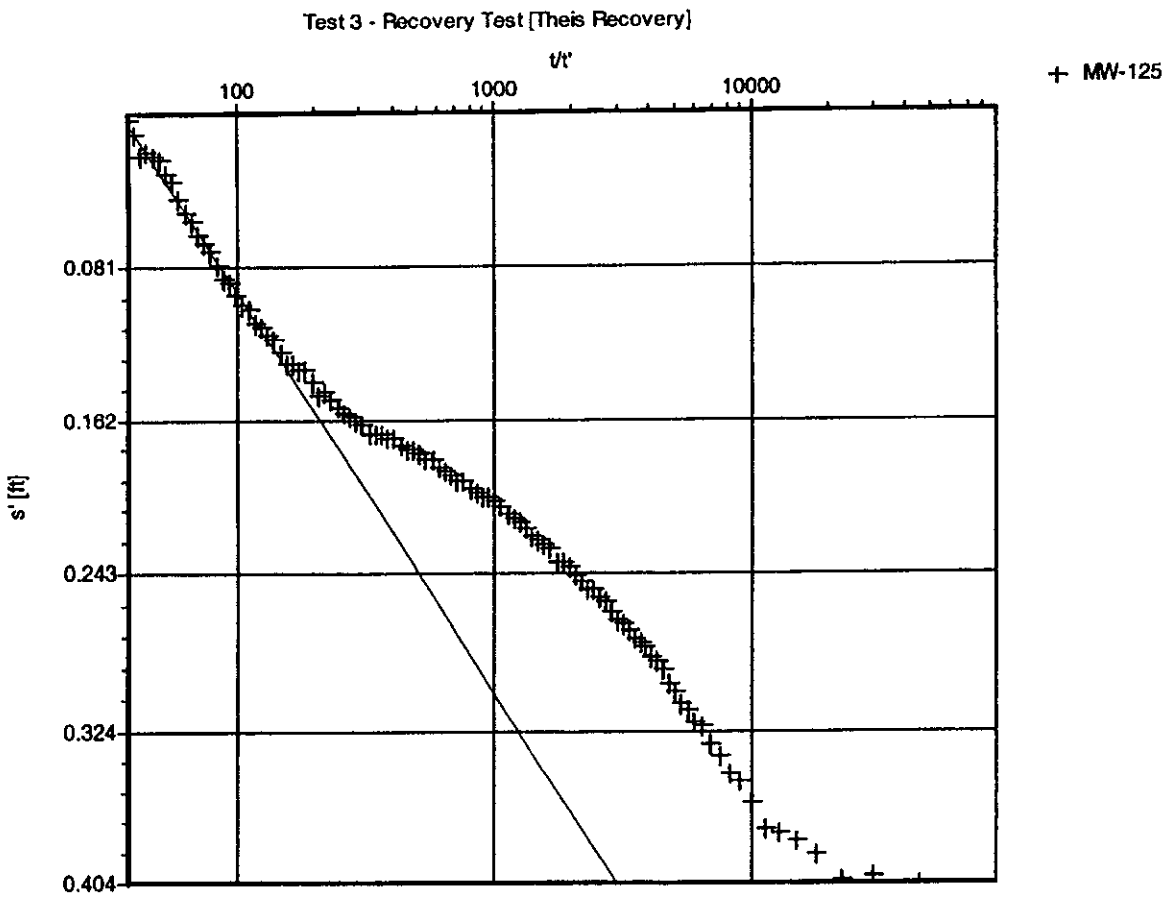
Test parameters:	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]	Unconfined Aquifer	
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		
	Pumping Time	4344 [min]		

Comments:

Evaluated by: Jim Huang
Evaluation Date: 02/11/2004

CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346
CH2MHILL Phone: 770-604-9182 * 545

Pumping Test Analysis Report	
Project:	Main Installation Pumping Tests
Number:	170039.TS.S2
Client:	Huntsville Alabama COE



Pumping Test: **Test 3 - Recovery Test**

Analysis Method: **Theis Recovery**

Analysis Results:	Transmissivity:	1.37E+1 [cm²/s]	Conductivity:	2.97E-2 [cm/s]
Test parameters:	Pumping Well:	MW-120	Aquifer Thickness:	15.18 [ft]
	Casing radius:	0.0833 [ft]	Unconfined Aquifer	
	Screen length:	10 [ft]		
	Boring radius:	0.333 [ft]		
	Discharge Rate:	7.6 [U.S. gal/min]		
	Pumping Time	4344 [min]		

Comments:

Evaluated by: Jim Huang
Evaluation Date: 02/11/2004

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Attachment D
72-Hour Aquifer Test Water Levels
Monitoring Wells Without Pressure Transducers
Main Installation, Memphis Depot

Well	Date	Time	Water Level (feet BTOC)
MW-20	01/12/2004	1212	84.33
	01/13/2003	950	85.96
	01/13/2003	1300	84.28
	01/13/2003	1700	84.28
	01/13/2003	1800	84.31
	01/13/2003	2000	84.29
	01/13/2003	2200	84.29
	01/13/2003	2400	84.29
	01/14/2004	200	84.29
	01/14/2004	400	84.21
	01/14/2004	600	84.18
	01/14/2004	800	84.14
	01/14/2004	1000	84.14
	01/14/2004	1200	84.07
	01/14/2004	1400	84.00
	01/14/2004	1600	83.96
	01/14/2004	1800	83.98
	01/14/2004	2000	84.02
	01/14/2004	2200	84.08
	01/14/2004	2400	84.11
	01/15/2004	200	84.16
	01/15/2004	400	84.23
	01/15/2004	600	84.27
	01/15/2004	800	84.31
	01/15/2004	1000	84.35
	01/15/2004	1200	84.31
	01/15/2004	1400	84.25
	01/15/2004	1600	84.26
	01/15/2004	1800	84.25
	01/15/2004	2000	84.26
	01/15/2004	2200	84.27
	01/15/2004	2400	84.26
	01/16/2004	200	84.24
	01/16/2004	400	84.24
	01/16/2004	600	84.23
	01/16/2004	800	84.24
	01/16/2004	1000	84.25
	01/16/2004	1645	84.11
MW-21	01/12/2004	1205	93.15
	01/13/2004	950	94.80
	01/16/2004	1645	93.03
MW-22	01/12/2004	1111	96.07
	01/13/2004	950	96.09
	01/13/2004	1300	96.02
	01/13/2004	1400	96.00
	01/13/2004	1500	96.00
	01/13/2004	1600	96.01
	01/13/2004	1700	96.00
	01/13/2004	1800	96.01
	01/13/2004	1900	96.02
	01/13/2004	2000	96.02
	01/13/2004	2125	96.02
	01/13/2004	2200	96.02
	01/13/2004	2300	96.00
	01/13/2004	2400	95.99
	01/14/2004	100	95.97
	01/14/2004	200	95.96

Well	Date	Time	Water Level (feet BTOC)
MW-22	01/14/2004	300	95.95
	01/14/2004	400	95.95
	01/14/2004	500	95.95
	01/14/2004	600	95.91
	01/14/2004	700	95.91
	01/14/2004	800	95.90
	01/14/2004	900	95.88
	01/14/2004	1000	95.88
	01/14/2004	1100	95.86
	01/14/2004	1200	95.82
	01/14/2004	1300	95.76
	01/14/2004	1400	95.75
	01/14/2004	1500	95.75
	01/14/2004	1600	95.72
	01/14/2004	1700	95.74
	01/14/2004	1800	95.76
	01/14/2004	1900	95.78
	01/14/2004	2000	95.80
	01/14/2004	2100	95.83
	01/14/2004	2200	95.85
	01/14/2004	2300	95.88
	01/14/2004	2400	95.90
	01/15/2004	100	95.94
	01/15/2004	200	95.95
	01/15/2004	300	95.98
	01/15/2004	400	96.01
	01/15/2004	500	96.03
	01/15/2004	600	96.04
	01/15/2004	700	96.09
	01/15/2004	800	96.10
	01/15/2004	900	96.12
	01/15/2004	1000	96.12
	01/15/2004	1100	96.11
	01/15/2004	1200	96.08
	01/15/2004	1300	96.06
	01/15/2004	1400	96.03
	01/15/2004	1500	96.05
	01/15/2004	1600	96.03
	01/15/2004	1700	96.02
	01/15/2004	1800	96.01
	01/15/2004	1900	96.03
	01/15/2004	2000	96.03
	01/15/2004	2100	96.04
	01/15/2004	2200	96.04
	01/15/2004	2300	96.04
	01/15/2004	2400	96.03
	01/16/2004	100	96.01
	01/16/2004	200	96.00
	01/16/2004	300	96.01
	01/16/2004	400	96.01
	01/16/2004	500	96.00
	01/16/2004	600	96.00
	01/16/2004	700	96.00
	01/16/2004	800	96.00
	01/16/2004	900	96.01
	01/16/2004	1000	96.01
	01/16/2004	1100	95.95

Attachment D
72-Hour Aquifer Test Water Levels
Monitoring Wells Without Pressure Transducers
Main Installation, Memphis Depot

Well	Date	Time	Water Level (feet BTOC)
MW-22	01/16/2004	1645	95.87
MW-99	01/12/2004	1215	89.10
	01/13/2004	950	89.10
	01/16/2004	1645	87.25
MW-100B	01/12/2004	1432	90.70
	01/13/2004	950	92.31
	01/16/2004	1645	90.64
MW-101	01/12/2004	1220	91.22
	01/13/2004	950	91.28
	01/16/2004	1645	91.07
MW-102B	01/12/2004	1110	108.65
	01/13/2004	950	108.68
	01/13/2004	1300	108.57
	01/13/2004	1400	108.59
	01/13/2004	1500	108.60
	01/13/2004	1600	108.60
	01/13/2004	1700	108.59
	01/13/2004	1800	108.61
	01/13/2004	1900	108.61
	01/13/2004	2000	108.64
	01/13/2004	2100	108.62
	01/13/2004	2200	108.62
	01/13/2004	2300	108.61
	01/13/2004	2400	108.57
	01/14/2004	100	108.57
	01/14/2004	200	108.55
	01/14/2004	300	108.55
	01/14/2004	400	108.54
	01/14/2004	500	108.53
	01/14/2004	600	108.51
	01/14/2004	700	108.50
	01/14/2004	800	108.48
	01/14/2004	900	108.48
	01/14/2004	1000	108 49
	01/14/2004	1100	108.49
	01/14/2004	1200	108.41
	01/14/2004	1300	108.35
	01/14/2004	1400	108.33
	01/14/2004	1500	108.34
	01/14/2004	1600	108.32
	01/14/2004	1700	108.35
	01/14/2004	1800	108.36
	01/14/2004	1900	108.38
	01/14/2004	2000	108.41
	01/14/2004	2100	108.44
	01/14/2004	2200	108.46
	01/14/2004	2300	108.50
	01/14/2004	2400	108.50
	01/15/2004	100	108.54
	01/15/2004	200	108.56
	01/15/2004	300	108.57
	01/15/2004	400	108.62
	01/15/2004	500	108.63
	01/15/2004	600	108.65
	01/15/2004	700	108.68
	01/15/2004	800	108.68
	01/15/2004	900	108.72

Well	Date	Time	Water Level (BTOC)
MW-102B	01/15/2004	1000	108.73
	01/15/2004	1100	108.71
	01/15/2004	1200	108.68
	01/15/2004	1300	108.65
	01/15/2004	1400	108.61
	01/15/2004	1500	108.63
	01/15/2004	1600	108.61
	01/15/2004	1700	108.59
	01/15/2004	1800	108.61
	01/15/2004	1900	108.62
	01/15/2004	2000	108.61
	01/15/2004	2100	108.63
	01/15/2004	2200	108.63
	01/15/2004	2300	108.63
	01/15/2004	2400	108.62
	01/16/2004	100	108.61
	01/16/2004	200	108.61
	01/16/2004	300	108.60
	01/16/2004	400	108.61
	01/16/2004	500	108.60
	01/16/2004	600	108.58
	01/16/2004	700	108 60
	01/16/2004	800	108.59
	01/16/2004	900	108.61
	01/16/2004	1000	108.61
	01/16/2004	1100	108.56
	01/16/2004	1645	108.47
MW-115	01/12/2004	1150	91.09
	01/13/2004	950	92.72
	01/13/2004	1300	91.52
	01/13/2004	1400	91.54
	01/13/2004	1500	91.56
	01/13/2004	1600	91.60
	01/13/2004	1700	91.59
	01/13/2004	1800	91.63
	01/13/2004	1900	91.62
	01/13/2004	2000	91.61
	01/13/2004	2100	91.64
	01/13/2004	2200	91.64
	01/13/2004	2300	91.62
	01/13/2004	2400	91.61
	01/14/2004	100	91.66
	01/14/2004	200	91.65
	01/14/2004	300	91.63
	01/14/2004	400	91.63
	01/14/2004	500	91.61
	01/14/2004	600	91.61
	01/14/2004	700	91.59
	01/14/2004	800	91.55
	01/14/2004	900	91.53
	01/14/2004	1000	91.55
	01/14/2004	1100	91.54
	01/14/2004	1200	91.52
	01/14/2004	1300	91.48
	01/14/2004	1400	91.41
	01/14/2004	1500	91.43
	01/14/2004	1600	91.44

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Attachment D
72-Hour Aquifer Test Water Levels
Monitoring Wells Without Pressure Transducers
Main Installation, Memphis Depot

Well	Date	Time	Water Level (feet BTOC)
MW-115	01/14/2004	1700	91.45
	01/14/2004	1800	91.43
	01/14/2004	1900	91.46
	01/14/2004	2000	91.46
	01/14/2004	2100	91.46
	01/14/2004	2200	91.53
	01/14/2004	2300	91.55
	01/14/2004	2400	91.60
	01/15/2004	100	91.63
	01/15/2004	200	91.65
	01/15/2004	300	91.67
	01/15/2004	400	91.68
	01/15/2004	500	91.72
	01/15/2004	600	91.75
	01/15/2004	700	91.78
	01/15/2004	800	91.78
	01/15/2004	900	91.78
	01/15/2004	1000	91.82
	01/15/2004	1100	91.81
	01/15/2004	1200	91.76
	01/15/2004	1300	91.72
	01/15/2004	1400	91.71
	01/15/2004	1500	91.74
	01/15/2004	1600	91.72
	01/15/2004	1700	91.71
	01/15/2004	1800	91.71
	01/15/2004	1900	91.71
	01/15/2004	2000	91.70
	01/15/2004	2100	91.71
	01/15/2004	2200	91.72
	01/15/2004	2300	91.72
	01/15/2004	2400	91.70
	01/16/2004	100	91.68
	01/16/2004	200	91.67
	01/16/2004	300	91.66
	01/16/2004	400	91.67
	01/16/2004	500	91.66
	01/16/2004	600	91.65
	01/16/2004	700	91.66
	01/16/2004	800	91.65
	01/16/2004	900	91.68
	01/16/2004	1000	91.69
	01/16/2004	1100	91.62
	01/16/2004	1645	91.04
MW-116	01/12/2004	1149	91.08
	01/13/2004	950	92.75
	01/13/2004	1300	-
	01/13/2004	1400	-
	01/13/2004	1500	-
	01/13/2004	1600	91.73
	01/13/2004	1700	91.72
	01/13/2004	1800	91.74
	01/13/2004	1900	91.79
	01/13/2004	2000	91.79
	01/13/2004	2100	91.79
	01/13/2004	2200	91.79
	01/13/2004	2300	91.77

Well	Date	Time	Water Level (BTOC)
MW-116	01/13/2004	2400	91.76
	01/14/2004	100	91.75
	01/14/2004	200	91.74
	01/14/2004	300	91.74
	01/14/2004	400	91.72
	01/14/2004	500	91.71
	01/14/2004	600	91.69
	01/14/2004	700	91.68
	01/14/2004	800	91.66
	01/14/2004	900	91.66
	01/14/2004	1000	91.67
	01/14/2004	1100	91.65
	01/14/2004	1200	91.61
	01/14/2004	1300	91.54
	01/14/2004	1400	91.53
	01/14/2004	1500	91.51
	01/14/2004	1600	91.51
	01/14/2004	1700	91.51
	01/14/2004	1800	91.51
	01/14/2004	1900	91.54
	01/14/2004	2000	91.55
	01/14/2004	2100	91.58
	01/14/2004	2200	91.62
	01/14/2004	2300	91.65
	01/14/2004	2400	91.68
	01/15/2004	100	91.71
	01/15/2004	200	91.76
	01/15/2004	300	91.76
	01/15/2004	400	91.79
	01/15/2004	500	91.82
	01/15/2004	600	91.83
	01/15/2004	700	91.87
	01/15/2004	800	91.87
	01/15/2004	900	91.89
	01/15/2004	1000	91.91
	01/15/2004	1100	91.91
	01/15/2004	1200	91.87
	01/15/2004	1300	91.83
	01/15/2004	1400	91.82
	01/15/2004	1500	91.83
	01/15/2004	1600	91.83
	01/15/2004	1700	91.81
	01/15/2004	1800	91.82
	01/15/2004	1900	91.83
	01/15/2004	2000	91.83
	01/15/2004	2100	91.85
	01/15/2004	2200	91.85
	01/15/2004	2300	91.85
	01/15/2004	2400	91.84
	01/16/2004	100	91.83
	01/16/2004	200	91.83
	01/16/2004	300	91.80
	01/16/2004	400	91.81
	01/16/2004	500	91.80
	01/16/2004	600	91.78
	01/16/2004	700	91.81
	01/16/2004	800	91.80

Attachment D
72-Hour Aquifer Test Water Levels
Monitoring Wells Without Pressure Transducers
Main Installation, Memphis Depot

Well	Date	Time	Water Level (feet BTOC)
MW-116	01/16/2004	900	91.81
	01/16/2004	1000	91.82
	01/16/2004	1100	91.78
	01/16/2004	1645	91.02
MW-117	01/12/2004	1144	91.14
	01/13/2004	1300	91.17
	01/13/2004	1400	91.18
	01/13/2004	1500	91.20
	01/13/2004	1600	91.20
	01/13/2004	1700	91.22
	01/13/2004	1800	91.24
	01/13/2004	1900	91.25
	01/13/2004	2000	91.28
	01/13/2004	2100	91.28
	01/13/2004	2200	91.28
	01/13/2004	2300	91.27
	01/13/2004	2400	91.26
	01/14/2004	100	91.25
	01/14/2004	200	91.23
	01/14/2004	300	91.23
	01/14/2004	400	91.23
	01/14/2004	500	91.22
	01/14/2004	600	91.19
	01/14/2004	700	91.19
	01/14/2004	800	91.17
	01/14/2004	900	91.17
	01/14/2004	1000	91.17
	01/14/2004	1100	91.15
	01/14/2004	1200	91.14
	01/14/2004	1300	91.07
	01/14/2004	1400	91.04
	01/14/2004	1500	91.03
	01/14/2004	1600	91.01
	01/14/2004	1700	91.01
	01/14/2004	1800	91.02
	01/14/2004	1900	91.03
	01/14/2004	2000	91.05
	01/14/2004	2100	91.05
	01/14/2004	2200	91.10
	01/14/2004	2300	91.13
	01/14/2004	2400	91.16
	01/15/2004	100	91.19
	01/15/2004	200	91.21
	01/15/2004	300	91.23
	01/15/2004	400	91.27
	01/15/2004	500	91.30
	01/15/2004	600	91.31
	01/15/2004	700	91.37
	01/15/2004	800	91.37
	01/15/2004	900	91.38
	01/15/2004	1000	91.41
	01/15/2004	1100	91.42
	01/15/2004	1200	91.40
	01/15/2004	1300	91.36
	01/15/2004	1400	91.34
	01/15/2004	1500	91.34
	01/15/2004	1600	91.33

Well	Date	Time	Water Level (BTOC)
MW-117	01/15/2004	1700	91.32
	01/15/2004	1800	91.31
	01/15/2004	1900	91.32
	01/15/2004	2000	91.32
	01/15/2004	2100	91.32
	01/15/2004	2200	91.33
	01/15/2004	2300	91.35
	01/15/2004	2400	91.34
	01/16/2004	100	91.33
	01/16/2004	200	91.32
	01/16/2004	300	91.31
	01/16/2004	400	91.31
	01/16/2004	500	91.31
	01/16/2004	600	91.30
	01/16/2004	700	91.30
	01/16/2004	800	91.31
	01/16/2004	900	91.31
	01/16/2004	1000	91.31
	01/16/2004	1100	91.30
	01/16/2004	1645	90.76
MW-118	01/12/2004	1145	90.69
	01/13/2004	950	92.29
	01/16/2004	1646	90.58
MW-119	01/12/2004	1148	90.95
	01/13/2004	950	92.60
	01/13/2004	1300	91.27
	01/13/2004	1400	91.30
	01/13/2004	1500	91.30
	01/13/2004	1600	91.32
	01/13/2004	1700	91.31
	01/13/2004	1800	91.32
	01/13/2004	1900	91.33
	01/13/2004	2000	91.38
	01/13/2004	2100	91.35
	01/13/2004	2200	91.37
	01/13/2004	2300	91.35
	01/13/2004	2400	91.35
	01/14/2004	100	91.34
	01/14/2004	200	91.32
	01/14/2004	300	91.32
	01/14/2004	400	91.32
	01/14/2004	500	91.30
	01/14/2004	600	91.30
	01/14/2004	700	91.29
	01/14/2004	800	91.26
	01/14/2004	900	91.25
	01/14/2004	1000	91.28
	01/14/2004	1100	91.24
	01/14/2004	1200	91.20
	01/14/2004	1300	91.17
	01/14/2004	1400	91.17
	01/14/2004	1500	91.12
	01/14/2004	1600	91.13
	01/14/2004	1700	91.13
	01/14/2004	1800	91.17
	01/14/2004	1900	91.18
	01/14/2004	2000	91.19

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Attachment D
72-Hour Aquifer Test Water Levels
Monitoring Wells Without Pressure Transducers
Main Installation, Memphis Depot

Well	Date	Time	Water Level (feet BTOC)
MW-119	01/14/2004	2100	91.20
	01/14/2004	2200	91.22
	01/14/2004	2300	91.25
	01/14/2004	2400	91.28
	01/15/2004	100	91.31
	01/15/2004	200	91.33
	01/15/2004	300	91.36
	01/15/2004	400	91.38
	01/15/2004	500	91.42
	01/15/2004	600	91.47
	01/15/2004	700	91.48
	01/15/2004	800	91.48
	01/15/2004	900	91.52
	01/15/2004	1000	91.52
	01/15/2004	1100	91.52
	01/15/2004	1200	91.48
	01/15/2004	1300	91.44
	01/15/2004	1400	91.43
	01/15/2004	1500	91.43
	01/15/2004	1600	91.45
	01/15/2004	1700	91.43
	01/15/2004	1800	91.43
	01/15/2004	1900	91.45
	01/15/2004	2000	91.44
	01/15/2004	2100	91.45
	01/15/2004	2200	91.44
	01/15/2004	2300	91.45
	01/15/2004	2400	91.43
	01/16/2004	100	91.46
	01/16/2004	200	91.45
	01/16/2004	300	91.45
	01/16/2004	400	91.44
	01/16/2004	500	91.44
	01/16/2004	600	91.41
	01/16/2004	700	91.41
	01/16/2004	800	91.41
	01/16/2004	900	91.42
	01/16/2004	1000	91.43
	01/16/2004	1100	91.36
	01/16/2004	1645	90.91
MW-120	01/12/2004	1146	90.97
	01/13/2004	950	91.40
	01/16/2004	1645	90.91
MW-121	01/12/2004	1147	91.06
	01/13/2004	950	91.11
	01/16/2004	1645	91.00
MW-122	01/12/2004	1140	91.09
	01/13/2004	950	92.75
	01/16/2004	1645	91.02
MW-123	01/12/2004	1143	90.57
	01/13/2004	950	90.62
	01/16/2004	1645	90.52
MW-124	01/12/2004	1141	90.88
	01/13/2004	950	90.92
	01/16/2004	1645	90.81
MW-125	01/12/2004	1142	90.81
	01/13/2014	950	92.49
	01/16/2004	1645	90.76

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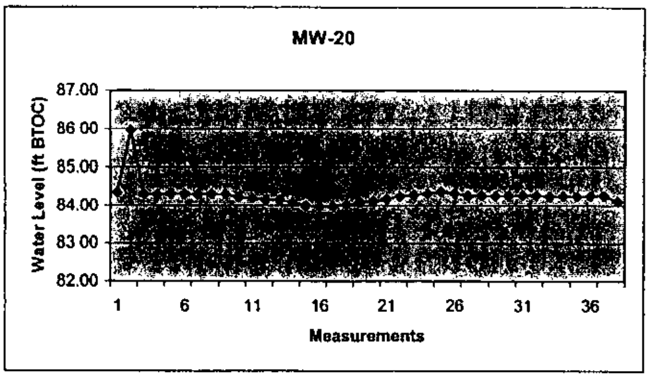
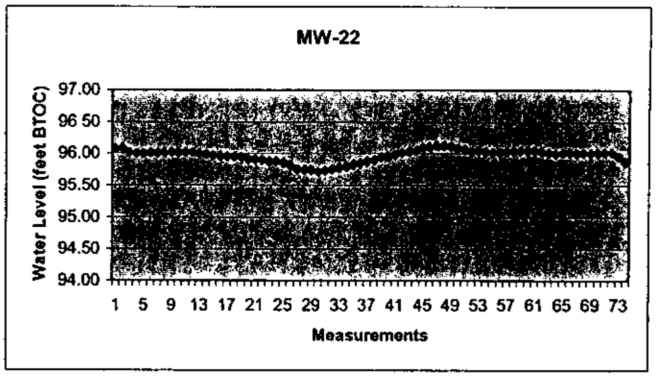
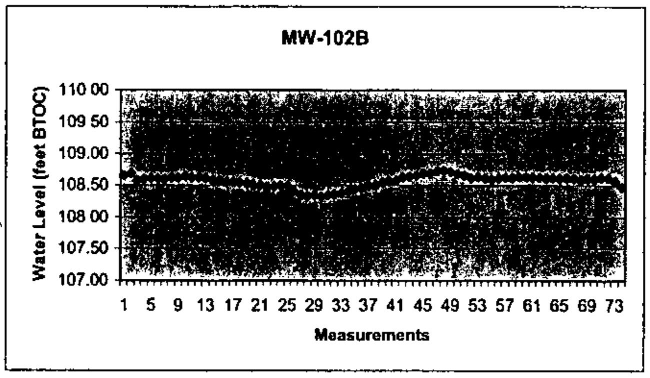
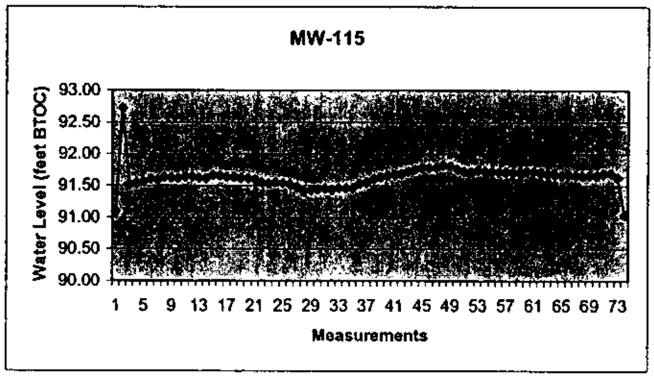
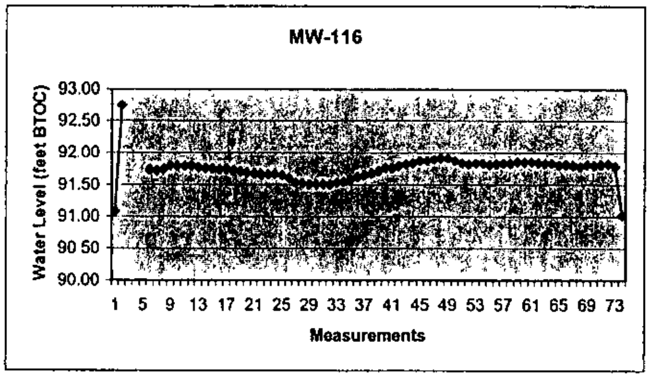
Attachment D
72-Hour Aquifer Test Water Levels
Monitoring Wells Without Pressure Transducers
Main Installation, Memphis Depot

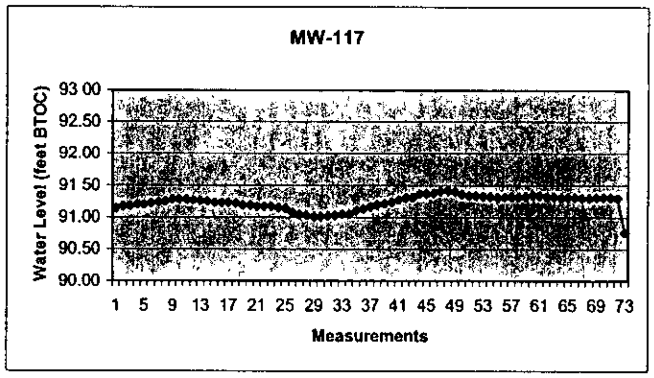


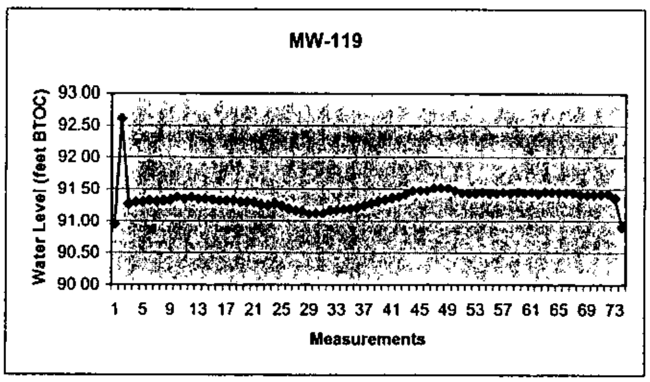








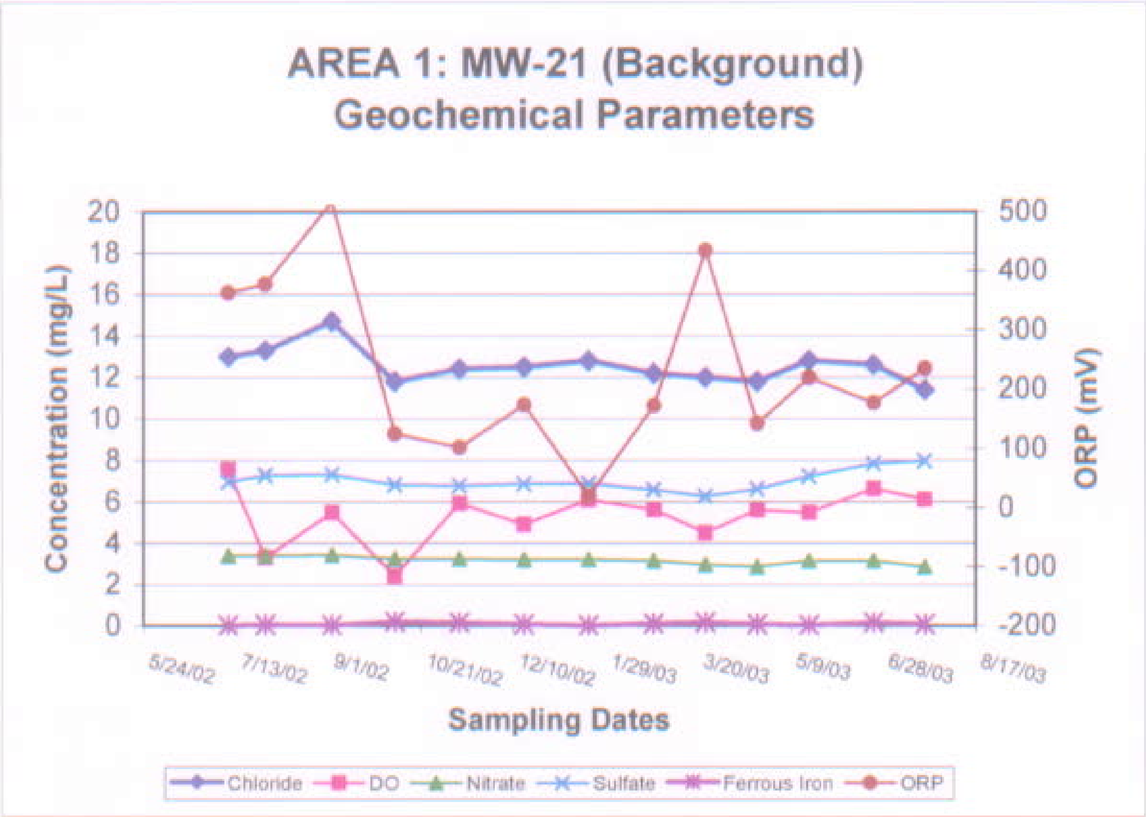




ATTACHMENT E

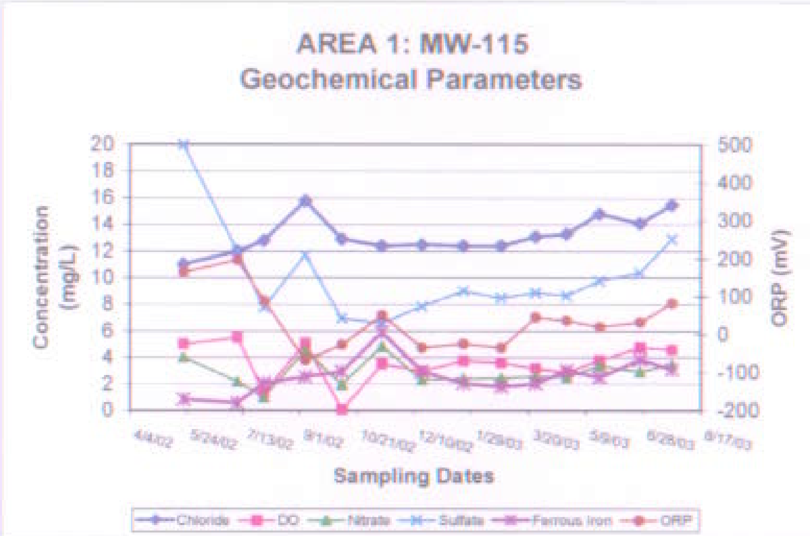
Geochemical Graphs for Study Areas

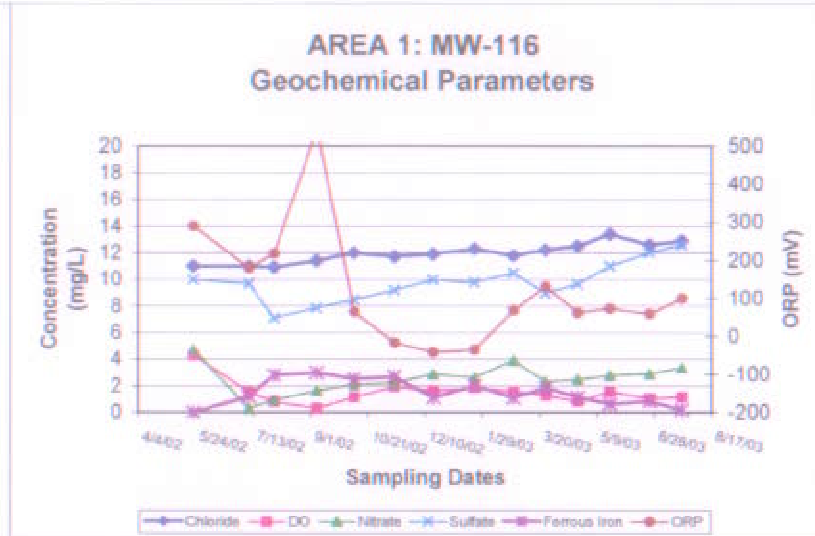
Attachment E
Area 1: Geochemical Parameters of Upgradient Monitoring Well
Main Installation, Memphis Depot

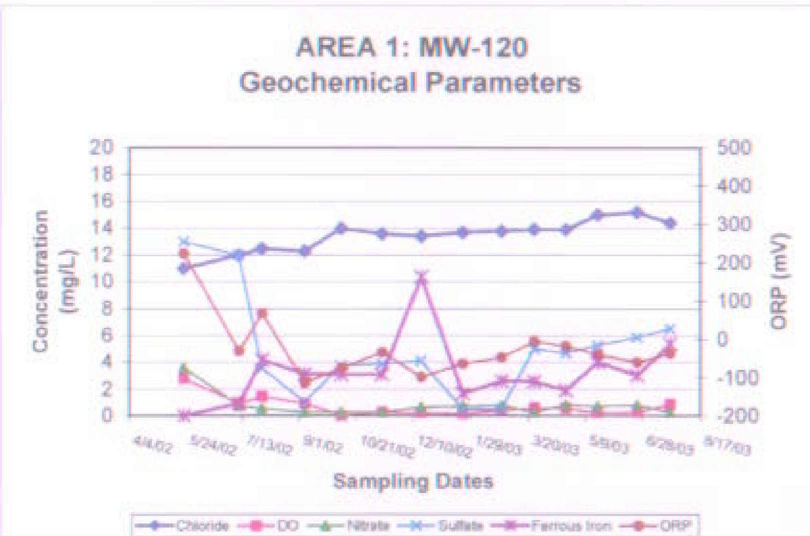


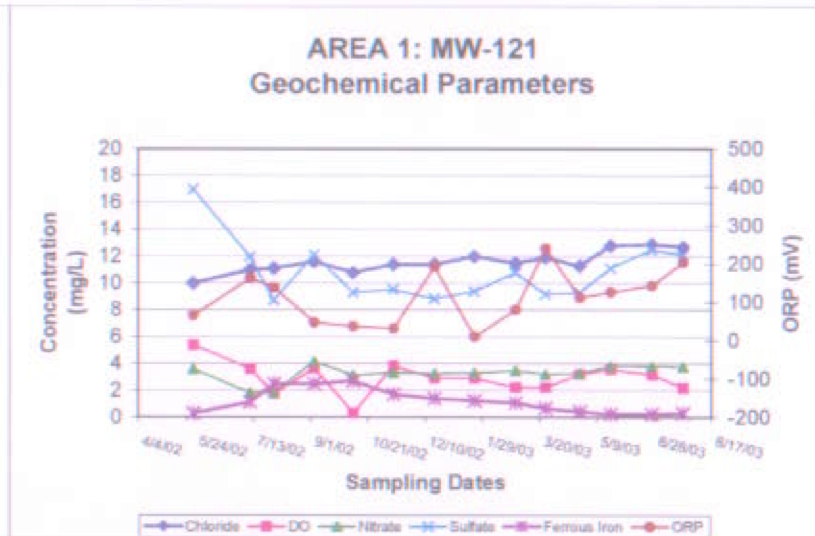
Note: Gap(s) in data are due to suspect analytical data.

Attachment E
Area 1: Geochemical Parameters of Downgradient Monitoring Wells
Main Installation, Memphis Depot





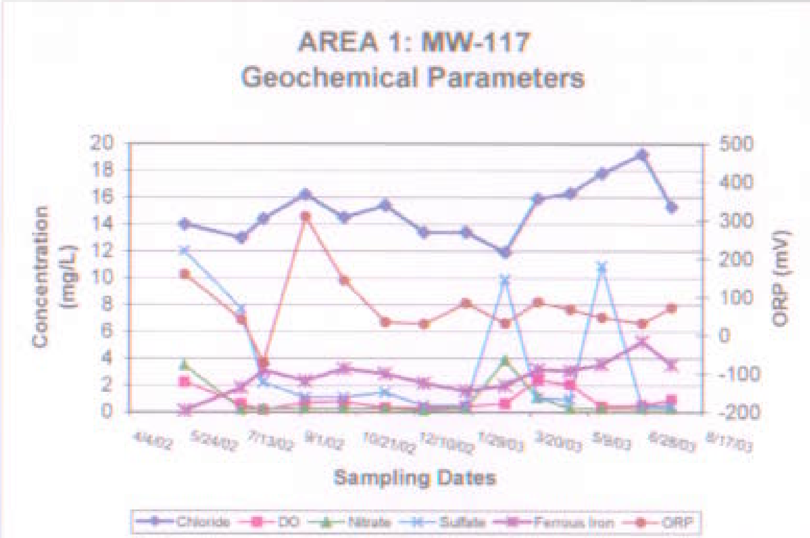


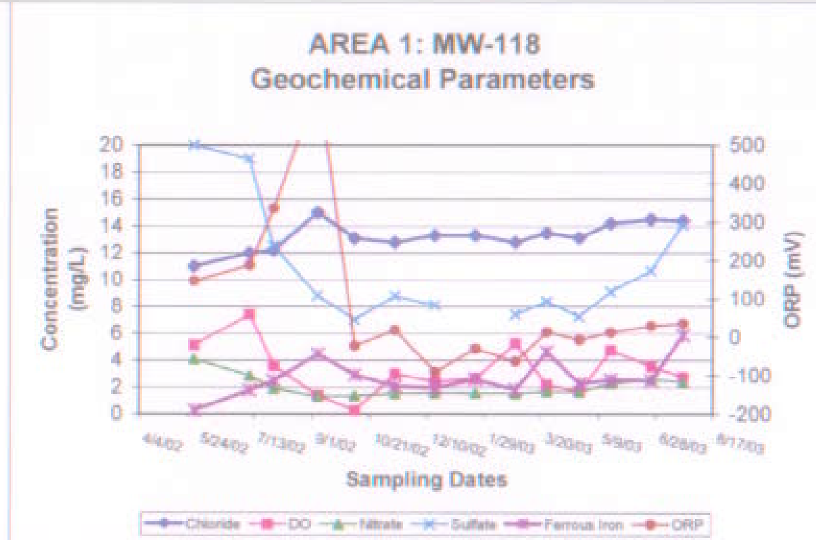


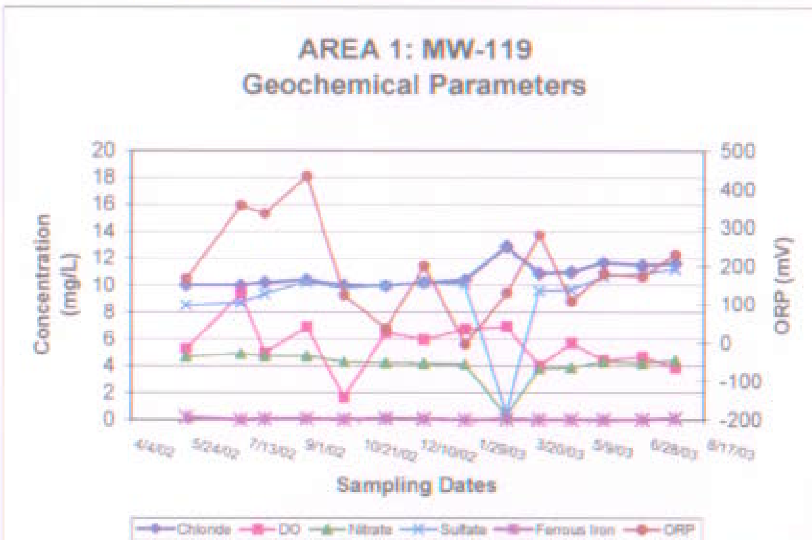
Note: Gap(s) in data are due to suspect analytical data.

