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Memorandum

To: John Hill, AFCEE/EXA
John DeBack, DAIM-ODB

From: John Sperry
Tom Holmes

Date: 30 December 2010

Re: **Intermediate Aquifer Groundwater Samples, October 2010**
Main Installation - Defense Depot Memphis, Tennessee
FA8903-08-D-8771-0019

HDR has prepared this report to present the results of the October 2010 groundwater samples from three Intermediate Aquifer (IAQ) wells on the Main Installation (MI) at Defense Depot Memphis, Tennessee (DDMT). This work was performed under Contract FA8903-08-D-8771, Task Order 0019 to the Air Force Center for Engineering and the Environment.

Additional deep monitoring wells were recommended in the *Main Installation Interim Remedial Action Completion Report* (IRACR) (HDR|e^{2}M, 2010) to support groundwater modeling results, which indicated the identified groundwater plumes in the Fluvial aquifer on the MI would not significantly impact groundwater quality in the deeper Memphis aquifer (MAQ). Two IAQ wells, MW-252 and MW-253, were installed in June 2010 and a third IAQ well, MW-256, was installed in July 2010.

Well installation and groundwater sample analyses were reported in a memorandum, *Deep Well Installation - Intermediate Aquifer Well Installation*, dated 27 August 2010. The hydrogeologic data supported the conceptual model of a connection between the fluvial and deeper aquifers and indicated the IAQ wells are appropriately located to serve as sentinel wells for vertical migration of contaminants. The analytical results were consistent with the groundwater model with low chlorinated volatile organic compound (CVOC) concentrations in the Intermediate aquifer at the MI.

This report describes quarterly groundwater sampling of the three IAQ wells. Water level measurements and groundwater samples were collected at the same time as the October 2010 MI long term monitoring (LTM) biennial sample event. These three wells will be incorporated into the LTM program in 2011. The well locations are shown on Figure 1.

FIELD ACTIVITIES

The field activities consisted of groundwater sampling of three IAQ wells. Activities were performed in accordance with the *Work Plan for Deep Wells and 2010 Long Term Monitoring* (HDR, 2010) and the *Remedial Action Sampling and Analysis Plan* (MACTEC, 2005).

Water Level Measurements

Groundwater levels were measured in the IAQ and MAQ wells on 4 October 2010. Measurements were made using Solinist Model 101 water level meters with electronic sensors and tapes graduated in 0.01-foot increments. The water level measurements are shown on Table 1.

Groundwater Sampling

Groundwater samples were collected from the three IAQ wells on 5 and 6 October 2010 using low-flow purging methods with stainless steel bladder pumps, Teflon® bladders and Teflon®-lined polyethylene tubing. The pumping rate was set to limit the water level drop to less than 1.2 inches (0.1 foot).

Purging continued for up to two hours at each well in order to meet the stabilization criteria: three successive readings within 0.1 for pH, 10 milliVolts for oxygen reduction potential, 10 percent for specific conductance, 10 percent for dissolved oxygen and <20 nephelometric turbidity units for turbidity. Temperature was also measured and recorded but was not used as a stabilization parameter. Samples were collected when stabilization criteria were met. The final stabilization measurements are shown on Table 2.

Samples were collected in 40-milliliter vials preserved with hydrochloric acid. Samples were sent to Microbac Laboratories in Marietta, Ohio, for analysis of volatile organic compounds (VOCs) by method 8260B.

IDW Management

The waste generated during groundwater sampling in October 2010 was classified as either non-investigative waste or investigation-derived waste (IDW). Non-investigative waste, such as packaging materials, personal protective equipment, disposable sampling supplies, and other inert refuse, was collected, containerized, and transported to a designated collection bin for disposal at a municipal landfill.

The groundwater from purging was collected in five gallon buckets with lids and added to the fluvial soil vapor extraction condensate waste water fractionation tank. When the storage tank nears capacity, a waste water sample will be collected and a discharge request submitted to the City of Memphis.

SUMMARY OF FINDINGS

Water Level Measurements

Water level measurements in the IAQ and MAQ wells are contoured on Figure 2. The water levels in the three deepest wells indicate the gradient is to the west, from MW-140 to MW-254.