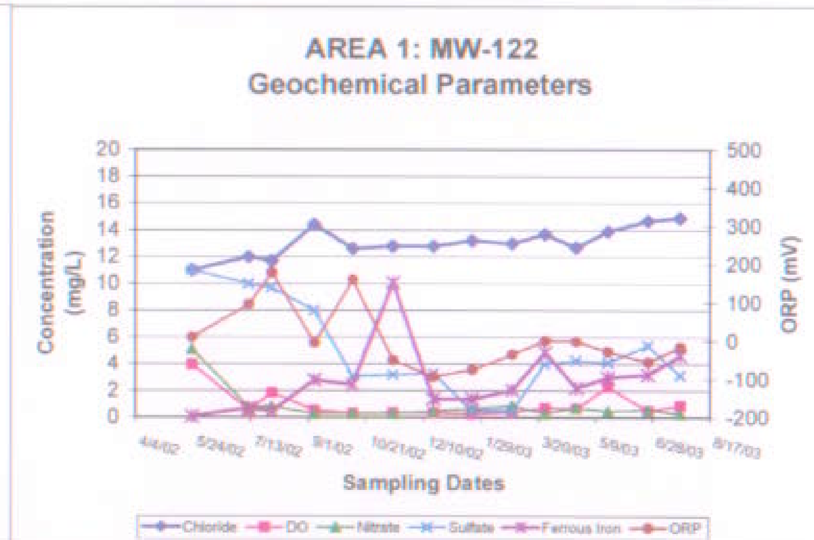
794 474

Attachment E
Area 1: Geochemical Parameters of Downgradient Monitoring Wells
Main Installation, Memphis Depot





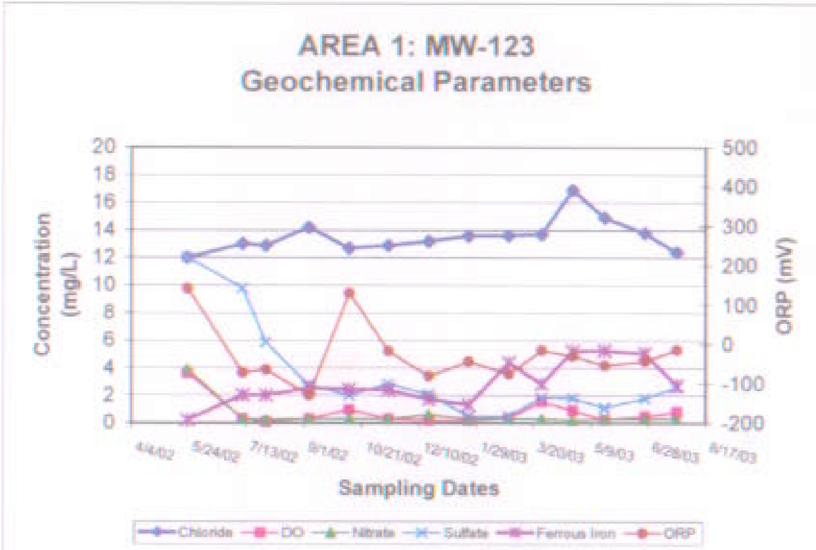


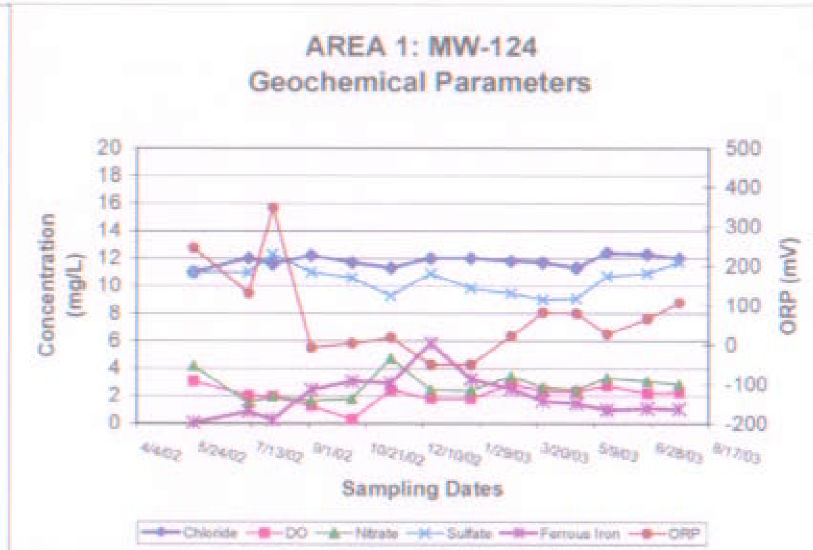


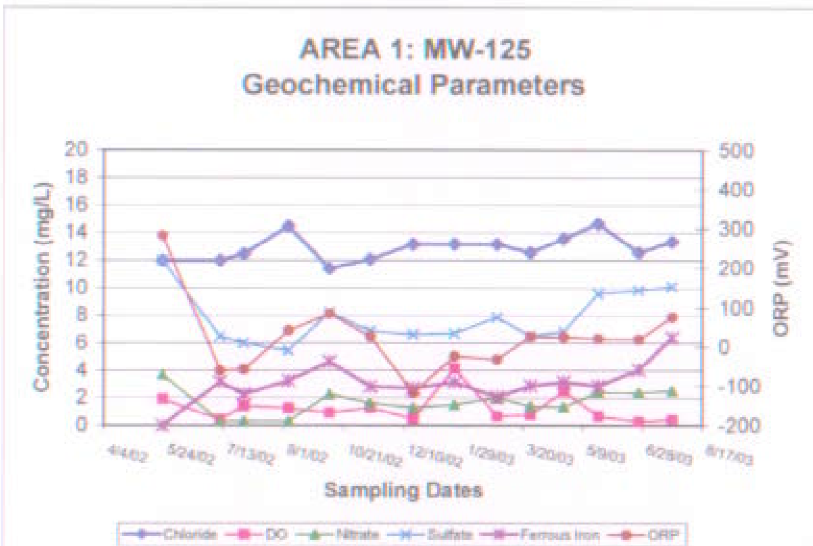
Note: Gap(s) in data are due to suspect analytical data.

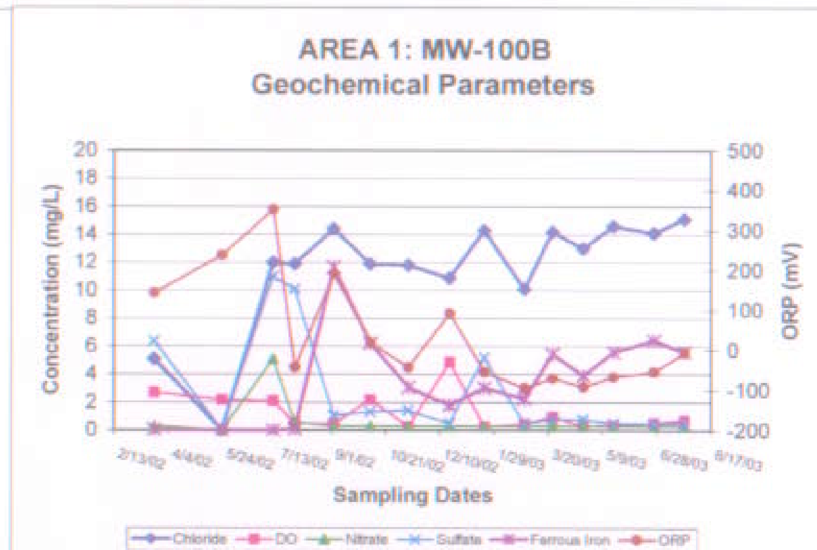
794 475

Attachment E
Area 1: Geochemical Parameters of Downgradient Monitoring Wells
Main Installation, Memphis Depot





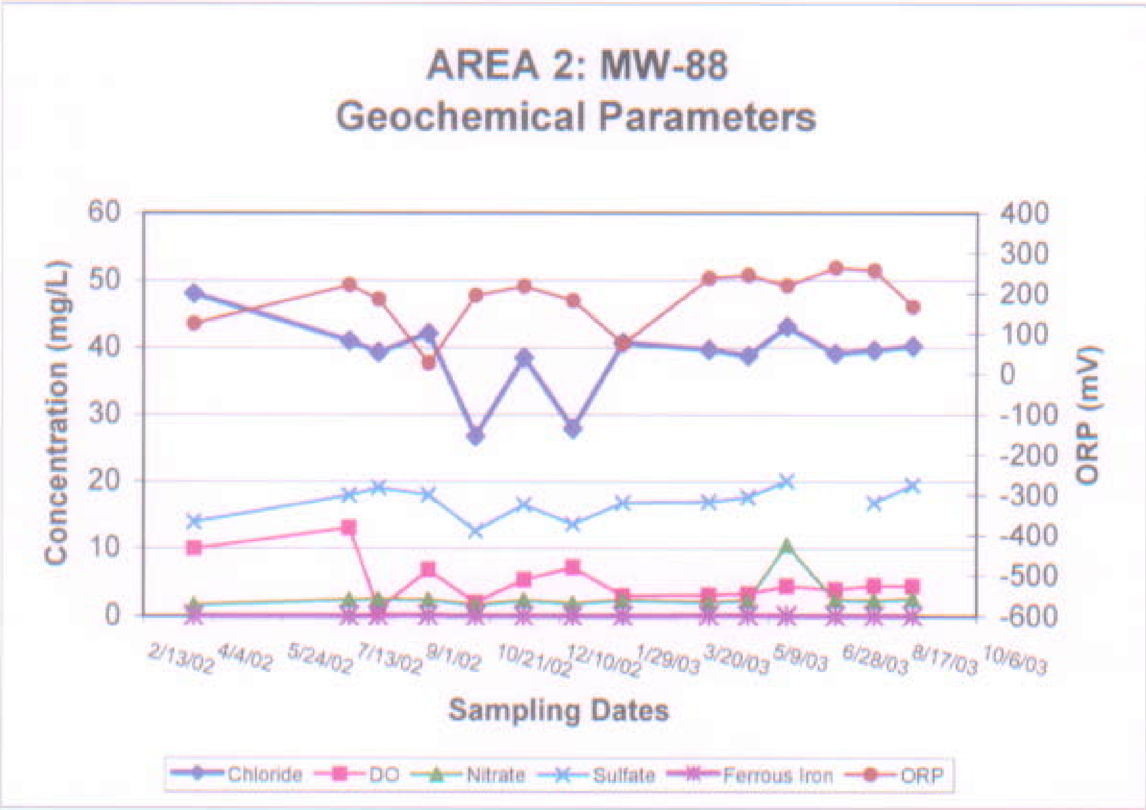




Note: Gap(s) in data are due to suspect analytical data.

794 476

Attachment E
Area 2: Geochemical Parameters of Upgradient Monitoring Well
Main Installation



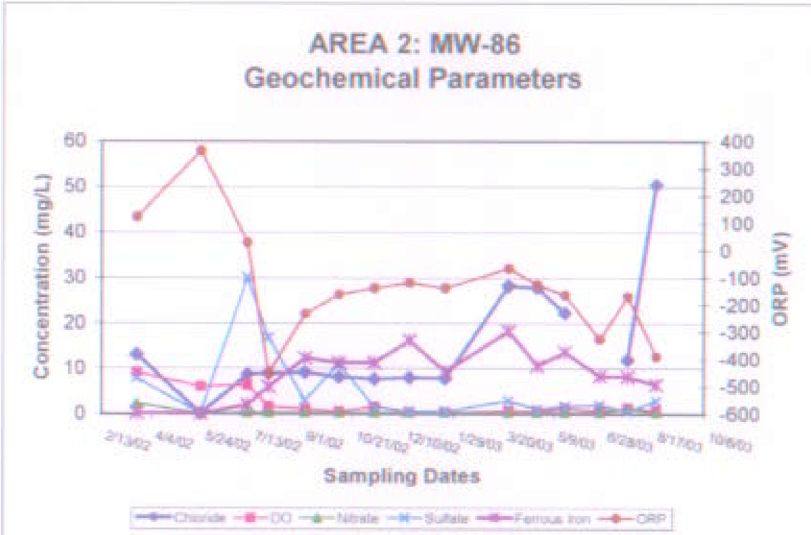
Note: Gap(s) in data are due to suspect analytical data.

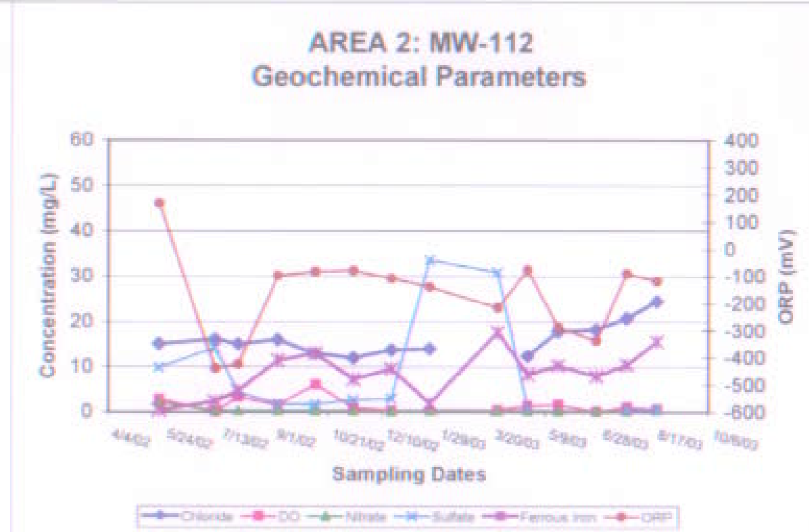
Attachment E
Area 2: Geochemical Parameters of Downgradient Monitoring Wells
Main Installation, Memphis Depot

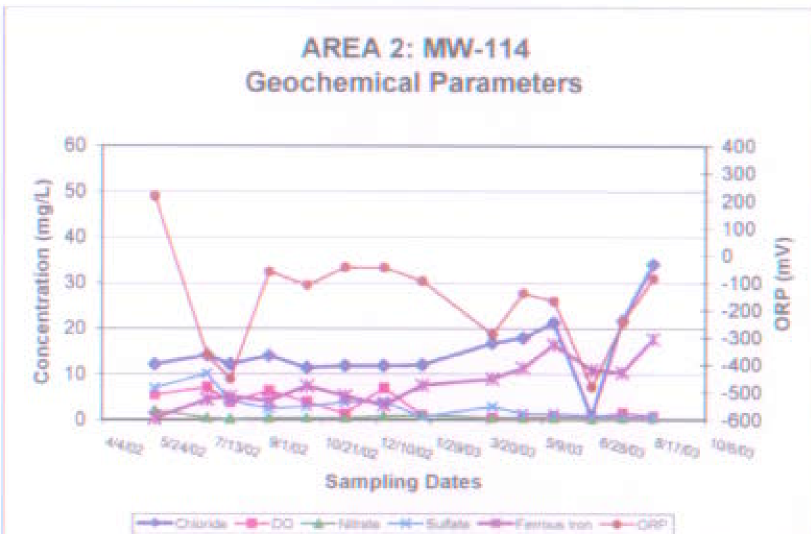
Note: Gap(s) in data are due to suspect analytical data

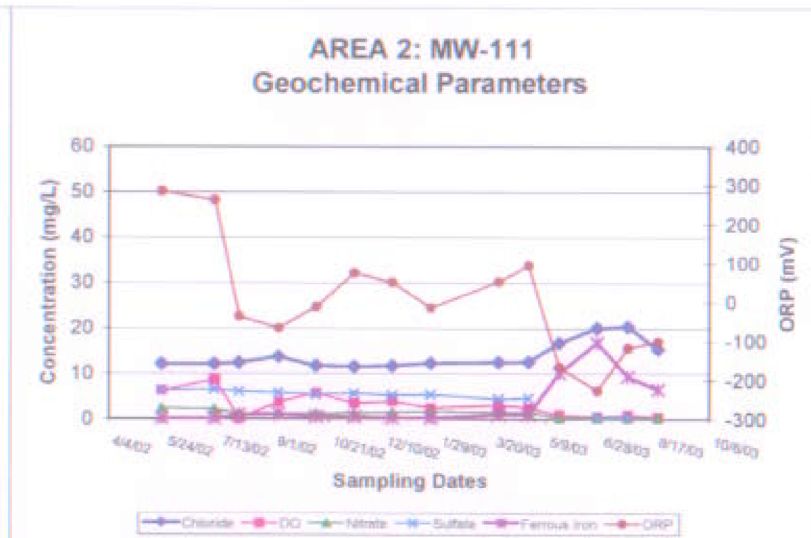
794 476

Attachment E
Area 2: Geochemical Parameters of Downgradient Monitoring Wells
Main Installation, Memphis Depot





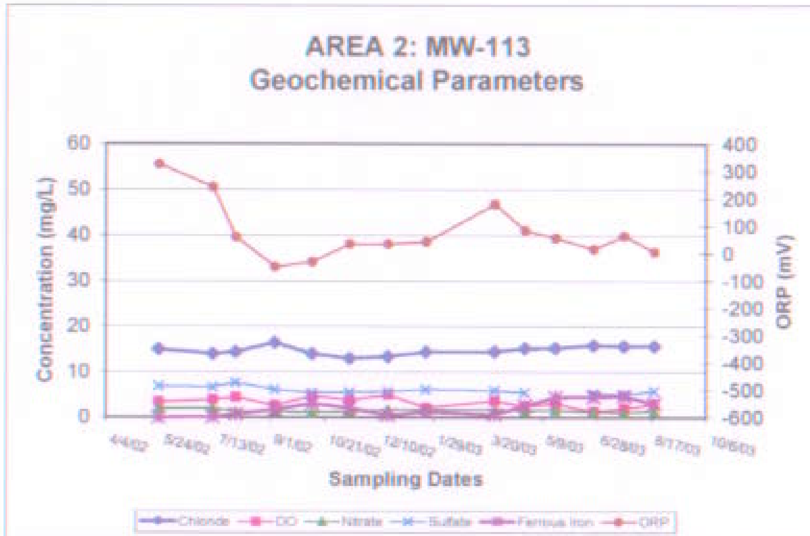




Note: Gap(s) in data are due to suspect analytical data.

794 479

Attachment E
Area 2: Geochemical Parameters of Downgradient Monitoring Wells
Main Installation, Memphis Depot



Note: Gap(s) in data are due to suspect analytical data

794 480

ATTACHMENT F

IRB and SRB BART Field Data

BASELINE SAMPLING EVENT

MW110 Present, IRB pseudomonads and enterics, 100 - 5,000 cfu/ml
Sampled 5/20/03

IRB
5/21/03: Solution: light yellow throughout.
5/22/03: Same as above.
5/23/03: Solution: cloudy yellow. Ball: dark yellow ring at waterline, 40% bubbles on bottom.
5/24/03: Solution: cloudy dark yellow. Ball: dark yellow, almost brown ring at waterline, 40% medium bubbles on bottom.
5/25/03: Solution: dark brown throughout. Ball: brown film w/bubbles at waterline, 40% large bubbles on bottom.
5/26/03: Solution: dark brown throughout. Ball: brown film w/bubbles at waterline. Large bubbles on bottom.
5/27/03: Same as above.
5/28/03: Solution: black. Ball: black film around ball. Tube: black film on bottom.

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MW 111 Absent, anaerobic bacteria
Sampled 5/22/03

IRB
5/23/03: Solution: clear at ball graduating to light yellow at bottom of tube. Tube: dark on bottom, but not solid black.
5/24/03: Same as above.
5/25/03: Solution: clear at ball graduating to light yellow at bottom of tube. Ball: 5% bubbles on bottom.
5/26/03: Solution: medium yellow throughout. Ball: 85% small bubbles.
5/27/03: Solution: cloudy yellow throughout. Ball: dark yellow ring at waterline, fewer bubbles than yesterday.
5/28/03: Same as above, except solution less cloudy.
5/29/03: Same as above, except fewer bubbles on ball.
5/30/03: Solution: yellow throughout. Ball: dark yellow ring with small bubbles at waterline. A few bubbles on bottom.

MW119 Present, IRB, 100 - 5,000 cfu/ml
Sampled 5/22/03

IRB
5/23/03: Solution: clear at ball graduating to light yellow at bottom of tube. Tube: dark color on very bottom of tube, but not black.
5/24/03: Solution: clear at ball graduating to light yellow at bottom of tube.
5/25/03: Solution: clear at ball graduating to light yellow at bottom of tube. Ball: Ring of small bubbles at waterline and 2% small bubbles on bottom.
5/26/03: Solution: medium yellow throughout. Ball: dark yellow ring of small bubbles at waterline and a few small bubbles on bottom.
5/27/03: Solution: cloudy medium yellow throughout. Ball: light brown ring of small bubbles at waterline, 75% small/medium bubbles on sides/bottom.
5/28/03: Solution: slightly cloudy (less than yesterday) medium yellow throughout. Ball: light brown ring of small bubbles at waterline, 10% small/medium bubbles on sides/bottom.
5/29/03: Solution: slightly cloudy medium yellow throughout. Ball: dark brown ring of small bubbles at waterline, a few small/medium bubbles on sides/bottom.
5/30/03: Solution: slightly cloudy medium yellow throughout. Ball: brown ring of small bubbles at waterline, black film on bottom. Tube: black film on sides from ball to just above bottom. No black on bottom.

MW120 Present, anaerobic bacteria, IRB, 100
Sampled 5/22/03

IRB
5/23/03: Solution: light yellow throughout.
5/24/03: Solution: light yellow throughout. Ball: light yellow ring at waterline.
5/25/03: Solution: slightly cloudy medium yellow throughout. Ball: dark yellow ring at waterline, 5% bubbles on bottom.
5/26/03: Solution: cloudy dark yellow at ball graduating to medium yellow at bottom of tube. Ball: dark yellow, almost brown, ring at waterline, 75% large/medium bubbles on bottom.
5/27/03: Same as above.
5/28/03: Same as above, except fewer bubbles and less cloudy.
5/29/03: Solution: slightly cloudy dark yellow at ball graduating to medium yellow at bottom of tube. Ball: 50% bubbles, brown film ring at waterline, black film on bubbles on bottom. Tube: thin black film on sides from under ball to just above bottom of tube.
5/30/03: Same as above.

MW118 present, IRB anaerobic bacteria pseudomonads enterics, 5,000
Sampled 5/22/03

IRB
5/23/03: Solution: light yellow throughout.
5/24/03: Solution: yellow throughout. Ball: dark yellow ring at waterline.
5/25/03: Solution: cloudy dark yellow throughout. Ball: dark yellow ring of large/medium bubbles at waterline.
5/26/03: Solution: brown throughout. Ball: brown film ring with large/medium bubbles at waterline, 75% of ball covered with large/medium bubbles.
5/27/03: Same as above, except fewer bubbles.
5/28/03: Solution: black. Ball: black film on bottom, brown film ring with large/medium bubbles at waterline, 50% of ball covered with large/medium bubbles.
5/29/03: Same as above, except fewer bubbles on ball.
5/30/03: Solution: black. Ball: black film on bottom, brown film ring with black spots and large/medium bubbles at waterline, 40% of ball covered with large/medium bubbles. Tube: black film on sides and bottom.

MW116 present, 100, IRB, anaerobic bacteria, heterotrphic bacteria
Sampled 5/22/03

IRB
5/23/03: Solution: light yellow throughout tube.
5/24/03: Same as above. Yellow ring around ball at waterline.
5/25/03: Solution: slightly cloudy medium yellow throughout. Ball: ring of small bubbles at waterline, large bubbles on bottom.
5/26/03: Solution: slightly cloudy dark yellow throughout. Ball: 80% small/medium bubbles, dark yellow film at waterline.
5/27/03: Same as above, except fewer and larger bubbles on ball.
5/28/03: Solution: dark yellow throughout. Ball: dark yellow film with bubbles at waterline.
5/29/03: Same as above.
5/30/03: Solution: cloudy dark yellow throughout. Ball: light brown film with bubbles at waterline. Tube: thin black film on bottom.

MW116 Duplicate present, anaerobic bacteria, IRB, 5,000
Sampled 5/22/03

IRB
5/23/03: Solution: light yellow throughout.
5/24/03: Solution: light yellow throughout. Ball: light yellow ring at waterline.
5/25/03: Solution: cloudy medium yellow. Ball: dark yellow film with small/medium bubbles at waterline.
5/26/03: Solution: cloudy dark yellow/hint of brown. Ball: brown film with small/medium bubbles at waterline, 75% bubbles.
5/27/03: Solution: cloudy light brown. Ball: brown film with small/medium bubbles at waterline, 75% bubbles.
5/28/03: Solution: light brown. Ball: brown film with small/medium bubbles at waterline, 40% bubbles.
5/29/03: Solution: light brown. Ball: brown film with small/medium bubbles at waterline, 20% bubbles.
5/30/03: Same as above.

MW124 present, IRB, anaerobic bacteria, pseudomonads and enterics, 5,000 - 100,000
Sampled 5/23/03

IRB
5/24/03: Solution: light yellow throughout.
5/25/03: Solution: light yellow. Ball: dark yellow ring at waterline.
5/26/03: Solution: cloudy medium yellow througout. Ball: thin brown film ring with small bubbles at waterline.
5/27/03: Solution: dark yellow at ball graduating to blackish at bottom of tube. Ball: thin brown film ring with small bubbles at waterline, 70% medium/large bubbles. Tube: thin black film on bottom.
5/28/03: Solution: black throughout tube. Ball: 30% bubbles.
5/29/03: Same as above, except 10% bubbles on ball.
5/30/03: Solution: black. Ball: thin brown film ring with small bubbles at waterline, black film on bottom, bubbles at waterline and bottom of ball. Tube: thin black film on sides.
5/31/03: Solution: black. Ball: thin brown film ring with small bubbles at waterline, black film on sides/bottom. Tube: thin black film on sides/bottom.

MW122 present, anaerobic bacteria, IRB, pseudomonads and enterics, 5,000 – 100,000
Sampled 5/23/03

IRB
5/24/03: Solution light yellow throughout tube.
5/25/03: Solution: light yellow throughout tube. Ball: dark yellow ring with medium bubbles at waterline.
5/26/03: Solution: cloudy dark yellow/light brown throughout tube. Ball: brown film ring with small bubbles at waterline, 85% small/medium bubbles.
5/27/03: Solution: medium brown throughout tube. Ball: brown film ring with small bubbles at waterline, 75% small/medium bubbles. Tube: 2% black film on bottom.
5/28/03: Solution: black throughout. Ball: black film on bottom, brown film ring with small bubbles at waterline, 65% small/medium bubbles. Tube: 2% black film on bottom.
5/29/03: Same as above.
5/30/03: Same as above, except spots of black film at waterline.
5/31/03: Solution: black throughout. Ball: black film on bottom, brown film ring above and below waterline, 75% small/medium bubbles, one side covered with bubbles, black slime. Tube: black film on sides/bottom.

MW114 present, IRB, heterotrophic bacteria, 5,000 - 100
Sampled 5/22/03

IRB
5/23/03: Solution: clear at ball graduating to yellow at bottom. Dark color at bottom, but not black.
5/24/03: Same as above.
5/25/03: Solution: cloudy medium yellow throughout. Ball: thick ring of small bubbles at waterline.
5/26/03: Solution: slightly cloudy medium yellow throughout. Ball: dark yellow/almost brown film with small bubbles at waterline.
5/27/03: Solution: slightly cloudy light brown throughout. Ball: brown film with small bubbles at waterline. Tube: hint of black on bottom.
5/28/03: Same as above, except black on bottom.
5/29/03: Same as above, except fewer bubbles.
5/30/03: Ball: brown film at waterline. Tube: black film on sides at bottom.

BASELINE CONTINUED.

MW118 - present, dense slime bacterial and SRB consortium, 100 – 1,000 cfu/mL
Sampled 6/17/02

SRB
6/18/02: Solution: clear with small bubbles throughout. Slightly milky within cone on bottom.
6/19/02: Same as above.
6/20/02: Same as above.
6/21/02: Same as above, except possibly getting more milky in color at bottom.
6/22/02: Same as above.
6/23/02: Same as above.
6/24/02: Black on bottom.
6/25/02: Same as above.

MW 120 - absent
Sampled 6/17/02

SRB
6/18/02: Solution: clear with small bubbles throughout. Slightly milky within cone on bottom.
6/19/02: Same as above, except small bubbles only within lower 25% of solution.
6/20/02: Same as above.
6/21/02: Same as above, possible ring forming at bottom, milky yellow.
6/22/02: Same as above.
6/23/02: Same as above.
6/24/02: Same as above.
6/25/02: Same as above.

MW116 - absent
Sampled 6/17/02

SRB
6/18/02: Clear with small bubbles only near bottom (1/4 way up) and slightly milky within cone on bottom.
6/19/02: Same as above, but no bubbles.
6/20/02: Same as above.
6/21/02: Same as above, except possible ring forming at bottom, milky yellow
6/22/02: Same as above.
6/23/02: Same as above.
6/24/02: Same as above.
6/25/02: Same as above.

MW124 - present, complex bacterial consortium with SRB present, 1,000 - 10,000
Sampled 6/17/02

SRB
6/18/02: Clear with small bubbles throughout and slightly milky within cone on bottom.
6/19/02: Same as above.
6/20/02: Same as above.
6/21/02: Same as above, except possible ring forming at bottom, milky yellow.
6/22/02: Water below ball (1/4 down from top) turning black (cloudy black) not on ball.
6/23/02: Entire sample black. Darkest at bottom (opaque) moving to clear with black tint below ball.
6/24/02: Same as above.
6/25/02: Same, very black.

MW122 - absent
Sampled 6/17/02

SRB
6/18/02: Clear with small bubbles within solution (3/4 way up from bottom) and slightly milky within cone on bottom.
6/19/02: Same as above, but bubbles only ½ from bottom.
6/20/02: Same as above.
6/21/02: Same as above. Possible ring forming at bottom, milky yellow.
6/22/02: Same as above.
6/23/02: Same as above.
6/24/02: Same as above.
6/25/02: Same as above.

MW116 Duplicate - absent
Sampled 6/17/02

SRB
6/18/02: Clear with small bubbles only near bottom (1/4 way up) and slightly milky within cone on bottom.
6/19/02: Same as above, but no bubbles.
6/20/02: Same as above.
6/21/02: Same as above. Possible ring forming at bottom, milky yellow.
6/22/02: Same as above.
6/23/02: Same as above.
6/24/02: Same as above.
6/25/02: Same as above.

MW110 - absent
Sampled 6/17/02

SRB
6/18/02: Clear with small bubbles within solution (3/4 way up from bottom) and slightly milky within cone on bottom.
6/19/02: Same as above, but bubbles only ½ from bottom.
6/20/02: Same as above, but very few bubbles remaining.
6/21/02: Same as above. Possible ring forming at bottom, milky yellow.
6/22/02: Same as above.
6/23/02: Same as above.
6/24/02: Same as above.
6/25/02: Same as above.

MW113 - absent
Sampled 6/17/02

SRB
6/18/02: Solution: clear with small bubbles throughout. Slightly milky within cone at bottom.
6/19/02: Same as above.
6/20/02: Same as above.
6/21/02: Same as above, possible ring forming at bottom, milky yellow.
6/22/02: Same as above.
6/23/02: Same as above.
6/24/02: Same as above.
6/25/02: Same as above.

MW114 - absent
Sampled 6/17/02

SRB
6/18/02: Solution: clear with small bubbles throughout. Slightly milky within cone at bottom.
6/19/02: Same as above, except bubbles only ½ way up from bottom.
6/20/02: Same as above, but few bubbles remaining.
6/21/02: Same as above, possible ring forming at bottom, milky yellow.
6/22/02: Same as above.
6/23/02: Same as above.
6/24/02: Same as above.
6/25/02: Same as above.

MW112 - present, dense slime bacterial and SRB consortium, 100
Sampled 6/17/02

IRB
6/18/02: Solution: clear with small bubbles throughout. Slightly milky within cone at bottom.
6/19/02: Same as above.
6/20/02: Same as above.
6/21/02: Same as above, possible ring forming at bottom, milky yellow.
6/22/02: Same as above.
6/23/02: Same as above.
6/24/02: Same as above.
6/25/02: Same as above, black at bottom in cone.

MW112 Duplicate - present, dense slime bacterial and SRB consortium, 100
Sampled 6/17/02

SRB
6/18/02: Solution: clear with small bubbles throughout. Slightly milky within cone at bottom.
6/19/02: Same as above.
6/20/02: Same as above, but fewer bubbles.
6/21/02: Same as above, possible ring forming at bottom, milky yellow.
6/22/02: Same as above.
6/23/02: Same as above.
6/24/02: Same as above.
6/25/02: Black at bottom in cone.

MW111 - absent
Sampled 6/17/02

SRB
6/18/02: Clear with small bubbles throughout solution and slightly milky within cone on bottom.
6/19/02: Same as above, but fewer bubbles.
6/20/02: Same as above, but bubbles only ¾ way up from bottom.
6/21/02: Same as above. Possible ring forming at bottom, milky yellow with white spots.
6/22/02: Same as above.
6/23/02: Same as above.
6/24/02: Same as above.
6/25/02: Same as above.

POST SAMPLING EVENT #1

MW110D
Sampled 7/9/02

IRB	SRB
Present, IRB, pseudomonads and enterics, 100,000	Present, complex bacterial consortium with SRB present, 10,000
7/10/02: Solution slightly yellow throughout with darker yellow at bottom of tube. 3% of tube covered in small bubbles throughout, evenly dispersed.	7/10/02: Solution clear throughout. 2% of tube covered in small bubbles with majority near bottom of tube.
7/11/02: Medium yellow throughout tube. 85% of ball covered in small to medium bubbles. Slight hint of brown around top of ball at waterline and on very bottom of ball.	7/11/02: Solution mostly clear throughout with layer of cloudiness at bottom of tube. A few small black flecks on bottom of ball.
7/12/02: Solution medium brown throughout. 70% of ball covered in medium to large bubbles. Thin black film in center bottom of tube. Medium brown ring around top of ball at waterline.	7/12/02: Solution clear throughout with a slightly cloudy ring at bottom of tube. 1% of tube covered with small bubbles. Small black flecks on 1/8% of ball, concentrated in one small area of side and bottom of ball.
7/13/02: Solution black close to ball turning dark brownish yellow at bottom of tube. Black film in bottom of tube and on bottom of ball. Dark brown ring around top of ball at waterline. Large/medium bubbles on bottom of ball.	7/13/02: Same as above. Thin black film developing on bottom of ball.
7/14/02: Solution black throughout tube. Black film in bottom of tube and on bottom of ball. Dark brown ring around top of ball at waterline.	7/14/02: Same as above. Black film more pronounced around ball at and just below waterline.
7/15/02: Same as above.	7/15/02: Same as above.
7/16/02: Same as above.	7/16/02: Same as above. Black film around top of ball at waterline and on bottom of ball. No black film in bottom of tube.
7/17/02: Same as above.	7/17/02: Same as above, except black film in bottom of tube.

MW110
Sampled 7/9/02

SRB	IRB
Present, aerobic slime bacterial and SRB consortium, 10,000	Present, BR, pseudomonads and enterics, 100,000
7/10/02: Solution clear with slightly cloudy ring at bottom of tube. 3% of tube covered with small bubbles evenly dispersed throughout.	7/10/02: Solution slightly yellow throughout with darker yellow at bottom of tube. 3% of tube covered with bubbles evenly dispersed. Slight hint of brown at bottom of tube.
7/11/02: Solution clear throughout with slightly cloudy ring at bottom of tube. 3% of tube covered in small bubbles. ½% of ball (bottom) covered in small bubbles. Small black flecks on 1/8% of ball concentrated on one side just below waterline.	7/11/02: Medium yellow evenly dispersed throughout. 15% of tube and 75% of ball covered with small to medium bubbles. Hint of brown ring around top of ball at waterline.
7/12/02: Same as above.	7/12/02: Solution cloudy brown throughout. Brown film in center bottom of tube. 1% of tube (sides) covered with small bubbles. 80% of ball covered in small/medium bubbles. Bottom of ball covered in black film. Dark brown ring around top of ball at waterline.
7/13/02: Same as above. Very thin black film developing on ball just below waterline.	7/13/02: Solution black at bottom of ball and bottom of tube with dark yellow/brown between the two black areas. Black film on bottom of ball. Dark brown ring around top of ball at waterline. 80% of ball covered in medium/large bubbles.
7/14/02: Same as above.	7/14/02: Solution black throughout. Black film on bottom of tube and bottom of ball. Dark brown ring around top of ball at waterline.
7/15/02: Same as above. Black film more fully developed, but still thin, around top of ball at and below waterline.	7/15/02: Same as above.
7/16/02: Same as above.	7/16/02: Same as above.
7/17/02: Same as above. Black film around top of ball and bottom of ball from waterline down. Not a significant black film in bottom of tube.	7/17/02: Same as above.

MW114
Sampled 7/9/02

SRB	IRB
Present, complex bacterial consortium with SRB present, 2	Present, BL, 100,000
7/10/02: Solution slightly cloudy throughout. Thin black film on bottom of ball beginning at waterline. 1% of tube covered with small bubbles mostly at bottom of tube.	7/10/02: Solution slightly yellow throughout with darker yellow at bottom of tube. Hint of brown at bottom of tube. 1% of bottom of tube and 2% of bottom of ball covered with small bubbles.
7/11/02: Solution slightly cloudy throughout. Thin black film on ball below waterline and on sides and bottom of tube. 1% of tube covered with small bubbles mostly at bottom of tube.	7/11/02: Solution black cloudy from ball to just above bottom of tube where solution is cloudy dark yellow. 3% of tube covered with medium bubbles concentrated at bottom of tube where solution turns from black to dark yellow. 5% of ball covered in medium bubbles around top of ball at waterline.
7/12/02: Same as above.	7/12/02: Solution blackish brown throughout tube. Black film on ball at and below waterline. Small ring of bubbles around top of ball at waterline. Hard to see bottom of tube through solution, but there appears to be black film in bottom of tube.
7/13/02: Solution clear. Black film on sides of tube and bottom of ball. Slight black ring at bottom of tube.	7/13/02: Solution black throughout. Black film on ball at and below waterline and on sides and bottom of tube. Ring of bubbles around top of ball at waterline.
7/14/02: Solution clear. Black film on bottom and sides of tube and on bottom of ball from waterline down.	7/14/02: Same as above.
7/15/02: Same as above.	7/15/02: Same as above.
7/16/02: Same as above.	7/16/02: Same as above.
7/17/02: Same as above.	7/17/02: Same as above. Most of ball covered in black film.

MW118
Sampled 7/9/02

SRB	IRB
Present, BA, 10,000	Present, BL, IRB, 100,000
7/10/02: Solution clear except for slightly cloudy ring at bottom of tube. 1% of bottom of tube covered in small to medium bubbles.	7/10/02: Solution cloudy yellow throughout. 3% of bottom of tube covered in large to medium bubbles. 10% of ball covered in large/medium bubbles split between bottom of ball and top of ball at waterline. Slight hint of brown at bottom of tube.
7/11/02: Same as above except for few small black flecks on bottom of ball.	7/11/02: Solution cloudy light brown throughout. Thin dark brown film in center bottom of tube. 60% of ball covered in large/medium bubbles around top of ball at waterline and on bottom of ball. Black film on bottom of ball with hint of brown ring around top of ball at waterline.
7/12/02: Same as above except for hint of black ring around top of ball just below waterline. Very few bubbles mostly on sides of tube.	7/12/02: Solution blackish brown throughout. Large bubbles and black film on bottom of ball. A few bubbles and dark brown ring around top of ball at waterline. Hard to see bottom of tube through solution.
7/13/02: Same as above. Very thin black film developing on bottom of ball below waterline.	7/13/02: Solution black throughout. Black film on bottom of ball and bottom of tube. Dark brown ring around top of ball at waterline. Large bubbles around bottom of ball.
7/14/02: Solution very slightly cloudy. Very thin black film on bottom of ball and on sides and bottom of tube.	7/14/02: Same as above.
7/15/02: Solution clear. Black film on bottom of ball from waterline down and on bottom and sides of tube.	7/15/02: Same as above.
7/16/02: Solution slightly cloudy. Black film on bottom of tube and on bottom of ball from waterline down.	7/16/02: Same as above. Black film on sides of tube.
7/17/02: Solution clear. Black film on bottom and sides of tube. Very thin black film on bottom of ball from waterline down.	7/17/02: Same as above.

MW116D
Sampled 7/9/02

SRB	IRB
Present, BA, 10,000 – 100,000	Present, BL, IRB, 100,000
7/10/02: Solution clear except for slightly cloudy ring at bottom of tube. 1% of tube covered in small bubbles evenly dispersed.	7/10/02: Solution blackish brown throughout tube with dark brown at bottom of tube. Light brown ring around top of ball at waterline. 80% of tube from bottom of ball to middle of tube and 80% of top at waterline and bottom of ball covered in small/medium bubbles.
7/11/02: Same as above except for few small black flecks on bottom of ball. 3% of tube covered in small bubbles evenly dispersed.	7/11/02: Solution blackish brown throughout and at bottom of tube. Black film on bottom of ball with ring of bubbles. Ring of small/medium bubbles around to of ball at waterline with hint of brown ring.
7/12/02: Solution clear. Black film ring at bottom of tube and black flecks on ¼% of ball bottom. 1% of tube sides covered with small bubbles. 10% of bottom of ball covered in small/medium bubbles.	7/12/02: Solution blackish brown throughout. Large/medium bubbles and black film on bottom of ball. Ring of bubbles, dark brown ring and splotches of black film around top of ball at waterline.
7/13/02: Solution clear. Black film on sides and bottom of tube and developing on bottom of ball. 40% of tube covered in small bubbles with just a few on bottom of ball.	7/13/02: Solution black throughout. Black film around bottom of ball and at bottom of tube. Brownish flecks and slight bubble ring around top of ball at waterline.
7/14/02: Same as above.	7/14/02: Same as above.
7/15/02: Same as above. Black film on bottom and sides of tube and on bottom and around top of ball at waterline.	7/15/02: Same as above. Black film on sides of tube. Dark brown chunks in ring around top of ball at waterline.
7/16/02: Same as above.	7/16/02: Same as above. Dark brown chunks in ring around top of ball at waterline now contain small black flecks.
7/17/02: Same as above.	7/17/02: Same as above.

794 509

MW116
Sampled 7/9/02

SRB	IRB
Present, BA, 10,000 – 100,000	Present, BL, 100,000
7/10/02: Solution clear except for slightly cloudy ring at bottom of tube. 1% of tube covered with medium bubbles evenly dispersed. Many small black flecks on bottom of ball covering approximately 1/8% of bottom of ball.	7/10/02: Solution blackish brown throughout tube graduating from black at bottom of ball to middle of tube where solution becomes dark brown. 80% of tube and 80% of top around waterline and bottom of ball covered in small/medium bubbles.
7/11/02: Same as above except increase in amount of small black flecks on bottom of ball.	7/11/02: Solution blackish/brown throughout. Black film on bottom of ball with ring of large/medium bubbles. Ring of medium bubbles with hint of brown ring around top of ball at waterline.
7/12/02: Solution clear with black ring at the bottom of tube. 1% of tube sides covered in small bubbles. 5% of ball (bottom) covered in small bubbles with a few black flecks.	7/12/02: Solution blackish brown throughout. Black film on bottom of tube. Ring of bubbles and medium brown ring around top of ball at waterline.
7/13/02: Solution clear. Black film on sides and bottom of tube. Very thin black film on very bottom of ball. 5% of ball covered in small bubbles.	7/13/02: Solution black throughout. Black film on bottom of ball and on bottom of tube. Ring of large bubbles on bottom of ball. Dark yellow/light brown ring around top of ball at waterline with just a few bubbles.
7/14/02: Same as above.	7/14/02: Same as above.
7/15/02: Same as above. Black film more pronounced on very bottom of ball.	7/15/02: Same as above. Dark brown ring around top of ball at waterline.
7/16/02: Same as above. Black film on ball from waterline down and around top of ball at waterline.	7/16/02: Same as above.
7/17/02: Same as above.	7/17/02: Same as above. Black film on bottom and sides (thick on sides) of tube. Black film on bottom and around top of ball at waterline.

MW124
Sampled 7/9/02

SRB	IRB
Present, BA, 100,000	Present, BL, IRB, 100,000
7/11/02: Solution slightly cloudy throughout with thin line of darker cloudiness (off-white more than any color) at bottom of tube. 90% of tuber covered with small bubbles with only 5% of ball (bottom) covered with small bubbles.	7/11/02: Solution light yellow throughout with darker yellow film in center bottom of tube. 80% of tube and 30% of ball (bottom) covered with small bubbles.
7/12/02: Solution clear with slightly cloudy ring at bottom of tube. Small bubbles on sides of tube near bottom. ½% of ball (bottom) covered in small bubbles. Bottom of ball from waterline down covered in a very thin black film with a few black specks.	7/12/02: Solution graduates from dark yellow under ball to lighter yellow in bottom of tube. 80% of tube sides covered with small bubbles. 90% of ball covered with small bubbles concentrated around top of ball at waterline. Hint of light brown ring around top of ball at waterline.
7/13/02: Same as above.	7/13/02: Solution cloudy dark yellow. 80% of tube and 90% of ball covered in small bubbles concentrated around top of ball at waterline. Dark brown ring around top of ball at waterline. Black ring around top of ball just below waterline.
7/14/02: Same as above. Black film developing on sides of tube, but not at bottom of tube.	7/14/02: Solution black throughout. Black film on bottom of ball from waterline down. Ring of small bubbles and dark brown around top of ball at waterline.
7/15/02: Same as above. Black film on bottom and sides of tube.	7/15/02: Same as above. Black film on bottom and sides of tube.
7/16/12: Solution very slightly cloudy. Black film on bottom and sides of tube and on bottom of ball from waterline down.	7/16/02: Same as above.
7/17/02: Solution clear. Black film on bottom and sides of the tube. Black film on bottom and around top of ball at waterline.	7/17/02: Same as above.
7/18/02: Same as above.	7/18/02: Same as above. Black film on bottom and sides of tube. Black film on bottom of ball, not so much on sides of ball. Dark brown ring with black specks around top of ball at waterline.

794 511

MW120
Sampled 7/9/02

SRB	**IRB**
Present, BA and CL, 10,000	Present, BL, 100 – 5,000
7/11/02: Solution in outer tube very cloudy throughout (looks like watered-down milk) making it difficult to see inner tube. A few bubbles on sides of tube near ball.	7/11/02: Solution in outer very cloudy throughout (looks like watered-down milk) with a hint of yellow. 2% of sides of tube near ball covered with small bubbles.
7/12/02: Solution in outer tube very cloudy throughout making it difficult to see inner tube. No black in bottom of tube. Small black flecks on one small area of the ball. A few bubbles on sides of tube near ball.	7/12/02: Same as above.
7/13/02: Same as above. Black film on 5% of ball concentrated on one side.	7/13/02: Same as above.
7/14/02: Same as above. Black film around top of ball at waterline. Appears to be black film on sides and bottom of inner tube, but hard to see through cloudy solution in the outer tube.	7/14/02: Solution in outer tube remains very cloudy with brownish tint. Unable to clearly see inner tube, but no visible evidence of film developing on either ball or bottom of inner tube.
7/15/02: Same as above. Inner tube appears black, very pronounced at the bottom of the tube and around top of ball at waterline.	7/15/02: Same as above. Light brown ring around top of ball at waterline.
7/16/02: Same as above.	7/16/02: Same as above. Black film on bottom and sides of tube. Black film on ball from waterline down. Black film ring around top of ball at waterline.
7/17/02: Same as above. Inner tube appears black from bottom of tube to bottom of ball. Doesn't appear to be black film on sides of ball below waterline. Black film ring around top of ball at waterline.	7/17/02: Same as above. Inner tube black from bottom of tube to top of ball around waterline. Small area of ball (very top) that is not covered in black film.
7/18/02: Solution in outer tube very cloudy (milky) and smells of sulfur. Solution in inner tube is cloudy. Black film on bottom and sides of tube. Black film on bottom and around top of ball at waterline.	7/18/02: Solution in outer tube very cloudy (milky) and smells of sulfur. Solution in inner tube is blackish brown. Black film on bottom and sides of tube. Black film covering most of the ball with a small area (top) of the ball not covered with black film.

MW105
Sampled 7/9/02

SRB	IRB
Present, BA, 100,000	Present, BL, 100,000
7/11/02: Solution clear. Thin black film on sides and bottom of tube and on bottom of ball. ½% of tube and 10% of ball covered with small bubbles.	7/11/02: Solution mostly clear throughout graduating from clear at ball to slightly cloudy dark yellow at bottom of tube. Thin brown film in center bottom of tube, not on sides. Very few bubbles in tube or on ball.
7/12/02: Solution clear. Solid black film on bottom of tube and on bottom of ball. ½% of tube sides covered with small bubbles. 2% of ball (bottom) covered with small bubbles.	7/12/02: Solution slightly cloudy. Medium yellow at bottom of tube graduating to grayish black under ball (color change begins at middle of tube). Thin black film on bottom of ball. ½% of tube sides covered with small bubbles. 2% of ball below waterline covered in medium bubbles.
7/13/02: Same as above.	7/13/02: Solution black at ball and throughout most of tube graduating down to dark yellow/brown at bottom of tube. Black film at bottom and sides of tube and on ball. Large/medium bubbles around bottom of ball below waterline.
7/14/02: Same as above. Black film developing on sides of tube.	7/14/02: Solution black throughout. Black film on bottom of ball from waterline down. Thick black film ring around top of ball at waterline. Black film on sides and bottom of tube.
7/15/02: Same as above. Solid black film on bottom and sides of tube and on bottom of ball from waterline down.	7/15/02: Same as above.
7/16/02: Same as above.	7/16/02: Same as above.
7/17/02: Same as above.	7/17/02: Same as above.
7/18/02: Same as above.	7/18/02: Same as above.

MW112
Sampled 7/9/02

SRB	IRB
Present, BA, 100,000	Present, BL, 100,000
7/11/02: Solution clear throughout. Thin black film on bottom of ball and on sides of tube near ball. Very few bubbles in tube or on ball.	7/11/02: Solution clear throughout graduating from clear at ball to dark yellow at bottom of tube. Thin brown film in center bottom of tube, not on sides.
7/12/02: Solution clear. Thin black film ring in bottom of tube. Thin black film on bottom of ball. Very few bubbles in tube or on ball.	7/12/02: Solution slightly cloudy. Medium/dark yellow at bottom of tube graduating to grayish black just under the ball (color change begins at middle of tube). 70% of tube sides covered in medium/large bubbles. 20% of ball covered in small/medium bubbles with thin black film on bottom of ball. Small ring of bubbles around top of ball at waterline.
7/13/02: Solution clear. Black film now fully developed on ball. Black film in bottom of tube and in several small areas on sides of tube.	7/13/02: Solution black throughout graduating to dark yellow/brown at bottom of tube. Black film on bottom of ball below waterline and in bottom and sides of tube. Some bubbles on ball and sides of tube.
7/14/02: Same as above.	7/14/02: Solution black throughout. Black film on bottom of ball from waterline down and on sides and bottom of tube.
7/15/02: Same as above.	7/15/02: Same as above.
7/16/02: Same as above. Black film covers more area on the sides of the tube.	7/16/02: Same as above.
7/17/02: Same as above. Black film on bottom and sides of tube. Black film on bottom of ball from waterline down.	7/17/02: Same as above. Black film on bottom and sides of the tube and covering most of the ball. A small area (very top) of ball not covered in black film.
7/18/02: Same as above.	7/18/02: Same as above.

MW113
Sampled 7/9/02

SRB	IRB
Present, BA, 100 – 1,000	Present, BL, IRB, 100,000
7/11/02: Solution clear throughout tube. 70% of tube and ½% of ball covered in small bubbles.	7/11/02: Solution clear throughout graduating from clear at ball to yellow at bottom of tube. Hint of brown film in center bottom of tube, not on sides. 80% of tube and 5% of ball covered in small bubbles.
7/12/02: Solution clear throughout with slightly cloudy ring at bottom of tube. 30% of tube sides covered in small bubbles concentrated in bottom of tube. ½% of ball covered in small bubbles.	7/12/02: Solution cloudy, dark yellow/light brown. Dark brown in center bottom of tube. 60% of tube sides near ball covered in small bubbles. 40% of ball covered in small bubbles concentrated around top of ball at waterline. Dark yellow ring around top of ball at waterline and dark yellow film on bottom of ball.
7/13/02: Same as above.	7/13/02: Solution cloudy, dark yellow/brown throughout. Black film in bottom of tube and on bottom of ball. Small bubbles on sides of tube. Ring of small bubbles and dark brown film around top of ball at waterline.
7/14/02: Same as above. No black film on either ball or bottom of tube.	7/14/02: Solution black throughout. Black film on bottom of ball. Small ring of bubbles and dark brown ring with black flecks around top of ball at waterline. Black film on sides and bottom of tube.
7/15/02: Same as above. No black film within inner tube and very few (maybe 5 total) bubbles.	7/15/02: Same as above.
7/16/02: Same as above. No black film.	7/16/02: Same as above.
7/17/02: Same as above. Very thin black film developing on sides of the ball below waterline, not on the bottom or around top of the ball at waterline.	7/17/02: Same as above.
7/18/02: Same as above. Very thin black film on sides below waterline and bottom of ball, not so much around top of ball at waterline. Very thin black film ring in bottom of tube on sides, not on center bottom of tube.	7/18/02: Same as above. More black flecks, but not a solid ring of black film around top of ball at waterline.

794 515

MW122
Sampled 7/9/02

SRB	**IRB**
Present, BA, 100,000	Present, BL, IRB, FO
7/12/02: Solution clear with slightly cloudy ring at bottom of tube. 20% of tube sides covered in small bubbles concentrated near bottom of tube. 5% of ball (bottom) covered in small bubbles. 10% of ball covered with small black specks, not a film, on sides and bottom of ball.	7/12/02: Solution slightly cloudy. Medium yellow under ball graduating to darker yellow at bottom of tube. 60% of tube sides covered in small bubbles. 30% of ball covered in small bubbles concentrated on bottom.
7/13/02: Solution clear. Very thin area of black film on very bottom of ball. Small bubbles on sides of tube concentrated near bottom of tube.	7/13/02: Solution cloudy. Dark yellow under ball graduating to brown at bottom of tube. 50% of tube sides covered in small bubbles. 80% of ball covered in small/medium bubbles. Hint of brown ring around top of ball at waterline.
7/14/02: Solution clear throughout. Very thin area of black film on very bottom of ball and on one side of ball.	7/14/02: Solution black from bottom of ball to about middle of tube graduating to dark brown. Thin black film in bottom of tube and on bottom of ball. Dark brown ring and small bubble ring around ball at waterline and above black film.
7/15/02: Same as above. Black film in bottom of tube. Very thin black film on very bottom and on one side of ball.	7/15/02: Solution black throughout. Black film in bottom of tube and bottom of ball. Dark brown ring of small bubbles around top of ball at waterline.
7/16/02: Same as above. Black film on sides of tube. Black flecks in slightly cloudy ring around top of ball at waterline.	7/16/02: Same as above
7/17/02: Same as above. Black film on bottom and sides of tube. Black film on bottom and sides of ball below. Black flecks around top of ball at waterline.	7/17/02: Same as above. Black film on bottom and sides of tube. Black film on bottom of ball. Dark brown ring of small bubbles with black flecks around sides and top of ball at waterline.
7/18/02: Same as above.	7/18/02: Same as above.
7/19/02: Same as above. More black flecks around top of ball at waterline, but not a solid ring of black film.	7/19/02: Same as above. More black flecks around top of ball at waterline, but not a solid ring of black film.

POST SAMPLING EVENT #2

MW114
Sampled 7/30/02

IRB	SRB
7/31/02: Solution clear at ball graduating to light yellow in middle of tube and to dark yellow (black tint) at bottom of tube. No bubbles.	7/31/02: Solution clear with clear film in cone. No bubbles.
8/1/02: Solution slightly cloudy graduating from light yellow at ball to dark yellow (golden) at bottom of tube.	8/1/02: Same as above.
8/2/02: Black.	8/2/02: Same as above.
8/3/02:	8/3/02:
8/4/02: Thick black film throughout from waterline along sides to bottom of tube. Ball almost completely covered with black film.	8/4/02: Black film throughout tube – on bottom, middle and around top of ball, on sides and at bottom of tube.
8/5/02: Same as above.	8/5/02: Same as above.
8/6/02: Same as above.	8/6/02: Same as above.
8/7/02: Same as above.	8/7/02: Same as above.

794 517

MW110
Sampled 7/30/02

IRB	SRB
7/31/02: Solution light yellow at ball graduating to dark yellow at bottom of tube. Bubbles under ball and along sides.	7/31/02: Solution clear with clear film in cone. Bubbles under ball and along sides.
8/1/02: Solution cloudy amber yellow. Lots of large bubbles below ball.	8/1/02: Same as above.
8/2/02: Black.	8/2/02: Same as above.
8/3/02:	8/3/02:
8/4/02: Thick black film on sides and bottom of tube. Black film on bottom of ball. Dark brown film around top of ball at waterline. No black film around middle of ball.	8/4/02: Thin black film on bottom and at top of ball at waterline, on sides and bottom of tube.
8/5/02: Same as above.	8/5/02: Same as above.
8/6/02: Same as above except dark brown film around top of ball at waterline has turned black and black film has developed around middle of ball.	8/6/02: Same as above.
8/7/02: Same as above.	8/7/02: Same as above.

MW110 Duplicate
Sampled 7/30/02

IRB	SRB
7/31/02: Solution clear at ball graduating to light yellow in middle of tube and to dark yellow at bottom of tube. Bubbles along sides and below ball.	7/31/02: Solution clear with clear film in cone. Bubbles along sides and under ball.
8/1/02: Solution slightly cloudy graduating from light yellow at ball to dark yellow (golden) at bottom of tube.	8/1/02: Same as above.
8/2/02: Black.	8/2/02: Same as above.
8/3/02:	8/3/02:
8/4/02: Thick black film throughout tube – from bottom of ball to bottom of tube. Dark brown film around top of ball at waterline. No black film on middle of ball.	8/4/02: Very thin black film on bottom of ball, on sides and bottom of tube. Black film around top of ball at waterline beginning to form.
8/5/02: Same as above.	8/5/02: Same as above.
8/6/02: Same as above except dark brown film around top of ball is black.	8/6/02: Same as above except black film in bottom of tube more pronounced.
8/7/02: Same as above.	8/7/02: Thin black film on bottom and around top of ball at waterline, on sides and bottom of tube.

MW120
Sampled 7/30/02

IRB	SRB
7/31/02: Solution cloudy light yellow at ball graduating to dark yellow at bottom of tube. Bubbles along sides and under ball.	7/31/02: Solution clear with clear film in cone. Bubbles along side and under ball.
8/1/02: Solution cloudy, amber. Top half of water column black.	8/1/02: Same as above.
8/2/02: Black.	8/2/02: Same as above with some black tint in water below ball.
8/3/02:	8/3/02:
8/4/02: Thick black film from bottom of ball to bottom of tube. Dark brown film around top of ball at waterline. No black film around middle of ball.	8/4/02: Thin black film on bottom, sides and around top of ball at waterline. Black film along sides and at bottom of tube.
8/5/02: Same as above.	8/5/02: Same as above.
8/6/02: Same as above.	8/6/02: Same as above.
8/7/02: Same as above except dark brown film around top of ball at waterline is much darker, almost black. Black film around middle of ball.	8/7/02: Same as above.

MW118
Sampled 7/30/02

IRB	SRB
7/31/02: Solution cloudy light yellow at ball graduating to dark yellow at bottom of tube. Bubbles along sides and under ball.	7/31/02: Solution cloudy with clear film at bottom in cone. Bubbles along sides and under ball.
8/1/02: Solution slightly cloudy yellow to light yellow at ball. No bubbles	8/1/02: Same as above except no bubbles.
8/2/02: Solution cloudy light yellow throughout most of tube. Amber just in cone.	8/2/02: Same as above.
8/3/02:	8/3/02:
8/4/02: Thick black film on bottom and around middle of ball, along sides and at bottom of tube. Ring of bubbles with dark brown flecks around top of ball at waterline.	8/4/02: Solution cloudy. Black film around top of ball at waterline. Very thin black film with black flecks on sides and bottom of ball. No black film in bottom of tube.
8/5/02: Same as above.	8/5/02: Black film around top of ball at waterline. Very thin black film with black flecks on sides and bottom of ball. Black film along sides and in bottom of tube.
8/6/02: Same as above except dark brown film around top of ball at waterline is black.	8/6/02: Same as above.
8/7/02: Same as above.	8/7/02: Solution cloudy. Black film around top of ball at waterline, around middle and on bottom of ball. Black film along sides and in bottom of tube.

MW113
Sampled 7/31/02

IRB	SRB
8/1/02: Solution clear, light yellow at ball graduating to dark yellow at bottom of tube. Small bubbles along sides and under ball.	8/1/02: Solution clear with clear film in cone. Small bubbles along sides and under ball.
8/2/02: Solution clear, amber. Lots of large bubbles.	8/2/02: Same as above.
8/3/02:	8/3/02:
8/4/02: Thick black film on bottom of ball, along sides and at bottom of tube. Dark brown film around middle and top of ball at waterline.	8/4/02: Very thin black film on bottom of ball. Thin black film along sides and at bottom of tube. Black tint forming around top of ball at waterline.
8/5/02: Same as above.	8/5/02: Same as above.
8/6/02: Same as above.	8/6/02: Same as above except black flecks in film along sides of tube.
8/7/02: Same as above except dark brown film around middle of ball is now black. Dark brown film around top of ball at waterline is darker, almost black.	8/7/02: Thin black film on bottom and around top of ball at waterline. Black film with black flecks along sides of tube. Black film in bottom of tube.
8/8/02: Same as above except dark brown film now black.	8/8/02: Same as above.

MW105
Sampled 7/31/02

IRB	SRB
8/1/02: Solution clear at ball graduating to dark yellow at bottom of tube. No bubbles.	8/1/02: Solution slightly cloudy with clear film at bottom. No bubbles.
8/2/02: Solution clear, light yellow at ball graduating to dark yellow at bottom of tube. Large bubbles around ball.	8/2/02: Black.
8/3/02:	8/3/02:
8/4/02: Thick black film from around top of ball at waterline, along sides to bottom of tube.	8/4/02: Thin black film around ball from waterline to bottom of ball, along sides and at bottom of tube.
8/5/02: Same as above.	8/5/02: Same as above.
8/6/02: Same as above.	8/6/02: Same as above.
8/7/02: Same as above.	8/7/02: Black film more pronounced around ball from waterline to bottom of ball, along sides and at bottom of tube.
8/8/02: Same as above.	8/8/02: Same as above.

794 523

MW112
Sampled 7/31/02

IRB	SRB
8/1/02: Solution clear at ball graduating to dark yellow at bottom of tube. No bubbles.	8/1/02: Solution slightly cloudy (black) under ball. Clear at bottom with black tint in upper ¼. Lower ¾ of tube has many small bubbles.
8/2/02: Solution clear graduating from light yellow at ball to dark yellow at bottom of tube.	8/2/02: Solution clear with slight black tint throughout.
8/3/02:	8/3/02:
8/4/02: Thick black film from waterline along sides to the bottom of the tube. Dark brown film around top of ball at waterline.	8/4/02: Thin black film around top at waterline, around middle and on bottom of ball, along sides and at bottom of tube. Sides of lower ¾ of tube covered in small bubbles.
8/5/02: Same as above.	8/5/02: Same as above.
8/6/02: Same as above except dark brown film much darker, almost black.	8/6/02: Same as above.
8/7/02: Same as above except dark brown film now black with two huge bubbles.	8/7/02: Black film more pronounced from waterline to bottom of ball and on sides and bottom of tube.
8/8/02: Same as above except bubbles much smaller.	8/8/02: Same as above.

MW116
Sampled 7/31/02

IRB	SRB
8/1/02: Solution light yellow at ball graduating to dark yellow at bottom of tube. Small bubbles along sides and under ball.	8/1/02: Solution clear with clear film in cone. Small bubbles along side and under ball.
8/2/02: Black.	8/2/02: Same as above.
8/3/02:	8/3/02:
8/4/02: Thick black film on bottom of ball, along sides and at bottom of tube. Dark brown film around top of ball at waterline. Black and dark brown film around middle of ball.	8/4/02: Very, very thin black film around top of ball at waterline. Thin black film (more pronounced than around top of ball) on bottom of ball, along sides and at bottom of tube.
8/5/02: Same as above.	8/5/02: Same as above.
8/6/02: Same as above.	8/6/02: Same as above.
8/7/02: Same as above except dark brown film around middle of ball is black and dark brown film around top of ball at waterline is darker, almost black.	8/7/02: Black film more pronounced around top of ball at waterline. Black film on bottom and around middle of ball, along sides of tube and is very pronounced at bottom of tube.
8/8/02: Same as above except dark brown film around top of ball is black.	8/8/02: Same as above.

MW116 Duplicate
Sampled 7/31/02

IRB	SRB
8/1/02: Solution light yellow at ball graduating to dark yellow at bottom of tube. Many Small bubbles along sides and below ball.	8/1/02: Solution clear. Small bubbles along side and below ball.
8/2/02: Black.	8/2/02: Same as above.
8/3/02:	8/3/02:
8/4/02: Thick black film from bottom of ball along sides to bottom of tube. Dark brown film around top of ball at the waterline and somewhat around middle of ball.	8/4/02: Black film on bottom and sides of ball. Black film on sides of tube just under ball, but not all the way down. Black film in very bottom of tube. Air bubbles on sides of tube from bottom of ball to bottom of tube.
8/5/02: Same as above.	8/5/02: Same as above.
8/6/02: Same as above.	8/6/02: Same as above.
8/7/02: Same as above except dark brown film around top of ball at waterline is darker, almost black.	8/7/02: Black film around top of ball at waterline, around middle and on bottom of ball. Black film along sides and at bottom of tube.
8/8/02: Same as above except dark brown film around top of ball now black.	8/8/02: Same as above.

MW 124
Sampled 7/31/02

IRB	SRB
8/1/02: Solution clear at ball graduating to light yellow in middle of tube and to dark yellow at bottom of tube. No bubbles.	8/1/02: Solution clear with clear film in cone. Small bubbles along side and under ball.
8/2/02: Solution golden yellow throughout. Lots of large bubbles. Appears clear.	8/2/02: Same as above.
8/3/02:	8/3/02:
8/4/02: Thick black film from bottom of ball along sides to bottom of tube. Small bubbles and dark brown film around top of ball at waterline and around middle of ball.	8/4/02: Solutioin clear. Small bubbles on sides of tube. Bottom of ball covered in black flecks, not solid film.
8/5/02: Same as above.	8/5/02: Solution clear. Small bubbles on sides of tube. Very thin black film with black flecks on bottom of ball. Black film at bottom of tube.
8/6/02: Same as above.	8/6/02: Same as above except black film developing around top of ball at waterline and around middle of ball.
8/7/02: Same as above except dark brown film around top of ball and middle of ball is darker, almost black.	8/7/02: Black film around top of ball at waterline, around middle and on bottom of ball. Black film along sides of tube and is very pronounced in the bottom of the tube.
8/8/02: Same as above except dark brown film around top of ball now black.	8/8/02: Same as above.

MW122
Sampled 7/31/02

IRB	SRB
8/1/02: Solution clear at ball graduating to light yellow in middle of tube and to dark yellow at bottom of tube. Bubbles along side and under ball.	8/1/02: Solution clear with clear film at bottom of tube. Bubbles along side and below ball.
8/2/02: Solution yellow throughout. Amber in cone. Lots of large bubbles, clear.	8/2/02: Same as above.
8/3/02:	8/3/02:
8/4/02: Thick black film from bottom of ball along sides to bottom of tube. Dark brown film around top of ball at waterline and around middle of ball.	8/4/02: Black film around top of ball at waterline and around sides of ball. Very, very thin black film in very center bottom of tube, not on sides. Small bubbles on sides of the tube.
8/5/02: Same as above.	8/5/02: Black film around top of ball at waterline and around sides of ball. Black film along sides and at bottom of tube.
8/6/02: Same as above.	8/6/02: Same as above.
8/7/02: Same as above except dark brown film around top of ball at waterline and around middle of ball is much darker, almost black.	8/7/02: Same as above.
8/8/02: Same as above except dark brown film around top and middle of ball is now black.	8/8/02: Same as above.

POST SAMPLING EVENT #3

MW124
Sampled 9/03/02

IRB	SRB
9/4/02: Solution light yellow from bottom of ball to bottom of tube. Sides of tube and bottom of ball covered with small bubbles. Dark brown tint at bottom of tube.	9/4/02: Solution clear with clear film in bottom of tube. Just a few bubbles on bottom of ball and sides of tube.
9/5/02: Solution dark yellow/light brown. Ring of small air bubbles around top and bottom of ball as well as on sides to bottom of tube.	9/5/02: Solution clear. Thin black film with black specks around bottom of ball at waterline.
9/6/02: Solution light brown. Light yellow ring of small bubbles around top of ball at waterline. Black film developing under medium bubbles on bottom of ball. Small bubbles on sides of tube.	9/6/02: Same as above. Thin black film on one side of tube near ball.
9/7/02: Black film on bottom of ball and sides and bottom of tube. Medium yellow ring of small bubbles around top of ball at waterline.	9/7/02: Same as above.
9/8/02: Same as above.	9/8/02: Thin black film with black flecks from top of ball at waterline to bottom of ball and in bottom of tube. Thin black film with black flecks becoming more pronounced on sides of tube from ball to about middle of tube.
9/9/02: Same as above, except ring around top of ball now dark yellow with splotches of black film.	9/9/02: Same as above.
9/10/02: Same as above.	9/10/02: Same as above.
9/11/02: Same as above, except ring around top of ball now black.	9/11/02: Same as above, except black film much thicker around top of ball at waterline, side and bottom of ball, sides and bottom of tube.

MW 114
Sampled 9/4/02

IRB	SRB
9/5/02: Solution dark brown. Pronounced black film on bottom of ball. Thinner black film on sides and bottom of tube. Medium yellow ring underneath ring of medium bubbles around top of ball at waterline. A few medium bubbles on sides of tube.	9/5/02: Solution clear with clear film in bottom of tube. Thin black film with black flecks on bottom of ball. A few black flecks and several small bubbles on side of tube.
9/6/02: Black film on bottom of ball, sides of tube and bottom of tube. Ring of bubbles with spots of black film around top of ball at waterline.	9/6/02: Solution clear with thin black film developing on sides of tube. Thin black film in bottom of tube. Thin black film with black flecks on bottom of ball.
9/7/02: Same as above.	9/7/02: Black film more pronounced on bottom of ball, sides and bottom of tube.
9/8/02: Same as above.	9/8/02: Same as above. Black film a bit thicker.
9/9/02: Same as above, except black film on one side of ball from bottom to top of ball at waterline. Black film ring around top of ball at waterline.	9/9/02: Same as above.
9/10/02: Same as above.	9/10/02: Black film ring around top of ball at waterline, bottom of ball, sides and bottom of tube.
9/11/02: Same as above.	9/11/02: Same as above.
9/12/02: Thick black film around top of ball at waterline, on one side of ball, on bottom of ball, on sides of tube from ball to bottom of tube.	9/12/02: Thin black film ring around top of ball at waterline and on bottom of ball. Thin black film on sides of tube from ball to bottom of tube. Film thicker on bottom of tube than on sides.

MW110
Sampled 9/4/02

IRB	SRB
9/5/02: Solution medium yellow throughout tube. Ring of medium bubbles around top of ball. Small bubbles under ball and on sides of tube.	9/5/02: Solution clear with clear film in bottom of tube. A few small bubbles under ball and on sides of tube.
9/6/02: Solution slightly cloudy light brown throughout tube. Medium yellow ring of medium bubbles around top of ball at waterline. A few medium bubbles on bottom of ball. No bubbles on sides of tube.	9/6/02: Same as above, except no bubbles on ball or sides of tube.
9/7/02: Solution medium brown with black film in bottom of tube. Ring of black film about ¼ up from bottom of tube. Splotches of black film on one side of ball. Dark yellow ring of medium bubbles around top of ball at waterline.	9/7/02: Very thin black film with black flecks on bottom of ball. A few small bubbles on sides of tube about ¼ up from bottom of tube.
9/8/02: Same as above, except black film developing on sides of tube and on ball below waterline. Black film ring with small bubbles around top of ball at waterline.	9/8/02: Same as above.
9/9/02: Black film from top of ball to bottom of tube.	9/9/02: Same as above, except thin black film on ball a bit thicker.
9/10/02: Same as above.	9/10/02: Thick black film from top of ball at waterline, on sides and bottom of ball as well as on sides and bottom of tube.
9/11/02: Same as above.	9/11/02: Same as above.
9/12/02: Thick black film around top of ball at waterline and bottom of ball, on sides of tube from ball to bottom of tube. Black flecks on sides of ball, but not solid layer of film.	9/12/02: Black film ring around top of ball at waterline, on sides and bottom of ball. Thick black film on sides of tube from ball to bottom of tube.

794 531

MW110 Duplicate
Sampled 9/4/02

IRB	SRB
9/5/02: Solution light yellow at ball graduating to dark yellow with hint of brown at bottom of tube. Light yellow ring of small bubbles around top of ball at waterline. A few bubbles on sides and bottom of ball as well as on sides of tube.	9/5/02: Solution clear with clear film in bottom of tube. Hardly any bubbles on ball or tube.
9/6/02: Same as above, except solution dark yellow with hint of brown throughout tube.	9/6/02: Same as above, except thin black film with black flecks on one side of bottom of ball.
9/7/02: Solution light brown throughout tube. Two black film dots on side of ball. Medium yellow ring of small bubbles around top of ball at waterline.	9/7/02: Thin black film on bottom of ball and sides of tube from ball to about ¼ down from ball.
9/8/02: Solution medium brown. Splotches of black film from waterline to bottom of ball and on sides of tube. Black film in bottom of tube. Medium brown ring with black splotches and bubbles around top of ball at waterline.	9/8/02: Thin black film around top of ball at waterline, bottom of ball, sides and bottom of tube.
9/9/02: Black film at top of ball at waterline, bottom of ball, sides and bottom of tube.	9/9/02: Same as above, except black film on sides and bottom of tube much thicker.
9/10/02: Same as above.	9/10/02: Same as above.
9/11/02: Same as above.	9/11/02: Same as above.
9/12/02: Thick black film around top of ball at waterline, on sides and bottom of ball. Thick black film on sides of tube from ball to bottom of tube.	9/12/02: Thin black film around top of ball at waterline and on bottom of ball. Black flecks on sides of ball. Thin black film on sides and bottom of tube. Film thicker in bottom than on sides of tube.

MW120
Sampled 9/4/02

IRB	SRB
9/5/02: Solution light yellow throughout tube with light yellow ring around top of ball at waterline. Bubbles on sides and bottom of ball. A few bubbles on side of tube.	9/5/02: Solution clear with clear film in bottom of tube. Thin black film with hint of brown around top of ball at waterline. Thin black film on bottom of ball. Small bubbles on side of tube near bottom.
9/6/02: Solution slightly cloudy medium yellow throughout tube. Dark yellow/hint of brown ring of small bubbles around top of ball at waterline. Bubbles on sides and bottom of ball.	9/6/02: Solution clear throughout tube. Black film on ball from waterline to bottom of ball. Black film on sides of tube at top near ball.
9/7/02: Same as above. A couple of black film dots on side of ball.	9/7/02: Same as above, except black film on sides of tube from ball to bottom of tube.
9/8/02: Black film from top of ball at waterline to bottom of tube.	9/8/02: Same as above, except black film more pronounced on ball, sides and bottom of tube.
9/9/02: Same as above.	9/9/02: Black film ring around top of ball at waterline, sides and bottom of ball. Black film on sides and bottom of tube; thicker in bottom than on sides.
9/10/02: Ball almost completely covered with black film. Black film from top of ball to bottom of tube.	9/10/02: Same as above.
9/11/02: Same as above.	9/11/02: Same as above.
9/12/02: Thick black film covering entire ball. Thick black film on sides of tube from ball to bottom of tube.	9/12/02: Thick black film around top of ball at waterline, on sides and bottom of ball. Thin black film on sides of tube. Thick black film in bottom of tube.

794 533

MW118
Sampled 9/4/02

IRB	SRB
9/5/02: Solution light yellow throughout tube. Light yellow ring with a few bubbles around top of ball at waterline. Bubbles along sides and under ball. Hardly any bubbles on sides of tube.	9/5/02: Solution slightly cloudy with clear film at bottom in tube. Hardly any bubbles on ball or tube.
9/6/02: Solution cloudy light brown throughout tube. Black film in bottom of tube. Medium yellow ring of small bubbles around top of ball at waterline. A few bubbles on sides and bottom of ball.	9/6/02: Same as above.
9/7/02: Black film from top of ball at waterline to bottom of ball and on sides of tube from ball to bottom of tube.	9/7/02: Solution slightly cloudy. Black flecks on sides of ball just under waterline.
9/8/02: Same as above. Black film more pronounced around top of ball at waterline.	9/8/02: Same as above, except thin black film with black flecks developing around sides of ball just under waterline.
9/9/02: Black film from top of ball at waterline, sides and bottom of ball, sides and bottom of tube.	9/9/02: Black film on sides and bottom of tube; thicker in bottom than on sides. Thin black film on sides and bottom of ball.
9/10/02: Same as above.	9/10/02: Same as above.
9/11/02: Same as above.	9/11/02: Same as above.
9/12/02: Thick black film around top of ball at waterline, on sides and bottom of ball. Thick black film on sides of tube from bottom of ball to bottom of tube.	9/12/02: Thin black film around top of ball at waterline and on sides of ball just under waterline. No black film on bottom of ball. Very, very thin (barely visible) black film on sides of tube from just under ball to bottom of tube. Thick black film in bottom of tube.

MW116
Sampled 9/4/02

IRB	SRB
9/5/02: Solution yellow with hint of brown throughout tube. Ring of small bubbles around top of ball at waterline and on bottom of ball. Sides of tube covered in small bubbles.	9/5/02: Solution clear with clear film in cone. Black flecks and spots of thin black film on ball from waterline to bottom of ball. Hardly any bubbles on ball or tube.
9/6/02: Solution clear light brown. Small bubbles cover sides of tube. Black film on sides of tube from middle to bottom of tube. Dark yellow ring with a few black flecks and small bubbles around top of ball at waterline. Small bubbles on bottom of ball.	9/6/02: Same as above, except black film on ball more pronounced.
9/7/02: Black film on bottom of ball and sides of tube from ball to bottom of tube. Dark brown ring with black flecks around top of ball at waterline.	9/7/02: Black film on ball from waterline to bottom of ball. Black film developing on sides of tube near ball and in very center bottom of tube.
9/8/02: Same as above.	9/8/02: Same as above, except black film in center bottom of tube moving towards sides of tube.
9/9/02: Same as above, except black film on bottom of ball, sides and bottom of tube thicker.	9/9/02: Same as above. Black film in bottom of tube covering bottom.
9/10/02: Same as above.	9/10/02: Thick black film on ball, sides and bottom of tube.
9/11/02: Same as above.	9/11/02: Same as above.
9/12/02: Dark brown ring with black flecks around top of ball at waterline. Thick black film on bottom of ball. Thin black film on sides of tube just under ball growing thicker at middle of tube. Thick black film on sides near bottom and bottom of tube.	9/12/02: Thick black film around top of ball at waterline. Thin black film on sides of ball just below waterline. Thick black film on bottom of ball. Thin, yet thick enough to obscure view into tube, black film on sides of tube just under ball to bottom of tube. Thick black film in bottom of tube.

MW116 Duplicate
Sampled 9/4/02

IRB	SRB
9/5/02: Solution slightly cloudy dark yellow with hint of brown throughout tube. Dark yellow ring underneath ring of small bubbles around top of ball at waterline. Patches of black film underneath medium/large bubbles on bottom of ball. Thin black film on sides of tube at middle of tube. Hardly any bubbles on sides of tube.	9/5/02: Solution clear with cloudy film at bottom of tube. Thin black film with black flecks around ball at waterline. A few small bubbles on ball and tube.
9/6/02: Black film on bottom of ball and sides of tube from bottom of ball to bottom of tube. Dark yellow/light brown ring of small bubbles around top of ball at waterline.	9/6/02: Same as above, except thin black film with black flecks on ball moving down from waterline to bottom of ball.
9/7/02: Same as above.	9/7/02: Black film on ball from waterline to bottom of ball. Black film in bottom of tube.
9/8/02: Thick black film on bottom of ball, sides and bottom of tube. Dark brown ring with bubbles around top of ball at waterline.	9/8/02: Same as above, except black film more pronounced in bottom of tube.
9/9/02: Same as above.	9/9/02: Same as above.
9/10/02: Same as above, except black flecks in dark brown ring around top of ball at waterline.	9/10/02: Same as above.
9/11/02: Same as above, except dark brown ring around top of ball at waterline almost completely black.	9/11/02: Same as above.
9/12/02: Dark brown/black film around top of ball at waterline. No film on sides of ball. Thick black with patches of dark brown film on bottom of ball. Thick black film on sides of tube from bottom of ball to bottom of tube.	9/12/02: Very thin black film with black flecks on sides and bottom of ball. Very, very thin black film on sides of tube. Thick black film in bottom of tube.

MW113
Sampled 9/5/02

IRB	SRB
9/6/02: Solution light yellow throughout tube. No bubbles on ball or on sides of tube.	9/6/02: Solution clear throughout tube with slightly cloudy film in bottom of tube. No bubbles on ball or sides of tube.
9/7/02: Solution slightly cloudy medium yellow throughout tube. Black film in center bottom of tube. Light yellow ring of medium bubbles around top of ball at waterline.	9/7/02: Solution clear. Very thin black film with black flecks on sides and bottom of ball and on one side of tube near ball.
9/8/02: Same as above, except black film covering bottom of tube and moving up sides of tube.	9/8/02: Same as above.
9/9/02: Solution dark brown. Black film on sides of tube from just under ball to bottom of tube. Medium yellow ring with medium bubbles around top of ball at waterline. Thin black film on one side of ball under waterline.	9/9/02: Same as above.
9/10/02: Black film on bottom of ball, sides and bottom of tube. Medium brown ring with black flecks and medium bubbles around top of ball at waterline. Light brown film on sides of ball.	9/10/02: Black film around top of ball at waterline, very thin on sides of ball, thicker on bottom of ball. Thin black film on sides of tube just under ball. No black film in bottom or on sides near bottom of tube.
9/11/02: Black film around top of ball at waterline and bottom of ball. Light brown film on sides of ball. Black film on sides and bottom of tube.	9/11/02: Thin black film around top of ball at waterline, sides and bottom of ball. Thicker on bottom of ball than sides or top. Black film on sides of tube just under ball. Thin black film in bottom of tube and on sides near bottom of tube.
9/12/02: Same as above.	9/12/02: Same as above.
9/13/02: Black film around top of ball at waterline and bottom of ball. Thin black overlaying light brown film on sides of ball. Thick black film on sides and bottom of tube.	9/13/02: Thin black film around top of ball at waterline, sides and bottom of ball. Thicker on bottom of ball than sides or top. Medium black film on sides of tube just under ball to bottom of tube. Thick black film in bottom of tube.

794 537

MW105
Sampled 9/5/02

IRB	SRB
9/6/02: Solution clear light yellow throughout inner tube. No bubbles on ball or tube. There appears to be brown sediment on sides and in bottom of outer tube.	9/6/02: Solution clear throughout inner tube. Small bubbles on sides of inner tube. There appears to be brown sediment on sides and in bottom of outer tube.
9/7/02: Solution slightly cloudy medium . yellow throughout tube. Large bubbles on bottom and sides of tube.	9/7/02: Very thin black film with black flecks on very bottom of ball and on sides of tube just under ball.
9/8/02: Solution medium brown. Black film on bottom of ball and sides and bottom of tube.	9/8/02: Black film fully developed on bottom of ball, sides and bottom of tube.
9/9/02: Black film on bottom of ball, sides and bottom of tube. Medium yellow ring around top of ball at waterline with a few black specks.	9/9/02: Black film on sides and bottom of ball as well as sides and bottom of tube.
9/10/02: Same as above.	9/10/02: Same as above, except black film much thicker.
9/11/02: Same as above.	9/11/02: Same as above.
9/12/02: Same as above.	9/12/02: Thick black film around top of ball at waterline, on sides and bottom of ball. Thick, but still able to see through it, black film on sides of tube from ball to bottom of tube. Thick black film in bottom of tube.
9/13/02: Medium yellow ring around top of ball at waterline with a few black specks. No black film on sides of ball. Thick black film on bottom of ball and on sides from ball to bottom of tube.	9/13/02: Same as above.

MW112
Sampled 9/5/02

IRB	SRB
9/6/02: Solution clear light yellow throughout tube. No bubbles on ball or sides of tube.	9/6/02: Solution clear with slightly cloudy film in bottom of tube. Thin black film on bottom of ball.
9/7/02: Solution slightly cloudy medium yellow throughout tube. Medium bubbles on bottom of ball.	9/7/02: Same as above, except black film more pronounced on sides and bottom of ball. Thin black film with black flecks on one side of tube near ball.
9/8/02: Solution slightly cloudy light brown. Black film on bottom of ball and bottom of tube. Thin black film on sides of tube between ball and bottom of tube. A few bubbles with black specks around top of ball at waterline.	9/8/02: Black film on sides and bottom of ball, sides and bottom of tube.
9/9/02: Black film from top of ball at waterline to bottom of ball as well as sides and bottom of tube.	9/9/02: Same as above, except black film thicker.
9/10/02: Same as above, except black film developing on top of ball.	9/10/02: Same as above.
9/11/02: Same as above. Black film almost completely covering top of ball.	9/11/02: Same as above.
9/12/02: Thick black film from around top of ball at waterline, almost covering top of ball, down sides of ball and on sides of tube to bottom of tube.	9/12/02: Medium black film around top of ball at waterline. Thicker black film on sides and bottom of ball. Thick, but still able to see through it, black film on sides of tube from ball to bottom of tube. Thick black film in bottom of tube.
9/13/02: Same as above.	9/13/02: Same as above.

794 539

MW122
Sampled 9/6/02

IRB	SRB
9/7/02: Solution clear light yellow. Medium bubbles on bottom of ball and sides of tube. Very thin black film splotch on one side in very center bottom of tube.	9/7/02: Solution clear throughout tube. Very thin black film with black flecks on one side of ball under waterline. Small bubbles on sides of tube from middle to bottom of tube.
9/8/02: Solution slightly cloudy medium yellow. Ring of small bubbles around top of ball at waterline.	9/8/02: Same as above, except thin black film becoming more pronounced.
9/9/02: Solution medium brown. Thin black film on bottom of ball as well as sides and bottom of tube.	9/9/02: Same as above.
9/10/02: Black film much thicker on bottom of ball, sides and bottom of tube. Medium brown ring of bubbles with black flecks around top of ball at waterline.	9/10/02: Thin black film with black flecks on sides and bottom of ball. No black film on sides or bottom of tube.
9/11/02: Black film ring around top of ball at waterline. Black film on bottom of ball, sides and bottom of tube.	9/11/02: Well developed black film on sides and bottom of ball. Thin black film on sides of tube just under ball and in bottom of tube.
9/12/02: Thick black film around top of ball at waterline. No film on sides of ball. Thick black film on bottom of ball. Thick black film on sides of tube from bottom of ball to bottom of tube.	9/12/02: Thin black film around top of ball at waterline and on sides of ball. Thick black film on bottom of ball. Thick, but still able to see through it, black film on sides of tube from ball to bottom of tube. Thick black film in bottom of tube.
9/13/02: Same as above.	9/13/02: Same as above.
9/14/02: Same as above.	9/14/02: Same as above.

POST SAMPLING EVENT #4

MW114
Sampled 10/8/02

IRB	SRB
10/9/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. No bubbles.	10/9/02: Solution clear with slightly cloudy film in bottom of tube. No bubbles.
10/10/02: Solution light yellow at bottom of ball graduating to light brown at bottom of tube. Large/medium bubbles around top of ball at waterline and on bottom of ball. A few small bubbles on sides of tube.	10/10/02: Solution clear with slightly cloudy film in bottom of tube. No bubbles. Four to five black flecks on bottom of ball.
10/11/02: Solution light brown throughout tube. Medium bubbles around top of ball at waterline and on bottom of ball. Black slime on bottom of ball, in bottom of tube and in small spots on sides of tube.	10/11/02: Solution clear with slightly cloudy film in bottom of tube. No bubbles. Thin black film with black flecks on bottom of ball. Thin black film ring around top of ball at waterline.
10/12/02: Solution medium brown throughout tube. Medium bubbles around top of ball at waterline and on bottom of ball. Black slime on bottom of ball, in bottom of tube and almost covering sides of tube.	10/12/02: Solution clear with slightly cloudy film in bottom of tube. No bubbles. Thin black film with black flecks on bottom and sides of ball and on sides and bottom of tube. Thin black film ring around top of ball at waterline.
10/13/02: Black slime on sides and bottom of ball and on sides and bottom of tube. Medium brown ring around top of ball at waterline, but no bubbles.	10/13/02: Black film with black flecks more pronounced on bottom and sides of ball, on sides of tube from bottom of ball to bottom of tube and in bottom of tube. Thin black film ring around top of ball at waterline.
10/14/02: Same as above.	10/14/02: Same as above
10/15/02: Same as above.	10/15/02: Black film on ball from top at waterline to bottom. Black film on sides of tube from top to bottom.
10/16/02: Same as above, except more black film in brown ring around top of ball at waterline.	10/16/02: Same as above.