Analytical Results

The complete analytical results for the October 2010 samples from the three IAQ wells are presented in Appendix A. Table 3 lists the analytical results for the primary CVOCs [carbon tetrachloride , chloroform (CF), cis-1,2-dichloroethene, tetrachloroethene (PCE), trans-1,2-dichloroethene, trichloroethene (TCE) and vinyl chloride] and other VOCs detected above reporting limits (RL*s*) in one or more samples. Data quality evaluation of the analytical results will be presented in the 2010 annual LTM report.

Four VOCs were detected above RLs in two IAQ wells, MW-253 and MW-256. The analytical results for the primary CVOCs are summarized below:

- CF was reported in in MW-256 at 2.01 µg/L.
- PCE was reported in MW-256 at 9.44 µg/L.
- TCE was reported in MW-253 at 2.99 µg/L and MW-256 at 2.77 µg/L.

The analytical results for other VOCs are summarized as follows:

- Methyl t-butyl ether was reported in MW-253 at 6.79 µg/L.

The analytical results for PCE and TCE in the IAQ wells are shown on Figures 3 and 4, respectively, with the results and isopleths from the October 2010 LTM event. The results are also presented on the cross-section in Figure 5.

CONCLUSIONS AND RECOMENDATIONS

The analytical results were similar to those for the initial samples collected following well installation and are consistent with the groundwater modeling described in the IRACR, which indicated the potential for low CVOC concentrations in the Intermediate and Memphis aquifers at the MI.

The five deep wells, MW-252 to MW-256, were sampled in December 2010; the results will be reported in January 2011. The final quarterly samples from these wells will be collected during the April 2010 LTM sampling event.

TABLES

1 Water Level Measurements

2 Final Well Stabilization Measurements

3 Analytical Results Summary

TABLE 1
WATER LEVEL MEASUREMENTS
IAQ GROUNDWATER SAMPLES, OCTOBER 2010
Main Installation - Defense Depot Memphis, Tennessee

Well ID	Aquifer	Top of Casing Elevation (ft, msl)	Top of Screen Elevation (ft, msl)	Depth to Water 4-Oct-2010 (ft, btoc)	Groundwater Elevation 4-Oct-2010 (ft, msl)
MW-34	Intermediate	299.97	163.37	134.12	165.85
MW-38	Intermediate	307.45	167.55	127.69	179.76
MW-63A	Fluvial/Intermediate	305.96	165.96	100.49	205.47
MW-90	Intermediate	304.19	189.19	112.51	191.68
MW-107	Fluvial/Intermediate	304.92	176.92	105.16	199.76
MW-108	Fluvial/Intermediate	303.07	143.07	105.61	197.46
MW-140	Intermediate	298.12	73.52	139.75	158.37
MW-141	Intermediate	303.71	155.01	109.94	193.77
MW-197A	Fluvial	291.26	129.30	92.16	199.10
MW-199A	Intermediate	301.53	155.45	106.79	194.74
MW-202A	Intermediate	299.23	122.73	121.37	177.86
MW-202B	Intermediate	299.51	180.42	120.41	179.10
MW-205A	Fluvial	291.93	150.96	93.61	198.32
MW-206A	Fluvial	299.92	172.58	102.30	197.62
MW-207A	Fluvial	303.78	154.13	106.29	197.49
MW-208A	Fluvial	301.50	118.05	104.21	197.29
MW-209A	Fluvial	298.05	109.07	102.60	195.45
MW-210A	Intermediate	289.66	112.60	97.88	191.78
MW-211	Intermediate	303.74	137.48	106.92	196.82
MW-229	Intermediate	311.77	123.34	152.65	159.12
MW-252	Intermediate	294.16	168.36	134.28	159.88
MW-253	Intermediate	290.47	172.47	109.21	181.26
MW-254	Memphis	292.84	7.24	136.01	156.83
MW-255	Memphis	291.84	7.34	134.42	157.42
MW-256	Intermediate	292.68	166.68	133.29	159.39

Notes:
ft, btoc: feet below top of casing
ft, msl: feet mean sea level

TABLE 2
FINAL WELL STABILIZATION MEASUREMENTS
IAQ GROUNDWATER SAMPLES, OCTOBER 2010
Main Installation - Defense Depot Memphis, Tennessee

Well ID	Sample Date	Method	Time Sampled	Sample Pump Depth (ft, btoc)	Water Depth (ft, btoc)	Purge Rate (mL/min)	Volume Purged (Liters)	pH	Temp (˚C)	Specific Conductivity (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTUs)
MW-252	10/6/2010	low flow	9:15	138.2	134.11	370	14.0	5.9	19.4	0.257	5.50	-43.5	1.7
MW-253	10/6/2010	low flow	9:57	124.2	108.91	300	7.6	5.7	19.4	0.294	6.22	-33.4	14.5
MW-256	10/5/2010	low flow	8:52	136.3	133.34	340	22.0	5.5	19.1	0.478	5.66	-101.0	9.0

Notes:
˚C : degrees Celsius
DO : Dissolved Oxygen
ft, btoc: feet below top of casing
L : liters
mg/L : milligrams per liter
mL/min: milliliters per minute
mS/cm : milliSiemens per centimeter
mV :millivolts
NTUs: nephelometric turbidity units
ORP : Oxidation Reduction Potential

TABLE 3
ANALYTICAL RESULTS SUMMARY
IAQ GROUNDWATER SAMPLES, OCTOBER 2010
Main Installation - Defense Depot Memphis, Tennessee

	Well ID	Maximum	MW-252	MW-253	MW-256
	Lab ID	Contaminant	L10100199-03	L10100199-04	L10100199-01
	Date	Level	10/6/2010	10/6/2010	10/5/2010
Analyte	**Units**				
Carbon tetrachloride	µg/L	5	<1 Q	<1 Q	**0.32 Q**
Chloroform	µg/L	80	<0.3	<0.3	**2.01**
cis-1,2-Dichloroethene	µg/L	70	<1	<1	<1
Tetrachloroethene	µg/L	5	<1	<1	**9.44**
trans-1,2-Dichloroethene	µg/L	100	<1	<1	<1
Trichloroethene	µg/L	5	<1	**2.99**	**2.77**
Vinyl chloride	µg/L	2	<1	<1	<1
Additional VOCs*					
Methyl t-butyl ether (MTBE)	µg/L	--	<5	**6.79**	<5

Notes:
VOC samples analyzed using method 8260B
µg/L : micrograms per liter
<: Not detected at sample reporting limit
Results detected at or above reporting limits shown in bold

DQE FLAGS:
F: Concentration estimated below RL and above the MDL
M: Concentration estimated due to matrix effect
Q: One or more quality control criteria failed.