794 541

MW 120
Sampled 10/8/02

IRB	SRB
10/9/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. Small bubbles on sides of tube from bottom of ball to bottom of tube.	10/9/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on sides of tube from bottom of ball to bottom of tube. A few bubbles on bottom of ball.
10/10/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. Light yellow ring around top of ball at waterline. Small bubbles on sides of tube from bottom of ball to bottom of tube.	10/10/02: Solution clear with light yellow ring around top of ball at waterline and slightly cloudy film in bottom of tube. Small bubbles on sides of tube from bottom of ball to bottom of tube. A few bubbles on bottom of ball.
10/11/02: Solution light yellow throughout tube. Light yellow ring around top of ball at waterline. A few small bubbles on bottom of ball. No bubbles on sides of tube.	10/11/02: Solution clear with thin black ring around top of ball at waterline, thin black film on bottom of ball and slightly cloudy film in bottom of tube. Small bubbles on sides of tube from bottom of ball to bottom of tube. A few bubbles on bottom of ball.
10/12/02: Same as above, except bubbles on bottom of ball are bigger.	10/12/02: Same as above.
10/13/02: Solution medium yellow throughout tube. Medium yellow ring around top of ball at waterline. A few large bubbles with black flecks on bottom of ball. No bubbles on sides of tube.	10/13/02: Solution clear. Middle and top of ball at waterline covered in black film. Thin black film with black flecks on bottom of ball. Slightly cloudy film in bottom of tube. Small bubbles on sides of tube from bottom of ball to bottom of tube.
10/14/02: Same as above.	10/14/02: Same as above.
10/15/02: Sides and bottom of ball covered in black film. Black film in bottom of tube and thin black film on sides of tube. Solution dark brown from bottom of ball to just above bottom of tube. Dark brown ring with around top of ball at waterline.	10/15/02: Black film on ball from top at waterline to bottom. Black film in bottom of tube. No black film on sides of tube, but a few small bubbles.
10/16/02: Same as above.	10/16/02: Same as above.

MW110
Sampled 10/8/02

IRB	SRB
10/9/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. No bubbles.	10/9/02: Solution clear with slightly cloudy film in bottom of tube. A few small bubbles under ball and on sides of tube.
10/10/02: Solution light yellow at bottom of ball graduating to light brown at bottom of tube. Ring of small bubbles around top of ball at waterline and a few medium bubbles on bottom of ball.	10/10/02: Solution clear with slightly cloudy film in bottom of tube. A few small bubbles under ball and on sides of tube.
10/11/02: Solution light brown at bottom of ball graduating to medium brown at bottom of tube. Ring of medium bubbles around top of ball at waterline and large/medium bubbles on bottom of ball.	10/11/02: Same as above.
10/12/02: Solution medium brown at bottom of ball graduating to dark brown/black at bottom of tube. Ring of small bubbles with black flecks around top of ball at waterline. A few large/medium bubbles on bottom of ball.	10/12/02: Solution clear. Thin black film with black flecks on bottom of ball. Slightly cloudy film in bottom of tube. A few small bubbles on bottom of ball and sides of tube.
10/13/02: Solution dark brown at bottom of ball graduating to black at bottom of tube. Ring of small bubbles with black flecks around top of ball at waterline. Black film on one side of ball and in bottom of tube.	10/13/02: Same as above.
10/14/02: Same as above.	10/14/02: Same as above, except black film in center of bottom of tube.
10/15/02: Black film on ball from top at waterline to bottom. Black film in bottom of tube and thin black film on sides of tube. Solution dark brown from bottom of ball to just above bottom of tube.	10/15/02: Thin black film on sides of ball. Thicker black film on bottom of ball and in bottom of tube. Black film on sides of tube from bottom of ball to about middle of tube. Medium bubbles between black film on sides and in bottom of tube.
10/16/02: Same as above.	10/16/02: Same as above.

794 543

MW110 Duplicate
Sampled 10/8/02

IRB	SRB
10/9/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. No bubbles.	10/9/02: Solution clear with slightly cloudy film in bottom of tube. A few small bubbles on sides of tube.
10/10/02: Solution light yellow at bottom of ball graduating to light brown at bottom of tube. Ring of small bubbles around top of ball at waterline and medium bubbles on bottom of ball.	10/10/02: Solution clear with slightly cloudy film in bottom of tube. A few small bubbles on sides of tube.
10/11/02: Solution light brown at bottom of ball graduating to medium brown at bottom of tube. Ring of medium bubbles around top of ball at waterline and medium bubbles on bottom of ball.	10/11/02: Same as above.
10/12/02: Same as above, except black flecks on one side of ball and in bubble ring around top of ball.	10/12/02: Solution clear. Thin black film with black flecks on bottom of ball. A few medium bubbles on sides of tube.
10/13/02: Solution medium brown at bottom of ball graduating to dark brown/black at bottom of tube. Dark yellow ring of small bubbles with black flecks around top of ball at waterline. Black film in bottom of tube.	10/13/02: Solution clear. Thin black film with black flecks on sides and bottom of ball. Black film in center of bottom of ball. A few medium bubbles on sides of tube.
10/14/02: Solution light brown at bottom of ball graduating to medium brown at bottom of tube. Ring of medium bubbles around top of ball at waterline and medium bubbles on bottom of ball.	10/14/02: Same as above.
10/15/02: Thin black film with large black flecks on ball from top at waterline to bottom. Black film on sides of tube from just below ball to bottom of tube.	10/15/02: Thin black film on bottom of ball, sides and bottom of tube. Ring of small bubbles around top of ball at waterline.
10/16/02: Same as above.	10/16/02: Same as above, except black film thicker in bottom of tube.

MW118
Sampled 10/8/02

IRB	SRB
10/9/02: Solution clear at bottom of ball graduating to light yellow at bottom of tube. A few small bubbles on bottom of ball and sides of tube.	10/9/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on side of tube near bottom.
10/10/02: Solution light yellow throughout tube. Most of ball bottom covered in medium bubbles. Medium/small bubbles on sides of tube to just above bottom of tube.	10/10/02: Solution clear with ring of black flecks around top of ball at waterline and slightly cloudy film in bottom of tube. A few small bubbles on bottom of ball. Small bubbles on sides of tube.
10/11/02: Solution light yellow throughout tube. Most of ball bottom covered in medium bubbles. Medium/small bubbles on sides of tube to just above bottom of tube.	10/11/02: Solution clear with thin black ring with black flecks around top of ball at waterline and sides of ball. Slightly cloudy film in bottom of tube. A few small bubbles on bottom of ball. Small bubbles on sides of tube.
10/12/02: Solution medium yellow throughout tube. Ring of medium yellow small bubbles around top of ball at waterline. Medium bubbles with black flecks on bottom of ball. Medium/small bubbles with black flecks on sides of tube to just above bottom of tube.	10/12/02: Same as above.
10/13/02: Same as above, except black film developing in bottom of tube.	10/13/02: Thin black film ring around top of ball at waterline. Thin black film with black flecks on sides of ball and sides of tube. Black film in bottom of tube. Small bubbles on sides of tube. A few large bubbles on bottom of ball.
10/14/02: Black film from bottom of ball to bottom of tube. Ring of dark yellow edged in black film around top of ball at waterline.	10/14/02: Same as above, except black film on sides and bottom of tube more pronounced.
10/15/02: Same as above, except more black film around top of ball at waterline.	10/15/02: Same as above, except black film ring more pronounced around top of ball at waterline.
10/16/02: Same as above.	10/16/02: Same as above.

794 545

MW105
Sampled 10/9/02

IRB	SRB
10/10/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. No bubbles.	10/10/02: Solution light brown with clear film in bottom of tube. A few small bubbles on ball and sides of tube.
10/11/02: Solution medium yellow at bottom of ball graduating to medium brown at bottom of tube. Large/medium bubbles around top of ball at waterline, on bottom of ball and sides of tube.	10/11/02: Same as above.
10/12/02: Solution dark yellow at bottom of ball graduating to dark brown/black at bottom of tube. Large/medium bubbles with black flecks on bottom of ball. Thin black film on sides of tube. Ring of medium yellow medium bubbles around top of ball at waterline.	10/12/02: Solution light brown with thin black film around top of ball, on sides of ball, on sides of tube and in bottom of tube. A few small bubbles on sides of tube.
10/13/02: Dark yellow ring around top of ball at waterline. Large/medium bubbles and black film on bottom of ball. Medium bubbles and black film on sides of tube. Black film in bottom of tube.	10/13/02: Black film throughout tube from top of ball at waterline to bottom of tube.
10/14/02: Solution dark yellow around top of ball at waterline. Black film and large/medium bubbles on bottom of ball. Black film on sides of tube from bottom of ball to bottom of tube and in bottom of tube.	10/14/02: Same as above.
10/15/02: Dark yellow ring around top of ball at waterline with medium bubbles and thick black film on one side. Thick black film on bottom of ball, sides and bottom of tube.	10/15/02: Same as above, except black film appears thicker.
10/16/02: Same as above.	10/16/02: Same as above.
10/17/02: Same as above.	10/17/02: Same as above.

MW116
Sampled 10/9/02

IRB	SRB
10/10/02: Solution clear at bottom of ball graduating to light yellow at bottom of tube. A few small bubbles on bottom of ball and sides of tube.	10/10/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on bottom of ball and on sides of tube.
10/11/02: Solution light yellow throughout tube. Ring of medium bubbles around top of ball at waterline, small bubbles on bottom of ball and sides of tube.	10/11/02: Solution clear with slightly cloudy film in bottom of tube. Black flecks and small bubbles on bottom of ball. Small bubbles on sides of tube.
10/12/02: Solution medium yellow at bottom of ball graduating to dark yellow at bottom of tube. Ring of medium bubbles with black flecks around top of ball at waterline, small bubbles with black flecks on bottom of ball and sides of tube.	10/12/02: Same as above.
10/13/02: Ring of medium bubbles with black flecks around top of ball at waterline. Black film on bottom of ball with medium bubbles. Black film on sides and bottom of tube.	10/13/02: Same as above, except film on sides and bottom of ball more pronounced. Cloudy ring around top of ball at waterline.
10/14/02: Same as above, except black film on bottom of ball and sides and bottom of tube more pronounced.	10/14/02: Same as above.
10/15/02: Dark brown ring with black flecks around top of ball at waterline. Thick black film on sides and bottom of ball, on sides and bottom of tube.	10/15/02: Thin black film ring around top of ball at waterline. Thin black film on sides of ball. Thick black film on bottom of ball and in bottom of tube. Thin black film on sides of tube.
10/16/02: Same as above.	10/16/02: Same as above.
10/17/02: Black film ring around top of ball at waterline. Thick black film on bottom of ball, sides and bottom of tube.	10/17/02: Same as above, except black film thicker on sides of tube.

794 547

MW116 Duplicate
Sampled 10/9/02

IRB	SRB
10/10/02: Solution light yellow at bottom of ball graduating to light brown at bottom of tube. A few small bubbles on bottom of ball and sides of tube.	10/10/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on bottom of ball and on sides of tube.
10/11/02: Solution light brown at bottom of ball graduating to medium brown at bottom of tube. Ring of medium bubbles around top of ball at waterline. Medium bubbles on bottom of ball and sides of tube.	10/11/02: Solution clear with slightly cloudy film in bottom of tube. A few black flecks on bottom of ball. Small bubbles on bottom of ball and on sides of tube.
10/12/02: Solution medium brown at bottom of ball graduating to dark brown/black at bottom of tube. Medium yellow ring of medium bubbles with a few black flecks around top of ball at waterline. Medium bubbles with black flecks on bottom of ball and sides of tube.	10/12/02: Solution clear with slightly cloudy film in bottom of tube. Thin black film with black flecks on sides and bottom of ball. Small bubbles on sides of tube.
10/13/02: Black film on bottom of ball. Black film on sides and bottom of tube. Medium yellow ring with black flecks and medium bubbles around top of ball at waterline.	10/13/02: Same as above.
10/14/02: Same as above, except black film on sides and bottom of tube more pronounced.	10/14/02: Same as above.
10/15/02: Dark brown ring with black flecks around top of ball at waterline. Thick black film on bottom of ball. Thick black film on sides and bottom of tube.	10/15/02: Uneven black film with black flecks on sides and bottom of ball – thicker on some areas than on others. Thick black film in bottom of tube and very thin black film on sides of tube. Small bubbles on sides of tube just above bottom of tube.
10/16/02: Same as above.	10/16/02: Same as above.
10/17/02: Thick black film ring around top of ball at waterline. Thick black film on bottom of ball, sides and bottom of tube.	10/17/02: Thin black film ring around top of ball at waterline. Black film with black flecks on sides and bottom of ball – thicker on some areas than on others. Thick black film on sides and bottom of tube.

MW113
Sampled 10/9/02

IRB	SRB
10/10/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. No bubbles.	10/10/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on bottom of ball and on sides of tube.
10/11/02: Solution light yellow at bottom of ball graduating to light brown at bottom of tube. Ring of large bubbles around top of ball at waterline and a few large bubbles on bottom of ball. A few medium bubbles on one side of tube at bottom.	10/11/02: Solution clear with slightly cloudy film in bottom of tube. A few black flecks on one side of ball. Small bubbles on bottom of ball and on sides of tube.
10/12/02: Solution dark yellow at bottom of ball graduating to dark brown/black at bottom of tube. Medium yellow ring of medium bubbles with black flecks around top of ball at waterline. Large bubbles with black flecks on bottom of ball. Black film developing on sides and bottom of tube.	10/12/02: Solution clear with slightly cloudy film in bottom of tube. Thin black film with black flecks on side and bottom of ball. Small bubbles on sides of tube.
10/13/02: Black film on sides and bottom of ball, sides and bottom of tube. Medium yellow ring of medium bubbles with black flecks around top of ball at waterline.	10/13/02: Same as above.
10/14/02: Same as above, except black film on bottom of ball, sides and bottom of tube more pronounced.	10/14/02: Same as above.
10/15/02: Brown ring with black flecks and small/medium bubbles around top of ball at waterline. Thick black film on bottom of ball, sides and bottom of tube.	10/15/02: Thin black film ring around top of ball at waterline. Thin black film on sides and bottom of ball and on sides of tube. Thick black film in bottom of tube.
10/16/02: Same as above.	10/16/02: Same as above.
10/17/02: Same as above, except more black flecks in brown ring around top of ball at waterline.	10/17/02: Same as above.

794 549

MW112
Sampled 10/9/02

IRB	SRB
10/10/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. No bubbles.	10/10/02: Solution slightly cloudy with slightly cloudy film in bottom of tube. Small bubbles on bottom of ball and on sides of tube.
10/11/02: Same as above.	10/11/02: Same as above.
10/12/02: Solution medium yellow at bottom of ball graduating to dark yellow then medium brown at bottom of tube. Ring of small bubbles around top of ball at waterline. Small bubbles on sides of tube.	10/12/02: Thin black film with black flecks developing on sides and bottom of ball and sides and bottom of tube.
10/13/02: Solution dark yellow at bottom of ball graduating to dark brown/black at bottom of tube. Medium yellow ring of medium bubbles with black flecks around top of ball at waterline. Large bubbles with black flecks on bottom of ball. Black film developing on sides and bottom of tube.	10/13/02: Same as above, except black film on sides and bottom of ball and sides and bottom of tube more pronounced.
10/14/02: Black film on bottom of ball and sides of tube from bottom of ball to bottom of tube. Dark yellow ring with black flecks around top of ball at waterline.	10/14/02: Thin black film with black flecks around top of ball at waterline, sides and bottom of ball. Thin black film on sides of tube. Thick black film in bottom of tube.
10/15/02: Thin dark brown ring with black flecks around top of ball at waterline. Thick black film on bottom of ball, sides and bottom of tube.	10/15/02: Same as above.
10/16/02: Same as above.	10/16/02: Same as above, except film on sides of tube has become thicker.
10/17/02: Black film ring around top of ball at waterline. Thick black film on bottom of ball, sides and bottom of tube.	10/17/02: Same as above.

MW122
Sampled 10/9/02

IRB	SRB
10/10/02: Solution clear at bottom of ball graduating to light yellow at bottom of tube. A few small bubbles on bottom of ball. Many small bubbles on sides of tube.	10/10/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on bottom of ball and on sides of tube.
10/11/02: Solution medium yellow throughout tube. Ring of medium bubbles around top of ball at waterline. Small bubbles on bottom of ball. Many small bubbles on sides of tube.	10/11/02: Solution clear with slightly cloudy film in bottom of tube. A few small black flecks on one side of ball. Small bubbles on bottom of ball and on sides of tube.
10/12/02: Solution dark brown throughout tube. Ring of medium bubbles edged in black film around top of ball at waterline. Large/medium bubbles with black flecks on bottom of ball. Bubbles with black flecks on sides and bottom of tube.	10/12/02: Solution clear with slightly cloudy film in bottom of tube. Thin black film with small black flecks on sides and bottom of ball. Small bubbles on bottom of ball and on sides of tube.
10/13/02: Black film on sides and bottom of ball and sides and bottom of tube. Dark yellow ring of small bubbles edged in black film around top of ball at waterline.	10/13/02: Same as above.
10/14/02: Same as above.	10/14/02: Same as above.
10/15/02: Brown ring with black flecks and small bubbles around top of ball at waterline. Thick black film on sides and bottom of ball, sides and bottom of tube.	10/15/02: Medium black film with black flecks on sides and bottom of ball. Black film in bottom of tube. Small bubbles on sides just above bottom of tube.
10/16/02: Same as above.	10/16/02: Same as above, except very black film on sides of tube.
10/17/02: Same as above, except more black film in bubble ring around top of ball at waterline.	10/17/02: Same as above, except film on sides of tube is thicker.

794 551

MW124
Sampled 10/9/02

IRB	SRB
10/10/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. A few small bubbles on bottom of ball. Many small bubbles on sides of tube.	10/10/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on bottom of ball and on sides of tube.
10/11/02: Solution medium yellow at bottom of ball graduating to medium brown at bottom of tube. Ring of medium bubbles around top of ball at waterline. Bottom of ball covered in medium bubbles. Medium bubbles on sides of tube.	10/11/02: Solution clear with slightly cloudy film in bottom of tube. Black flecks on bottom of ball. Small bubbles on bottom of ball and on sides of tube.
10/12/02: Solution dark yellow at bottom of ball graduating to dark brown/black at bottom of tube. Dark yellow ring of small bubbles around top of ball at waterline. Bottom of ball covered in medium bubbles with black flecks. Medium bubbles with black flecks on sides of tube.	10/12/02: Solution clear with slightly cloudy film in bottom of tube. Thin black film with black flecks on sides and bottom of ball. Small bubbles on bottom of ball and on sides of tube.
10/13/02: Black film with medium bubbles on sides and bottom of ball. Black film on sides and bottom of tube. Dark yellow ring with a few small bubbles around top of ball at waterline.	10/13/02: Same as above.
10/14/02: Same as above.	10/14/02: Same as above.
10/15/02: Same as above.	10/15/02: Medium black film on sides and bottom of ball. Black film in bottom of tube. Small bubbles on sides just above bottom of tube.
10/16/02: Same as above.	10/16/02: Same as above.
10/17/02: Thick black film around top of ball at waterline. Thick black film on bottom of ball, sides and bottom of tube.	10/17/02: Thick black film ring around top of ball at waterline. Medium black film with black flecks on side of ball. Thick black film on bottom of ball, sides and bottom of tube.

MW124
Sampled 10/9/02

IRB	SRB
10/10/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. A few small bubbles on bottom of ball. Many small bubbles on sides of tube.	10/10/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on bottom of ball and on sides of tube.
10/11/02: Solution medium yellow at bottom of ball graduating to medium brown at bottom of tube. Ring of medium bubbles around top of ball at waterline. Bottom of ball covered in medium bubbles. Medium bubbles on sides of tube.	10/11/02: Solution clear with slightly cloudy film in bottom of tube. Black flecks on bottom of ball. Small bubbles on bottom of ball and on sides of tube.
10/12/02: Solution dark yellow at bottom of ball graduating to dark brown/black at bottom of tube. Dark yellow ring of small bubbles around top of ball at waterline. Bottom of ball covered in medium bubbles with black flecks. Medium bubbles with black flecks on sides of tube.	10/12/02: Solution clear with slightly cloudy film in bottom of tube. Thin black film with black flecks on sides and bottom of ball. Small bubbles on bottom of ball and on sides of tube.
10/13/02: Black film with medium bubbles on sides and bottom of ball. Black film on sides and bottom of tube. Dark yellow ring with a few small bubbles around top of ball at waterline.	10/13/02: Same as above.
10/14/02: Same as above.	10/14/02: Same as above.
10/15/02: Same as above.	10/15/02: Medium black film on sides and bottom of ball. Black film in bottom of tube. Small bubbles on sides just above bottom of tube.
10/16/02: Same as above.	10/16/02: Same as above.
10/17/02: Thick black film around top of ball at waterline. Thick black film on bottom of ball, sides and bottom of tube.	10/17/02: Thick black film ring around top of ball at waterline. Medium black film with black flecks on side of ball. Thick black film on bottom of ball, sides and bottom of tube.

POST SAMPLING EVENT #5

MW124
Sampled 11/12/02

IRB	SRB
11/13/02: Solution clear at bottom of ball graduating to light yellow at bottom of tube. No bubbles.	11/13/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on bottom of ball and sides (middle) of tube.
11/14/02: Same as above. Very few bubbles on sides of tube.	11/14/02: Same as above.
11/15/02: Solution dark yellow at bottom of ball graduating to dark brown/black at bottom of tube. Dark yellow ring of small bubbles around top of ball at waterline. Bottom of ball covered in medium bubbles with patches of black film.	11/15/02: Solution clear with slightly cloudy film in bottom of tube. Few black flecks on bottom of ball.
11/16/02: Black film with large bubbles on bottom of ball. Black film on sides and bottom of tube. Dark yellow ring with a few small bubbles around top of ball at waterline.	11/16/02: Same as above except hint of black film mostly at waterline.
11/17/02: Thick black film on bottom of ball and sides and bottom of tube. Bubble ring around top of ball at waterline. Dark yellow ring on ball from middle to waterline.	11/17/02: Same as above.
11/18/02: Same as above. Dark yellow concentrated at ring of bubbles around top of ball at waterline.	11/18/02: Solution clear. Slightly cloudy film around top of ball at waterline and bottom of tube. Thin black film on ball from waterline down.
11/19/02: Same as above. Black flecks in ring of bubbles around top of ball at waterline.	11/19/02: Medium Black film on ball from waterline down. Black film on sides of tube at ball and at bottom of tube. Slightly cloudy film around top of ball at waterline.
11/20/02: Same as above.	11/20/02: Same as above except black film thicker.

MW 118
Sampled 11/12/02

IRB	SRB
11/13/02: Solution clear, light yellow throughout tube. No bubbles.	11/13/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on sides of tube from bottom of ball to bottom of tube. A few bubbles on bottom of ball.
11/14/02: Solution clear, light yellow throughout tube. Light yellow ring around top of ball at waterline. Few bubbles on bottom of ball.	11/14/02: Same as above.
11/15/02: Solution medium yellow throughout tube. Ring of medium yellow small bubbles around top of ball at waterline. Medium bubbles with black flecks on bottom of ball. Medium/small bubbles with black flecks on sides of tube to just above bottom of tube.	11/15/02: Solution clear with slightly cloudy film in bottom of tube. Few black flecks on bottom of ball. Small bubbles on bottom of ball and sides of tube.
11/16/02: Black film on bottom of ball and sides and bottom of tube. Bubble ring around top of ball at waterline. Dark yellow ring around ball from middle to waterline.	11/16/02: Same as above except thin black film on bottom and sides of ball.
11/17/02: Same as above.	11/17/02: Same as above.
11/18/02: Same as above except fewer bubbles around top of ball at waterline. Dark yellow ring around ball around middle up to waterline with brown flecks at waterline.	11/18/02: Black film on ball from waterline down. Black film on sides of tube at ball. Small bubbles on sides of tube.
11/19/02: Same as above except black flecks in bubbles around top of ball at waterline.	11/19/02: Medium black film on ball from waterline down. Medium black film on sides of tube from waterline to bottom of tube.
11/20/02: Same as above except solid black ring in bubbles around top of ball at waterline.	11/20/02: Same as above except black film thicker.

MW110
Sampled 11/12/02

IRB	SRB
11/13/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. No bubbles.	11/13/02: Solution clear with slightly cloudy film in bottom of tube. No bubbles.
11/14/02: Same as above.	11/14/02: Same as above.
11/15/02: Solution light brown at bottom of ball graduating to medium brown at bottom of tube. Ring of medium bubbles around top of ball at waterline and large/medium bubbles on bottom of ball.	11/15/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on ball and sides of tube.
11/16/02: Solution light brown at bottom of ball graduating to dark brown at bottom of tube. Medium yellow ring of medium bubbles around top of ball at waterline.	11/16/02: Solution clear. Black flecks on ball below waterline. Slightly cloudy film ring around top of ball at waterline. Small bubbles on sides of tube.
11/17/02: Same as above except black film in bottom of tube.	11/17/02: Same as above except black film in bottom of tube.
11/18/02: Solution medium brown under ball and dark brown/black at bottom of tube. Black film from bottom of tube up sides about 1". One small patch of black film on side of ball. Dark yellow ring of small bubbles around top of ball at waterline.	11/18/02: Small patches of very thin black film on ball with many black flecks. Black film in bottom of tube. Just a few bubbles on bottom of ball.
11/19/02: Same as above except solution dark brown under ball and more black flecks on ball.	11/19/02: Same as above.
11/20/02: Black film on sides and bottom of tube. Very thin black film with many black flecks on ball. Black film ring around top of ball at waterline.	11/20/02: Same as above.

MW110 Duplicate
Sampled 11/12/02

IRB	SRB
11/13/02: Solution clear at bottom of ball graduating to light yellow then dark yellow at bottom of tube. No bubbles.	11/13/02: Solution clear with slightly cloudy film in bottom of tube. No bubbles.
11/14/02: Same as above.	11/14/02: Same as above.
11/15/02: Solution light brown at bottom of ball graduating to medium brown at bottom of tube. Medium yellow ring of medium bubbles around top of ball at waterline. Medium bubbles on bottom of ball.	11/15/02: Same as above.
11/16/02: Same as above, except black flecks on ball and in bubble ring around top of ball.	11/16/02: Solution clear. Thin black film developing in bottom of tube. No black on ball.
11/17/02: Solution light brown at bottom of ball graduating to dark brown at bottom of tube. Black film in bottom of tube. Medium yellow ring of medium bubbles around top of ball at waterline. Ring of medium bubbles around bottom of ball.	11/17/02: Same as above.
11/18/02: Solution dark brown under ball and dark brown/black at bottom of tube. Black film from bottom of tube up sides about 1". Large bubbles on bottom of ball. Dark yellow ring of small bubbles around top of ball at waterline.	11/18/02: Solution clear throughout. Black film in center bottom of tube. Slightly cloudy ring around top of ball at waterline. A few bubbles on ball.
11/19/02: Same as above except black flecks on ball.	11/19/02: Same as above except a handful of black flecks on one side of ball.
11/20/02: Black film on sides and bottom of tube. Spots of black film on bottom of ball. Many black flecks on ball. Black film ring around top of ball at waterline.	11/20/02: Same as above.

MW114
Sampled 11/12/02

IRB	SRB
11/13/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. No bubbles.	11/13/02: Solution clear with slightly cloudy film in bottom of tube. No bubbles.
11/14/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. Few bubbles on bottom of ball.	11/14/02: Same as above.
11/15/02: Solution light brown throughout tube. Medium bubbles around top of ball at waterline and on bottom of ball. Black slime on bottom of ball, in bottom of tube and in small spots on sides of tube.	11/15/02: Solution clear with slightly cloudy film in bottom of tube. No bubbles. Thin black film with black flecks on bottom of ball.
11/16/02: Black film on bottom of ball, sides and bottom of tube. Large bubbles on bottom of ball. Ring of medium bubbles around top of ball at waterline.	11/16/02: Same as above except slightly cloudy film ring around top of ball at waterline and black film in bottom of tube.
11/17/02: Same as above.	11/17/02: Same as above except black film more developed on sides and bottom of ball.
11/18/02: Thick black film on ball and sides of tube from bottom of ball to bottom of tube. Dark yellow ring of small bubbles around top of ball at waterline. Large bubbles on bottom of ball.	11/18/02: Thin black film on sides and bottom of ball and sides and bottom of tube. No bubbles.
11/19/02: Same as above.	11/19/02: Thick black film on ball from waterline down and on sides and bottom of tube.
11/20/02: Same as above except one spot of black film in bubble ring around top of ball at waterline.	11/20/02: Same as above.

794 558

MW105
Sampled 11/13/02

IRB	SRB
11/14/02: Solution clear at ball graduating to light yellow then light brown at bottom of tube. No bubbles.	11/14/02: Solution slightly cloudy throughout. No bubbles.
11/15/02: Solution medium yellow at bottom of ball graduating to medium brown at bottom of tube. Large/medium bubbles around top of ball at waterline, on bottom of ball and sides of tube.	11/15/02: Same as above.
11/16/02: Solution light brown at bottom of ball graduating to dark brown/black at bottom of tube. Large/medium bubbles with black flecks on bottom of ball. Thin black film on sides of tube. Ring of medium yellow medium bubbles around top of ball at waterline.	11/16/02: Solution clear but discolored (light brown) with thin black film with flecks on bottom of ball, on sides of ball, on sides of tube and in bottom of tube. A few small bubbles on sides of tube.
11/17/02: Black film on bottom of ball, sides and bottom of tube. Medium yellow ring around top of ball at waterline with a few small bubbles.	11/17/02: Same as above except black film thicker on bottom of ball and in bottom of tube.
11/18/02: Same as above except black film thicker and higher up sides of ball. Fewer bubbles in dark yellow ring around top of ball at waterline.	11/18/02: Medium black film on ball and sides of tube from the waterline to bottom of tube. No bubbles.
11/19/02: Thick black film on ball and sides and bottom of tube. Spots of black film in bubble ring around top of ball at waterline.	11/19/02: Same as above except black film thicker.
11/20/02: Same as above.	11/20/02: Same as above.

MW116
Sampled 11/13/02:

IRB	SRB
11/14/02: Solution clear at ball graduating to light yellow at bottom of tube. Few small bubbles on bottom of ball and sides of tube.	11/14/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on bottom of ball and sides of tube.
11/15/02: Solution medium yellow throughout tube. Ring of medium bubbles around top of ball at waterline, small bubbles on bottom of ball and sides of tube.	11/15/02: Solution clear with slightly cloudy film in bottom of tube. Black flecks and small bubbles on bottom of ball. Small bubbles on sides of tube.
11/16/02: Solution light brown graduating to dark brown at bottom of tube. Ring of medium bubbles with black flecks around top of ball at waterline, small bubbles with black flecks on bottom of ball and sides of tube.	11/16/02: Same as above.
11/17/02: Black film on bottom of ball, sides and bottom of tube. Ring of bubbles around top of ball at waterline.	11/17/02: Black flecks on sides and bottom of ball. Small patches of very thin black film on bottom of ball. Many small bubbles on sides and bottom of tube.
11/18/02: Thick black film on ball and sides of tube from just below the waterline to bottom of tube. Wide band of medium bubbles in film on ball where film starts. Dark yellow ring of small bubbles around top of ball at waterline.	11/18/02: Small patches of thin black film and black flecks on sides and bottom of ball. No black film, but many small bubbles, on sides or bottom of tube.
11/19/02: Same as above except spots of black film in bubble ring around top of ball at waterline.	11/19/02: Thin black film with black flecks on ball. Many small bubbles on side of tube.
11/20/02: Thick black film on bottom and one side of ball. Thick black film on sides and bottom of tube. Dark yellow ring of small bubbles with spots of black film around top of ball at waterline.	11/20/02: Thin black film with black flecks on ball from waterline down. Thin black film ring around top of ball at waterline. Black film in bottom of tube. Small bubbles on sides of tube.
11/21/02: Same as above.	11/21/02: Same as above except film thicker.

794 560

MW116 Duplicate
Sampled 11/13/02

IRB	SRB
11/14/02: Solution clear at ball graduating to light yellow at bottom of tube. Few small bubbles on bottom of ball and sides of tube.	11/14/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on bottom of ball and sides of tube.
11/15/02: Solution light yellow throughout tube. Ring of medium bubbles around top of ball at waterline, small bubbles on bottom of ball and sides of tube.	11/15/02: Solution clear with slightly cloudy film in bottom of tube. Black flecks and small bubbles on bottom of ball. Small bubbles on sides of tube.
11/16/02: Solution medium yellow at bottom of ball graduating to dark yellow at bottom of tube. Light yellow ring of medium bubbles around top of ball at waterline. Small bubbles with black flecks on bottom of ball and sides of tube.	11/16/02: Solution clear with slightly cloudy film in bottom of tube. Very thin black film with black flecks on bottom of ball. Small bubbles on sides of tube.
11/17/02: Black film on bottom of ball with medium bubbles. Black film on sides and bottom of tube.	11/17/02: Same as above, except black film now on sides of ball and in bottom of tube. Black film on bottom of ball more pronounced. Slightly cloudy ring around top of ball at waterline.
11/18/02: Thick black film on ball and sides of tube from just under waterline to bottom of tube. Light yellow ring of small bubbles around top of ball at waterline. Wide band of medium bubbles in film on ball where film starts.	11/18/02: Medium black film on bottom of ball and on sides of tube at ball and in bottom of tube. Many small bubbles on sides of tube. Slightly cloudy film ring around top of ball at waterline.
11/19/02: Same as above except spots of black film in bubble ring around top of ball at waterline.	11/19/02: Same as above.
11/20/02: Thick black film on bottom of ball and sides and bottom of tube. Spots of black film in dark yellow bubble ring around top of ball at waterline.	11/20/02: Medium black film on bottom of ball and around top of ball at waterline. Medium black film on sides and bottom of tube. Many small bubbles on sides of tube.
11/21/02: Same as above.	11/21/02: Same as above except film thicker especially on sides of tube.

MW120
Sampled 11/13/02

IRB	SRB
11/14/02: Solution clear at ball graduating to light yellow at bottom of tube. Small bubbles on bottom of ball and sides of tube.	11/14/02: Solution clear with off-white/very light brown ring around top of ball at waterline and slightly cloudy film in bottom of tube. Small bubbles on bottom of ball and sides of tube.
11/15/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. Light yellow ring around top of ball at waterline. Small bubbles on sides of tube from bottom of ball to bottom of tube.	11/15/02: Same as above except small bubbles on sides of tube from bottom of ball to bottom of tube. A few bubbles on bottom of ball.
11/16/02: Solution light yellow throughout tube. Light yellow ring around top of ball at waterline. A few small bubbles on bottom of ball. No bubbles on sides of tube.	11/16/02: Solution clear with thin black ring around top of ball at waterline, thin black film on sides of ball and slightly cloudy film in bottom of tube. Small bubbles on sides of tube from bottom of ball to bottom of tube. A few bubbles on bottom of ball.
11/17/02: Same as above, except bubbles on bottom of ball are bigger.	11/17/02: Same as above.
11/18/02: Solution light yellow throughout tube. Medium yellow ring with a few bubbles around top of ball at waterline. Several medium bubbles on bottom of ball. Small bubbles on sides of tube.	11/18/02: Thin black film ring on sides and around top of ball at waterline. Thinner black film with black flecks on bottom of ball. No black film on sides or bottom of tube. Many small bubbles on sides of tube.
11/19/02: Same as above except more bubbles in ring around top of ball at waterline.	11/19/02: Black film on ball from waterline down. Small bubbles on sides of tube.
11/20/02: Black film on bottom of ball and sides and bottom of tube. Dark yellow ring of small bubbles with a few black flecks around top of ball at waterline.	11/20/02: Black film on ball from waterline down including ring around top of ball at waterline. Black film on sides of tube at ball. Small bubbles on sides of tube. No black film in bottom of tube.
11/21/02: Thin black film ring on top of dark yellow ring around top of ball at waterline. Thick black film on bottom of ball and sides and bottom of tube.	11/21/02: Black film on ball from waterline to bottom. Black film on sides and bottom of tube.

794 562

MW122
Sampled 11/13/02

IRB	SRB
11/14/02: Solution clear at ball graduating to light yellow at bottom of tube. Small bubbles on bottom of ball and sides of tube.	11/14/02: Solution clear with slightly cloudy film in bottom of tube. Small bubbles on bottom of ball and sides of tube.
11/15/02: Solution medium yellow throughout tube. Ring of medium bubbles around top of ball at waterline. Small bubbles on bottom of ball. Many small bubbles on sides of tube.	11/15/02: Solution clear with slightly cloudy film in bottom of tube. A few small black flecks on one side of ball. Small bubbles on bottom of ball and on sides of tube.
11/16/02: Solution dark brown throughout tube. Ring of medium bubbles edged in black film around top of ball at waterline. Large/medium bubbles with black flecks on bottom of ball. Bubbles with black flecks on sides and bottom of tube.	11/16/02: Solution clear with slightly cloudy film in bottom of tube. Thin black film with small black flecks on sides and bottom of ball. Small bubbles on bottom of ball and on sides of tube.
11/17/02: Black film on sides and bottom of ball and sides and bottom of tube. Medium yellow ring of small bubbles with small spots of black film around top of ball at waterline.	11/17/02: Same as above.
11/18/02: Black film on ball and tube from just under waterline to bottom of tube. Medium yellow ring of small bubbles with a black film patch around top of ball at waterline. Large bubbles in film on ball from where film starts.	11/18/02: Black film with black flecks on sides and bottom of ball. Black film in center bottom of tube. Many small bubbles on sides of tube.
11/19/02: Same as above except spots of black film in bubble ring around top of ball at waterline.	11/19/02: Thick black film on ball from waterline down and on sides and bottom of tube.
11/20/02: Thick black film on bottom of ball and sides and bottom of tube. Spots of black film in dark yellow small bubbles around top of ball at waterline.	11/20/02: Same as above except black film ring around top of ball at waterline.
11/21/02: Same as above except black film completely around top of ball at waterline.	11/21/02: Same as above.

MW113
Sampled 11/13/02

IRB	SRB
11/14/02: Solution clear at ball graduating to light yellow then light brown at bottom of tube. No bubbles.	11/14/02: Solution clear with slightly cloudy film in bottom of tube. No bubbles.
11/15/02: Solution light yellow at bottom of ball graduating to light brown at bottom of tube. Ring of large bubbles around top of ball at waterline and a few large bubbles on bottom of ball. A few medium bubbles on one side of tube at bottom.	11/15/02: Solution clear with slightly cloudy film in bottom of tube. A few black flecks on one side of ball. Small bubbles on bottom of ball and on sides of tube.
11/16/02: Solution light yellow at ball, dark yellow at bottom of ball graduating to dark brown/black at bottom of tube. Large bubbles with a few small black flecks on bottom of ball. Black film developing on sides and bottom of tube.	11/16/02: Same as above.
11/17/02: Same as above.	11/17/02: Same as above except small patch of thin black film developing on one side of ball.
11/18/02: Solution light yellow at ball, dark brown under ball graduating to dark brown/black at bottom of tube. Black film on bottom of tube and on sides of tube from the bottom up about 1". Ring of small bubbles around top of ball at waterline.	11/18/02: Solution clear. Small patch of thin black film with black flecks on side of ball. Slightly cloudy film in bottom of tube.
11/19/02: Thick black film on bottom of ball and on sides and bottom of tube. Solution dark yellow around top of ball. A few bubbles in ring around top of ball at waterline.	11/19/02: Same as above except very thin black film developing on bottom of ball and slightly cloudy film ring around top of ball at waterline.
11/20/02: Same as above except thin black film ring around top of ball at waterline.	11/20/02: Same as above.
11/21/02: Same as above except black film thicker around top of ball at waterline.	11/21/02: Very thin black film on sides and bottom of ball. Slightly cloudy film ring around top of ball at waterline.

MW112
Sampled 11/13/02

IRB	SRB
11/14/02: Solution clear at ball graduating to light yellow then light brown at bottom of tube. No bubbles.	11/14/02: Solution slightly cloudy throughout. No bubbles.
11/15/02: Solution light yellow at ball graduating to medium yellow then light brown at bottom of tube. Light yellow ring of small bubbles around top of ball at waterline. Small bubbles on sides of tube.	11/15/02: Solution slightly cloudy throughout tube. Small black flecks on sides and bottom of ball.
11/16/02: Solution medium yellow at bottom of ball graduating to dark yellow then medium brown at bottom of tube. Ring of small bubbles around top of ball at waterline. Small bubbles on sides of tube.	11/16/02: Thin black film with black flecks developing on sides and bottom of ball and sides and bottom of tube.
11/17/02: Solution dark yellow at bottom of ball graduating to dark brown/black at bottom of tube. Medium yellow ring of medium bubbles with black flecks around top of ball at waterline. Large bubbles with black flecks on bottom of ball. Black film developing on sides and bottom of tube.	11/17/02: Same as above, except black film on sides and bottom of ball and sides and bottom of tube more pronounced.
11/18/02: Solution dark brown under ball to black at bottom of tube. Black film in small patches on sides and bottom of ball. Black film on bottom of tube and on sides of tube from bottom up about 1". Dark yellow ring of medium bubbles with black flecks around top of ball at waterline.	11/18/02: Medium black film on sides and bottom of ball and sides and bottom of tube. Cloudy film ring with black flecks around top of ball at waterline. No bubbles.
11/19/02: Same as above except film is thicker on ball and on sides and bottom of tube.	11/19/02: Same as above except black film thicker on ball and sides and bottom of tube.
11/20/02: Thick black film on sides and bottom of ball and spots in bubble ring around top of ball at waterline. Thick black film on sides and bottom of tube.	11/20/02: Same as above except black film ring around top of ball at waterline.
11/21/02: Same as above except black film ring thicker around top of ball at waterline.	11/21/02: Same as above.

POST SAMPLING EVENT #6

MW110
Sampled 12/17/02

IRB	SRB
12/18/02: Solution light yellow throughout tube. No bubbles.	12/18/02: Solution clear throughout tube. A few small bubbles on bottom of ball.
12/19/02: Solution light yellow throughout tube. Light yellow ring of small bubbles around top of ball at waterline. Several medium bubbles on bottom of ball. A few medium bubbles on sides of tube.	12/19/02: Solution clear throughout tube. A few small bubbles on bottom of ball and on sides of tube.
12/20/02: Solution dark yellow at ball graduating to medium yellow at bottom of tube. Wide ring of small/medium bubbles on side of ball from top of waterline to start of ball bottom (80% of ball covered in bubbles, no bubbles on either end of ball).	12/20/02: Same as above.
12/21/02: Same as above.	12/21/02: Same as above.
12/22/02: Solution dark yellow/light brown. Medium yellow ring of small bubbles around top of ball at waterline.	12/22/02: Slightly cloudy film ring around top of ball at waterline.
12/23/02: Solution medium brown. Hint of black film on bottom of ball. Dark yellow ring of bubbles around top of ball at waterline.	12/23/02: Hint of black film bottom of ball. Thin black film bottom of tube.
12/24/02: Solution medium brown. Black film bottom of ball thicker. Black flecks on sides of tube at ball.	12/24/02: Thin black film with flecks on bottom of ball. Cr around top of ball at waterline. Black film on bottom of tube thicker.
12/25/02: Black film covers 98% of tube and ball. Ring of small bubbles around top of ball at waterline.	12/25/02: Same as above. except black film on bottom of tube even thicker.

794 566

MW 110D
Sampled 12/17/02

IRB	SRB
12/18/02: Solution clear at ball graduating to light yellow at middle of tube. No bubbles.	12/18/02: Solution clear throughout tube. A few small bubbles bottom of ball.
12/19/02: Solution clear at ball graduating to light yellow at middle of tube. Light yellow ring of small bubbles around top of ball at waterline. A few medium bubbles on bottom of ball and on sides of tube.	12/19/02: Solution clear throughout tube. A few medium bubbles bottom of ball and on sides of tube.
12/20/02: Solution dark yellow at ball graduating to medium yellow at bottom of tube. 80% of ball covered in wide ring of small/medium bubbles, no bubbles on either end of ball.	12/20/02: Same as above.
12/21/02: Same as above.	12/21/02: Solution clear. Several large bubbles on bottom of ball. Ring of small bubbles around top of ball at waterline. One patch of black flecks on ball.
12/22/02: Solution dark yellow/light brown. Medium yellow ring around top of ball at waterline. Black film on bottom of tube.	12/22/02: Thin black film with black flecks on ball. Slightly cloudy film ring around top of ball at waterline. Black film bottom of tube.
12/23/02: Solution light brown. Black film on bottom of tube thicker. Thin black film on bottom of ball and sides of tube. Dark yellow ring small bubbles around top of ball at waterline.	12/23/02: Same as above.
12/24/02: Thick black film on bottom of ball, sides and bottom of tube. Dark yellow ring small bubbles around top of ball at waterline.	12/24/02: Same as above. Black film on bottom of tube thicker.
12/25/02: Black film on 95% of tube and ball. Thin ring of small bubbles around top of ball at waterline.	12/25/02: Medium black film in center bottom of tube and sides of tube at bottom. Thin black film with black flecks on ball.

MW114
Sampled 12/17/02

IRB	SRB
12/18/02: Solution clear at bottom of ball graduating to light yellow at bottom of tube. No bubbles.	12/18/02: Solution clear throughout tube. No bubbles.
12/19/02: Solution clear at bottom of ball graduating to light yellow at middle of tube. Very light yellow ring of medium bubbles around top of ball at waterline. A few medium bubbles on bottom of ball and on sides of tube at bottom.	12/19/02: Solution clear throughout tube. Very thin black film with black flecks on bottom of ball. A few black flecks on sides and bottom of tube.
12/20/02: Solution dark yellow/light brown throughout. Ring of small/medium bubbles around top of ball at waterline. Several large bubbles on bottom of ball. No bubbles on sides of tube.	12/20/02: Same as above, except black film on ball and tube a bit thicker. Still thin, but thicker than yesterday.
12/21/02: Solution dark yellow/light brown throughout. Black film on sides at middle and in bottom of tube. Yellow ring of small/medium bubbles around top of ball at waterline. Several large bubbles on bottom of ball.	12/21/02: Thick black film in bottom of tube. Black film on bottom of ball. Thin black film in patches on sides of tube.
12/22/02: Black film on bottom of ball. Dark yellow ring rimmed with black film around top of ball at waterline. Black film on sides and bottom of tube.	12/22/02: Black film on bottom of ball, sides and bottom of tube thicker than yesterday. Slightly cloudy film ring rimmed with black film around top of ball at waterline.
12/23/02: Black film on ball thicker. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/23/02: Same as above, except film thicker on bottom of ball, sides and bottom of tube but not in ring around top of ball at waterline.
12/24/02: Thick black film on bottom of ball, sides and bottom of tube. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/24/02: Same as above.
12/25/02: Thick black film on bottom of ball, sides and bottom of tube. Medium brown film with black flecks around top of ball at waterline.	12/25/02: Same as above.

794 568

MW116
Sampled 12/17/02

IRB	SRB
12/18/02: Solution clear at ball graduating to light yellow at bottom of tube. A few small bubbles on ball and on sides of tube.	12/18/02: Solution clear throughout tube. A few small bubbles on bottom of ball and sides of tube.
12/19/02: Solution clear at ball graduating to light yellow then medium yellow at bottom of tube. Very light yellow ring of small bubbles around top of ball at waterline. Many small bubbles on bottom of ball and sides of tube.	12/19/02: Solution clear throughout tube. Many small bubbles on bottom of ball and sides of tube.
12/20/02: Solution dark yellow/light brown throughout. Ring of small/medium bubbles around top of ball at waterline. Several large bubbles on bottom of ball. A few medium bubbles on sides of tube.	12/20/02: Same as above.
12/21/02: Black film on bottom of ball, sides and bottom of tube. Yellow ring or small/medium bubbles around top of ball at waterline. 60% of ball covered in small bubbles. Several small bubbles on sides of tube.	12/21/02: Same as above.
12/22/02: Black film on bottom of ball, sides and bottom of tube. Dark yellow ring rimmed with black film around top of ball at waterline.	12/22/02: Solution clear. Fewer small bubbles on sides of tube. Slightly cloudy film ring around top of ball at waterline.
12/23/02: Black film on ball thicker. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/23/02: Hint of black film on bottom of tube. Slightly cloudy film ring around top of ball at waterline.
12/24/02: Thick black film on bottom of ball, sides and bottom of tube. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/24/02: black film thicker on bottom of tube. Hint of black film on bottom of ball.
12/25/02: Thick black film on bottom of ball, sides and bottom of tube. Medium brown ring of medium bubbles rimmed with black flecks around top of ball at waterline. Black film on one side of ball.	12/25/02: Cloudy ring around top of ball at waterline. Hint of black film with black flecks on bottom of ball. Thick black film in bottom of tube.

MW116D
Sampled 12/17/02

IRB	SRB
12/18/02: Solution clear at bottom of ball graduating to light yellow at middle of tube. A few small bubbles sides of tube.	12/18/02: Solution clear throughout tube. Many small bubbles on bottom of ball and sides of tube.
12/19/02: Solution clear at bottom of ball graduating to light yellow then light brown at bottom of tube. Ring of small bubbles around top of ball at waterline. Many small bubbles on bottom of ball and sides of tube.	12/19/02: Solution clear throughout tube. Many small bubbles on bottom of ball. Lots of small bubbles on sides of tube.
12/20/02: Solution light brown at ball graduating to medium yellow at bottom of tube. 70% of ball covered in wide ring of small, medium and large bubbles, no bubbles on either end of ball. Several small bubbles on sides of tube.	12/20/02: Same as above.
12/21/02: Same as above, except black film on sides at middle of tube.	12/21/02: Same as above.
12/22/02: Black film on bottom of ball, sides and bottom of tube. Dark yellow ring of small bubbles rimmed with black film around top of ball at waterline.	12/22/02: Hint of black film on bottom of ball.
12/23/02: Black film on ball thicker. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/23/02: Same as above.
12/24/02: Thick black film on bottom of ball, sides and bottom of tube. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/24/02: Same as above. Hint of black film on bottom of tube. Black film on bottom of ball thicker in one patch.
12/25/02: Thick black film on bottom of ball, sides and bottom of tube. Medium brown ring of medium bubbles rimmed with black flecks around top of ball at waterline. Black film on one side of ball.	12/25/02: Slightly cloudy film ring with black flecks around top of ball at waterline. Thin black film on one sob. Thick black film in bottom of tube. Many small bubbles on sides of tube.

794 570

MW118
Sampled 12/17/02

IRB	SRB
12/18/02: Solution clear at ball graduating to light yellow at middle of tube. A few small bubbles on bottom of ball.	12/18/02: Solution slightly cloudy throughout. A few small bubbles on sides of tube.
12/19/02: Solution clear at ball graduating to light yellow then light brown at bottom of tube. Many small bubbles on bottom of ball. A few medium bubbles on sides of tube.	12/19/02: Solution slightly cloudy throughout. A few small bubbles on bottom of ball. Many small bubbles on sides of tube.
12/20/02: Solution medium yellow throughout tube. Ring of medium bubbles around top of ball at waterline. Many large bubbles on bottom of ball. A few medium bubbles on sides of tube.	12/20/02: Solution same as above. Thin black film on sides and bottom of ball.
12/21/02: Same as above.	12/21/02: Same as above, except black film thicker on ball. Thin black film on sides of tube at ball.
12/22/02: Solution medium yellow. A few medium bubbles around top of ball at waterline. No bubbles on sides of tube.	12/22/02: Black film thicker on ball, bottom of tube.
12/23/02: Black film on ball thicker. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/23/02: Black film even thicker than yesterday.
12/24/02: Thick black film on bottom of ball, sides and bottom of tube. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/24/02: Thick black film on bottom of ball, sides and bottom of tube.
12/25/02: Thick black film on bottom of ball, sides and bottom of tube. Medium brown film with black flecks around top of ball at waterline. Thick dark brown rimmed in black film around top of ball at waterline.	12/25/02: Slightly cloudy film ring with black flecks around top of ball at waterline. Medium black film on bottom of ball, sides and bottom of tube.

MW120
Sampled 12/17/02:

IRB	SRB
12/18/02: Solution light yellow throughout tube. A few small bubbles on bottom of ball. Many small bubbles on sides of tube.	12/18/02: Solution slightly cloudy throughout tube. A few small bubbles on bottom of ball. Many small bubbles on sides of tube.
12/19/02: Solution light yellow throughout tube. Light yellow ring of small bubbles around top of ball at waterline. Many small bubbles on bottom of ball and sides of tube.	12/19/02: Same as above.
12/20/02: Solution medium yellow throughout. Light yellow ring, but no bubbles, around top of ball at waterline. Several medium bubbles on bottom of ball. Many small bubbles on sides of tube.	12/20/02: Solution slightly cloudy. Thin black film in patches on sides and bottom of ball.
12/21/02: Solution medium yellow throughout. Light yellow ring of small bubbles around top of ball at waterline. Several medium bubbles on bottom of ball. Many small bubbles on sides of tube.	12/21/02: Medium black film with black flecks on sides of ball. Thin black film on sides of tube at ball. Many small bubbles on sides of tube.
12/22/02: Same as above.	12/22/02: Same as above, except black film thicker.
12/23/02: Same as above, except thin black film on bottom of tube. No bubbles on sides of tube.	12/23/02: Same as above.
12/24/02: Solution light brown. Thick black film on bottom of tube. Dark yellow ring of small bubbles around top of ball at waterline.	12/24/02: Same as above, except black film thicker on bottom of ball, sides of tube at bottom.
12/25/02: Black film covers 98% of tube and ball. Ring of small bubbles around top of ball at waterline.	12/25/02: Thick black film side and bottom of ball, and bottom of tube. Many small bubbles on sides of tube.

794 572

MW124
Sampled 12/17/02

IRB	SRB
12/18/02: Solution clear at ball graduating to light yellow at bottom of tube. A few small bubbles on bottom of ball. Many small bubbles on sides of tube.	12/18/02: Solution clear throughout tube. A few small bubbles on bottom of ball. Many small bubbles on sides of tube.
12/19/02: Solution clear at ball graduating to medium yellow at middle of tube. Many small bubbles on bottom of ball. Many medium bubbles on sides of tube.	12/19/02: Solution clear throughout tube. Many small bubbles on bottom of ball and sides of tube.
12/20/02: Solution medium yellow throughout. Ring of med bubbles around top of ball at waterline. Several medium bubbles on bottom of ball. Several medium bubbles on sides of tube.	12/20/02: Solution same as above. Fewer bubbles on bottom of ball. Many small bubbles on sides of tube.
12/21/02: Solution medium yellow throughout. 80% of ball covered in medium bubbles. Several small bubbles on sides of tube. Hint of black film in bottom of tube.	12/21/02: One patch of very thin black film with black flecks on side of ball. A few small bubbles on bottom of ball. Many small bubbles on sides of tube.
12/22/02: Black film thicker in bottom of tube. Thin black film on sides of tube.	12/22/02: Patch thicker. Fewer bubbles on bottom of ball and sides of tube.
12/23/02: Black film on ball thicker. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/23/02: Same as above. Hint of black film around top of ball at waterline.
12/24/02: Thick black film on bottom of ball, sides and bottom of tube. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/24/02: Same as above. Black film thicker in bottom of tube.
12/25/02: Thick black film on bottom of ball, sides and bottom of tube. Medium brown film with black flecks around top of ball at waterline.	12/25/02: Slightly cloudy film ring with black flecks around top of ball at waterline. Thin black film on sob. Thick black film on bottom of ball, sides and bottom of tube.

MW105
Sampled 12/18/02

IRB	SRB
12/19/02: Solution clear at ball graduating to light yellow at middle of tube. No bubbles.	12/19/02: Solution slightly cloudy throughout. No bubbles.
12/20/02: Solution clear at ball graduating to medium yellow then light brown at bottom of tube. A few small bubbles on bottom of ball.	12/20/02: Same as above.
12/21/02: Solution light yellow throughout. Ring of medium bubbles around top of ball at waterline. Several med bubbles on sides of tube.	12/21/02: Same as above.
12/22/02: Black film on bottom of tube. Solution dark yellow/light brown. Medium yellow ring of bubbles around top of ball at waterline.	12/22/02: Black film on sides of tube at bottom. Hint of black film with black flecks on bottom of tube.
12/23/02: Black film on ball thicker. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/23/02: Thin black film on sides and bottom of ball, sides and bottom of tube.
12/24/02: Thick black film on bottom of ball, sides and bottom of tube. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/24/02: Same as above. Black film thicker on sides and bottom of tube.
12/25/02: Thick black film on bottom of ball, sides and bottom of tube. Medium brown film with black flecks around top of ball at waterline.	12/25/02: Slightly cloudy film ring with black flecks around top of ball at waterline. Medium black film on sides and bottom of ball, sides and bottom of tube.
12/26/02: Thick black film on bottom of ball, sides and bottom of tube. Black flecks in small bubbles around top of ball at waterline.	12/25/02: Same as above.

794 574

MW112
Sampled 12/18/02

IRB	SRB
12/19/02: Solution clear at ball graduating to light yellow at middle of tube. No bubbles.	12/19/02: Solution clear throughout. No bubbles.
12/20/02: Solution medium yellow throughout. No bubbles.	12/20/02: Same as above.
12/21/02: Solution medium yellow throughout. Ring of small bubbles around top of ball at waterline. A few med bubbles on sides of tube.	12/21/02: Thin black film around ball just below waterline.
12/22/02: Black film in bottom of tube. Solution dark yellow at ball. Dark yellow ring of medium bubbles around top of ball at waterline.	12/22/02: Black film ring around top of ball at waterline. No bubbles. Solution slightly cloudy.
12/23/02: Black film on ball thicker. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/23/02: Thin black film on sides and bottom of ball, sides and bottom of tube.
12/24/02: Thick black film on bottom of ball, sides and bottom of tube. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/24/02: Same as above. Black film thicker on sides and bottom of tube.
12/25/02: Thick black film on bottom of ball, sides and bottom of tube. Medium brown film of small bubbles with black flecks around top of ball at waterline.	12/25/02: Slightly cloudy film ring around top of ball at waterline. Patch of medium black flecks in thin film on bottom of ball. Thin black film on sides of tube graduating to thick black film in bottom of tube.
12/26/02: Thick black film on bottom of ball, sides and bottom of tube. Black flecks in light brown ring of small bubbles around top of ball at waterline.	12/26/02: Same as above.

MW113
Sampled 12/18/02

IRB	SRB
12/19/02: Solution clear at ball graduating to light yellow at bottom of tube. No bubbles.	12/19/02: Solution clear throughout. No bubbles.
12/20/02: Same as above.	12/20/02: Same as above.
12/21/02: Solution light yellow throughout. Ring of small bubbles around top of ball at waterline.	12/21/02: Same as above.
12/22/02: Same as above.	12/22/02: Slightly cloudy film ring around top of ball at waterline.
12/23/02: Solution dark yellow/light brown with hint of black film in bottom of tube. Dark yellow ring of medium bubbles around top of ball at waterline.	12/23/02: Same as above.
12/24/02: Same as above. Black film thicker in bottom of tube.	12/24/02: Same as above.
12/25/02: Dark yellow ring rimmed with thin black film and a few bubbles around top of ball at waterline. Medium black film on bottom of ball and sides of tube. Thick black film in bottom of tube.	12/25/02: Slightly cloudy film ring around top of ball at waterline. Black film in very center bottom of tube and around sides of tube at bottom. Black film doesn't completely cover bottom of tube.
12/26/02: Same as above, except fewer bubbles in ring around top of ball at waterline.	12/26/02: Same as above, except bottom of tube covered with black film.

794 576

MW122
Sampled 12/18/02

IRB	SRB
12/19/02: Solution clear at ball graduating to light yellow then light brown at bottom of tube. Many small bubbles on sides of tube.	12/19/02: Solution slightly cloudy throughout. Many small bubbles on bottom of ball and sides of tube.
12/20/02: Same as above, except many small bubbles on bottom of ball.	12/20/02: Same as above.
12/21/02: Solution light yellow throughout. Ring of small bubbles around top of ball at waterline. Several small bubbles on bottom of ball. Many small bubbles on sides of tube.	12/21/02: Bottom of ball covered in thin black film with black flecks. A few small bubbles on bottom of ball. Many small bubbles on sides of tube
12/22/02: Solution dark yellow at ball graduating to light brown at bottom of tube. Ring of small bubbles around top of ball at waterline.	12/22/02: Black film thicker on ball.
12/23/02: Black film on ball thicker. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	12/23/02: Same as above. Thin black film on sides of tube at ball and in bottom of tube.
12/24/02: Thick black film on bottom of ball, sides and bottom of tube. Dark yellow/light brown ring rimmed with black flecks around top of ball at waterline.	12/24/02: Same as above. Black film thicker on sides and bottom of tube.
12/25/02: Thick black film on bottom of ball, sides and bottom of tube. Medium brown film with black flecks and small bubbles around top of ball at waterline.	12/25/02: Slightly cloudy film ring with black flecks around top of ball at waterline. Patches of thick black film on sides and bottom of ball. Medium black film on sides of tube at ball graduating to thick black film at bottom of tube.
12/26/02: Same as above.	12/26/02: Same as above.

POST SAMPLING EVENT #7

MW110
Sampled 1/21/03

IRB	SRB
1/22/03: Solution clear at ball graduating to light yellow at middle to bottom of tube. No bubbles.	1/22/03: Solution clear throughout tube. No bubbles.
1/23/03: Same as above.	1/23/03: Same as above.
1/24/03: Same as above, a few bubbles around top of ball at waterline.	1/24/03: Same as above.
1/25/03: Solution cloudy medium yellow with hint of brown. Ring of small bubbles around top of ball at waterline. No bubbles on sides of tube.	1/25/03: Same as above.
1/26/03: Same as above, except more bubbles around top of ball at waterline.	1/26/03: Solution cloudy. Cloudy film ring around top of ball at waterline. Several medium bubbles on ball and sides of tube.
1/27/03: Solution dark yellow/light brown. Dark yellow ring of small bubbles around top of ball at waterline. One very small line of black film in the bottom of tube.	1/27/03: Black film in bottom of tube. Black flecks and patches of very thin black film on ball. Very few bubbles on ball/tube. Cloudy film ring around top of ball at waterline.
1/28/03: Black film on bottom of ball, sides and bottom of tube. Light brown ring of small bubbles with black flecks around top of ball at waterline.	1/28/03: Same as above. Film thicker in bottom of tube.
1/29/03: Same as above, except film thicker.	1/29/03: Same as above.

794 578

MW 110D
Sampled 1/21/03

IRB	SRB
1/22/03: Solution clear at ball graduating to light yellow at middle to bottom of tube. No bubbles.	1/22/03: Solution clear throughout tube. No bubbles.
1/23/03: Same as above.	1/23/03: Same as above.
1/24/03: Same as above.	1/24/03: Solution clear at ball, slightly cloudy at bottom of tube.
1/25/03: Same as above, except solution is medium yellow at bottom of tube and there are a few bubbles on the ball.	1/25/03: Same as above. No bubbles.
1/26/03: Same as above.	1/26/03: Solution slightly cloudy throughout tube. Cloudy film ring around top of ball at waterline.
1/27/03: Solution medium yellow throughout. Many medium bubbles on ball.	1/27/03: Black film in bottom of tube. Black flecks and one small patch of very thin black film on ball. Few bubbles on ball/tube.
1/28/03: Same as above.	1/28/03: Same as above. Black film on bottom of tube thicker.
1/29/03: Same as above.	1/29/03: Same as above.

MW114
Sampled 1/21/03

IRB	SRB
1/22/03: Solution clear at bottom of ball graduating to light yellow at middle of tube then dark greenish yellow at bottom of tube. No bubbles.	1/22/03: Solution clear throughout tube. No bubbles.
1/23/03: Same as above.	1/23/03: Solution clear at ball, but slightly cloudy at bottom of tube. Three bubbles on bottom of ball.
1/24/03: Same as above.	1/24/03: Same as above, except only one bubble on bottom of ball.
1/25/03: Same as above.	1/25/03: Thin black film with thicker patches and black flecks on sides and bottom of ball. Slightly cloudy film ring around top of ball at waterline. Solution slightly cloudy at bottom of tube.
1/26/03: Solution medium yellow at ball graduating to dark greenish yellow at bottom of tube. Several small bubbles on ball.	1/26/03: Black film on bottom of ball thicker than yesterday. Band of thin black film on side of tube at ball just under waterline. Cloudy film ring around top of ball at waterline.
1/27/03: Solution medium yellow throughout. Many medium bubbles on ball.	1/27/03: Thick black film in bottom of tube. Black film on ball and sides of tube. Black film ring around top of ball at waterline. A few medium bubbles on ball.
1/28/03: Same as above.	1/28/03: Same as above, except black film thicker on sides of tube.
1/29/03: Same as above.	1/29/03: Same as above.

794 580

MW118
Sampled 1/21/03

IRB	SRB
1/22/03: Solution clear light yellow throughout tube. No bubbles.	1/22/03: Solution slightly cloudy throughout. A few small bubbles on sides of ball.
1/23/03: Solution slightly cloudy light yellow throughout tube. No bubbles.	1/23/03: Same as above.
1/24/03: Solution cloudy medium yellow throughout tube. Ring of medium bubbles around top of ball at waterline.	1/24/03: Solution and bubbles same as above. Cloudy film ring around top of ball at waterline.
1/25/03: Same as above.	1/25/03: Solution slightly cloudy. Black film ring around top of ball at and just below waterline. Cloudy film ring around top of ball at waterline (above the black film).
1/26/03: Same as above, except several small bubbles on bottom of ball.	1/26/03: Same as above, except black film thicker on ball.
1/27/03: Same as above, except fewer bubbles on bottom of ball.	1/27/03: Black film in bottom of tube. Thin black film on sides of tube. Black film thicker on ball. Black film ring around top of ball at waterline.
1/28/03: Thick black film in bottom of tube. Solution cloudy dark yellow. Ring of small bubbles around top of ball at waterline.	1/28/03: Black film thicker in bottom and on sides of tube.
1/29/03: Same as above.	1/29/03: Same as above. Black film on ball thicker.

MW122
Sampled 1/21/03

IRB	SRB
1/22/03: Solution light yellow throughout most of tube with medium greenish yellow at bottom of tube. A few small bubbles on sides of tube.	1/22/03: Solution clear at ball, but slightly cloudy at bottom of tube. A few small bubbles on bottom of ball and sides of tube.
1/23/03: Same as above.	1/23/03: Same as above, except bubbles bigger.
1/24/03: Solution medium greenish yellow throughout tube. About 5 small bubbles on ball.	1/24/03: Solution slightly cloudy throughout tube. Sides and bottom of ball covered in thin black film with thicker spots and black flecks. A few small bubbles on bottom of ball. Slightly cloudy ring around top of ball at waterline. Several small bubbles on sides of tube.
1/25/03: Same as above.	1/25/03: Same as above, except black film thicker on ball.
1/26/03: Solution medium greenish yellow throughout tube. Several small/medium bubbles on ball.	1/26/03: Same as above, except black film thicker on ball and band of thin black film on sides of tube just under waterline around ball.
1/27/03: Solution medium yellow throughout. A few small bubbles on ball/tube.	1/27/03: Black film in bottom of tube. Black film on ball below waterline. Thin black film on sides of tube. Few bubbles on ball/tube.
1/28/03: Same as above.	1/28/03: Same as above. Black film thicker on sides and bottom of tube.
1/29/03: Same as above.	1/29/03: Same as above. Black film thicker on ball.

794 582

MW124
Sampled 1/21/03

IRB	SRB
1/22/03: Solution clear at ball graduating to light yellow at bottom of tube. A few small bubbles on sides of tube.	1/22/03: Solution clear throughout tube. A few small bubbles on bottom of ball and sides of tube.
1/23/03: Same as above, except bubbles bigger.	1/23/03: Same as above, except more bubbles.
1/24/03: Solution clear at ball graduating to medium greenish yellow at bottom of tube. A few very small bubbles on bottom of ball.	1/24/03: Solution slightly cloudy throughout tube. Many small black flecks on sides and bottom of ball. A few small bubbles on ball and sides of tube. Slightly cloudy film ring around top of ball at waterline.
1/25/03: Solution medium yellow throughout. Several small bubbles on ball and sides of tube.	1/25/03: Same as above.
1/26/03: Same as above, except more bubbles on ball.	1/26/03: Same as above, except spot of thin black film on side of tube just under waterline.
1/27/03: Solution medium yellow throughout. Many medium bubbles on ball.	1/27/03: Black film in bottom of tube. Black flecks and one small patch of very thin black film on ball. Few bubbles on ball/tube.
1/28/03: Same as above.	1/28/03: Same as above. Black film on ball and sides of tube thicker.
1/29/03: Same as above.	1/28/03: Same as above. Black film thicker in bottom of tube.

MW105
Sampled 1/22/03

IRB	SRB
1/23/03: Solution light yellow throughout tube. No bubbles.	1/23/03: Solution clear throughout. A few small bubbles on ball and sides of tube (less than 20).
1/24/03: Solution medium yellow throughout tube. No bubbles.	1/24/03: Solution slightly cloudy and off-white throughout tube. Several small bubbles on ball and sides of tube.
1/25/03: Same as above.	1/25/03: Same as above, except cloudy film ring around top of ball at waterline.
1/26/03: Same as above, except several small bubbles on ball.	1/26/03: Solution cloudy. Thin black film on bottom of tube. Patches of thin black film on ball. Cloudy film ring around top of ball at waterline.
1/27/03: Solution medium yellow throughout tube. Many small bubbles on ball.	1/27/03: Thin black film around top, on sides and bottom of ball and sides of tube. Thick black film in bottom of tube.
1/28/03: Same as above.	1/28/03: Same as above. Black film thicker on sides and bottom of tube.
1/29/03: Same as above.	1/29/03: Same as above, except film in bottom of tube thicker.
1/30/03: Same as above.	1/30/03: Same as above.

794 584

MW112
Sampled 1/22/03

IRB	SRB
1/23/03: Solution light yellow throughout tube. No bubbles.	1/23/03: Solution clear throughout. A few bubbles on ball and sides of tube (less than 20).
1/24/03: Solution medium yellow throughout tube. No bubbles.	1/24/03: Same as above.
1/25/03: Same as above.	1/25/03: Solution slightly cloudy and off-white. Less bubbles than yesterday. Cloudy film ring around top of ball at waterline.
1/26/03: Solution medium yellow throughout tube. Many small bubbles on bottom of ball. Medium yellow ring, no bubbles, around top of ball at waterline.	1/26/03: Same as above. A few bubbles on ball and sides of tube.
1/27/03: Solution medium yellow throughout tube. Yellow ring, but no bubbles, around top of ball at waterline. Many small bubbles on bottom of ball.	1/27/03: Same as above.
1/28/03: Same as above.	1/28/03: Thin black film over most of ball, on sides and in bottom of tube. Cloudy film ring around top of ball at waterline.
1/29/03: Same as above.	1/29/03: Same as above, except film thicker on ball, sides and bottom of tube.
1/30/03: Same as above.	1/30/03: Same as above.

MW113
Sampled 1/22/03

IRB	SRB
1/23/03: Solution light yellow throughout tube. No bubbles.	1/23/03: Solution clear throughout. A few small bubbles on ball and sides of tube (less than 20).
1/24/03: Solution medium yellow throughout tube. No bubbles.	1/24/03: Solution slightly cloudy throughout tube. Cloudy film ring around top of ball at waterline. Fewer bubbles than yesterday.
1/25/03: Same as above.	1/25/03: Same as above.
1/26/03: Solution medium yellow throughout tube. Many small bubbles on bottom of ball. Medium yellow ring, no bubbles, around top of ball at waterline.	1/26/03: Same as above. A few bubbles on ball and sides of tube.
1/27/03: Solution medium yellow throughout tube. Many small bubbles on ball.	1/27/03: Thin black film patch with black flecks on side of ball. Thin black film on sides of tube. Thick black film in bottom of tube. Few small bubbles on ball/tube.
1/28/03: Same as above.	1/28/03: Same as above.
1/29/03: Same as above.	1/29/03: Same as above, except film thicker on ball, sides and bottom of tube.
1/30/03: Same as above.	1/30/03: Same as above.

MW116
Sampled 1/22/03

IRB	SRB
1/23/03: Solution clear at ball graduating to light yellow at bottom of tube. A few small bubbles on ball and on sides of tube.	1/23/03: Solution clear throughout tube. A few small bubbles on ball and sides of tube.
1/24/03: Solution clear at ball graduating to medium yellow at bottom of tube. A few small bubbles on ball and sides of tube.	1/24/03: Solution slightly cloudy throughout tube. A few small bubbles on ball and sides of tube.
1/25/03: Solution medium yellow throughout. Ring of small/medium bubbles around top of ball at waterline. Several medium bubbles on sides and bottom of ball. Several medium bubbles on sides of tube.	1/25/03: Same as above.
1/26/03: Same as above, except more bubbles on ball and less bubbles on sides of tube.	1/26/03: Solution slightly cloudy throughout. Many medium bubbles on ball and sides of tube. One patch of thin black film with black flecks on ball.
1/27/03: Thick black film on bottom of ball, sides and bottom of tube. Dark yellow ring of medium bubbles around top of ball at waterline.	1/27/03: Same as above.
1/28/03: Black film thicker throughout. Dark yellow/light brown ring of small bubbles with black flecks around top of ball at waterline.	1/28/03: Hint of black film on bottom of ball and tube. Slightly cloudy film ring around top of ball at waterline.
1/29/03: Thick black film on bottom of ball, sides and bottom of tube. Dark yellow/light brown ring rimmed with black film around top of ball at waterline.	1/29/03: Black film thicker on ball and very thick in bottom of tube.
1/30/03: Thick black film on bottom of ball, sides and bottom of tube. Medium brown ring of medium bubbles rimmed with black flecks around top of ball at waterline. Black film on one side of ball.	1/30/03: Same as above.

MW116D
Sampled 1/22/03

IRB	SRB
1/23/03: Solution clear at bottom of ball graduating to light yellow at middle of tube. A few small bubbles sides of tube.	1/23/03: Solution clear throughout tube. Several small bubbles on ball and sides of tube.
1/24/03: Solution clear at bottom of ball graduating to medium yellow at bottom of tube. A few small bubbles on ball and sides of tube.	1/24/03: Solution slightly cloudy throughout tube. A few small bubbles on ball and sides of tube.
1/25/03: Solution medium yellow throughout. Ring of small/medium bubbles around top of ball at waterline. Several medium bubbles on sides and bottom of ball. Several medium bubbles on sides of tube.	1/25/03: Same as above, except cloudy film ring around top of ball at waterline.
1/26/03: Solution dark yellow throughout tube. 80% of ball covered in small/medium bubbles (mainly around ball above and below waterline).	1/26/03: Solution slightly cloudy throughout tube. Many small black flecks on ball. Cloudy film ring around top of ball at waterline. Several medium bubbles on ball and sides of tube.
1/27/03: Black film on bottom of ball, sides and bottom of tube. Dark yellow ring of small bubbles around top of ball at waterline.	1/27/03: Same as above. One small patch of thin black film with black flecks on side of ball just under waterline.
1/28/03: Black film thicker throughout. Light brown ring of small bubbles with black flecks around top of ball at waterline.	1/28/03: Hint of black film in bottom of tube. Black film thicker on ball.
1/29/03: Same as above.	1/28/03: Thick black film in bottom of tube. Thin black film on sides of tube. No change to film on ball.
1/30/03: Same as above.	1/29/03: Same as above.

794 588

MW120
Sampled 1/22/03

IRB	SRB
1/23/03: Solution light yellow throughout tube. Several small bubbles on ball and sides of tube.	1/23/03: Solution slightly cloudy throughout tube. Several small bubbles on ball and sides of tube. Small medium yellow spot on one side of ball just below waterline.
1/24/03: Solution medium yellow with hint of green throughout tube. A few very small bubbles on ball and sides of tube.	1/24/03: Solution slightly cloudy throughout, cloudier at bottom of tube. Hint of brown film ring around top of ball at waterline. Very few small bubbles on ball and sides of tube.
1/25/03: Solution medium yellow throughout. Light yellow ring, but no bubbles, around top of ball at waterline. Several medium bubbles on bottom of ball. A few small bubbles on sides of tube.	1/25/03: Same as above, except one spot of black film on one side of ball at waterline.
1/26/03: Same as above, except a few medium bubbles at yellow ring around top of ball at waterline.	1/26/03: Medium black film with black flecks around top of ball at waterline. Thin black film on sides of ball. A few small bubbles on ball and sides of tube.
1/27/03: Solution cloudy medium yellow throughout. Dark yellow ring of medium bubbles around top of ball at waterline.	1/27/03: Same as above, except black film thicker.
1/28/03: Same as above, except thin black film on bottom of tube. No bubbles on sides of tube.	1/28/03: Thin black film in bottom of tube. Black film thicker on sides, bottom around top of ball at waterline.
1/29/03: Thick black film in bottom of tube. Thin black film on sides of tube. Dark yellow ring of medium bubbles around top of ball at waterline.	1/29/03: Same as above, except black film thicker on bottom of tube.
1/30/03: Same as above.	1/30/03: Same as above.

POST SAMPLING EVENT #8

MW116
Sampled 2/25/03

IRB	SRB
2/26/03: Solution clear at ball graduating to light yellow at bottom of tube. No bubbles on ball and on sides of tube.	2/26/03: Solution clear throughout tube. A few small bubbles on ball and sides of tube.
2/27/03: Same as above.	2/27/03: Same as above, except bubbles bigger.
2/28/03: Solution medium yellow throughout. Ring of small bubbles around top of ball at waterline.	2/28/03: Solution clear throughout tube. Several medium bubbles on ball. No bubbles on sides of tube. Cloudy film ring around top of ball at waterline.
3/1/03: Solution medium yellow throughout. Very thick ring of small bubbles around top of ball at waterline. Many medium bubbles on bottom of ball. No bubbles on sides of tube.	3/1/03: Same as above.
3/2/03: Same as above, except dark yellow ring with bubbles around top of ball at waterline. 75% of ball covered with small/medium bubbles.	3/2/03: Same as above.
3/3/03: Dark yellow/light brown throughout. Dark yellow ring of small bubbles around top of ball at waterline. Ring of medium/large bubbles around bottom of ball. Thin black film in very bottom of tube.	3/3/03: Hint of black film with black flecks on one small spot on bottom of ball. Slightly cloudy film ring around top of ball at waterline.
3/4/03: Thick black film on bottom of tube and up sides about ¼". Dark yellow ring and thin black ring with small bubbles around top of ball at waterline.	3/4/03: Thick black film on bottom of tube. Hint of black film with black flecks on one small spot on bottom of ball. Slightly cloudy film ring around top of ball at waterline.
3/5/03: Thick black film on ball, sides and bottom of tube. Medium brown ring of medium bubbles rimmed with black flecks around top of ball at waterline.	3/5/03: Thick black film on bottom of tube. Medium black film on sides of tube. Very thin black film with black flecks on ball.

MW116 Duplicate
Sampled 2/25/03

IRB	SRB
2/26/03: Solution light yellow throughout tube. A few small bubbles sides of tube.	2/26/03: Solution clear throughout tube. A few small bubbles on ball and sides of tube.
2/27/03: Same as above.	2/27/03: Solution clear throughout tube. A few small bubbles on ball and sides of tube.
2/28/03: Solution medium yellow throughout. Light yellow ring of small bubbles around top of ball at waterline. Several medium bubbles on sides and bottom of ball. No bubbles on sides of tube.	2/28/03: Solution clear throughout tube. Cloudy film ring with some small bubbles around top of ball at waterline. One bubble on ball, one bubble on tube, so less bubbles than before.
3/1/03: Solution medium yellow throughout tube. 80% of ball covered in small/medium bubbles (mainly around ball above and below waterline). Medium yellow ring around top of ball at waterline.	3/1/03: Same as above, except one small spot of very thin black film with black flecks on side of ball.
3/2/03: Solution dark yellow throughout. Dark yellow/light brown at bottom of tube. Dark yellow ring of small bubbles around top of ball at waterline. 70% of ball covered with small/medium bubbles.	3/2/03: Same as above.
3/3/03: Solution dark yellow/light brown throughout. Dark yellow ring of small bubbles around top of ball at waterline. 70% of ball covered with small/medium bubbles. Thin black film in center bottom of tube.	3/3/03: Very thin black film around ball and on side of tube just under waterline. Cloudy film ring, but no bubbles, around top of ball at waterline.
3/4/03: Same as above, except black film thicker on bottom of tube.	3/4/03: Thick black film in bottom of tube. Thin black film on ball and sides of tube at ball. Cloudy film ring around top of ball at waterline.
3/5/03: Black film on bottom of tube and up sides about ¼". One spot of thick black film on side of ball. Solution brown. Dark yellow ring of bubbles around top of ball at waterline.	3/5/03: Thick black film in bottom of tube. Thin black film on sides of tube and on ball. Ring of cloudy film with black flecks around top of ball at waterline.

MW118
Sampled 2/25/03

IRB	SRB
2/26/03: Solution light yellow at ball graduating to medium greenish yellow at bottom of tube. No bubbles.	2/26/03: Solution off-white, slightly cloudy throughout. No bubbles.
2/27/03: Same as above, except solution light greenish yellow at bottom of tube. No bubbles.	2/27/03: Solution off-white, slightly cloudy throughout. Several medium bubbles on ball and sides of tube.
2/28/03: Solution cloudy medium yellow throughout tube with very light green tint at bottom of tube. Very light yellow ring of small bubbles around top of ball at waterline. A few very small bubbles on ball.	2/28/03: Solution and bubbles same as above. Cloudy film ring around top of ball at waterline. Fewer bubbles than yesterday.
3/1/03: Same as above, except ring of small bubbles around top of ball at waterline. Several medium bubbles on side of ball.	3/1/03: Solution slightly cloudy. Thin black film ring around top of ball at waterline.
3/2/03: Solution cloudy medium yellow throughout. Dark yellow ring of small bubbles around top of ball at waterline. Several medium bubbles on sides/bottom of ball. No bubbles on sides of tube.	3/2/03: Solution slightly cloudy. Thick black film ring around top of ball at waterline. No bubbles on ball or sides of tube.
3/3/03: Same as above, except fewer bubbles on bottom of ball.	3/3/03: Same as above.
3/4/03: Solution cloudy medium yellow throughout. Dark yellow ring of small bubbles around top of ball at waterline. Several medium bubbles with black film under them on sides/bottom of ball. No bubbles on sides of tube.	3/4/03: Thick black film on ball at waterline and on bottom of tube. Thin black film on sides and bottom of ball and sides of tube.
3/5/03: Medium black film on bottom of ball and sides of tube at ball. Ring of dark yellow with black flecks and bubbles.	3/5/03: Same as above, except film thicker on ball and tube.

MW120
Sampled 2/25/03

IRB	SRB
2/26/03: Solution clear at ball graduating to light yellow at bottom of tube. A few very small bubbles on ball.	2/26/03: Solution slightly cloudy throughout tube. Several small bubbles on ball and sides of tube. Thin off-white ring around top of ball at waterline.
2/27/03: Solution light yellow throughout tube. A few very small bubbles on ball.	2/27/03: Solution off-white, slightly cloudy throughout tube. Off-white/hint of brown film ring around top of ball at waterline. A few small bubbles on ball and sides of tube.
2/28/03: Solution medium yellow throughout. Light yellow ring with some small bubbles around top of ball at waterline. Several medium bubbles on bottom of ball. A few small bubbles on sides of tube.	2/28/03: Thin black film ring around top of ball at waterline. Several medium bubbles on bottom of ball and sides of tube.
3/1/03: Same as above.	3/1/03: 85% of ball covered in medium black film with black flecks. A few small bubbles on ball and sides of tube.
3/2/03: Same as above.	3/2/03: Same as above, except black film thicker.
3/3/03: Solution dark yellow throughout. Dark yellow ring of small/medium bubbles around top of ball at waterline. Several small bubbles on bottom of ball and sides of tube.	3/3/03: Thick black film on sides and bottom of ball. Spot of black film on bottom of tube.
3/4/03: Same as above.	3/4/03: Same as above, except bottom of tube covered with thick black film.
3/5/03: Thick black film in bottom of tube. Solution dark yellow. Dark yellow ring of bubbles around top of ball at waterline.	3/5/03: Thick black film on ball, sides and bottom of tube.

MW122
Sampled 2/25/03

IRB	SRB
2/26/03: Solution clear at ball graduating to light yellow at bottom of tube. Several small bubbles on sides of tube.	2/26/03: Solution slightly cloudy throughout tube. Many small bubbles on bottom of ball and sides of tube.
2/27/03: Same as above.	2/27/03: Solution slightly cloudy throughout tube. Off-white film ring around top of ball at waterline. Many medium bubbles on ball and sides of tube.
2/28/03: Solution medium yellow throughout tube. Light yellow ring of small bubbles around top of ball at waterline. Several medium bubbles on bottom of ball. A few medium bubbles on sides of tube.	2/28/03: Solution slightly cloudy throughout tube. Sides and bottom of ball covered in thin black film with black flecks. Several small bubbles on bottom of ball. Slightly cloudy ring around top of ball at waterline. Several small bubbles on sides of tube.
3/1/03: Same as above, except 80% of ball covered in small/medium bubbles.	3/1/03: Same as above, except black film thicker on ball.
3/2/03: Solution dark yellow throughout with black film in very bottom of tube. Medium yellow ring with small/medium bubbles around top of ball at waterline. Lots of medium bubbles on bottom of ball.	3/2/03: No change from yesterday.
3/3/03: Black film at bottom of tube – on very bottom and up sides about ¼". Dark yellow ring of medium bubbles around top of ball at waterline. Solution dark yellow/light brown.	3/3/03: 80% of ball covered in medium black film with black flecks. Cloudy film ring around top of ball at waterline. Small bubbles on sides of tube.
3/4/03: Same as above.	3/4/03: Sides and bottom of ball covered in thick black film. Bottom of tube covered in thick black film. Several small bubbles on sides of tube.
3/5/03: Black film on sides and bottom of tube. Ring of dark yellow with several large spots of black film and bubbles around top of ball at waterline.	3/5/03: Thick black film on sides and bottom of tube and on ball.

MW124
Sampled 2/25/03

IRB	SRB
2/26/03: Solution clear at ball graduating to light yellow at bottom of tube. A few small bubbles on sides of tube.	2/26/03: Solution clear throughout tube. A few small bubbles on bottom of ball and sides of tube.
2/27/03: Same as above.	2/27/03: Same as above, except more bubbles.
2/28/03: Solution medium yellow throughout tube. Light yellow ring of small bubbles around top of ball at waterline. Several medium bubbles on bottom of ball and sides of tube.	2/28/03: Solution clear throughout tube. A few small bubbles on ball and sides of tube. Very thin cloudy film ring around top of ball at waterline.
3/1/03: Solution dark yellow under ball graduating to medium yellow at bottom of tube. About 65% of ball covered with small/medium bubbles. A few medium bubbles on sides of tube.	3/1/03: Same as above, except one small patch of black flecks on side of ball.
3/2/03: Solution dark yellow throughout. Dark yellow ring of medium bubbles around top of ball at waterline. No bubbles on bottom of ball or sides of tube.	3/2/03: No change from yesterday.
3/3/03: Same as above.	3/3/03: Solution clear. More black flecks on ball than yesterday. Cloudy film ring around top of ball at waterline. A few small bubbles on sides of tube.
3/4/03: Thick black film on very bottom of ball and on sides of tube just below ball almost to bottom of tube. Dark yellow ring of bubbles around top of ball at waterline.	3/4/03: Solution clear. Many black flecks with patches of very thin black film. Thin black film in bottom of tube. Cloudy film ring around top of ball at waterline.
3/5/03: Thick black film on bottom of ball, sides and bottom of tube. Brown with a thin line of black film ring around top of ball at waterline.	3/5/03: Same as above. Black film thicker in bottom of tube.