FIGURES

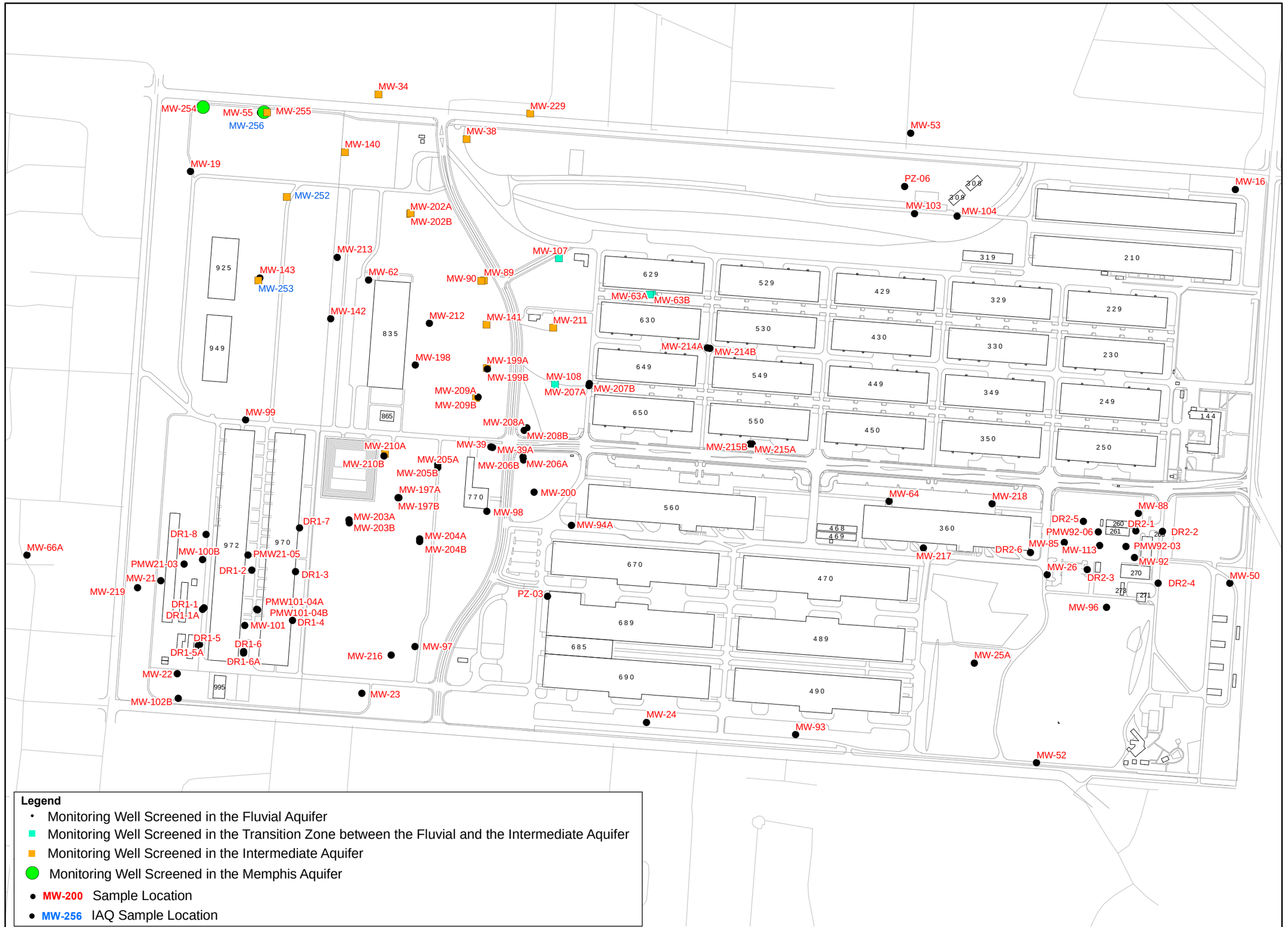
1 Well Location Map

2 Intermediate and Memphis Aquifer Groundwater Elevations

3 PCE Isopleth Map

4 TCE Isopleth Map

5 Lithologic Cross-Section with PCE and TCE Results



Legend

- Monitoring Well Screened in the Fluvial Aquifer
- Monitoring Well Screened in the Transition Zone between the Fluvial and the Intermediate Aquifer
- Monitoring Well Screened in the Intermediate Aquifer
- Monitoring Well Screened in the Memphis Aquifer
- **MW-200** Sample Location
- **MW-256** IAQ Sample Location

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Figure 1

WELL LOCATION MAP

INTERMEDIATE AQUIFER
GROUNDWATER SAMPLES
OCTOBER 2010

MAIN INSTALLATION
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 250 500 1,000
Feet

Installation Location
Memphis, Tennessee

Date: December 2010
Edition: Rev 0

HDR

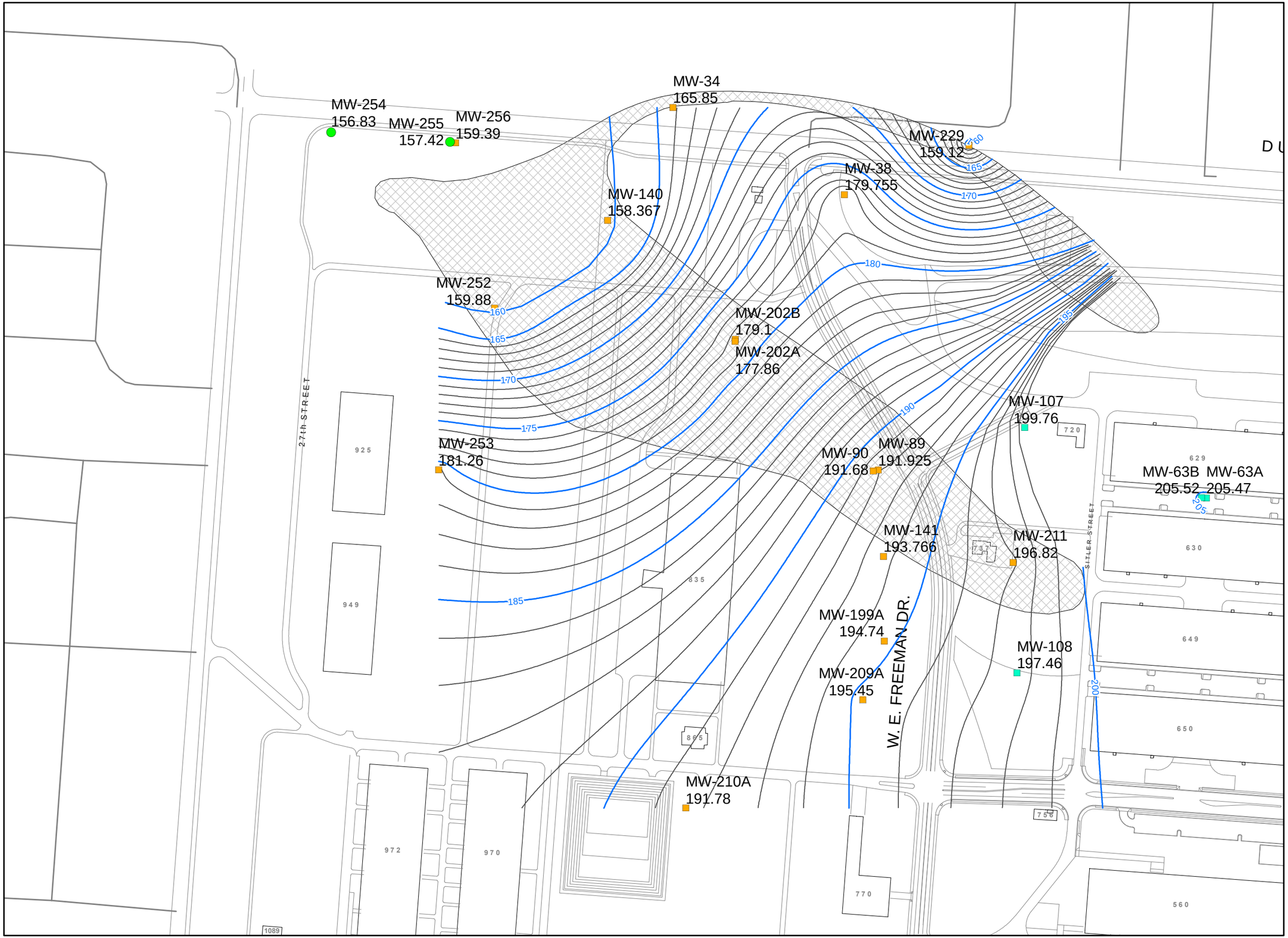

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Figure 2

INTERMEDIATE AND MEMPHIS AQUIFER GROUNDWATER ELEVATIONS

INTERMEDIATE AQUIFER
GROUNDWATER SAMPLES
OCTOBER 2010

MAIN INSTALLATION
DEFENSE DEPOT
MEMPHIS, TENNESSEE

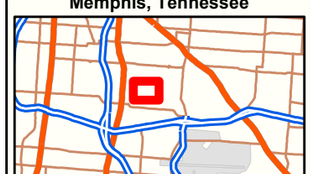
Legend

- Monitoring Well Screened in the Fluvial Aquifer
- Monitoring Well Screened in the Transition Zone
- Monitoring Well Screened in the Intermediate Aquifer
- Monitoring Well Screened in the Memphis Aquifer
- Potentiometric surface 1 - Ft. Contour
- Potentiometric surface 5 - Ft. Contour
- Clay Elevation Exceeds Fluvial Aquifer Groundwater Elevation
- MW-63 205.52 Groundwater Elevation (msl)

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 100 200 400
Feet

Installation Location
Memphis, Tennessee



Date: December 2010
Edition: Rev 0

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Figure 3

PCE ISOPLETH MAP

INTERMEDIATE AQUIFER
GROUNDWATER SAMPLES
OCTOBER 2010

MAIN INSTALLATION
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Legend

PCE Ranges
ug/L
- 0 - 5
- 5 - 10
- 10 - 50
- 50 - 100
- 100 - 300

PCE Isopleth
ug/L
- 5
- 10
- 50
- 100
- Clay Elevation Exceeds Groundwater Elevation
- Potentiometric surface of the Fluvial Aquifer 1-ft. contour
- Potentiometric surface of the Fluvial Aquifer 5-ft. contour
- Potentiometric surface of the Intermediate Aquifer 5-ft. contour

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 200 400 800
Feet

Installation Location
Memphis, Tennessee

Date: December 2010
Edition: Rev 0

Notes:

1. Analytical results from the Long Term Monitoring sample event (10/4/10 - 10/15/10).

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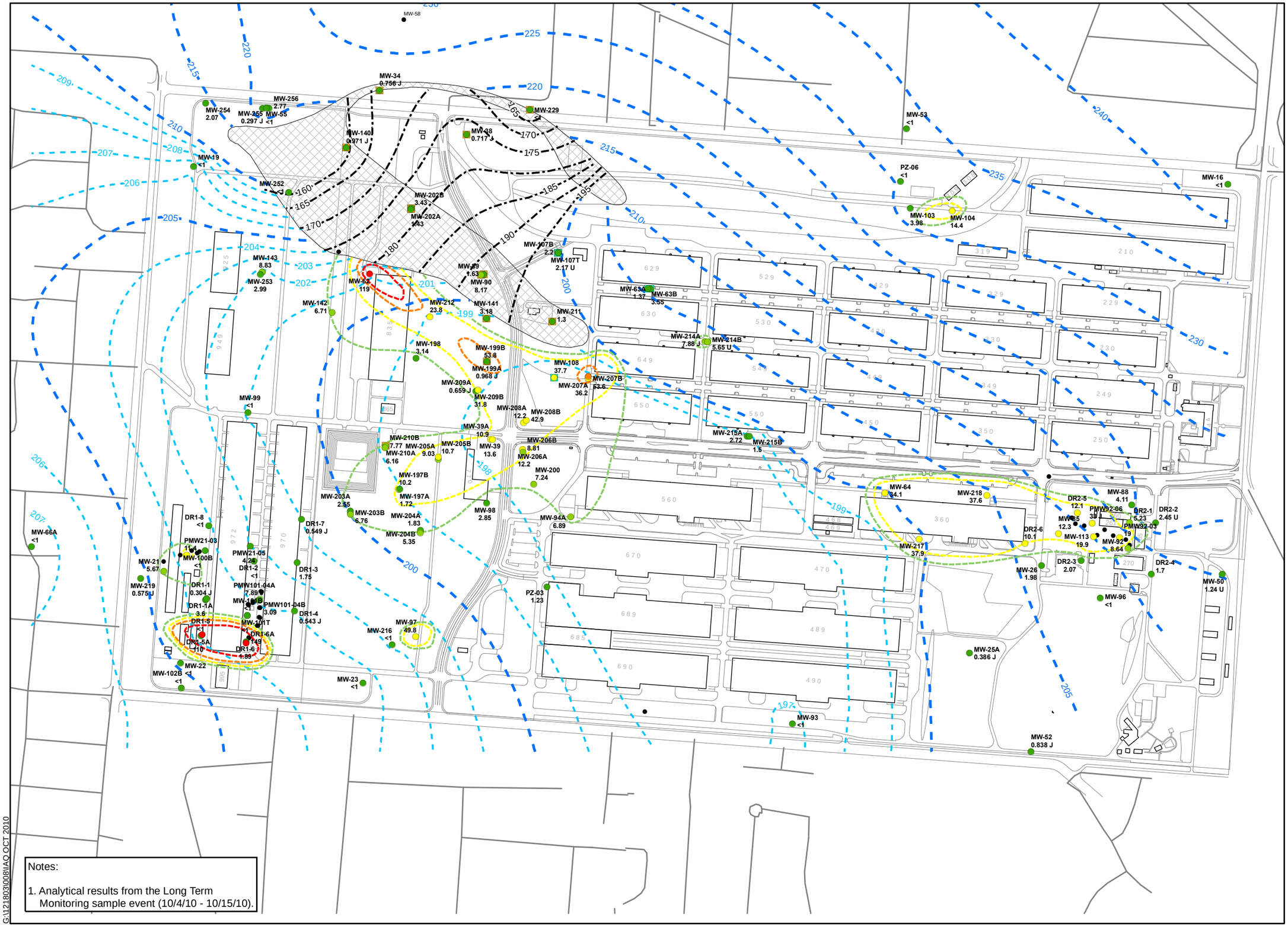

Notes:

1. Analytical results from the Long Term Monitoring sample event (10/4/10 - 10/15/10).

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Figure 4

TCE ISOPLETH MAP

INTERMEDIATE AQUIFER
GROUNDWATER SAMPLES
OCTOBER 2010

MAIN INSTALLATION
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Legend

TCE Ranges
ug/L
- 0 - 5
- 5 - 10
- 10 - 50
- 50 - 100
- 100 - 300

TCE Isopleth
ug/L
- 5
- 10
- 50
- 100
- Clay Elevation Exceeds Groundwater Elevation