POST SAMPLING EVENT #9

MW110
Sampled 3/24/03

IRB	SRB
3/25/03: Solution clear at ball graduating to light yellow at bottom of tube. No bubbles. Dark brown film at center bottom of tube. White particles suspended near bottom of tube.	3/25/03: Solution clear throughout tube. Many small bubbles on bottom of ball and sides of tube near bottom of tube.
3/26/03: Same as above.	3/26/03: Same as above, except fewer bubbles.
3/27/03: Solution light yellow throughout. Ring of small bubbles around top of ball at waterline. Several medium bubbles on bottom of ball. A few small bubbles on sides of tube.	3/27/03: Solution clear. Cloudy film ring around top of ball at waterline. No bubbles.
3/28/03: Solution medium yellow at ball graduating to dark greenish yellow at bottom of tube. Dark yellow ring of small bubbles around top of ball at waterline.	3/28/03: Same as above, except a few very small black spots on one side of ball.
3/29/03: Solution dark greenish yellow. Light brownish yellow ring of medium bubbles around top of ball at waterline. Medium bubbles on bottom of ball.	3/29/03: Solution clear. Cloudy film ring around top of ball at waterline. Several very small black spots on one side of ball.
3/30/03: Thin black film on sides and bottom of tube. Light brown ring with medium bubbles around top of ball at waterline. Medium bubbles on bottom of ball.	3/30/03: Solution slightly cloudy. Cloudy film ring with several black spots around top of ball at waterline. Several very small black spots on one side of ball.
3/31/03: Thick black film on sides and bottom of ball, sides and bottom of tube. Medium brown ring of medium bubbles around top of ball at waterline.	3/31/03: Same as above, except cloudy film ring thicker. Black film in center bottom of tube.
4/1/03: Thick black film on sides and bottom of ball, sides and bottom of tube. Ring of medium brown with lots of black flecks and medium bubbles around top of ball at waterline.	4/1/03: Solution slightly cloudy. Thick cloudy film ring with lots of black flecks around top of ball at waterline. Several very small black spots on one side of ball. Black film in center bottom of tube.

MW 110D
Sampled 3/24/03

IRB	SRB
3/25/03: Solution clear at ball graduating to light yellow at middle to bottom of tube. No bubbles.	3/25/03: Solution clear. Many small bubbles on bottom of ball and sides of tube near bottom of tube.
3/26/03: Same as above.	3/26/03: Same as above, except fewer bubbles.
3/27/03: Solution light yellow throughout. Medium bubbles ring around top of ball at waterline. Several medium bubbles on bottom of ball. No bubbles on sides of tube.	3/27/03: Solution clear. Cloudy film ring around top of ball at waterline. Small bubbles cover sides of tube. A few small bubbles on bottom of ball.
3/28/03: Solution medium yellow. Dark yellow ring of small bubbles around top of ball at waterline. Several medium bubbles on bottom of ball. No bubbles on sides of tube.	3/28/03: Same as above, except very thin black film in bottom of tube.
3/29/03: Solution dark greenish yellow. Light brownish yellow ring of medium bubbles around top of ball at waterline. Thin black film and medium bubbles on bottom of ball.	3/29/03: Solution clear. Cloudy film ring around top of ball at waterline. Black film in bottom of tube. Medium bubbles on bottom of ball. Several very small spots of black film on one side of ball.
3/30/03: Thin black film on sides and bottom of tube. Dark yellow ring with light brown flecks and medium bubbles around top of ball at waterline. Thin black film and medium bubbles on bottom of ball.	3/30/03: Same as above.
3/31/03: Thick black film on sides and bottom of ball, sides and bottom of tube. Medium brown ring of medium bubbles around top of ball at waterline.	3/31/03: Solution clear. Thick black film on bottom of tube. Thin black film with black flecks on sides and bottom of ball and on side of tube at ball. Cloudy film ring around top of ball at waterline.
4/1/03: Thick black film on sides and bottom of ball, sides and bottom of tube. Ring of medium brown with lots of black flecks and medium bubbles around top of ball at waterline.	4/1/03: Same as above.

MW114
Sampled 3/25/03

IRB	SRB
3/26/03: Solution clear at ball graduating to medium greenish yellow at bottom of tube. No bubbles.	3/26/03: Solution clear. No bubbles.
3/27/03: Solution medium greenish yellow throughout. No bubbles.	3/27/03: Same as above, except cloudy film ring around top of ball at waterline.
3/28/03: Same as above.	3/28/03: Solution clear. Cloudy film ring around top of ball at waterline. Thin black film on bottom of ball and center bottom of tube.
3/29/03: Same as above.	3/29/03: Same as above, except black film thicker.
3/30/03: Same as above.	3/30/03: Solution clear. Medium black film ring around top of ball at waterline, on sides of tube at ball and in bottom of tube. A few medium bubbles on bottom of ball.
3/31/03: Solution dark yellow. No bubbles.	3/31/03: Thick black film around top at waterline, on sides and bottom of ball, sides and bottom of tube.
4/1/03: Same as above.	4/1/03: Same as above.
4/2/03: Solution dark yellow. No bubbles. Medium black film around top of ball at waterline.	4/2/03: Same as above.

MW116
Sampled 3/25/03

IRB	SRB
3/26/03: Solution clear at ball graduating to light greenish yellow at bottom of tube. Many very small bubbles on ball and on sides of tube.	3/26/03: Solution clear throughout tube. Many small bubbles on ball and sides of tube.
3/27/03: Same as above.	3/27/03: Same as above, except cloudy film ring around top of ball at waterline.
3/28/03: Solution medium yellow throughout. Medium yellow ring of small bubbles around top of ball at waterline. Medium bubbles on bottom of ball. Sides of tube covered in very small bubbles.	3/28/03: Same as above, except several small black spots on ball.
3/29/03: Solution medium yellow throughout. Dark yellow ring around top of ball at waterline. Ring of medium bubbles encompassing about 80% of ball. Sides of tube covered in very small bubbles.	3/29/03: Solution clear. Cloudy film ring around top of ball at waterline. Very thin black film with black flecks on ball.
3/30/03: Solution dark greenish yellow throughout. About 70% of ball covered in medium bubbles. Spots of black film on sides of ball. Medium black film and small bubbles on sides of tube just under ball.	3/30/03: Same as above.
3/31/03: Thick black film on sides and bottom of ball, sides and bottom of tube. Dark yellow ring of medium bubbles around top of ball at waterline.	3/31/03: Thick black film in bottom of tube. Thin black film with black flecks on sides and bottom of ball. Many small bubbles on bottom of ball and sides of tube.
4/1/03: Same as above, except black flecks in dark yellow ring of medium bubbles around top of ball at waterline.	4/1/03: Thick black film on bottom of tube. Medium black film on sides of tube. Medium black film with black flecks on sides and bottom of ball. Cloudy film ring rimmed with black around top of ball at waterline. Several small bubbles on bottom of ball and sides of tube.
4/2/03: Thick black film on sides and bottom of ball, sides and bottom of tube. Black film ring rimmed in dark yellow around top of ball at waterline.	4/2/03: Same as above.

MW116 Duplicate
Sampled 3/25/03

IRB	SRB
3/26/03: Solution clear at ball graduating to medium greenish yellow at bottom of tube. Many small bubbles on ball and sides of tube.	3/26/03: Solution clear throughout tube. Many small bubbles on ball and sides of tube.
3/27/03: Same as above.	3/27/03: Same as above, except cloudy ring around top of ball at waterline.
3/28/03: Solution medium yellow throughout. Ring of small bubbles around top of ball at waterline. A few small bubbles on sides of tube.	3/28/03: Same as above.
3/29/03: Solution dark yellow throughout. 90% of ball covered in small bubbles. Many small bubbles on sides of tube.	3/29/03: Solution clear. Cloudy film ring around top of ball at waterline. Bottom of ball and sides of tube covered in very small bubbles.
3/30/03: Same as above, except fewer bubbles on ball (about 60% of ball covered). No bubbles on sides of tube.	3/30/03: Same as above, except fewer bubbles.
3/31/03: Solution light brown. Thin black film band (about ¼" thick) on sides of tube just under ball. Dark yellow ring of small bubbles around top of ball at waterline. Bottom of ball covered in small bubbles.	3/31/03: Solution clear. Thick cloudy film ring around top of ball at waterline. Medium black film in bottom of tube. Area of very small black spots on one side of ball. Bottom of ball and sides of tube covered in small bubbles.
4/1/03: Thick black film on sides and bottom of ball, sides and bottom of tube. Light brown ring with black flecks and small bubbles around top of ball at waterline.	4/1/03: Thick cloudy film ring rimmed in black around top of ball at waterline. Thick black film in bottom of tube. Thin black film with black flecks on sides of ball. Bottom of ball and sides of tube covered in small bubbles.
4/2/03: Thick black film on sides and bottom of ball, sides and bottom of tube. Black film ring and small bubbles around top of ball at waterline.	4/2/03: Same as above.

794 600

MW118
Sampled 3/25/03

IRB	SRB
3/26/03: Solution clear at ball graduating to medium greenish yellow at bottom of tube. No bubbles.	3/26/03: Solution slightly cloudy throughout. Many small bubbles on ball and sides of tube.
3/27/03: Solution medium greenish yellow throughout. Small bubble ring around top of ball at waterline. A few small bubbles on bottom of ball and sides of tube.	3/27/03: Same as above, except light brown ring around top of ball at waterline.
3/28/03: Same as above.	3/28/03: Solution clear. A few small black spots on ball. Several small bubbles on bottom of ball and on sides of tube.
3/29/03: Solution dark yellow. Black film in bottom of tube and up sides about ¼". Medium bubble ring around top of ball at waterline.	3/29/03: Solution clear. Medium black film with black flecks covering bottom of ball. Several small bubbles on bottom of ball. Many small bubbles on sides of tube.
3/30/03: Bottom and sides of tube and bottom of ball covered in thick black film. Dark yellow ring with medium bubbles and black spots around top of ball at waterline.	3/30/03: Same as above, except fewer bubbles.
3/31/03: Same as above.	3/31/03: Solution slightly cloudy. Medium black film with black flecks on sides and bottom of ball and on bottom of tube. Bottom of ball and sides of tube covered in small bubbles.
4/1/03: Thick black film on sides and bottom of ball, sides and bottom of tube. Dark yellow ring with black flecks, no bubbles, around top of ball at waterline.	4/1/03: Thick black film on sides and bottom of ball, sides and bottom of tube. Cloudy film ring rimmed in black around top of ball at waterline.
4/2/03: Same as above.	4/2/03: Same as above, except cloudy film ring now completely black.

MW120
Sampled 3/25/03

IRB	SRB
3/26/03: Solution clear at ball graduating to light greenish yellow at bottom of tube. Many very small bubbles on ball and sides of tube.	3/26/03: Solution clear throughout tube. Many small bubbles on ball and sides of tube.
3/27/03: Solution medium greenish yellow throughout. Ring of small bubbles around top of ball at waterline. Many small bubbles on bottom of ball and sides of tube.	3/27/03: Medium black film with black flecks on sides of ball. Small bubbles cover sides of tube.
3/28/03: Same as above, except medium yellow ring with small bubbles around top of ball at waterline. Several small bubbles on sides of tube.	3/28/03: Same as above.
3/29/03: Solution dark yellow. Dark yellow ring with small bubbles around top of ball at waterline. Sides of tube covered in small bubbles.	3/29/03: Solution clear. Medium black film with black flecks covering bottom of ball. Several small bubbles on bottom of ball. Many small bubbles on sides of tube.
3/30/03: Same as above, except thin black film on bottom of tube.	3/30/03: Same as above, except black film thicker around middle of ball.
3/31/03: Solution medium brown. Medium black film on sides and bottom of tube. Thin black film on bottom of ball. Dark yellow ring of small bubbles around top of ball at waterline. Medium bubbles on bottom of ball. Sides of tube covered in small bubbles.	3/31/03: Thick black film on sides and bottom of ball, sides at ball and bottom of tube. Sides of tube covered in small bubbles.
4/1/03: Thick black film sides and bottom of ball, sides and bottom of tube. Light brown ring rimmed with black film and small bubbles around top of ball at waterline.	4/1/03: Same as above.
4/2/03: Thick black film sides and bottom of ball, sides and bottom of tube. Thick black film ring and small bubbles around top of ball at waterline.	4/2/03: Thick black film on sides and bottom of ball, sides at ball and bottom of tube. Sides of tube covered in small bubbles. Black film ring around top of ball at waterline.

MW124
Sampled 3/25/03

IRB	SRB
3/26/03: Solution clear at ball graduating to medium greenish yellow at bottom of tube. A few small bubbles on bottom of ball and sides of tube.	3/26/03: Solution clear throughout tube. Many small bubbles on bottom of ball and sides of tube.
3/27/03: Solution dark yellow at ball graduating to light brown at bottom of tube. Medium bubble ring around top of ball at waterline. Many medium bubbles on bottom of ball and sides of tube.	3/27/03: Same as above, except cloudy film ring around top of ball at waterline.
3/28/03: Same as above, except medium yellow ring with medium bubbles around top of ball at waterline.	3/28/03: Same as above.
3/29/03: Solution dark yellow/light brown throughout. Dark yellow ring of medium bubbles around top of ball at waterline. Bottom of ball covered in large bubbles. Several small bubbles on sides of tube.	3/29/03: Solution clear. Cloudy film around top of ball at waterline. A few small black spots on sides of ball. Several small bubbles on bottom of ball. Sides of tube covered in small bubbles.
3/30/03: Same as above, except fewer bubbles on ball and sides of tube.	3/30/03: Same as above, except thick black film on bottom of tube.
3/31/03: Solution dark yellow/light brown. Thin black film band (about ¼") on sides of tube just under ball. Dark yellow ring of medium bubbles around top of ball at waterline.	3/31/03: Thick black film on bottom of tube. Medium black film on sides of tube. Cloudy film ring with black flecks around top of ball at waterline. Sides of tube covered in small bubbles.
4/1/03: Solution dark yellow/light brown. Thick black film band (about ¼") on sides of tube just under ball. Medium black film on bottom of ball. Light brown ring of small bubbles around top of ball at waterline.	4/1/03: Same as above.
4/2/03: Solution dark yellow/light brown. Thick black film band (about 1") on sides of tube just under ball. Thick black film on bottom of ball. Medium brown ring of small bubbles around top of ball at waterline.	4/2/03: Thick black film on bottom and sides of tube. Thin black film on bottom and sides of tube. Cloudy film ring rimmed with black film around top of ball at waterline. Sides of tube covered in small bubbles.

MW105
Sampled 3/26/03

IRB	SRB
3/27/03: Solution clear at ball graduating to light yellow at bottom of tube. No bubbles.	3/27/03: Solution clear. No bubbles.
3/28/03: Solution clear at ball graduating to medium yellow then light brown at bottom of tube. No bubbles.	3/28/03: Solution clear. No bubbles. Cloudy film ring around top of ball at waterline.
3/29/03: Same as above.	3/29/03: Same as above.
3/30/03: Same as above.	3/30/03: Medium thick black film ring around ball just under waterline. Thin black film on sides and bottom of ball. Very thin black film on sides of tube at ball.
3/31/03: Solution dark yellow at ball graduating to light brown at bottom of tube. No bubbles.	3/31/03: Thick black film on bottom of tube. Thin black film on sides of tube. Thick black film around middle of ball. Thin black film on bottom of ball.
4/1/03: Same as above.	4/1/03: Same as above, except black film thicker on bottom of ball.
4/2/03: Same as above.	4/2/03: Thick black film on bottom of tube. Thin black film on sides of tube. Thick black film around middle of ball. Medium black film on bottom of ball. Black film ring around top of ball at waterline.
4/3/03: Same as above. No change.	4/3/03: Same as above.

794 604

MW112
Sampled 3/26/03

IRB	SRB
3/27/03: Solution clear. No bubbles.	3/27/03: Solution clear. No bubbles.
3/28/03: Solution light yellow at ball graduating to medium greenish yellow at bottom of tube. No bubbles.	3/28/03: SAA. Cloudy film ring around top of ball at waterline.
3/29/03: Same as above.	3/29/03: Solution clear. Thin black film on bottom of tube and up sides about ½".
3/30/03: Solution dark yellow/light brown throughout. No bubbles.	3/30/03: Thick black film on bottom of tube. Thin black film on sides of tube. One spot of thick black film on side of ball. Thin black film on bottom of ball.
3/31/03: Same as above.	3/31/03: Thick black film on sides and bottom of tube and on bottom and one side of ball.
4/1/03: Solution light brown. No bubbles.	4/1/03: Thick black film on sides and bottom of tube and on bottom and one side of ball. Cloudy film ring rimmed with black film around top of ball at waterline.
4/2/03: Same as above.	4/2/03: Thick black film on sides and bottom of tube and on bottom and sides of ball. Black film ring around top of ball at waterline.
4/3/03: Same as above, except one small spot of black film on side of ball (about 1/8 diameter).	4/3/03: Same as above.

MW113
Sampled 3/26/03

IRB	SRB
3/27/03: Solution clear at ball graduating to light yellow at bottom of tube. No bubbles.	3/27/03: Solution clear throughout. No bubbles.
3/28/03: Same as above.	3/28/03: Same as above.
3/29/03: Solution medium yellow throughout. Medium yellow with medium bubbles ring around top of ball at waterline.	3/29/03: Solution clear throughout. About four small bubbles on bottom of ball. One very small spot of black on the ball.
3/30/03: Same as above, except medium bubbles on bottom of ball.	3/30/03: Solution clear. Cloudy film ring around top of ball at waterline. One area of ball covered in small spots of black.
3/31/03: Solution dark yellow/light brown throughout. Dark yellow ring of medium bubbles around top of ball at waterline. Bottom of ball covered with medium bubbles.	3/31/03: Medium black film on bottom of tube. Thin black film with black flecks on bottom and sides of ball. Several medium bubbles on sides/bottom of ball sides of tube. Cloudy film ring around top of ball at waterline.
4/1/03: Solution light brown throughout. Medium brown ring of small bubbles around top of ball at waterline. Bottom of ball covered with medium bubbles.	4/1/03: Same as above.
4/2/03: Same as above.	4/2/03: Same as above.
4/3/03: Solution dark brown. Thick black film in bottom of tube. Thin black film on sides of tube. Thin black film on bottom of ball. Thick black film ring with small bubbles around top of ball at waterline.	4/3/03: Thick black film on bottom of tube. Medium black film with black flecks on bottom and sides of ball. A few medium bubbles on sides/bottom of ball sides of tube. Cloudy film ring rimmed with black film around top of ball at waterline.

794 606

MW122
Sampled 3/26/03

IRB	SRB
3/27/03: Solution clear at ball graduating to light yellow at middle of tube. Many small bubbles on bottom of ball and sides of tube.	3/27/03: Solution clear. Many small bubbles on bottom of ball and sides of tube.
3/28/03: Solution light yellow at ball graduating to greenish medium yellow at bottom of tube. Small bubbles on bottom of ball and sides of tube.	3/28/03: Same as above, except cloudy film ring around top of ball at waterline.
3/29/03: Solution medium greenish yellow throughout tube. Very small bubbles on bottom of ball and covering sides of tube.	3/29/03: Solution clear. Ball covered in very thin black film with black flecks. Bottom of ball and sides of tube covered in very small bubbles.
3/30/03: Same as above, except about 70% of ball covered in small bubbles.	3/30/03: Same as above, except black film on ball thicker.
3/31/03: Solution dark yellow throughout. About 60% of ball covered in medium bubbles (ring around top at waterline and on bottom of ball). Several medium bubbles on sides of tube at ball.	3/31/03: Solution clear. Medium black film with black flecks around middle of ball. Thin black film with black flecks on bottom of ball. Bottom of ball and sides of tube covered in small bubbles.
4/1/03: Thick black film in bottom of tube. Thin black film on sides of tube near bottom. No black film on sides of tube at ball. About four spots of thick black film on side of ball. Sides and bottom (50%) of ball covered in medium bubbles. Dark yellow ring of small bubbles around top of ball at waterline.	4/1/03: Same as above.
4/2/03: Thick black film sides and bottom of tube. Thick black film bottom of ball. Thin black film sides of ball. Dark brown ring rimmed with black film of medium bubbles.	4/2/03: Thick black film bottom of tube and bottom of ball. Thin black film sides of tube, thicker at ball. Cloudy film ring rimmed with black film around top of ball at waterline.
4/3/03: Thick black film sides and bottom of tube. Thick black film bottom of ball. Thick black film on sides, bottom and around top, with small bubbles, of ball at waterline.	4/3/03: Thick black film bottom of tube, sides and bottom of ball. Medium black film sides of tube, thicker at ball. Black film ring rimmed around top of ball at waterline.

POST INJECTION EVENT #10

MW110
Sampled 4/21/03

IRB	SRB
4/22/03: Solution: clear at ball graduating to light yellow at bottom of tube. Ball: Light yellow ring at waterline. No bubbles. Tube: No bubbles.	4/22/03: Solution clear throughout tube. No bubbles.
4/23/03: Solution: medium yellow throughout tube. Ball: dark yellow ring on top of band of small bubbles around ball at waterline. Tube: No bubbles.	4/23/03: Same as above. Cloudy film ring around top of ball at waterline.
4/24/03: Solution: light yellow throughout. Ball: ring of small bubbles around top of ball at waterline. Several medium bubbles on bottom of ball. Tube: a few small bubbles on sides.	4/24/03: Solution clear. Cloudy film ring around ball at waterline. No bubbles.
4/25/03: Solution: dark brown at ball graduating to dark greenish yellow at bottom of tube. Ball: black film on bottom, dark yellow ring of small bubbles (80% of ball covered) around middle of ball. Tube: black film on sides of tube at ball.	4/25/03: Solution clear. Several black spots on sides of ball. Cloudy film ring thick around ball at waterline. No bubbles.
4/26/03: Black film on sides/bottom of ball and sides of tube. Light brown film on top, black on bottom ring of medium bubbles around ball above and below waterline (can't see bottom of ball, so estimate 70% of ball covered).	4/26/03: Solution clear. Several black spots and a very thin black film around middle of ball. Cloudy film ring thick around ball at waterline. No bubbles.
4/27/03: Thick black film on sides/bottom of ball and sides/bottom of tube. Dark brown film and ring of small/medium bubbles around ball at waterline. Black film and medium/large bubbles on bottom of ball.	4/27/03: Same as above, except cloudy film ring thicker.
4/28/03: Same as above, except dark brown film around ball at waterline now has spots of black film mixed in.	4/28/03: Solution clear. Several black spots and thin black film around middle of ball. Cloudy film ring thick around ball at waterline. No bubbles.
4/29/03: Thick black film on sides and bottom of ball, sides and bottom of tube. Ring of medium brown with lots of black flecks and medium bubbles around top of ball at	4/29/03: Solution clear. Several black spots and thin black film, thicker in spots, around middle of ball. Cloudy film ring thick around ball at waterline. Thin black film in bottom of tube. A few

waterline.	medium bubbles on bottom of ball, sides of tube.

MW 110D
Sampled 4/21/03

IRB	SRB
4/22/03: Solution clear at ball graduating to light yellow at middle to bottom of tube. No bubbles.	4/22/03: Solution clear. A few small bubbles on side of tube near bottom.
4/23/03: Solution light yellow throughout. Light yellow ring around ball at waterline. A few small bubbles on sides of ball.	4/23/03: Solution clear. A few small bubbles on side of tube near bottom. Cloudy film ring around ball at waterline. A few black flecks on one side of ball.
4/24/03: Solution light yellow throughout. Medium bubbles ring around top of ball at waterline. Several medium bubbles on bottom of ball. No bubbles on sides of tube.	4/24/03: Solution clear. Cloudy film ring around ball at waterline. Small bubbles cover sides of tube. A few small bubbles on bottom of ball.
4/25/03: Solution medium yellow. Medium yellow ring around ball at waterline. A few medium bubbles on bottom of ball. Less than five bubbles on sides of tube.	4/25/03: Solution cloudy. Thin black film ring around ball at waterline. Black film in bottom of tube. Less than five bubbles on ball or tube. Several very small spots of black film on one side of ball.
4/26/03: Same as above.	4/26/03: Solution clear. Cloudy film ring around ball at waterline. Black film in bottom of tube. Medium bubbles on bottom of ball. Several very small spots of black film on one side of ball.
4/27/03: Same as above.	4/27/03: Solution clear. Black film ring around ball at waterline. Black film in bottom of tube. Less than five bubbles on ball and tube. Several spots of black film around middle of ball.
4/28/03: Same as above.	4/28/03: Same as above, except black film thicker at waterline and on sides of ball.
4/29/03: Solution medium yellow. Medium yellow ring around ball at waterline. A few medium bubbles on bottom of ball. Less than five bubbles on sides of tube.	4/29/03: Medium black film around ball at, and on sides just below, waterline. Thin black film on bottom of tube.

794 610

MW114
Sampled 4/22/03

IRB	SRB
4/23/03: Solution clear at ball graduating to medium greenish yellow at bottom of tube. Very light brown at very bottom of tube. No bubbles.	4/23/03: Solution clear. No bubbles.
4/24/03: Solution medium greenish yellow throughout. No bubbles.	4/24/03: Solution slightly cloudy and off-white. Cloudy film ring around ball at waterline. No bubbles.
4/25/03: Same as above.	4/25/03: Same as above.
4/26/03: Solution medium yellow at ball, medium greenish yellow at bottom of tube. Several small bubbles on ball at waterline. Several medium bubbles on sides of ball.	4/26/03: Solution slightly cloudy and off-white. Cloudy film ring around ball at waterline. Thin black film, thicker in spots, on ball. No bubbles.
4/27/03: Solution dark greenish yellow. Dark yellow ring of medium bubbles around ball at waterline. Several medium bubbles on sides of ball.	4/27/03: Solution clear. Thick black film ring around ball at waterline and in bottom of tube. Thin black film on ball and sides of tube. No bubbles.
4/28/03: Solution cloudy dark yellow. Black film on bottom of tube. Thin black film on sides and around ball at waterline.	4/28/03: Ball: 85% thick black film Tube: 100% thin to medium black film
4/29/03: Medium black film around top at, and just below, waterline and on bottom of ball. Sides of tube: 100% medium black film.	4/29/03: Tube: 100% medium black film Ball: 85% thin to medium black film
4/30/03: Ball: 95% thick black film. Tube: 100% thick black film.	4/30/03: Ball: 85% medium black film. Tube: 100% thin (ball) to thick (bottom) black film.

MW116
Sampled 4/22/03

IRB	SRB
4/23/03: Solution clear at ball graduating to light greenish yellow at bottom of tube. Many very small bubbles on ball and on sides of tube.	4/23/03: Solution clear. Many small bubbles on ball and sides of tube.
4/24/03: Same as above. Ring of small bubbles around ball at waterline.	4/24/03: Solution clear. Many small bubbles on ball and sides of tube. Cloudy film ring around ball at waterline.
4/25/03: Solution medium yellow throughout. Small/medium bubbles on ball at waterline (75% coverage). Many small bubbles on sides of tube.	4/25/03: Solution clear. Many small bubbles on ball and sides of tube. Cloudy film ring around ball at waterline. Several very small black spots on ball.
4/26/03: Solution dark yellow throughout. Ring of medium bubbles around ball at waterline. Many very small bubbles on sides of tube.	4/26/03: Solution clear. Cloudy film ring around top of ball at waterline. Several small black spots, pinprick size, on ball.
4/27/03: Solution dark yellow/light brown throughout. Black film on bottom of tube. Ring of medium bubbles around ball at waterline.	4/27/03: Solution clear. Thick black film on bottom of tube. Cloudy film ring around top of ball at waterline. Several small black spots, pinprick size, on ball.
4/28/03: Solution medium brown throughout. Black film on about 20% of tube at bottom and sides. Thin black film on ring of small bubbles around ball at waterline.	4/28/03: Thick black film in bottom of tube. Thin black film with black flecks on sides and bottom of ball. Many small bubbles on sides of tube.
4/29/03: Solution: dark brown Ball: 15% thick black ring top at waterline Tube: 40% medium to thick black film at bottom.	4/29/03: Solution: clear Ball: cloudy ring at waterline, 85% very thin to thin black film Tube: 100% very thin (ball) to medium (bottom) black film
4/30/03: Solution: dark brown. Ball: 70% thin black film on sides, thick black film ring with small bubbles at waterline. Tube: 100% very thin (ball) to thick (bottom) black film.	4/30/03: Solution clear: Ball: cloudy ring at waterline, 85% very thin to thin black film Tube: 100% very thin (ball) to medium (bottom) black film

794 612

MW116 Duplicate
Sampled 4/22/03

IRB	SRB
4/23/03: Solution clear at ball graduating to medium greenish yellow at bottom of tube. Many small bubbles on ball and sides of tube.	4/23/03: Solution clear throughout tube. Many small bubbles on ball and sides of tube.
4/24/03: Solution medium yellow throughout. Ring of small bubbles around ball at waterline. Many small bubbles on sides of tube.	4/24/03: Same as above, except cloudy film ring around ball at waterline.
4/25/03: Solution medium yellow throughout. Ring of medium bubbles around ball at waterline. Several small bubbles on sides of tube.	4/25/03: Solution clear. Many small bubbles on sides of tube. Cloudy film ring around ball at waterline. Several very small black spots on ball.
4/26/03: Solution dark yellow throughout. Ring of medium bubbles over light brown film around ball at waterline. Several medium bubbles on sides of ball. Several small bubbles on sides of tube.	4/26/03: Solution clear. A few patches of black pinpricks on sides of ball. Cloudy film ring around top of ball at waterline. Sides of tube covered in very small bubbles.
4/27/03: Solution dark yellow/light brown throughout. Dark yellow/light brown ring of medium bubbles around ball at waterline.	4/27/03: Solution clear. Thick black film on bottom of tube. Many black pinpricks on sides of ball. Cloudy film ring around top of ball at waterline. Many small bubbles on sides of tube.
4/28/03: Solution light brown. Medium black film on bottom of tube (about 20%). Dark yellow ring of small bubbles around top of ball at waterline. Bottom of ball covered in small bubbles.	4/28/03: Solution clear. Thick cloudy film ring around top of ball at waterline. Medium black film in bottom of tube. Very thin black film on sides of ball. Many small bubbles on sides of tube.
4/29/03: Solution: dark brown Ball: 20% medium black film and medium bubbles at, and just below, waterline. Tube: 100% medium (ball) to thick (bottom) black film.	4/29/03: Solution: clear. Ball: Thick cloudy film ring at waterline, patches of thin black film on sides and bottom. Tube: 100% very thin (ball) to medium (bottom) black film
4/30/03: Ball: 95% thick (waterline) to medium (sides/bottom) black film, medium bubble ring at waterline. Tube: 100% thin (ball) to thick (bottom) black film.	4/30/03: Solution: clear. Ball: 75% thin black film (sides/bottom), thick cloudy film ring at waterline. Tube: 100% very thin (ball) to thick (bottom) black film

MW118
Sampled 4/22/03

IRB	SRB
4/23/03: Solution clear at ball graduating to medium greenish yellow at bottom of tube. Several small bubbles on sides of tube.	4/23/03: Solution slightly cloudy throughout. Cloudy film ring with hint of brown around ball at waterline. Many small bubbles on ball and sides of tube.
4/24/03: Solution medium greenish yellow throughout. A few small bubbles on sides/bottom and a ring of small bubbles around ball at waterline. Several medium bubbles on sides of tube.	4/24/03: Solution slightly cloudy throughout. Cloudy film ring with hint of brown around ball at waterline. Many small bubbles on ball and sides of tube. One small spot of very thin black film on side of ball.
4/25/03: Same as above, except solution a bit darker and the bubbles a bit larger.	4/25/03: Ball covered in thin black film. Cloudy film ring around ball at waterline. Solution slightly cloudy. A few small bubbles on bottom of ball. Many small bubbles on sides of tube.
4/26/03: Solution medium greenish yellow. Medium bubbles over light brown film ring ball at waterline. Several medium bubbles on bottom of ball. Several small bubbles on tube.	4/26/03: Solution clear. 85% of ball covered in thin black film. Medium black film ring around ball at waterline. Several small bubbles on sides of tube.
4/27/03: Same as above.	4/27/03: Same as above.
4/28/03: Solution dark yellow. Ring of medium/large bubbles around ball at waterline. Medium bubbles on bottom of ball.	4/28/03: Solution slightly cloudy. Medium black film with black flecks on sides and bottom of ball and on bottom of tube. Many small bubbles on side of tube.
4/29/03: Solution: dark yellow at ball Ball: 30% thick black film on bottom, dark yellow ring with medium bubbles at waterline. Tube: 90% thick black film (from bottom of ball to bottom of tube).	4/29/03: Solution: clear. Ball: 85% medium black film (sides and bottom), cloudy film at waterline. Tube: 100% thin (ball) to thick (bottom) black film
4/30/03: Solution: dark yellow at waterline. Ball: 80% black film - medium (sides) to thick (bottom), dark yellow ring with black spots and medium bubbles at waterline. Tube: 95% black film – thin (just under waterline) to thick (from bottom of ball to bottom of tube).	4/30/03: Solution: clear Ball: 95% medium black film - waterline, sides and bottom. Tube: 100% thin (ball) to thick (bottom) black film

794 614

MW120
Sampled 4/22/03

IRB	SRB
4/23/03: Solution clear at ball graduating to light greenish yellow at bottom of tube. Many very small bubbles on ball and sides of tube.	4/23/03: Solution clear. Many small bubbles on ball and sides of tube.
4/24/03: Solution medium greenish yellow throughout. Medium yellow ring around ball at waterline. Many small bubbles on bottom of ball and sides of tube.	4/24/03: Solution slightly cloudy. Cloudy film ring around ball at waterline. Many, but less than yesterday, small bubbles sides of tube.
4/25/03: Solution medium greenish yellow throughout. Medium yellow ring around ball at waterline. Several small/medium bubbles on bottom of ball. Many small bubbles on sides of tube.	4/25/03: Solution slightly cloudy. Thin line of black film (about ½") on one side of ball. Cloudy film ring around ball at waterline. Several small bubbles on sides of tube.
4/26/03: Same as above.	4/26/03: Solution slightly cloudy. Small area of thin black film on one side of ball. Cloudy film ring around ball at waterline. Several small bubbles on sides of tube.
4/27/03: Solution dark yellow. Dark yellow ring around ball at waterline. About 75% of ball covered in small/medium bubbles. Several medium bubbles on tube.	4/27/03: Solution cloudy. Black film on bottom of tube. Thin black film around middle of ball. Cloudy film ring around ball at waterline. Several small bubbles on sides of tube.
4/28/03: Same as above, except bubbles on ball bigger, covering about 60% of ball.	4/28/03: Same as above, except black film on ball thicker.
4/29/03: Solution: 100% medium yellow. Ball: dark yellow ring of medium bubbles at waterline, medium bubbles on bottom Tube: less than 5 bubbles on sides.	4/29/03: Solution: cloudy. Ball: 85% very thin black film with thick patches. Tube: 100% black film, very thin (ball) to thick (bottom)
4/30/03: Solution: 100% medium yellow. Ball: dark yellow ring of medium bubbles at waterline, medium bubbles on bottom. Tube: less than 5 bubbles on sides.	4/30/03: Solution: cloudy. Ball: 85% medium black film with thick patches, cloudy grey ring at waterline. Tube: 100% black film, very thin (ball) to thick (bottom).

MW122
Sampled 4/22/03

IRB	SRB
4/23/03: Solution clear at ball graduating to light yellow at middle of tube then light greenish yellow at bottom of tube. Many small bubbles on bottom of ball and sides of tube.	4/23/03: Solution clear. Many small bubbles on bottom of ball and sides of tube.
4/24/03: Solution light yellow at ball graduating to greenish medium yellow at bottom of tube. Ring of medium bubbles around ball at waterline. Small bubbles on bottom of ball and sides of tube.	4/24/03: Solution slightly cloudy. One small area (10%) of very thin black film on side of ball. Cloudy film ring around ball at waterline. Many small bubbles sides of tube.
4/25/03: Solution medium greenish yellow. 90% of ball covered with small/medium bubbles. Many small bubbles on sides of tube.	4/25/03: Solution clear. Thin black film rings ball just below waterline. Many small bubbles on bottom of ball and sides of tube.
4/26/03: Solution dark yellow/light brown at ball, dark greenish yellow at bottom of tube. Medium thick black film on bottom of ball. Thin black film on sides of tube. About 75% of ball covered in small/medium bubbles.	4/26/03: Solution clear. Thin black film on 85% of ball. Cloudy film ring around ball at waterline. Many small bubbles on tube.
4/27/03: Thick black film on bottom of ball, sides/bottom of tube. Dark yellow ring of small bubbles around ball at waterline.	4/27/03: Solution clear. Medium black film with black flecks on 85% of ball. Thick black film on bottom of tube. Many small bubbles on side of tube.
4/28/03: Solution: dark yellow at and just below waterline. Ball: 35% thick black film on bottom, dark yellow ring of small bubbles at waterline. Tube: 90% thick black film (from bottom of ball to bottom of tube).	4/28/03: Solution: clear. Ball: 85% medium black film (small patches of very thin black film), cloudy film ring at waterline. Tube: 100% very thin (ball) to thick (bottom) black film, many small bubbles.
4/29/03: Solution: dark yellow at and just below waterline. Ball: 60% thick black film on sides/bottom, dark yellow ring of small bubbles at waterline. Tube: 95% thick black film (from middle of ball to bottom of tube).	4/29/03: Solution: clear. Ball: 85% medium black film with patches of thin, cloudy film ring at waterline. Tube: 100% very thin (ball) to thick (bottom) black film, many small bubbles.
4/30/03: Solution: dark yellow at and just below waterline. Ball: 60% thick black film from middle down, dark yellow ring of small bubbles at waterline. Tube: 95% thick black film (from middle of ball to bottom of tube).	4/30/03: Solution: clear. Ball: 85% medium black film with patches of thin, cloudy film ring at waterline. Tube: 100% very thin (ball) to thick (bottom) black film, many small bubbles.

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MW105
Sampled 4/23/03

IRB	SRB
4/24/03: Water in outer tube is light yellow. Inner tube solution light yellow at ball graduating to light brown at bottom of tube. No bubbles.	4/24/03: Water in outer tube is light yellow. Inner tube solution clear, light yellow. No bubbles.
4/25/03: Solution clear at ball graduating to medium yellow then light brown at bottom of tube. No bubbles.	4/25/03: Solution clear. No bubbles. Cloudy film ring around ball at waterline.
4/26/03: Water in outer tube is dark yellow, almost brown. Solution in tube dark yellow. Darker/greenish in bottom of tube. No bubbles.	4/26/03: Water in outer tube is dark yellow. Solution clear. No bubbles. Cloudy film ring around ball at waterline. Thin black film covering 30% of tube at bottom.
4/27/03: Same as above.	4/27/03: Same as above, except a small patch of black film on side of ball.
4/28/03: Same as above.	4/28/03: Thick black film on bottom of tube. Thin black film on sides of tube. Thin black film on bottom of ball.
4/29/03: Solution: dark yellow. Ball: ring of small bubbles at waterline, medium bubbles on bottom.	4/29/03: Solution: clear. Ball: 30% medium black film on bottom; cloudy film ring at waterline. Tube: 90% very thin (ball) to medium (bottom) black film (from bottom of ball to bottom of tube).
4/30/03: Solution: dark yellow. Ball: ring of medium bubbles at waterline, medium bubbles on bottom.	4/30/03: Solution: clear. Ball: 70% medium black film on sides/bottom and at waterline. Tube: 100% very thin (ball) to medium (bottom of ball to bottom of tube) black film.
5/1/03: No change.	5/1/03: Solution: clear. Ball: 95% medium black film from waterline down. Tube: 100% medium black film.

MW112
Sampled 4/23/03

IRB	SRB
4/24/03: Solution: outer tube: dark yellow, inner tube: clear, not much darker than outer tube. Water in outer tube is dark yellow, almost brown. Solution clear, dark yellow/light brown at ball. Dark greenish yellow at bottom of tube. No bubbles.	4/24/03: Water in outer tube is dark yellow, almost brown. Solution clear, dark yellow. A few bubbles on sides of tube.
4/25/03: Same as above.	4/25/03: Same as above. Cloudy film ring around top of ball at waterline.
4/26/03: Solution: outer tube: dark yellow, inner tube: clear, not much darker than outer tube. Inner tube darker at bottom.	4/26/03: Water in outer tube is dark yellow, almost brown. Solution clear. 20% of tube, at bottom, covered in thin black film. Cloudy film ring around ball at waterline. One small area of thin black film.
4/27/03: Same as above.	4/27/03: Thick black film on bottom/sides of tube. Medium black film on sides of tube, sides and bottom of ball.
4/28/03: Same as above.	4/28/03: Thick black film on sides and bottom of tube and sides/bottom of ball.
4/29/03: Solution: outer tube: dark yellow, inner tube: clear, not much darker than outer tube. Ball: small bubble ring at waterline. A few medium bubbles on bottom. Tube: clear.	4/29/03: Solution: clear. Ball: 85% thick black film, cloudy film ring with black flecks at waterline. Tube: 90% thick black film (from bottom of ball to bottom of tube).
4/30/03: Solution: outer tube: dark yellow, inner tube: clear, not much darker than outer tube. Ball: Several spots of medium black film on sides/bottom, small bubble ring with spots of black film at waterline, several medium bubbles on sides/bottom. Tube: Several medium bubbles on sides.	4/29/03: Solution: clear. Ball: 90% thick black film, cloudy film ring with black spots at waterline. Tube: 100% medium (ball) to thick (bottom of ball to bottom of tube) black film.
5/1/03: Ball: 90%. Patchy medium to thin black film from waterline down, black film ring of medium bubbles at waterline. Tube: 95%. Thick black film on sides from middle of ball down.	5/1/03: Solution: clear. Ball: 95%. thick black film from waterline down, cloudy film ring rimmed with black film at waterline. Tube: 100%. medium (ball) to thick (bottom of ball to bottom of tube) black film.

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MW113
Sampled 4/23/03

IRB	SRB
4/24/03: Solution clear at ball graduating to light yellow then light greenish yellow at bottom of tube. No bubbles.	4/24/03: Solution clear. A few small bubbles on bottom of ball and sides of tube. Cloudy film ring around ball at waterline.
4/25/03: Same as above, except a few small bubbles sides and around ball at waterline and sides of tube.	4/25/03: Solution clear. Bubbles larger on bottom of ball and sides of tube. Cloudy film ring thicker around ball at waterline.
4/26/03: Solution medium yellow throughout. Medium yellow with medium bubbles ring around ball at waterline. Medium bubbles on bottom of ball.	4/26/03: Solution clear throughout. About four small bubbles on bottom of ball. One small area and several pinpricks of black on sides of ball.
4/27/03: Solution medium yellow throughout. Medium yellow film with small/medium bubble ring around ball at waterline. 70% of ball covered with medium bubbles.	4/27/03: Solution clear. Cloudy film ring around top of ball at waterline. Thin black film with black spots on sides/bottom of ball. A few medium bubbles on tube.
4/28/03: Same as above.	4/28/03: Same as above.
4/29/03: Solution: 100% light brown, cloudy. Ball: 50% medium brown ring of small/medium bubbles at waterline and on bottom. Tube: clear.	4/29/03: Solution: clear. Ball: 80% very thin black film, cloudy film ring rimmed in black at waterline. Tube: 2% black film (on very bottom).
4/30/03: Solution: 100% dark brown, clear. Ball: 75% dark brown ring of small/medium bubbles at waterline and on bottom. Tube: clear.	4/30/03: Solution: cloudy. Ball: 90% thin black film, cloudy film ring rimmed in black at waterline. Tube: 100% very thin (ball) to medium (on very bottom) black film.
5/1/03: no change	5/1/03: Solution: cloudy. Ball: 90% thin black film, cloudy film ring rimmed in black at waterline. Tube: 100% very thin (ball) to medium (on very bottom) black film.