- Potentiometric surface of the Fluvial Aquifer 1-ft. contour
- Potentiometric surface of the Fluvial Aquifer 5-ft. contour
- Potentiometric surface of the Intermediate Aquifer 5-ft. contour

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 200 400 800
Feet

Installation Location
Memphis, Tennessee

Date: December 2010
Edition: Rev 0

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A NORTH

A' SOUTH

MW-254 | MW-55 MW-256 MW-255 | MW-252 offset 333-ft. from centerline | MW-140 offset 88-ft. from centerline | MW-202A/MW-202B | MW-89/MW-90 | MW-141 | MW-199A MW-199B | MW-209A MW-209B | MW-39 MW-39A | MW-206A MW-206B | MW-200 | MW-94A | MW-94 | MW-81/MW-24

300 280 260 240 220 200 180 160 140 120 100 80 60 40 20 0

Silty Clay to Clayey Silt

Sandy Clay to Clayey Sand

Sand with Gravel

Grey Clay

Clay

Clayey Sand

Silty Sand

Sand

Memphis Sand

MW-254 MW-255 MW-256 MW-252 MW-140 MW-55 MW-202B MW-202A MW-90 MW-89 MW-141 MW-199B MW-199A MW-209B MW-209A MW-39 MW-39A MW-206B MW-206A MW-200 MW-94A MW-94 MW-24 MW-81

PCE 0.623
TCE 2.07

PCE <1
TCE 0.297

PCE 9.44
TCE 2.77

PCE <1
TCE <1

PCE 1.18
TCE 0.971

PCE 23.1
TCE 3.43

PCE 1
TCE 1.43

PCE 47.9
TCE 8.17

PCE 1.43
TCE 1.63

PCE 19.6
TCE 3.18

PCE 0.707
TCE 53.8

PCE <1
TCE 0.968

PCE 0.479
TCE 31.8

MW-209A
195.45

PCE <1
TCE 0.659

20
0
200

B.T.

Note:
PCE and TCE concentrations in ug/L from IAQ and LTM samples collected October 2010.

N W E S

Figure 5

LITHOLOGIC CROSS-SECTION

INTERMEDIATE AQUIFER
GROUNDWATER SAMPLES
OCTOBER 2010

MAIN INSTALLATION
DEFENSE DEPOT
MEMPHIS, TENNESSEE

- Silty Clay to Clayey Silt
- Sandy Clay to Clayey Sand
- Fluvial Sand or Sand with Gravel
- Clayey Sand to Silty Clay
- Intermediate Sand
- Clay
- Memphis Sand
- Groundwater Elevation
- Fluvial Aquifer Groundwater Elevation 10/4/2010
- Intermediate Aquifer Groundwater Elevation 10/4/2010
- Memphis Aquifer Groundwater Elevation 10/4/2010
- Well Screen Interval

Date: December 2010
Edition: Rev 0

Appendix A

Results of Laboratory Analyses

TABLE A-1
ANALYTICAL RESULTS
IAQ GROUNDWATER SAMPLES, OCTOBER 2010
Main Installation - Defense Depot Memphis, Tennessee

	Well ID	MW-252	MW-253	MW-256	MW-256 DUP-9
	Date	10/6/2010	10/6/2010	10/5/2010	10/5/2010
	Lab ID	L10100199-03	L10100199-04	L10100199-01	L10100199-02
Analyte	**Units**				
1,1,1,2-Tetrachloroethane	µg/L	<0.5	<0.5	<0.5	<0.5
1,1,1-Trichloroethane	µg/L	<1	<1	<1	<1
1,1,2,2-Tetrachloroethane	µg/L	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	<1	<1	<1	<1
1,1-Dichloroethane	µg/L	<1	<1	0.138 F	<1
1,1-Dichloroethene	µg/L	<1	<1	<1	<1
1,1-Dichloropropene	µg/L	<1	<1	<1	<1
1,2,3-Trichlorobenzene	µg/L	<1	<1	<1	<1
1,2,3-Trichloropropane	µg/L	<1	<1	<1	<1
1,2,4-Trichlorobenzene	µg/L	<1	<1	<1	<1
1,2,4-Trimethylbenzene	µg/L	<1	<1	<1	<1
1,2-Dibromo-3-chloropropane	µg/L	<2	<2	<2	<2
1,2-Dibromoethane	µg/L	<1	<1	<1	<1
1,2-Dichlorobenzene	µg/L	<1	<1	<1	<1
1,2-Dichloroethane	µg/L	<0.5	<0.5	<0.5	<0.5
1,2-Dichloropropane	µg/L	<1	<1	<1	<1
1,3,5-Trimethylbenzene	µg/L	<1	<1	<1	<1
1,3-Dichlorobenzene	µg/L	<1	<1	<1	<1
1,3-Dichloropropane	µg/L	<0.4	<0.4	<0.4	<0.4
1,4-Dichlorobenzene	µg/L	<0.5	<0.5	<0.5	<0.5
1-Chlorohexane	µg/L	<1	<1	<1	<1
2,2-Dichloropropane	µg/L	<1	<1	<1	<1
2-Chlorotoluene	µg/L	<1	<1	<1	<1
2-Hexanone	µg/L	<10	<10	<10	<10
4-Chlorotoluene	µg/L	<1	<1	<1	<1
Acetone	µg/L	<10	<10	<10	<10
Benzene	µg/L	<0.4	<0.4	<0.4	<0.4
Bromobenzene	µg/L	<1	<1	<1	<1
Bromochloromethane	µg/L	<1	<1	<1	<1
Bromodichloromethane	µg/L	<0.5	<0.5	<0.5	<0.5
Bromoform	µg/L	<1	<1	<1	<1
Bromomethane	µg/L	<1	<1	<1	<1
Carbon disulfide	µg/L	<1	<1	<1	<1
Carbon tetrachloride	µg/L	<1 Q	<1 Q	0.32 Q	0.295 Q
Chlorobenzene	µg/L	<0.5	<0.5	<0.5	<0.5
Chloroethane	µg/L	<1 Q	<1 Q	<1 Q	<1 Q
Chloroform	µg/L	<0.3	<0.3	2.01	1.99
Chloromethane	µg/L	<1	<1	<1	<1
cis-1,2-Dichloroethene	µg/L	<1	<1	<1	<1
cis-1,3-Dichloropropene	µg/L	<0.5	<0.5	<0.5	<0.5
Dibromochloromethane	µg/L	<0.5	<0.5	<0.5	<0.5
Dibromomethane	µg/L	<1	<1	<1	<1
Dichlorodifluoromethane	µg/L	<1 Q	<1 Q	<1 Q	<1 Q
Ethylbenzene	µg/L	<1	<1	<1	<1
Hexachlorobutadiene	µg/L	<0.6	<0.6	<0.6	<0.6
Isopropylbenzene	µg/L	<1	<1	<1	<1
m-,p-Xylene	µg/L	<2	<2	<2	<2
MEK (2-Butanone)	µg/L	<10	<10	<10	<10
Methyl t-butyl ether (MTBE)	µg/L	<5	6.79	<5	<5
Methylene chloride	µg/L	<1	<1	<1	<1
MIBK (methyl isobutyl ketone)	µg/L	<10	<10	<10	<10
Naphthalene	µg/L	<1	<1	<1	<1
n-Butylbenzene	µg/L	<1	<1	<1	<1
n-Propylbenzene	µg/L	<1	<1	<1	<1
o-Xylene	µg/L	<1	<1	<1	<1
p-Isopropyltoluene	µg/L	<1	<1	<1	<1
sec-Butylbenzene	µg/L	<1	<1	<1	<1
Styrene	µg/L	<1	<1	<1	<1
tert-Butylbenzene	µg/L	<1	<1	<1	<1
Tetrachloroethene	µg/L	<1	<1	9.44	9.53
Toluene	µg/L	<1	<1	<1	<1
trans-1,2-Dichloroethene	µg/L	<1	<1	<1	<1
trans-1,3-Dichloropropene	µg/L	<1	<1	<1	<1
Trichloroethene	µg/L	<1	2.99	2.77	2.76
Trichlorofluoromethane	µg/L	<1 Q	<1 Q	<1 Q	<1 Q
Vinyl chloride	µg/L	<1	<1	<1	<1

VOC samples analyzed using method 8260B
µg/L : micrograms per liter
<: Not detected at sample reporting limit
DQE FLAGS:
F: Concentration estimated below RL and above the MDL
M: Concentration estimated due to matrix effect
Q: One or more quality control criteria failed.