MW124
Sampled 4/23/03

IRB	SRB
4/24/03: Solution clear at ball graduating to medium greenish yellow at bottom of tube. A few small bubbles on bottom of ball and sides of tube.	4/24/03: Solution clear throughout tube. Many small bubbles on bottom of ball and sides of tube. Cloudy film ring around ball at waterline.
4/25/03: Solution clear at ball graduating to medium greenish yellow at bottom of tube. Medium bubble ring around ball at waterline. Many small/medium bubbles on bottom of ball and sides of tube.	4/25/03: Solution clear throughout tube. Very thin black film with black pinpricks on one side (10%) of ball. Many small bubbles on bottom of ball and sides of tube. Cloudy film ring around ball at waterline.
4/26/03: Solution dark yellow at ball graduating to medium greenish yellow at bottom of tube. 80% of ball covered in medium bubbles. Many medium bubbles on sides of tube.	4/26/03: Same as above.
4/2703: Solution dark yellow at ball graduating to dark greenish yellow at bottom of tube. Ring (about ¼" wide) of medium black film around middle of tube. Ring of medium bubbles around ball at waterline and on bottom of ball (about 60%). Several medium bubbles on sides of tube.	4/27/03: Solution clear. Cloudy film around top of ball at waterline. Thin black film with black spots around middle of ball just under waterline. Several small bubbles on bottom of ball. Many small bubbles on tube.
4/28/03: Solution dark yellow/light brown. Thin black film band (about ¼") on sides of tube just under ball. Dark yellow ring of medium bubbles around top of ball at waterline.	4/28/03: Thick black film on bottom of tube. Medium black film on sides of tube. Cloudy film ring with black flecks around top of ball at waterline. Sides of tube covered in small bubbles.
4/29/03: Solution: light brown (ball) to dark yellow (bottom of tube), clear. Ball: 25% medium black film with thicker patches sides/bottom, many medium bubbles on sides/bottom, light brown ring of small bubbles at waterline. Tube: black film 90% - thick (bottom of ball) to very thin (bottom of tube)	4/29/03: Solution: clear. Ball: 20% thin black film just under waterline, cloudy film ring at waterline. Tube: 10% black film on very bottom, many small bubbles on sides.
4/30/03: Solution: medium brown (at and just under waterline), clear. Ball: 50% medium black film with thicker patches (sides/bottom), many medium bubbles on sides/bottom, light brown ring with black spots and small bubbles at waterline. Tube: 90% black film - thick (bottom of ball to bottom of tube.	4/30/03: Solution: clear. Ball: 90% thin black film (waterline to bottom). Tube: 100% thin (waterline) to thick (bottom) black film, many small bubbles on sides.

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5/1/03: Solution: medium brown (at and just under waterline), clear. Ball: 50%. medium black film with thicker patches and medium bubbles from middle down, dark brown ring rimmed with black and a few small bubbles at waterline. Tube: 90%. thick black film from bottom of ball to bottom of tube.	5/1/03: Solution: clear. Ball: 95% thin black film from waterline down, thicker around middle, medium black film at waterline. Tube: 100%. thin (waterline) to thick (bottom) black film, many small bubbles on sides.

POST INJECTION EVENT #11

MW110
Sampled 5/19/03

IRB	SRB
5/20/03: Solution: clear at ball graduating to light yellow at bottom of tube. Ball: Light yellow ring at waterline. A few bubbles at waterline and on bottom. Tube: A few bubbles near bottom.	5/20/03: Solution clear throughout tube. No bubbles.
5/21/03: Solution: medium yellow throughout tube. Ball: light yellow ring at waterline, 80% small bubbles. Tube: Several medium bubbles near bottom.	5/21/03: Solution: clear. Ball: Cloudy film ring at waterline; no bubbles. Tube: A few small bubbles near bottom.
5/22/03: Solution: brown. Ball: 50% thick black film and large bubbles; ring of small bubbles with black spots at waterline. Tube: 90% thin black film on sides; medium black film on bottom.	5/22/03: Solution: clear. Ball: 40% thin black film with thicker spots on sides and bottom; cloudy film ring at waterline; no bubbles. Tube: A few small bubbles near bottom.
5/23/03: Same as above, except film thicker on sides of tube.	5/23/03: Same as above, except more bubbles at bottom of tube.
5/24/03: Same as above, except brown film with black spots and small/medium bubbles on ball at waterline.	5/24/03: Solution: clear. Ball: 50% thin black film with thicker spots on sides and bottom; cloudy film ring at waterline; bubbles on bottom. Tube: Several small bubbles near bottom.
5/25/03: Ball: 90% thick black film; dark brown film with black spots and ring of small/medium bubbles at waterline. Tube: 95% thick black film.	5/25/03: Solution: clear, but discolored (pale greenish yellow). Ball: Same as above. Tube: Black film on bottom; several small bubbles near bottom.
5/26/03: Same as above.	5/26/03: Solution: clear. Ball: 50% thin black film with thicker spots on sides and bottom; thick cloudy film ring at waterline; bubbles at waterline and on bottom. Tube: 90% thin black film on sides.
5/27/03: Same as above.	5/27/03: Solution clear. Ball: 50% medium black film (ring at waterline and on bottom). Tube: 90% black film (thin at ball to thick at bottom).

MW 110D
Sampled 5/19/03

IRB	SRB
5/20/03: Solution: clear at ball graduating to light yellow. Ball: A few small bubbles at waterline and on bottom. Tube: A few small bubbles near bottom.	5/20/03: Solution: clear. Ball: clear. Tube: clear.
5/21/03: Solution: light yellow throughout. Ball: 70% small bubbles, light yellow ring at waterline. Tube: A few small bubbles near bottom.	5/21/03: Solution: clear. Ball: Cloudy film ring at waterline. Tube: About 5 small bubbles near bottom.
5/22/03: Solution: medium brown. Ball: 50% medium black film on bottom, medium bubbles at waterline. Tube: 80% thin black film on sides and bottom.	5/22/03: Solution clear. Ball: Several small black spots on bottom, cloudy film ring at waterline. Tube: Same as above.
5/23/03: Solution: medium brown. Ball: 60% medium black film (on bottom and mixed in the medium brown ring of medium bubbles at waterline). Tube: 90% medium black film.	5/23/03: Solution clear. Ball: 10% thin black film with small thicker spots on bottom, cloudy film ring with small/medium bubbles at waterline. Tube: Black film on bottom and about 5 small bubbles on sides near bottom.
5/24/03: Same as above.	5/24/03: Same as above.
5/25/03: Same as above.	5/25/03: Solution clear. Ball: 80% thin black film (black ring at waterline and thin film with spots on bottom). Tube: Black film on bottom.
5/26/03: Same as above.	5/26/03: Solution clear. Ball: 80% thin black film (black ring at waterline and thin film with spots on bottom). Tube: 90% thin black film.
5/27/03: Same as above.	5/27/03: Solution clear. Ball: 90% black film (thin ring at waterline to thick on bottom). Tube: 90% black film (thin at ball to thick on bottom).

MW114 – Solution in outer tube medium yellow
Sampled 5/20/03

IRB (Red)	SRB (Black)
5/21/03: Solution: very light yellow at ball graduating to medium greenish yellow at bottom of tube. Ball: Clear. Tube: Clear.	5/21/03: Solution: clear. Ball: Clear. Tube: Clear.
5/22/03: Solution: clear, pale greenish yellow. Ball: clear Tube: clear	5/22/03: Solution: clear light yellow. Ball: clear. Tube: clear
5/23/03: Same as above.	5/23/03: Same as above.
5/24/03: Solution: yellow. Ball: ring of large bubbles at waterline, small/medium bubbles on bottom. Tube: A few tiny bubbles on sides.	5/24/03: Solution: clear, brownish. Ball: Several medium bubbles at waterline. Tube: Black film on bottom, many small bubbles on sides.
5/25/03: Solution dark greenish yellow. Ball: ring of large bubbles at waterline, small/medium bubbles on bottom. Tube: A few tiny bubbles on sides.	5/25/03: Solution clear. Ball: 25% thin black film on bottom, several medium bubbles at waterline. Tube: 90% thin black film (sides and bottom) with many small bubbles.
5/26/03: Same as above.	5/26/03: Solution clear. Ball: 25% thick black film (on bottom and spots in medium bubble ring at waterline). Tube: 90% thin black film (sides and bottom) with many small bubbles.
5/27/03: Same as above.	5/27/03: Solution clear. Ball: 90% thick black film. Tube: 90% thick black film.
5/28/03: Same as above. No brown or black film on ball or tube.	5/28/03: Same as above.

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MW116
Sampled 5/20/03

IRB	SRB
5/21/03: Solution: clear at ball graduating to light greenish yellow at bottom of tube. Ball: A few very small bubbles on bottom. Tube: 90% very small bubbles on sides.	5/21/03: Solution: clear. Ball: 40% very small bubbles on bottom. Tube: 95% very small bubbles on sides.
5/22/03: Solution: light yellow. Ball: A few very small bubbles at waterline and on bottom. Tube: 90% very small bubbles on sides.	5/22/03: Solution clear. Ball: 40% very small bubbles on bottom. Tube: 95% very small bubbles on sides.
5/23/03: Solution: clear at ball graduating to light greenish yellow at bottom of tube. Ball: 70% bubbles (small/medium at waterline, small on bottom). Tube: 90% very small bubbles on sides.	5/23/03: Solution clear. Ball: Many very small black spots on sides/bottom, cloudy film ring at waterline, 25% bubbles (very small on bottom). Tube: 95% very small bubbles on sides.
5/24/03: Solution: dark yellow. Ball: 70% bubbles (thick ring of medium at waterline, small on bottom). Tube: 90% bubbles, very small on sides.	5/24/03: Solution clear. Ball: Many very small black spots on sides/bottom, cloudy film ring at waterline, 25% bubbles (very small on bottom). Tube: 95% very small bubbles on sides.
5/25/03: Solution: dark yellow/light brown. Ball: 70% bubbles (medium at waterline and on bottom). Tube: 80% small bubbles on sides.	5/25/03: Solution clear. Ball: Many very small black spots on sides/bottom, cloudy film ring at waterline, 25% bubbles (very small on bottom). Tube: 95% very small bubbles on sides.
5/26/03: Solution: medium brown. Ball: Thin brown film on ring of small bubbles at waterline. Tube: 90% thin black film (sides and bottom).	5/26/03: Solution clear. Ball: 80% thin black film with small black spots on sides/bottom, cloudy film ring at waterline. Tube: Thick black film on bottom, 95% very small bubbles on sides.
5/27/03: Solution: dark brown Ball: 15% thick black ring at waterline Tube: 90% black film (medium at ball to thick at bottom). .	5/27/03: Solution: clear Ball: 85% thin black film with small black spots on sides/bottom, cloudy film ring at waterline. Tube: 90% black film (thin at ball to thick on bottom), 95% very small bubbles on sides.
5/28/03: Solution: dark brown. Ball: 70% thin black film on sides, thick black film ring with small bubbles at waterline. Tube: 90% thick black film.	5/28/03: Solution clear: Ball: 85% thin black film with small black spots on sides/bottom, cloudy film ring at waterline. Tube: 90% black film (thin at ball to thick on bottom), 95% very small bubbles on sides.

MW116 Duplicate
Sampled 5/20/03

IRB	SRB
5/21/03: Solution: Clear at ball graduating to medium greenish yellow at bottom of tube. Ball: One small bubble on side. Tube: 70% small bubbles on sides.	5/21/03: Solution: Clear. Ball: 40% small bubbles on sides. Tube: 70% small bubbles on sides.
5/22/03: Solution medium yellow throughout. Ball: Small bubble ring at waterline. Tube: 100% small bubbles on sides.	5/22/03: Solution: Clear. Ball: 40% small bubbles on sides. Tube: 70% small bubbles on sides.
5/23/03: Solution medium yellow throughout. Ball: 25% small/medium bubbles, ring at waterline and on bottom. Tube: 100% small/medium bubbles on sides.	5/23/03: Solution: Clear. Ball: 50% small/medium bubbles on sides and at waterline. Tube: 80% small bubbles on sides.
5/24/03: Solution dark yellow. Ball: Cloudy film ring at waterline. Tube: 100% small bubbles on sides.	5/24/03: Solution: Clear yellow. Ball: 50% small bubbles on sides and at waterline. Tube: 90% small bubbles on sides.
5/25/03: Solution dark yellow/light brown throughout. Ball: 30% small/medium bubbles, at waterline and bottom. Dark yellow/light brown film at waterline. Tube: Black film on bottom and sides at bottom of tube. 100% small bubbles on sides.	5/25/03: Solution: Clear. Ball: Cloudy film ring at waterline, many black pinpricks on sides. 20% small bubbles on bottom. Tube: Thick black film on bottom, 30% small bubbles sides.
5/26/03: Solution light brown. Ball: Same as above. Tube: 90% medium black film	5/26/03: Solution: Clear. Ball: Thick cloudy film ring at waterline, patches of thin black film on sides. 20% small bubbles on bottom. Tube: Thick black film on bottom, 30% small bubbles sides.
5/27/03: Solution: dark brown Ball: 20% medium black film and medium bubbles at, and just below, waterline. Tube: 90% medium (ball) to thick (bottom) black film.	5/27/03: Solution: clear. Ball: Thick cloudy film ring at waterline, patches of thin black film on sides and bottom. Tube: 100% very thin (ball) to medium (bottom) black film
5/28/03: Ball: 80% black film, thick black and brown ring with medium bubbles at waterline. Thick on bottom. Tube: 90% thick black film.	5/28/03: Solution: clear. Ball: 80% black film, thin (sides) to thick (bottom), thick cloudy film ring rimmed with black at waterline. Tube: 100% black film, very thin (ball) to thick (bottom)

MW118
Sampled 5/20/03

IRB	SRB
5/21/03: Solution: Clear at ball graduating to medium greenish yellow at bottom of tube. Ball: 5% small bubbles near bottom. Tube: 70% small bubbles on sides.	5/21/03: Solution: Slightly cloudy. Ball: 40% small bubbles on bottom and sides. Tube: 80% small bubbles on sides.
5/22/03: Solution medium greenish yellow throughout. Ball: A few small bubbles on sides/bottom and a ring of small bubbles at waterline. Tube: 75% small bubbles on sides.	5/22/03: Solution clear pale yellow. Many small bubbles on ball and sides of tube.
5/23/03: Same as above, except solution a bit darker, bubbles on ball a bit larger and 100% of tube sides in small bubbles.	5/23/03: Ball covered in thin black film. Cloudy film ring around ball at waterline. Solution slightly cloudy. A few small bubbles on bottom of ball. Many small bubbles on sides of tube.
5/24/03: Solution light yellow. Ball: Medium bubbles with brown film at waterline. 85% small/medium bubbles. Tube: 85% small bubbles.	5/24/03: Solution clear. Ball: 85% thin black film. Medium cloudy film ring at waterline. Tube: 90% small bubbles on sides of tube.
5/25/03: Solution light yellow. Ball: 30% black film on bottom, dark yellow/light brown film at waterline. 85% small/medium bubbles at waterline and on bottom. Tube: 90% black film with small bubbles.	5/25/03: Same as above.
5/26/03: Solution dark yellow at ball. Ball: 30% black film on bottom, dark yellow/light brown film at waterline. 85% small/medium bubbles at waterline and on bottom. Tube: 90% black film with small bubbles.	5/26/03: Solution clear. Ball: 75% medium black film with black flecks on sides and bottom. Tube: Black film on bottom of tube. Many small bubbles on side of tube.
5/27/03: Solution: dark yellow at ball Ball: 30% thick black film on bottom, dark yellow/light brown ring with medium bubbles at waterline. Tube: 90% thick black film (from bottom of ball to bottom of tube).	5/27/03: Solution: clear. Ball: 90% medium black film, black film at waterline. Tube: 100% thin (ball) to thick (bottom) black film
5/28/03: Solution: dark yellow at waterline. Ball: 80% black film - medium (sides) to thick (bottom), dark yellow ring with black spots and medium bubbles at waterline. Tube: 95% black film.	5/28/03: Solution: clear Ball: 95% medium black film - waterline, sides and bottom. Tube: 100% thin (ball) to thick (bottom) black film

MW120
Sampled 5/20/03

IRB	SRB
5/21/03: Solution: Clear at ball graduating to medium greenish yellow at bottom of tube. Ball: 5% small bubbles on bottom. Tube: 70% small bubbles on sides.	5/21/03: Solution: slightly cloudy. Ball: 5% small bubbles near bottom. Tube 70% small bubbles on sides.
5/22/03: Solution medium greenish yellow throughout. Medium yellow ring around ball at waterline. Many small bubbles on bottom of ball and sides of tube.	5/22/03: Solution slightly cloudy. Ball: 60% thin black film and small bubbles. Tube: 90% small bubbles.
5/23/03: Solution medium greenish yellow throughout. Ball: Medium yellow ring and small bubbles at waterline. Many small/medium bubbles on bottom of ball. Tube: 90% small bubbles on sides.	5/23/03: Solution slightly cloudy and pale yellow. Ball: 85% thin black film. Cloudy film ring at waterline. Tube: 90% small bubbles.
5/24/03: Solution medium greenish yellow throughout. Ball: Medium yellow ring and small bubbles at waterline. Many small/medium bubbles on bottom of ball. Tube: Black film on bottom. 90% small bubbles on sides.	5/24/03: Same as above.
5/25/03: Solution dark yellow. Ball: Dark yellow ring around of small bubbles at waterline. 50% small/medium bubbles. Tube: 90% black film and small bubbles.	5/25/03: Solution slightly cloudy and pale yellow. Ball: 85% thin black film. Cloudy film ring at waterline. Tube: Black film on bottom. 90% small bubbles.
5/26/03: Same as above.	5/26/03: Same as above.
5/27/03: Solution dark yellow. Ball: 25% thin black film on bottom, brown ring of small bubbles at waterline. 50% small/medium bubbles. Tube: 90% black film and small bubbles.	5/27/03: Solution: cloudy. Ball: 85% thin black film with thick patches, cloudy film ring at waterline. Tube: 100% black film, very thin (ball) to thick (bottom)
5/28/03: Sane as above.	5/28/03: Solution: cloudy. Ball: 90% medium black film with thick patches, black ring at waterline. Tube: 100% black film, very thin (ball) to thick (bottom).

MW122
Sampled 5/20/03

IRB (Red)	SRB (Black)
5/21/03: Solution: Clear at ball graduating to medium greenish yellow at bottom of tube. Ball: 10% small bubbles on bottom. Tube: 70% small bubbles on sides.	5/21/03: Solution: Clear. Ball: 5% small bubbles on bottom. Tube: 70% small bubbles on sides.
5/22/03: Solution: light yellow. Ball: 10% small bubbles on bottom. Tube: 100% small bubbles on sides.	5/22/03: Solution: Clear. Ball: 50% small bubbles on sides/bottom. Tube: 100% small bubbles on sides.
5/23/03: Solution medium greenish yellow. Ball: 40% of ball covered with small/medium bubbles. Tube: 100% small bubbles on sides.	5/23/03: Solution: Clear. Ball: Cloudy film ring at waterline. Many black pinpricks on sides. 25% small bubbles on bottom. Tube: 100% small bubbles on sides.
5/24/03: Solution greenish yellow. Ball: 75% small/medium bubbles (at waterline and on bottom). Tube: 100% small bubbles.	5/24/03: Solution: Clear. Ball: 60% thin black film on sides and bottom. Cloudy film ring at waterline. 25% small bubbles on bottom. Tube: 100% small bubbles on sides.
5/25/03: Solution dark yellow. Ball: 90% small/medium bubbles (at waterline and on bottom), dark yellow ring at waterline. Tube: 100% small/medium bubbles.	Solution: Clear. Ball: 60% medium black film on sides and bottom. Cloudy film ring at waterline. 25% small bubbles on bottom. Tube: 100% small bubbles on sides.
5/26/03: Solution: dark yellow/light brown. Ball: 35% black spots on bottom, dark yellow ring of small bubbles at waterline. Tube: 90% thick black film (from bottom of ball to bottom of tube).	5/26/03: Solution: clear. Ball: 85% medium black film (small patches of very thin black film), cloudy film ring at waterline. Tube: 90% thick black film, many small bubbles.
5/27/03: Solution: dark yellow at and just below waterline. Ball: 60% thick black film on sides/bottom, dark yellow ring of small bubbles at waterline. Tube: 95% thick black film (from middle of ball to bottom of tube).	5/27/03: Solution: clear. Ball: 85% medium black film with patches of thin, cloudy film ring at waterline. Tube: 100% very thin (ball) to thick (bottom) black film, many small bubbles.
5/28/03: Solution: dark yellow at and just below waterline. Ball: 60% thick black film from middle down, dark yellow ring of small bubbles at waterline. Tube: 95% thick black film (from middle of ball to bottom of tube).	5/28/03: Solution: clear. Ball: 85% medium black film with patches of thin, cloudy film ring at waterline. Tube: 100% very thin (ball) to thick (bottom) black film, many small bubbles.

MW124
Sampled 5/20/03

IRB	SRB
5/21/03: Solution: Clear at ball graduating to medium greenish yellow at bottom of tube. Ball: 5% small bubbles on bottom. Tube: 50% small bubbles on sides.	5/21/03: Solution: Clear. Ball: 50% small bubbles on bottom and sides. Tube: 40% small bubbles on sides.
5/22/03: Solution: Clear at ball graduating to medium greenish yellow at bottom of tube. Ball: 10% small bubbles on bottom. Tube: 70% small bubbles on sides.	5/22/03: Solution: Clear. Ball: 50% small bubbles on bottom and sides. Tube: 80% small bubbles on sides.
5/23/03: Solution: Medium yellow. Ball: 20% small bubbles on bottom. Tube: 70% small bubbles on sides.	5/23/03: Solution: Clear. Ball: 25% small bubbles and black pinprick size spots. Cloudy film at waterline. Tube: 80% small bubbles.
5/2403: Solution: Medium yellow. Ball: 60% medium bubbles (at waterline and on bottom). Tube: 80% small/medium bubbles on sides.	5/24/03: Solution clear. Ball: 25% thin black film with black pinprick size spots (one side) and small bubbles (bottom). Cloudy film at waterline. Tube: 90% small bubbles on sides.
5/25/03: Solution: Cloudy yellow. Ball: 85% medium/large bubbles (at waterline and on bottom). Dark yellow film at waterline. Tube: 90% small bubbles.	5/25/03: Same as above.
5/26/03: Solution: Clear medium yellow. Ball: 25% medium black film with thicker patches sides/bottom, many medium bubbles on sides/bottom, light brown ring of small bubbles at waterline. Tube: 90% small bubbles.	5/26/03: Solution: clear. Ball: Same as above. Tube: 5% thin black film (bottom). 90% small bubbles (sides).
5/27/03: Solution: medium brown, clear. Ball: 50% medium black film with thicker patches (sides/bottom), many medium bubbles on sides/bottom, light brown ring with black spots and small bubbles at waterline. Tube: 90% thick black film.	5/27/03: Solution: clear. Ball: 90% thin black film (sides/bottom), black film at waterline. Tube: 100% thin (waterline) to thick (bottom) black film and small bubbles on sides.
5/28/03: Same as above.	5/28/03: Same as above.

MW105
Sampled 5/21/03

IRB	SRB
5/22/03: Solution: light yellow. Ball: clear. Tube: clear.	5/22/03: Solution: clear, light yellow. Ball: clear. Tube: 2% small bubbles.
5/23/03: Solution: light yellow. Ball: clear. Tube: clear.	5/23/03: Solution: clear, light yellow. Ball: clear. Tube: clear.
5/24/03: Solution: light yellow. Ball: clear. Tube: clear.	5/24/03: Solution: clear, light yellow. Ball: 2% thin black pinprick size spots on one side. Tube: clear.
5/25/03: Same as above.	5/25/03: Same as above.
5/26/03: Same as above.	5/26/03: Solution: clear, light yellow. Ball: 2% thin black pinprick size spots on one side. Tube: 2% black flecks on bottom.
5/27/03: Same as above.	5/27/03: Solution: clear. Ball: 30% thin black film (sides/bottom); cloudy film at waterline. Tube: 20% thin black film at bottom.
5/28/03: Solution: dark yellow. Ball: clear. Tube: clear.	5/28/03: Same as above.
5/1/03: Same as above.	5/1/03: Solution: clear. Ball: 30% thin black film (sides/bottom), cloudy film at waterline. Tube: 50% thin black film (at ball and at bottom, not in the middle).

MW112
Sampled 5/21/03

IRB	SRB
5/22/03: Solution: clear, light yellow. Ball: clear. Tube: clear	5/22/03: Solution: clear, pale yellow. Ball: 1 to 2 bubbles on bottom. Tube: clear.
5/23/03: Same as above.	5/23/03: Solution: clear, pale yellow. Ball: clear. Tube: 50% thin black film on sides.
5/24/03: Same as above.	5/24/03: Solution: cloudy, pale yellow. Ball: cloudy film at waterline. Tube: 50% thin black film on sides.
5/25/03: Same as above.	5/25/03: Solution: clear, pale yellow. Ball: 25% thin black film on bottom, cloudy film at waterline. Tube: 90% medium to thick black film on sides/bottom.
5/26/03: Same as above.	5/26/03: Same as above.
5/27/03: Same as above.	5/27/03: Solution: clear, pale yellow. Ball: 90% thick black film (sides/bottom), cloudy film with black spots at waterline. Tube: 90% medium to thick black film on sides/bottom.
5/28/03: Solution: dark yellow. Ball: clear. Tube: clear.	5/28/03: Same as above.
5/29/03: Solution: dark yellow. Ball: 5% thin black film with spots of medium at waterline. Tube: clear.	5/29/03: Same as above.

MW113
Sampled 5/21/03

IRB	SRB
5/22/03: Solution: clear, light yellow. Ball: 2 small bubbles and 2 small black spots. Tube: clear.	5/22/03: Solution clear. Ball: clear. Tube: 10% small bubbles on sides.
5/23/03: Solution: clear, light yellow. Ball: 30% small/medium bubbles (waterline, bottom). Tube: clear.	5/23/03: Solution cloudy. Ball: cloudy film at waterline. Tube: 10% small bubbles on sides.
5/24/03: Solution: cloudy, medium yellow. Ball: 30% small/medium bubbles (waterline, bottom). Medium yellow/light brown ring at waterline. Tube: 10% small bubbles at bottom.	5/24/03: Solution clear. Ball: About four small bubbles at waterline, cloudy film at waterline. Tube: 10% small bubbles on sides.
5/25/03: Solution: clear, light yellow. Ball: 25% thin black film (bottom). 90% small/medium bubbles. Brown film with medium bubbles at waterline. Tube: 10% black film (bottom).	5/25/03: Solution clear. Ball: 5% thin black film, cloudy film ring at waterline, 5% small bubbles. Tube: A few medium bubbles on tube.
5/26/03: Solution: clear, dark yellow. Ball: 25% thin black film (bottom). 90% small/medium bubbles. Brown film with medium bubbles at waterline. Tube: 90% thin black film.	5/26/03: Same as above.
5/27/03: Solution: light brown, cloudy. Ball: 50% black film (sides/bottom). Medium brown ring of small/medium bubbles at waterline. Tube: 90% thick black film.	5/27/03: Solution: clear. Ball: 80% very thin black film with thicker spots, cloudy film ring rimmed in black at waterline. Tube: 2% black film (on very bottom).
5/28/03: Same as above.	5/28/03: Solution: clear. Ball: 90% thin black film, cloudy film ring rimmed in black at waterline. Tube: 100% very thin (ball) to medium (on very bottom) black film.
5/29/03: Same as above.	5/29/03: Solution: clear. Ball: 90% thin black film, cloudy film ring rimmed in black at waterline. Tube: 100% very thin (ball) to medium (on very bottom) black film.

POST SAMPLING EVENT #12

MW110
Sampled 6/23/03

IRB	SRB
6/24/03: Solution: clear at ball graduating to medium yellow at bottom of tube. Ball: Light yellow ring of small bubbles at waterline. 10% small bubbles on sides and bottom. Tube: 5% small bubbles on sides, mostly at bottom.	6/24/03: Solution clear throughout tube. No bubbles. About 10 pinprick size black spots.
6/25/03: Solution: light brown. Ball: 20% thick black film on sides; large/medium bubbles on bottom; medium yellow ring with small bubbles at waterline. Tube: Black film on very bottom. No bubbles.	6/25/03: Solution: clear. Ball: 85% thin black film with thicker spots; cloudy film ring at waterline; no bubbles. Tube: Clear.
6/26/03: Solution: brown. Ball: 60% thick black film and large bubbles (sides/bottom); dark yellow ring of small bubbles with brown spots at waterline. Tube: 40% medium black film (at ball and on bottom.	6/26/03: Solution: clear. Ball: 85% thin black film with thicker spots; cloudy film ring at waterline; no bubbles. Tube: 10% thin black film at ball; a few black spots on bottom.
6/27/03: Solution: brown. Ball: 60% thick black film and large bubbles (sides/bottom); dark yellow ring of small bubbles with brown spots at waterline. Tube: 95% thick black film.	6/27/03: Solution: clear. Ball: 85% thin black film with thicker spots; cloudy film ring at waterline; no bubbles. Tube: 100% thin black film, thick in bottom; no bubbles.
6/28/03: Solution: brown. Ball: 65% thick black film; large bubbles on bottom; black film mixed into dark yellow ring of small bubbles at waterline. Tube: 95% thick black film.	6/28/03: Solution: clear. Ball: 95% medium black film; black film ring at waterline; a few small bubbles on sides/bottom. Tube: 100% black film, medium at ball, thick in bottom; no bubbles.
6/29/03: Ball: 95% black film, thin on sides, thick on bottom; black film and small/medium bubbles at waterline. Tube: 95% thick black film.	6/29/03: Solution: clear. Ball: 98% medium black film; black film ring at waterline; a few small bubbles on sides/bottom. Tube: 100% black film, medium at ball, thick in bottom; no bubbles.
6/30/03: Ball: 95% thick black film, a few bubbles at waterline. Tube: 100% thick black film.	6/30/03: Same as above, except film on ball and tube thicker.
6/31/03: Same as above.	6/31/03: Same as above.

MW 110D
Sampled 6/23/03

IRB	SRB
6/24/03: Solution: clear at ball graduating to medium yellow at bottom. Ball: Light yellow and small bubble ring at waterline. 5% small bubbles on sides and bottom. Tube: 5% small bubbles on sides.	6/24/03: Solution: clear. Ball: About 5 pinprick size black spots on very bottom. No bubbles. Tube: No bubbles.
6/25/03: Solution: light brown. Ball: 30% thick black film on sides/bottom; small bubbles, light yellow ring with small/medium bubbles at waterline. Tube: Black film on very bottom; several black spots on sides; no bubbles.	6/25/03: Solution: clear. Ball: 85% thin black film; cloudy film ring at waterline. Tube: Clear.
6/26/03: Solution: medium brown. Ball: 70% medium black film and large bubbles on bottom/sides, dark yellow ring with medium bubbles and black spots at waterline. Tube: 80% thin black film on sides and bottom.	6/26/03: Solution: clear. Ball: 85% thin black film; cloudy film ring at waterline. Tube: 2% thin black film at ball; no bubbles.
6/27/03: Solution: medium brown. Ball: 90% medium black film (sides, bottom and mixed with brown and medium bubbles at waterline). Tube: 90% medium black film.	6/27/03: Solution: clear. Ball: 80% thin black film with thicker spots sides/bottom, cloudy film ring at waterline. Tube: Thin black film at ball and at bottom; no bubbles.
6/28/03: Solution: medium brown. Ball: 95% thick black film (sides, bottom and in ring of small bubbles at waterline. Tube: 95% thick black film.	6/28/03: Solution: clear. Ball: 90% thin black film with thicker spots sides/bottom, black ring at waterline. Tube: 75% thin black film (at ball and at bottom); no bubbles.
6/29/03: Ball: 100% black film thin top and sides, thick on bottom and at waterline. Tube: 95% thick black film.	6/29/03: Solution: clear. Ball: 98% black film, thin top and sides, thick at waterline and on bottom. Tube: 100% medium black film; no bubbles.
6/30/03: Ball: 100% thick black film. Tube: 100% thick black film.	6/30/03: Same as above, except film on ball and tube thicker.
6/31/03: Same as above.	6/31/03: Same as above.

MW120
Sampled 6/23/03

IRB	SRB
6/24/03: Solution: Clear at ball graduating to medium greenish yellow at bottom. Ball: 5% small bubbles on bottom. Tube: 70% small bubbles on sides.	6/24/03: Solution: slightly cloudy. Ball: 5% small bubbles and many pinprick size black spots on bottom. Tube 80% small bubbles on sides.
6/25/03: Solution: dark yellow/light brown. Ball: 40% small bubbles at waterline and on bottom; medium yellow ring at waterline. Tube: 10% small bubbles at bottom; brown film on bottom.	6/25/03: Solution: clear. Ball: 80% thin black film with thicker spots; cloudy film ring at waterline; no bubbles. Tube: 2% thin black film at ball; 80% small bubbles.
6/26/03: Solution: brown. Ball: 10% thick black film and medium bubbles around middle; dark yellow ring with small bubbles at waterline. Many small/medium bubbles on bottom of ball. Tube: black film on bottom; 10% small bubbles at bottom.	6/26/03: Solution: clear. Ball: 80% thin black film with thicker spots; cloudy film ring at waterline; no bubbles. Tube: 2% thin black film at ball; 80% small bubbles.
6/27/03: Solution: medium brown. Ball: 50% medium black film (sides, bottom); dark yellow with medium bubbles at waterline. Tube: 90% medium black film; 90% small bubbles.	6/27/03: Same as above. Black film on ball and tube at ball thicker.
6/28/03: Solution: medium brown. Ball: 50% thick black film (sides, bottom); dark yellow with medium bubbles at waterline. Tube: 90% thick black film and small bubbles.	6/28/03: Solution: clear. Ball: 95% medium black film; black ring at waterline; no bubbles. Tube: 100% medium black film; 80% small bubbles.
6/29/03: Solution: clear at ball. Ball: 50% thick black film (sides, bottom); dark yellow with medium bubbles at waterline. Tube: 95% thick black film; 30% small bubbles.	6/29/03: Solution: clear. Ball: 98% medium black film. Tube: 100% black film (thicker than yesterday); 80% small bubbles.
6/30/03: Solution: clear at ball. Ball: 50% thick black film (sides, bottom); dark yellow with a few small bubbles at waterline. Tube: 95% thick black film; 30% small bubbles.	6/30/03: Same as above.
6/31/03: Same as above.	6/31/03: Same as above.

MW114
Sampled 6/24/03

IRB	SRB
6/25/03: Solution: very light yellow at ball graduating to medium greenish yellow at bottom of tube. Ball: Clear (no bubbles). Tube: Clear (no bubbles).	6/25/03: Solution: clear. Ball: Clear. Tube: Clear.
6/26/03: Solution: clear, pale greenish yellow. Ball: Clear (no bubbles). Tube: Clear (no bubbles).	6/26/03: Solution: clear light yellow. Ball: clear. Tube: clear
6/27/03: Same as above.	6/27/03: Solution: clear, yellowish. Ball: 2% medium black film (sides). Tube: 90% medium black film; no bubbles.
6/28/03: Solution: clear, medium yellow/light brown at bottom. Ball: Clear (no bubbles). Tube: Clear (no bubbles).	6/28/03: Solution: clear, yellowish. Ball: 20% medium black film (bottom/mainly one side). Tube: 90% medium black film; thicker at bottom; no bubbles.
6/29/03: Solution: clear, medium yellow/light brown at bottom. Ball: Clear (no bubbles). Tube: Clear (no bubbles).	6/29/03: Solution clear. Ball: 95% black film. Tube: 100% medium black film, no bubbles.
6/30/03: Same as above.	6/30/03: Solution clear. Ball: 95% thick black film. Tube: 100% medium black film, no bubbles.
6/31/03: Same as above.	6/31/03: Solution clear. Ball: 90% thick black film. Tube: 90% thick black film.
7/1/03: Same as above. No brown or black film on ball or tube.	7/1/03: Same as above.

MW116
Sampled 6/24/03

IRB	SRB
6/25/03: Solution: clear at ball graduating to light greenish yellow at bottom of tube. Ball: A few very small bubbles on bottom. Tube: 90% very small bubbles on sides.	6/25/03: Solution: clear. Ball: 40% very small bubbles on bottom. Tube: 95% very small bubbles on sides.
6/26/03: Solution: dark yellow/light brown. Ball: 80% small bubbles (waterline and sides). Tube: Black film on bottom; 60% small bubbles on sides.	6/26/03: Solution clear. Ball: 20% very small bubbles on bottom; a few small black pinpricks on side. Tube: 90% very small bubbles on sides.
6/27/03: Solution: dark yellow. Ball: 1% black film (sides); 30% bubbles (small/medium at waterline, small on bottom). Tube: 20% black film at bottom; 50% very small bubbles on sides.	6/27/03: Solution clear. Ball: About 8 very small black spots on sides/bottom, cloudy film ring at waterline, no bubbles. Tube: 80% very small bubbles on sides.
6/28/03: Solution: light brown. Ball: 3% black film (sides); 30% bubbles (small/medium at waterline, small on bottom). Tube: 30% black film at bottom; 40% medium bubbles on sides.	6/28/03: Solution clear. Ball: 2% thin black film with black pinpricks on sides; cloudy film at waterline, a few small bubbles on bottom. Tube: Black film in bottom; 40% very small bubbles on sides.
6/29/03: Solution: dark yellow at ball. Ball: 40% black film (bottom/sides), 2 black spots at waterline; 30% bubbles (waterline/bottom). Tube: 30% black film at bottom; 40% medium bubbles on sides.	6/29/03: Solution clear. Ball: 15% thin black film with black pinpricks on sides; cloudy film at waterline, a few small bubbles on bottom. Tube: Black film in bottom; 60% very small bubbles on sides.
6/30/03: Solution: clear at ball. Ball: 50% black film (bottom/sides and at waterline), 30% bubbles (waterline/bottom). Tube: 95% thick black film, 40% medium bubbles on sides.	6/30/03: Solution clear. Ball: 80% thin black film with small black spots on sides/bottom, cloudy film ring at waterline. Tube: 90% black film, thin at ball, thick at bottom, 80% small bubbles on sides.
6/31/03: Solution: clear at ball. Ball: 75% black film (bottom/sides and at waterline), 20% bubbles (waterline/bottom). Tube: 95% thick black film, 40% medium bubbles on sides.	6/31/03: Solution clear. Ball: 95% medium black film. Tube: 100% black film, medium at ball, thick at bottom, 80% small bubbles on sides.
7/1/03: Same as above.	7/1/03: Same as above.

794 638

MW116 Duplicate
Sampled 6/24/03

IRB	SRB
6/25/03: Solution: Clear at ball graduating to medium greenish yellow at bottom of tube. Ball: One small bubble on side. Tube: 70% small bubbles on sides.	6/25/03: Solution: Clear. Ball: 40% small bubbles on sides. Tube: 70% small bubbles on sides.
6/26/03: Solution: dark yellow/light brown. Ball: 80% small bubbles (waterline and sides). Tube: Brown film on bottom; 80% small bubbles on sides.	6/26/03: Solution: Clear. Ball: A few small bubbles and a few black pinpricks on one side. Tube: 40% small bubbles on sides.
6/27/03: Solution: dark yellow/light brown. Ball: 40% small bubbles (waterline and sides). Tube: 20% black film at bottom; 40% small bubbles on sides.	6/27/03: Solution: Clear. Ball: About 10 black pinpricks; 8 small bubbles on sides; cloudy film ring at waterline. Tube: 40% small bubbles on sides.
6/28/03: Solution: dark yellow/light brown. Ball: 2% medium black film on one side; 40% small bubbles (waterline and sides); dark yellow ring at waterline. Tube: 20% black film at bottom; 40% small bubbles on sides.	6/28/03: Solution: Clear. Ball: About 10 black pinpricks; 8 small bubbles on sides; cloudy film ring at waterline. Tube: Black film in bottom; 40% small bubbles on sides.
6/29/03: Solution: dark yellow at ball, light brown at bottom. Ball: 40% thick black film on bottom, 3 black spots at waterline; 40% small bubbles (waterline and sides). Tube: 40% black film at bottom; 30% small bubbles on sides.	6/29/03: Solution: Clear. Ball: 85% thin black film with several black pinpricks; a few small bubbles on sides; cloudy film at waterline. Tube: 100% black film, thin at ball, thick at bottom; 40% small bubbles on sides.
6/30/03: Solution: clear at ball. Ball: 70% black film (thick sides/bottom, thin at waterline); 30% bubbles (waterline and bottom). Tube: 90% thick black film; 30% small bubbles on sides.	6/30/03: Same as above, except film on ball and tube thicker.
6/31/03: Solution: clear at ball. Ball: 90% black film (thick sides/bottom, medium at waterline); 30% bubbles (waterline and bottom). Tube: 90% thick black film; 30% small bubbles on sides.	6/31/03: Solution: Clear. Ball: 95% medium black film with a few small bubbles on sides. Tube: 100% black film, medium at ball, thick at bottom; 40% small bubbles on sides.
7/1/03: Same as above.	7/1/03: Same as above.

MW118
Sampled 6/24/03

IRB	SRB
6/25/03: Solution: Clear at ball graduating to medium greenish yellow at bottom of tube. Ball: 5% small bubbles near bottom. Tube: 70% small bubbles on sides.	6/25/03: Solution: Slightly cloudy. Ball: 40% small bubbles on bottom and sides. Tube: 80% small bubbles on sides.
6/26/03: Solution: Dark yellow. Ball: 60% small bubbles (sides, bottom and waterline). Dark yellow ring at waterline. Tube: 75% small bubbles on sides.	6/26/03: Solution: clear Ball: 75% thin black film with thicker spots; a few small bubbles on bottom. Tube: 75% small bubbles on sides.
6/27/03: Solution: Dark yellow/light brown. Ball: 20% black film on bottom; 60% small bubbles (bottom and waterline). Dark yellow ring at waterline. Tube: 30% black film at bottom; 50% small bubbles on sides.	6/27/03: Solution: clear Ball: 75% thin black film with thicker spots; a few small bubbles on bottom. Tube: 50% small bubbles on sides.
6/28/03: Solution: Dark yellow/light brown. Ball: 30% thick black film sides/bottom; large bubbles on bottom; dark yellow ring with small bubbles at waterline. Tube: 90% thick black film; 50% small bubbles on sides.	6/28/03: Solution: clear Ball: 75% medium black film; cloudy film at waterline; a few small bubbles on bottom. Tube: 20% black film (thin at ball; thick at bottom); 50% small bubbles on sides.
6/29/03: Solution: clear at ball. Ball: 50% thick black film sides/bottom; large bubbles on bottom; light brown and small bubbles at waterline. Tube: 95% thick black film; 50% small bubbles on sides.	6/29/03: Solution: clear Ball: 85% black film, medium at waterline/sides, thick on bottom; a few large bubbles on bottom. Tube: 100% black film (thin at ball; thick at bottom); 50% small bubbles on sides.
6/30/03: Solution: clear at ball. Ball: 50% thick black film sides/bottom; large bubbles on bottom; light brown with a couple of black spots and small bubbles at waterline. Tube: 95% thick black film; 50% small bubbles on sides.	6/30/03: Same as above, except film on ball and tube thicker.
6/31/03: Solution: clear at ball. Ball: 50% thick black film sides/bottom; large bubbles on bottom; light brown with a couple of black spots and small bubbles at waterline. Tube: 95% thick black film; 50% small bubbles on sides.	6/31/03: Solution: clear Ball: 85% thick black film; a few large bubbles on bottom. Tube: 100% medium/thick black film; 50% small bubbles on sides.
7/1/03: Same as above.	7/1/03: Same as above.

MW122
Sampled 6/24/03

IRB (Red)	SRB (Black)
6/25/03: Solution: Clear at ball graduating to medium greenish yellow at bottom of tube. Ball: 10% small bubbles on bottom. Tube: 70% small bubbles on sides.	6/25/03: Solution: Clear. Ball: 5% small bubbles on bottom. Tube: 70% small bubbles on sides.
6/26/03: Solution: dark yellow/light brown. Ball: 80% small bubbles (waterline and sides); dark yellow ring at waterline. Tube: Brown film on bottom; 90% small bubbles on sides.	6/26/03: Solution: clear Ball: 75% thin black film with thicker spots; a few small bubbles on bottom; cloudy film ring at waterline. Tube: 5% thin black film at ball; 85% small bubbles on sides.
6/27/03: Solution: Dark yellow/light brown. Ball: 10% black film on sides; 60% small bubbles (bottom and waterline). Dark yellow ring with black spots at waterline. Tube: 10% black film at bottom; 70% small bubbles on sides.	6/27/03: Solution: clear Ball: 80% thin black film with thicker spots; cloudy film ring at waterline; 5% small bubbles on bottom. Tube: 2% black film at bottom; 50% small bubbles on sides.
6/28/03: Solution: brown. Ball: 50% black film bottom/sides; 30% small bubbles (bottom and waterline). Dark yellow ring with black spots at waterline. Tube: 30% black film (thin at ball, thick at bottom); 80% small bubbles on sides.	6/28/03: Solution: clear Ball: 80% medium black film; black ring at waterline; 5% small bubbles on bottom. Tube: 30% black film (thin at ball, thick at bottom); 50% small bubbles on sides.
6/29/03: Solution: clear at ball. Ball: 60% black film, thick bottom/sides; 30% small bubbles (bottom and waterline); brown film with black spots at waterline. Tube: 90% thick black film; 80% small bubbles on sides.	6/29/03: Solution: clear Ball: 98% black film, thin on top/sides; medium ring at waterline, thick on bottom; 10% small bubbles on bottom. Tube: 100% medium black film; 50% small bubbles on sides.
6/30/03: Solution: clear at ball. Ball: 80% black film, thick bottom/sides, thin and mixed with brown at waterline; 10% small bubbles (bottom). Tube: 95% thick black film; 80% small bubbles on sides.	6/30/03: Same as above, except film thicker on sides/bottom of ball and on tube.
6/31/03: Solution: clear at ball. Ball: 95% thick black film. Tube: 95% thick black film; 80% small bubbles on sides.	6/31/03: Solution: clear Ball: 98% medium black film. Tube: 100% medium black film; 50% small bubbles on sides.
7/1/03: Same as above.	7/1/03: Same as above.

MW124
Sampled 6/24/03

IRB	SRB
6/25/03: Solution: Clear at ball graduating to medium greenish yellow at bottom of tube. Ball: 5% small bubbles on bottom. Tube: 50% small bubbles on sides.	6/25/03: Solution: Clear. Ball: 50% small bubbles on bottom and sides. Tube: 40% small bubbles on sides.
6/26/03: Solution: dark yellow/light brown. Ball: 40% small bubbles (waterline and sides); dark yellow ring at waterline; a few small black spots on sides. Tube: black film on bottom; 80% small bubbles at bottom.	6/26/03: Solution: Clear. Ball: 2% small bubbles on bottom. Tube: 80% small bubbles on sides.
6/27/03: Solution: Dark yellow/light brown. Ball: 10% black film on sides; 60% small bubbles (bottom and waterline). Dark yellow ring at waterline. Tube: 50% black film at bottom; 70% small bubbles on sides.	6/27/03: Solution: Clear. Ball: 25% small bubbles and about 10 black pinprick size spots. Cloudy film at waterline. Tube: 80% small bubbles.
6/28/03: Solution: yellow at ball. Ball: 60% black film bottom/sides and mixed with brown small bubbles at waterline; 30% small bubbles (bottom and waterline). Tube: 90% black film; 90% small bubbles on sides.	6/28/03: Solution clear. Ball: 5% small bubbles and about 10 black pinprick size spots (one side) and small bubbles (bottom). Cloudy film at waterline. Tube: Black film on bottom; 70% small bubbles on sides.
6/29/03: Solution: clear at ball. Ball: 80% black film, thin on sides, thick on bottom, mixed with brown small bubbles at waterline. Tube: 90% thick black film; 80% small bubbles on sides.	6/29/03: Solution clear. Ball: 50% thin black film with several black pinpricks; a few small bubbles (bottom). Cloudy film at waterline. Tube: 100% black film, very thin at ball, thicker at bottom; 60% small bubbles on sides.
6/30/03: Solution: clear at ball. Ball: 95% black film, medium on sides, thick on bottom and at waterline; small bubbles at waterline. Tube: 95% thick black film; 80% small bubbles on sides.	6/30/03: Solution clear. Ball: 60% medium black film at waterline and on sides with several black pinpricks. Tube: 100% black film, medium at ball, thicker at bottom; 60% small bubbles on sides.
6/31/03: Solution: clear at ball. Ball: 100% thick black film. Tube: 100% thick black film; 80% small bubbles on sides.	6/31/03: Solution: clear. Ball: 90% medium black film. Tube: 100% thick black film and small bubbles on sides.
7/1/03: Same as above.	7/1/03: Same as above.

794 642

MW105
Sampled 6/25/03

IRB	SRB
6/26/03: Solution: clear at ball graduating to dark yellow/light brown at bottom. Ball: clear. Tube: dark brown film on bottom; no bubbles.	6/26/03: Solution: clear, light yellow. Ball: clear. Tube: clear.
6/27/03: Solution: clear at ball graduating to dark yellow/light brown at bottom. Ball: clear. Tube: 2% brown film on bottom; no bubbles.	6/27/03: Solution: clear, yellowish. Ball: 2 black spots, no bubbles. Tube: clear.
6/28/03: Same as above.	6/28/03: Same as above.
6/29/03: Same as above.	6/29/03: Solution: clear, yellowish. Ball: 1% black film (one spot), no bubbles. Tube: 60% black film, thin at ball, medium on bottom.
6/30/03: Same as above.	6/30/03: Solution: clear, yellowish. Ball: 1% black film (one spot), no bubbles. Tube: 60% black film, thin at ball, thick on bottom.
6/31/03: Same as above.	6/31/03: Same as above.
7/1/03: Same as above.	7/1/03: Same as above.
7/2/03: Same as above.	7/2/03: Same as above.

MW112
Sampled 6/25/03

IRB	SRB
6/26/03: Solution: clear at ball graduating to dark yellow/light brown at bottom. Ball: clear. Tube: dark brown film on bottom; no bubbles.	6/26/03: Solution: clear. Ball: A few small bubbles on bottom. Tube: 75% thin black film on sides; no bubbles.
6/27/03: Same as above.	6/27/03: Solution: clear. Ball: 1% black film. No bubbles. Tube: 80% thin black film on sides; 2% small bubbles.
6/28/03: Solution: dark yellow, light brown at bottom. Ball: clear. Tube: dark brown film on bottom; no bubbles.	6/28/03: Solution: clear. Ball: 80% thin black film with several thick spots. No bubbles. Tube: 90% black film (thin at ball; thick at bottom); 2% small bubbles.
6/29/03: Same as above.	6/29/03: Solution: clear. Ball: 85% medium black film, no bubbles. Tube: 100% black film (thin at ball; thick at bottom); 2% small bubbles.
6/30/03: Same as above.	6/30/03: Same as above.
6/31/03: Same as above.	6/31/03: Solution: clear, pale yellow. Ball: 90% thick black film (sides/bottom), cloudy film with black spots at waterline. Tube: 100% thick black film; 2% small bubbles.
7/1/03: Solution: dark brown. Ball: clear. Tube: dark brown film on bottom.	7/1/03: Same as above.
7/2/03: Same as above.	7/2/03: Same as above.

794 644

MW113
Sampled 6/25/03

IRB	SRB
6/26/03: Solution: clear, medium yellow. Ball: 10% small/medium bubbles (sides, waterline); dark yellow ring at waterline. Tube: 40% medium bubbles on sides.	6/26/03: Solution: clear. Ball: 70% very thin black film with black pinpricks. Tube: 2% very thin black film at ball; 10% small bubbles on sides.
6/27/03: Solution: cloudy, dark yellow. Ball: 10% small/medium bubbles (bottom, waterline); dark yellow ring at waterline. Tube: No bubbles.	6/27/03: Solution: clear. Ball: 70% very thin black film with black pinpricks. Tube: 2% very thin black film at ball; 1% small bubbles on sides.
6/28/03: Solution: dark yellow, brown at bottom. Ball: 10% small/medium bubbles (bottom, waterline); dark yellow ring at waterline. Tube: No bubbles.	6/28/03: Solution: clear. Ball: 70% very thin black film with black pinpricks; cloudy ring at waterline. Tube: 10% very thin black film with black pinpricks at ball; 1% small bubbles on sides.
6/29/03: Solution: brown. Ball: 95% medium black film, small bubbles at waterline. Tube: 100% medium black film.	6/29/03: Solution: clear. Ball: 80% thin black film with many black pinpricks; cloudy ring at waterline. Tube: 20% black film, very thin with black pinpricks at ball, medium on bottom; 1% small bubbles on sides.
6/30/03: Ball: 98% thick black film, small bubbles at waterline. Tube: 100% thick black film.	6/30/03: Solution: clear. Ball: 90% thin black film at waterline and on sides with many black pinpricks. Tube: 100% black film, thin with black pinpricks at ball, medium on bottom; 1% small bubbles on sides.
6/31/03: Same as above.	6/31/03: Solution: clear. Ball: 90% medium black film. Tube: 100% medium black film; 1% small bubbles on sides.
7/1/03: Same as above.	7/1/03: Same as above.
7/2/03: Same as above.	7/2/03: Same as above.

POST SAMPLING EVENT #13

MW110
Sampled 7/21/03

IRB	SRB
7/22/03: Solution: dark yellow. Ball: Small bubbles at waterline. Tube: Clear.	7/22/03: Solution: Clear. Ball: 10% thin black film (sides). Tube: Clear.
7/23/03: Solution: light brown. Ball: 50% medium black film (bottom/sides); dark yellow ring of small bubbles at waterline. Tube: Black film on very bottom. No bubbles.	7/23/03: Solution: Clear. Ball: 70% thin black film with thicker spots; cloudy film ring at waterline. Tube: Thin black film on bottom.
7/24/03: Solution: brown. Ball: 50% thick black film (sides/bottom); dark yellow ring of small bubbles with brown spots at waterline. Tube: 90% thick black film.	7/24/03: Solution: clear. Ball: 85% thin black film with thicker spots; cloudy film ring at waterline; a few bubbles. Tube: 100% black film (thin at ball, thick at bottom).
7/25/03: Solution: brown. Ball: 50% thick black film (sides/bottom); dark yellow ring of small bubbles with black spots at waterline. Tube: 95% thick black film.	7/25/03: Same as above.
7/26/03: Same as above.	7/26/03: Same as above.
7/27/03: Same as above.	7/27/03: Solution: clear. Ball: 95% medium black film; black film ring at waterline; a few small bubbles on sides/bottom. Tube: 100% black film, medium at ball, thick at bottom; 10% small bubbles on sides.
7/28/03: Same as above.	7/28/03: Same as above.
7/29/03: Same as above.	7/29/03: Same as above.

MW 110D
Sampled 7/21/03

IRB	SRB
7/22/03: Solution: dark yellow Ball: Small bubble ring at waterline. Tube: Clear.	7/22/03: Solution: clear. Ball: 10% thin black film (sides). No bubbles. Tube: Clear.
7/23/03: Solution: light brown. Ball: 10% thick black film on sides/bottom; 20% small bubbles at waterline and sides. Tube: Black film on very bottom.	7/23/03: Solution: clear. Ball: 85% medium black film; cloudy film ring at waterline. Tube: 50% thin black film at bottom; a few bubbles.
7/24/03: Solution: medium brown. Ball: 70% medium black film and large bubbles on bottom/sides, dark yellow ring with medium bubbles and black spots at waterline. Tube: 80% thin black film on sides and bottom.	7/24/03: Solution: clear. Ball: 80% thin black film; cloudy film ring at waterline; a few bubbles on bottom. Tube: 90% thin black film; a few bubbles.
7/25/03: Solution: medium brown. Ball: 90% medium black film (sides, bottom and mixed with brown and medium bubbles at waterline). Tube: 90% medium black film.	7/25/03: Solution: clear. Ball: 95% thick black film. Tube: 100% thick black film.
7/26/03: Solution: medium brown. Ball: 95% thick black film (sides, bottom and in ring of small bubbles at waterline. Tube: 95% thick black film.	7/26/03: Same as above.
7/27/03: Ball: 100% black film thin top and sides, thick on bottom and at waterline. Tube: 95% thick black film.	7/27/03: Same as above.
7/28/03: Ball: 100% thick black film. Tube: 100% thick black film.	7/28/03: Same as above.
7/29/03: Same as above.	7/29/03: Same as above.

MW114 SOLTION IN OUTER TUBE DARK YELLOW
Sampled 7/22/03

IRB	SRB
7/23/03: Solution: No darker than outer tube. Ball: Clear (no bubbles). Tube: Thin black film on bottom.	7/23/03: Solution: Clear. Ball: Clear. Tube: Thin black film on bottom.
7/24/03: Solution: No darker than outer tube. Ball: Clear; several medium bubbles (sides). Tube: Thin black film on bottom; several small bubbles on sides.	7/24/03: Solution: Clear. Ball: 80% thin black film; cloudy film ring at waterline. Tube: 100% medium black film; small bubbles.
7/25/03: Same as above.	7/25/03: Solution: Clear. Ball: 90% thin black film; cloudy film ring at waterline. Tube: 100% medium black film; small bubbles on sides.
7/26/03: Same as above.	7/26/03: Same as above.
7/27/03: Same as above.	7/27/03: Solution clear. Ball: 95% black film. Tube: 100% medium black film, no bubbles.
7/28/03: Solution: No darker than outer tube. Ball: Thin black film at waterline w/ about 10 large bubbles on bottom. Tube: Thin black film on bottom; several small bubbles on sides.	7/28/03: Same as above.
7/29/03: Same as above.	7/29/03: Same as above.
7/30/03: Same as above.	Same as above.

734 648

MW116
Sampled 7/22/03

IRB	SRB
7/23/03: Solution: clear at ball graduating to medium yellow at bottom of tube. Ball: 15% small bubbles on bottom. Tube: 30% very small bubbles on sides.	7/23/03: Solution: clear. Ball: Clear Tube: 75% very small bubbles on sides.
7/24/03: Solution: dark yellow. Ball: 80% small bubbles (waterline and sides). Tube: Black film on bottom; 60% small bubbles on sides.	7/24/03: Solution: clear. Ball: Cloudy film ring at waterline; no bubbles. Tube: 75% very small bubbles on sides.
7/25/03: Solution: dark yellow. Ball: 30% bubbles (small/medium at waterline, small on bottom). Tube: Black film at bottom; 50% very small bubbles on sides.	7/25/03: Solution: clear. Ball: Cloudy film ring at waterline; no bubbles. Tube: 80% very small bubbles on sides.
7/26/03: Solution: light brown. Ball: 90% bubbles (small/medium at waterline, small on bottom). Tube: Black film at bottom; 20% small bubbles on sides.	7/26/03: Solution clear. Ball: Pinkish cloudy film at waterline, a few small bubbles on bottom. Tube: Black film on bottom, 40% very small bubbles on sides.
7/27/03: Solution: light brown. Ball: 40% black film (bottom/sides); 30% bubbles (waterline/bottom); dark yellow ring at waterline. Tube: 30% black film at bottom; 40% medium bubbles on sides.	7/27/03: Solution clear. Ball: 15% thin black film with black pinpricks on sides; cloudy film at waterline, a few small bubbles on bottom. Tube: Black film in bottom; 60% very small bubbles on sides.
7/28/03: Solution: dark yellow at ball. Ball: 50% black film (bottom/sides and at waterline), 30% bubbles (waterline/bottom). Tube: 95% thick black film, 40% medium bubbles on sides.	7/28/03: Solution clear. Ball: 80% thin black film with small black spots on sides/bottom, cloudy film ring at waterline. Tube: 90% black film, thin at ball, thick at bottom, 80% small bubbles on sides.
7/29/03: Solution: dark yellow at ball. Ball: 85% black film (bottom and at waterline); dark yellow on sides; 20% bubbles (waterline/bottom). Tube: 95% thick black film, 40% medium bubbles on sides.	7/29/03: Solution clear. Ball: 95% medium black film. Tube: 100% black film, thin at ball, thick at bottom, 80% small bubbles on sides.
7/30/03: Same as above.	7/30/03: Same as above.

MW116 Duplicate
Sampled 7/22/03

IRB	SRB
7/23/03: Solution: Clear at ball graduating to light yellow at bottom of tube. Ball: 15% small bubbles on bottom. Tube: 50% small bubbles on sides.	7/23/03: Solution: Clear. Ball: 1% thin black film on bottom, 5% small bubbles on bottom. Tube: 70% small bubbles on sides.
7/24/03: Solution: dark yellow/light brown. Ball: 80% small bubbles (waterline and sides). Tube: Brown film on bottom; 80% small bubbles on sides.	7/24/03: Solution: Clear. Ball: A few small bubbles and a few black pinpricks on one side. Tube: 40% small bubbles on sides.
7/25/03: Solution: dark yellow/light brown. Ball: 40% small bubbles (waterline and sides). Tube: 1% black film on bottom; a few small bubbles on sides.	7/25/03: Solution: Clear. Ball: About 10 black pinpricks; 8 small bubbles on sides; cloudy film ring at waterline. Tube: 40% small bubbles on sides.
7/26/03: Solution: brown. Ball: 60% small bubbles (waterline and sides); dark yellow ring at waterline. Tube: 5% black film on bottom; a few small bubbles on sides.	7/26/03: Solution: Clear. Ball: 50% thin black film with many pinpricks; 10% small bubbles on bottom, cloudy film ring at waterline. Tube: 5% black film on bottom; 2% small bubbles on sides.
7/27/03: Solution: dark yellow at ball, light brown at bottom. Ball: 40% thick black film on bottom, 3 black spots at waterline; 40% small bubbles (waterline and sides). Tube: 40% black film at bottom; 30% small bubbles on sides.	7/27/03: Solution: Clear. Ball: 85% thin black film with several black pinpricks; a few small bubbles on sides; cloudy film at waterline. Tube: 100% black film, thin at ball, thick at bottom; 40% small bubbles on sides.
7/28/03: Solution: dark yellow at ball. Ball: 70% black film (thick sides/bottom, thin at waterline); 30% bubbles (waterline and bottom). Tube: 90% thick black film; 30% small bubbles on sides.	7/28/03: Same as above, except film on ball and tube thicker.
7/29/03: Solution: dark yellow at ball. Ball: 90% black film (thick sides/bottom, medium at waterline); 30% bubbles (waterline and bottom). Tube: 90% thick black film; 30% small bubbles on sides.	7/29/03: Solution: Clear. Ball: 95% medium black film with several black pinpricks and a few small bubbles on sides. Tube: 100% black film, thin at ball, thick at bottom; 40% small bubbles on sides.
7/30/03: Same as above.	7/30/03: Same as above.

794 650

MW118
Sampled 7/22/03

IRB	SRB
7/23/03: Solution: Clear at ball graduating to medium yellow at bottom of tube. Ball: 5% small bubbles near bottom. Tube: 20% small bubbles on sides.	7/23/03: Solution: clear. Ball: 2% small bubbles on bottom. Tube: 10% small bubbles on sides.
7/24/03: Solution: Dark yellow. Ball: 60% small bubbles (sides, bottom and waterline). Dark yellow ring at waterline. Tube: 75% small bubbles on sides.	7/24/03: Solution: clear Ball: 75% thin black film with thicker spots; a few small bubbles on bottom. Tube: 75% small bubbles on sides.
7/25/03: Solution: Dark yellow/light brown. Ball: 20% black film on bottom; 60% small bubbles (bottom and waterline). Dark yellow ring at waterline. Tube: 30% black film at bottom; 50% small bubbles on sides.	7/25/03: Solution: clear Ball: 75% thin black film with thicker spots; a few small bubbles on bottom. Tube: 50% small bubbles on sides.
7/26/03: Solution: Dark yellow/light brown. Ball: 10% black film bottom; large bubbles on bottom; dark yellow ring with small bubbles at waterline. Tube: 80% thick black film; 20% small bubbles on sides.	7/26/03: Solution: clear Ball: 85% medium black film; cloudy film at waterline; a few small bubbles on bottom. Tube: 10% black film at bottom); 20% small bubbles on sides.
7/27/03: Solution: clear at ball. Ball: 50% thick black film sides/bottom; large bubbles on bottom; light brown and small bubbles at waterline. Tube: 95% thick black film; 50% small bubbles on sides.	7/27/03: Solution: clear Ball: 85% black film, medium at waterline/sides, thick on bottom; a few large bubbles on bottom. Tube: 100% black film (thin at ball; thick at bottom); 50% small bubbles on sides.
7/28/03: Solution: clear at ball. Ball: 50% thick black film sides/bottom; large bubbles on bottom; light brown with a couple of black spots and small bubbles at waterline. Tube: 95% thick black film; 50% small bubbles on sides.	7/28/03: Same as above, except film on ball and tube thicker.
7/29/03: Solution: clear at ball. Ball: 50% thick black film sides/bottom; large bubbles on bottom; light brown with a couple of black spots at waterline. Tube: 95% thick black film; 50% small bubbles on sides.	7/29/03: Solution: clear Ball: 85% thick black film; a few large bubbles on bottom. Tube: 100% medium/thick black film; 50% small bubbles on sides.
7/30/03: Same as above.	7/30/03: Same as above.

MW120
Sampled 7/22/03

IRB	SRB
7/23/03: Solution: Clear at ball graduating to light yellow at bottom. Ball: 5% small bubbles on bottom. Tube: 20% small bubbles on sides.	7/23/03: Solution: clear. Ball: 85% thin black film, 2% small bubbles on bottom. Tube: 2% thin black film at ball, 90% small bubbles on sides.
7/24/03: Solution: dark yellow/light brown. Ball: 40% small bubbles at waterline and on bottom; medium yellow ring at waterline. Tube: 10% small bubbles at bottom; brown film on bottom.	7/24/03: Solution: clear. Ball: 80% thin black film with thicker spots; cloudy film ring at waterline; no bubbles. Tube: 2% thin black film at ball; 80% small bubbles.
7/25/03: Ball: 10% thick black film and medium bubbles around middle; dark yellow ring with small bubbles at waterline. Many small/medium bubbles on bottom of ball. Tube: black film on bottom; 10% small bubbles at bottom.	7/25/03: Solution: clear. Ball: 80% thin black film with thicker spots; cloudy film ring at waterline; no bubbles. Tube: 4% thin black film at ball and at bottom; 80% small bubbles.
7/26/03: Solution: medium brown. Ball: 50% medium black film (sides, bottom); dark yellow with small bubbles at waterline. Tube: 50% medium black film at bottom; 90% small bubbles.	7/26/03: Same as above. Black film on ball and tube at ball thicker.
7/27/03: Solution: medium brown. Ball: 50% thick black film (sides, bottom); dark yellow with medium bubbles at waterline. Tube: 90% thick black film and small bubbles.	7/27/03: Solution: clear. Ball: 95% medium black film; black ring at waterline; no bubbles. Tube: 100% medium black film; 80% small bubbles.
7/28/03: Solution: clear at ball. Ball: 50% thick black film (sides, bottom); dark yellow with medium bubbles at waterline. Tube: 95% thick black film; 30% small bubbles.	7/28/03: Solution: clear. Ball: 98% medium black film. Tube: 100% black film; 50% small bubbles.
7/29/03: Solution: clear at ball. Ball: 50% thick black film (sides, bottom); dark yellow at waterline. Tube: 95% thick black film; 80% small bubbles.	7/29/03: Same as above.
7/30/03: Same as above.	7/30/03: Same as above.

MW122
Sampled 7/22/03

IRB	SRB
7/23/03: Solution: Light yellow throughout. Ball: 15% small bubbles, bottom and waterline. Tube: 80% small bubbles on sides.	7/23/03: Solution: Clear. Ball: 2% thin black film on one side, 2% small bubbles on sides. Tube: 70% small bubbles on sides.
7/24/03: Solution: dark yellow/light brown. Ball: 80% small bubbles (waterline and sides); dark yellow ring at waterline. Tube: Brown film on bottom; 90% small bubbles on sides.	7/24/03: Solution: clear Ball: 75% thin black film with thicker spots; a few small bubbles on bottom; cloudy film ring at waterline. Tube: 5% thin black film at ball; 85% small bubbles on sides.
7/25/03: Solution: Dark yellow/light brown. Ball: 60% small bubbles (bottom and waterline). Dark yellow ring at waterline. Tube: 10% black film at bottom; 70% small bubbles on sides.	7/25/03: Solution: clear Ball: 30% thin black film with thicker spots; cloudy film ring at waterline; 5% small bubbles on bottom. Tube: 2% black film at bottom; 50% small bubbles on sides.
7/26/03: Solution: dark yellow. Ball: 20% small bubbles (bottom and waterline). Dark yellow ring with small bubbles at waterline. Tube: 30% black film (thin at ball, thick at bottom); 80% small bubbles on sides.	7/26/03: Solution: clear Ball: 30% medium black film on sides; cloudy ring at waterline; 1% small bubbles on bottom. Tube: 5% black film at ball and at bottom), 20% small bubbles on sides.
7/27/03: Solution: clear at ball. Ball: 60% black film, thick bottom/sides; 30% small bubbles (bottom and waterline); brown film with black spots at waterline. Tube: 90% thick black film; 80% small bubbles on sides.	7/27/03: Solution: clear Ball: 98% black film, thin on top/sides; medium ring at waterline, thick on bottom; 10% small bubbles on bottom. Tube: 100% medium black film; 50% small bubbles on sides.
7/28/03: Solution: clear at ball. Ball: 80% black film, thick bottom/sides, thin and mixed with brown at waterline; 10% small bubbles (bottom). Tube: 95% thick black film; 80% small bubbles on sides.	7/28/03: Same as above, except film thicker on sides/bottom of ball and on tube.
7/29/03: Solution: clear at ball. Ball: 98% thick black film. Tube: 100% thick black film; 80% small bubbles on sides.	7/29/03: Solution: clear Ball: 95% medium black film. Tube: 100% black film, medium at ball, thick at bottom; 50% small bubbles on sides.
7/30/03: Same as above.	7/30/03: Same as above.

MW124
Sampled 7/22/03

IRB	SRB
7/23/03: Solution: Light yellow throughout. Ball: 15% small bubbles on bottom and at waterline. Tube: 80% small bubbles on sides.	7/23/03: Solution: Clear. Ball: 1% small bubbles on bottom. Tube: 70% small bubbles on sides.
7/24/03: Solution: dark yellow/light brown. Ball: 40% small bubbles (waterline and sides); dark yellow ring at waterline; a few small black spots on sides. Tube: black film on bottom; 80% small bubbles at bottom.	7/24/03: Solution: Clear. Ball: 2% small bubbles on bottom. Tube: 80% small bubbles on sides.
7/25/03: Solution: Dark yellow/light brown. Ball: 10% black film on sides; 60% small bubbles (bottom and waterline). Dark yellow ring at waterline. Tube: 50% black film at bottom; 70% small bubbles on sides.	7/25/03: Solution: Clear. Ball: 25% small bubbles and about 10 black pinprick size spots. Cloudy film at waterline. Tube: 80% small bubbles.
7/26/03: Solution: yellow at ball. Ball: 50% black film bottom/sides; 30% small bubbles (bottom and waterline). Tube: 90% black film; 90% small bubbles on sides.	7/26/03: Solution clear. Ball: 5% small bubbles and about 5 black pinprick size spots (one side) and small bubbles (bottom). Cloudy film at waterline. Tube: 2% black film on bottom; 60% small bubbles on sides.
7/27/03: Solution: clear at ball. Ball: 50% black film on sides and bottom, brown small bubbles at waterline. Tube: 90% thick black film; 80% small bubbles on sides.	7/27/03: Solution clear. Ball: 50% thin black film with several black pinpricks; a few small bubbles (bottom). Cloudy film at waterline. Tube: 100% black film, very thin at ball, thicker at bottom; 60% small bubbles on sides.
7/28/03: Solution: clear at ball. Ball: 50% black film on sides and bottom; brown small bubbles at waterline. Tube: 95% thick black film; 50% small bubbles on sides.	7/28/03: Solution clear. Ball: 60% medium black film at waterline and on sides with several black pinpricks. Tube: 100% black film, medium at ball, thicker at bottom; 60% small bubbles on sides.
7/29/03: Solution: clear at ball. Ball: 50% black film on sides and bottom; brown small bubbles at waterline. Tube: 100% thick black film; 10% small bubbles on sides.	7/29/03: Solution: clear. Ball: 90% medium black film. Tube: 100% thick black film and small bubbles on sides.
7/30/03: Same as above.	7/30/03: Same as above.

794 654

MW105
Sampled 7/23/03

IRB	SRB
7/24/03: Solution: Clear. Ball: Clear. Tube: Clear.	7/24/03: Solution: Clear. Ball: Clear. Tube: Clear.
7/25/03: Solution: clear at ball graduating to yellow at bottom. Ball: Clear. Tube: 1% brown film on bottom; no bubbles.	7/25/03: Solution: Clear, yellowish. Ball: 2 black spots, no bubbles. Tube: Clear.
7/26/03: Solution: Light yellow throughout. Ball: Clear. Tube: 1% brown film on bottom; 10% small bubbles on sides.	7/26/03: Solution: Clear, yellowish. Ball: 95% thin black film. Tube: 100% thin black film.
7/27/03: Solution: Light yellow throughout. Ball: 2% thin black film at waterline. Tube: 1% brown film on bottom; 10% small bubbles on sides.	7/27/03: Solution: Clear. Ball: 95% thin black film. Tube: 100% thin black film; 90% small bubbles on sides.
7/28/03: Same as above.	7/28/03: Solution: Clear. Ball: 95% thin black film. Tube: 100% thin black film; 90% small bubbles on sides.
7/29/03: Solution: Light yellow. Ball: 5% thick black film at waterline. Tube: 50% thick black film at bottom; 10% small bubbles on sides.	7/29/03: Solution: Clear. Ball: 95% thin black film. Tube: 100% thin black film; 90% small bubbles on sides.
7/30/03: Solution: Light yellow at ball. Ball: 90% black film; thick at waterline, thin on sides/bottom. Tube: 100% black film, thin at ball, thick at bottom; 10% small bubbles on sides.	7/30/03: Same as above.
7/31/03: Solution: Light yellow at. Ball: 90% black film, thick at waterline, thin on sides/bottom. Tube: 100% thick black film; 10% small bubbles on sides.	7/31/03: Same as above.

MW112 SOLUTION IN OUTER TUBE DARK YELLOW
Sampled 7/23/03

IRB	SRB
7/24/03: Solution: clear at ball graduating to dark yellow at bottom. Ball: Clear. Tube: 1% dark brown film on bottom; no bubbles.	7/24/03: Solution: Clear. Ball: A few small bubbles on bottom. Tube: 75% thin black film on sides; no bubbles.
7/25/03: Same as above.	7/25/03: Solution: Clear. Ball: 1% black film. No bubbles. Tube: 80% thin black film on sides; 2% small bubbles.
7/26/03: Solution: dark yellow, darker yellow at bottom. Ball: About 3 black spots on side. Tube: About 3 black spots on side at ball.	7/26/03: Solution: Clear. Ball: 60% thick black film on sides/bottom, cloudy film ring at waterline. Tube: 90% thick black film; 2% small bubbles.
7/27/03: Solution: dark yellow, darker yellow at bottom. Ball: About 3 black spots on side, 5% small bubbles at waterline and on bottom. Tube: About 3 black spots on side at ball.	7/27/03: Solution: Clear. Ball: 85% medium black film, no bubbles. Tube: 100% black film; 2% small bubbles.
7/28/03: Solution: dark yellow, darker yellow at bottom. Ball: About 3 black spots on side; 5% small bubbles at waterline and on bottom. Tube: About 3 black spots on side at ball; 20% small bubbles on sides.	7/28/03: Same as above.
7/29/03: Same as above.	7/29/03: Solution: Clear. Ball: 95% thick black film. Tube: 100% thick black film; 2% small bubbles.
7/30/03: Solution: dark brown. Ball: 2% black film, at waterline with small bubbles. Tube: 80% black film, pinpricks on sides at ball, thick on bottom.	7/30/03: Same as above.
7/31/03: Same as above.	7/31/03: Same as above.

MW113
Sampled 7/23/03

IRB	SRB
7/24/03: Solution: clear, medium yellow. Ball: 10% small/medium bubbles (sides, waterline); dark yellow ring at waterline. Tube: 40% medium bubbles on sides.	7/24/03: Solution: clear. Ball: 70% very thin black film with black pinpricks. Tube: 2% very thin black film at ball; 10% small bubbles on sides.
7/25/03: Solution: cloudy, dark yellow. Ball: 10% small/medium bubbles (bottom, waterline); dark yellow ring at waterline. Tube: Clear.	7/25/03: Solution: clear. Ball: 70% very thin black film with black pinpricks. Tube: 2% very thin black film at ball; 1% small bubbles on sides.
7/26/03: Solution: dark yellow at bottom. Ball: 5% black film on bottom with small bubbles; dark yellow ring at waterline. Tube: 90% thick black film.	7/26/03: Solution: clear. Ball: 80% very thin black film with black pinpricks; cloudy ring at waterline. Tube: 10% very thin black film with black pinpricks at ball; 1% small bubbles on sides.
7/27/03: Solution: brown. Ball: 95% medium black film, small bubbles at waterline. Tube: 90% medium black film.	7/27/03: Solution: clear. Ball: 80% thin black film with many black pinpricks; cloudy ring at waterline. Tube: 20% black film, very thin with black pinpricks at ball, medium on bottom; 1% small bubbles on sides.
7/28/03: Ball: 95% black film, thick on bottom and at waterline, thin on sides; small bubbles at waterline. Tube: 90% thick black film.	7/28/03: Solution: clear. Ball: 90% thin black film. Tube: 100% black film, thin with black pinpricks at ball, medium on bottom; 1% small bubbles on sides.
7/29/03: Same as above.	7/29/03: Solution: clear. Ball: 90% medium black film. Tube: 100% medium black film; 1% small bubbles on sides.
7/30/03: Same as above.	7/30/03: Same as above.
7/31/03: Same as above.	7/31/03: Same as above.

POST SAMPLING EVENT #14

MW110
Sampled 8/18/03

IRB (Red)	SRB (Black)
8/19/03: Solution: clear at ball graduating to greenish yellow at bottom of tube. Ball: 5% small bubbles on bottom. Tube: 2% small bubbles on sides.	8/19/03: Solution: Clear. Ball: 80% very thin black film (sides) with pinpricks. Tube: 2% small bubbles at bottom.
8/20/03: Solution: yellow at ball graduating to greenish yellow at bottom. Ball: 20% medium black film (bottom/waterline); dark yellow ring of small bubbles at waterline. Tube: 20% medium bubbles on sides.	8/20/03: Solution: Clear. Ball: 80% thin black film with pinpricks. Tube: 2% small bubbles at bottom.
8/21/03: Solution: brown. Ball: 20% thick black film (sides/bottom); dark yellow ring of small bubbles with brown spots at waterline. Tube: 20% medium bubbles on sides.	8/21/03: Solution: clear. Ball: 85% thin black film; cloudy film ring at waterline; a few bubbles. Tube: 2% small bubbles at bottom.
8/22/03: Solution: brown. Ball: 50% thick black film (sides/bottom); dark yellow ring of small bubbles at waterline. Tube: 95% thick black film.	8/22/03: Solution: clear. Ball: 95% thin black film with thicker spots; cloudy film ring at waterline; a few bubbles. Tube: 2% black film at bottom, no bubbles.
8/23/03: Same as above, except black spots in yellow ring at waterline.	8/23/03: Same as above.
8/24/03: Same as above.	8/24/03: Solution: clear. Ball: 90% medium black film; cloudy film ring at waterline. Tube: 100% black film, thin at ball, thick at bottom.
8/25/03: Ball: 90% black film, thick on bottom, medium on sides and waterline. Tube: 95% thick black film.	8/25/03: Solution: clear. Ball: 95% medium black film, black film ring at waterline. Tube: 100% black film, thin at ball, thick at bottom.
8/26/03: Same as above.	8/26/03: Same as above.

MW 110D
Sampled 8/18/03

IRB	SRB
8/19/03: Solution: clear at ball graduating to greenish yellow at bottom of tube. Ball: 5% small bubble on bottom. Tube: 60% small bubbles on sides.	8/19/03: Solution: clear. Ball: 80% very thin black film (sides) with pinpricks. No bubbles. Tube: 2% very thin black film with pinpricks at ball. 50% small bubbles on sides.
8/20/03: Solution: yellow at ball graduating to greenish yellow at bottom of tube. Ball: 20% small bubbles at waterline and bottom. Tube: 60% small bubbles on sides.	8/20/03: Solution: clear. Ball: 80% thin black film with pinpricks. Tube: 2% very thin black film with pinpricks at ball. 2% small bubbles on sides.
8/21/03: Solution: yellow at ball graduating to greenish yellow at bottom of tube. Ball: small bubbles on bottom/sides, dark yellow ring with medium bubbles at waterline. Tube: small bubbles one side top to bottom.	8/21/03: Solution: clear. Ball: 80% thin black film; cloudy film ring at waterline; a few bubbles on bottom. Tube: 2% very thin black film with pinpricks at ball. 2% small bubbles on sides.
8/22/03: Solution: medium brown. Ball: bubbles at waterline and on bottom. Tube: small bubbles one side top to bottom. Black film on bottom.	8/22/03: Same as above, except black film thicker on ball.
8/23/03: Solution: dark brown. Ball: 5% black film on bottom, dark yellow ring of small bubbles rimmed with brown film at waterline. Tube: 90% black film; 3% small bubbles one side.	8/23/03: Same as above, except 1% black film on bottom of tube.
8/24/03: Ball: 100% black film thin top and sides, thick on bottom and at waterline. Tube: 95% thick black film; 3% small bubbles one side.	8/24/03: Solution: clear. Ball: 100% black film, thin on top and bottom, medium on sides. Tube: 5% black film, ring of thin at ball and ring of thick at bottom.
8/25/03: Ball: 98% black film, thick on bottom and waterline, medium on sides. Tube: 100% thick black film.	8/25/03: Solution: clear. Ball: 100% black film, thin on top and bottom, medium on sides. Tube: 100% thick black film.
8/26/03: Same as above.	8/26/03: Same as above.

MW114 Solution in outer tube yellow and many small bubbles.
Sampled 8/19/03

IRB (Red)	SRB (Black)
8/20/03: Solution: No darker than outer tube. Ball: Clear (no bubbles). Tube: Thin black film on bottom.	8/20/03: Solution: clear. Ball: 1% small bubbles on bottom. Tube: 50% small bubbles.
8/21/03: Same as above.	8/21/03: Same as above.
8/22/03: Solution: medium yellow. Ball: 30% medium/large bubbles. Tube: 30% medium/small bubbles	8/22/03: Solution: clear. Ball: clear. Tube: clear.
8/23/03: Solution: medium yellow. Ball: medium yellow ring with black spots at waterline, 5% black film on sides, medium/large bubbles sides/bottom. Tube: 10% medium bubbles on sides.	8/23/03: Solution: clear. Ball: 3% very thin black film just under waterline Tube: 5% small black pinpricks on sides.
8/24/03: Solution: brown Ball: 95% thick black film, large bubbles at waterline. Tube: 100% black film, thick at ball, thin sides/bottom, 40% medium bubbles.	8/24/03: Solution: clear. Ball: 90% black film, thick just under waterline, thin sides/bottom, cloudy film ring at waterline. Tube: 100% thin black film, thick at bottom.
8/25/03: Same as above.	8/25/03: Solution: clear. Ball: 100% black film, thick at waterline, thin top/sides/bottom. Tube: 100% thick black film.
8/26/03: Same as above.	8/26/03: Same as above.
8/27/03: Same as above.	8/27/03: Same as above.

MW105 Solution in outer tube dark yellow.
Sampled 8/20/03

IRB	SRB
8/21/03: Solution: Clear. Ball: Clear. Tube: 10% small bubbles at bottom.	8/21/03: Solution: Clear. Ball: Small/medium bubbles on bottom. Tube: 75% small bubbles.
8/22/03: Solution: Clear. Ball: Clear. Tube: Clear.	8/22/03: Solution: Clear. Ball: Clear. Tube: 2% black film at bottom, 5% small bubbles at bottom.
8/23/03: Same as above.	8/23/03: Solution: Clear. Ball: 15% thin black film on bottom. Tube: 90% thin black film.
8/24/03: Same as above.	8/24/03: Solution: Clear. Ball: 50% thin black film on bottom and one side, no bubbles. Tube: 90% black film, thin at ball, thick at bottom; 60% small bubbles on sides.
8/25/03: Same as above.	8/25/03: Solution: Clear. Ball: 95% thin black film. Tube: 100% thin black film; 90% small bubbles on sides.
8/26/03: Same as above.	8/26/03: Solution: Clear. Ball: 98% thin black film, very thin on top. Tube: 100% thin black film; 90% small bubbles on sides.
8/27/03: Solution: slightly darker than outer tube. Ball: clear film ring at waterline, about 10 bubbles sides/bottom. Tube: 1% black film at bottom.	8/27/03: Same as above.
8/28/03: Solution: dark Ball: 10% large bubbles, 1% spots of medium black film. Tube: 2% thin black film at bottom.	8/28/03: Same as above.

MW112 Solution in outer tube dark yellow.
Sampled 8/20/03

IRB	SRB
8/21/03: Solution: clear yellow. Ball: Clear. Tube: 1% bubbles at bottom.	8/21/03: Solution: Clear. Ball: clear Tube: 25% small bubbles at bottom.
8/22/03: Same as above.	8/22/03: Solution: Clear. Ball: clear. Tube: clear.
8/23/03: Same as above.	8/23/03: Solution: Clear. Ball: clear. Tube: 70% black film, thin at ball, thick at bottom.
8/24/03: Same as above.	8/24/03: Solution: Clear. Ball: 50% medium black film on bottom, no bubbles. Tube: 90% black film, thin at ball, thick at bottom; 2% small bubbles.
8/25/03: Same as above.	8/25/03: Same as above.
8/26/03: Same as above.	8/26/03: Solution: Clear. Ball: 50% thick black film. Tube: 100% thick black film; 2% small bubbles.
8/27/03: Solution: darker than outer tube. Ball: 2% small bubbles at waterline, 1% small bubbles sides/bottom. Tube: clear	8/27/03: Solution clear. Ball: 95% thick black film. Tube: 100% thick black film; 2% small bubbles.
8/28/03: Solution: dark yellow. Ball: 5% medium black film at waterline. Tube: 1% medium black film at bottom.	8/28/03: Same as above.

794 662

MW113
Sampled 8/20/03

IRB	SRB
8/21/03: Solution: clear. Ball: clear. Tube: 50% small bubbles on sides.	8/21/03: Solution: clear. Ball: clear, few small bubbles on bottom Tube: 10% small bubbles on sides.
8/22/03: Solution: cloudy, dark yellow. Ball: 10% small/medium bubbles (bottom, waterline). Tube: 1% small bubbles on sides.	8/22/03: Solution: clear. Ball: 50% very thin black film with black pinpricks. Tube: 1% very thin black film at ball; 1% small bubbles on sides near bottom.
8/23/03: Solution: medium yellow. Ball: 10% small bubbles at waterline and bottom. Tube: clear	8/23/03: Solution: clear. Ball: 80% very thin black film with black pinpricks; cloudy ring at waterline. Tube: 10% very thin black film with black pinpricks at ball.
8/24/03: Solution: dark yellow. Ball: dark yellow ring of small/medium bubbles at waterline; medium bubbles on bottom. Tube: 1% small bubbles on sides.	8/24/03: Solution: clear. Ball: 80% thin black film with many black pinpricks; cloudy ring at waterline. Tube: 20% black film, very thin with black pinpricks at ball, medium on bottom.
8/25/03: Ball: 55% black film on bottom, brown ring of medium bubbles at waterline. Tube: 90% thick black film.	8/25/03: Solution: clear. Ball: 90% black film, thin on bottom, medium on sides. Tube: 100% very thin black film with black pinpricks at ball, medium on bottom; 1% small bubbles on sides.
8/26/03: Ball: 50% thick black film on bottom; brown ring with black spots and small/medium bubbles at waterline. Tube: 90% thick black film.	8/26/03: Same as above.
8/27/03: Same as above.	8/27/03: Solution: clear. Ball: 95% medium black film. Tube: 100% medium black film.
8/28/03: Same as above.	8/28/03: Same as above.

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PART I

ADMINISTRATIVE RECORD

PART I

FINAL PAGE