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THE MEMPHIS DEPOT
TENNESSEE

ADMINISTRATIVE RECORD
COVER SHEET

AR File Number 947

MAIN INSTALLATION SOURCE AREA INVESTIGATION WORK PLAN

Defense Depot Memphis, Tennessee

Prepared for:

Defense Logistics Agency

e²M
Solutions Today for a Sustainable Tomorrow

AFCEE

AFCEE Contract FA8903-08-D-8771
Task Order No. 0019

August 2008

Revision 0

MAIN INSTALLATION
SOURCE AREA INVESTIGATION
WORK PLAN
REVISION 0

Defense Depot Memphis, Tennessee

Prepared for:

Air Force Center for Engineering and the Environment
Contract No. FA8903-08-D-8771
Task Order No. 0019

Prepared by:

engineering-environmental Management, Inc.
9563 S. Kingston Court
Suite 200
Englewood, Colorado 80112

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

Figures

LIST OF ACRONYMS AND ABBREVIATIONS

AFCEE	Air Force Center for Engineering and the Environment
bgs	below ground surface
CF	chloroform
CPT	Cone Penetration Testing
CWN	compliance well network
DDMT	Defense Depot Memphis, Tennessee
DLA	Defense Logistics Agency
DoD	Department of Defense
DPT	Direct Push Technology
EBT	Enhanced Bioremediation Treatment
ECD	electron capture detector
e^2M	engineering-environmental Management, Inc.
FID	flame ionization detector
GC	Gas Chromatograph
LTM	Long Term Monitoring
MCL	Maximum Contaminant Level
µg/L	micrograms per liter
mg/kg	milligram/kilogram
MI	Main Installation
MIP	membrane interface probe
MNA	Monitored Natural Attenuation
MW	monitoring well
OPS	Operating Properly and Successfully
PCA	1,1,2,2 tetrachloroethane
PCE	tetrachloroethene
PID	Photoionization Probe
RAO	Remedial Action Objectives
RAWP	Remedial Action Work Plan
RDI	Remedial Design Investigation
RG	Remediation Goal
RI	Remedial Investigation
ROD	Record of Decision
SSHP	Site Safety and Health Plan

TA	treatment area
TCE	trichloroethene
TM	Technical Memorandum
USACE	United States Army Corps of Engineers
µg/L	micrograms per liter
VOC	volatile organic compound

1.0 INTRODUCTION

This Main Installation (MI) Source Area Investigation Work Plan (Work Plan) was prepared by engineering-environmental Management, Inc. (e^2M) to describe the site-specific tasks that will be completed as part of the MI Source Area Investigation (Investigation). The Investigation will be completed to further evaluate subsurface conditions at the Main Installation (MI) at the Defense Depot Memphis, Tennessee (DDMT [Figure 1]) and to assess potential source areas for the identified MI groundwater plumes. This work will be performed for the Defense Logistics Agency under contract FA8903-08-D-8771, Task Order 0019 to the Air Force Center for Engineering and the Environment. Results from the Investigation will be used in evaluating the selected remedy for the MI.

1.1 WORK PLAN OVERVIEW

This Work Plan provides relevant background information and data and a plan of action for completing Investigation activities in a safe and effective manner. The Investigation is being completed subsequent to the *Main Installation Source Area Evaluation* (e^2M, 2008). This Work Plan describes the work to be completed as part of the Investigation and includes a schedule for implementation. The *Site Safety and Health Plan Main Installation, Revision 0* (e^2M, 2008) was developed in conjunction with this Work Plan and will provide a basis for site safety while completing the Investigation.

1.2 SITE HISTORY AND BACKGROUND

DDMT is located in southeastern Memphis. DDMT originated as a military facility in the 1940s. Its initial mission and function was to provide stock control, material storage, and maintenance services for the United Stated Army (Memphis Depot Caretaker Division, 2003). The DDMT is located approximately 5 miles east of the Mississippi River and just northeast of Interstate 240. The property consists of approximately 642 acres and includes two components: the MI which includes open storage areas, warehouses, former military family housing and outdoor recreational areas; and Dunn Field which was once used for mineral storage and waste disposal. In 1995, the DDMT was placed on the list of Department of Defense (DoD) facilities to be closed under BRAC. Storage and distribution activities continued until the DDMT closed in September 1997.

1.3 REMEDIAL ACTION OBJECTIVES

As outlined in the *Main Installation Final Remedial Design, Revision 1* (MI RD) (CH2MHill, 2004), remedial action objectives (RAOs) for the MI include restoration of groundwater quality to levels at or less than maximum contaminant levels (MCLs). This RAO is to be met by enhanced bioremediation treatment (EBT) in the treatment areas and by monitored natural attenuation (MNA) outside those areas. Well installation and long term monitoring (LTM), performed as part of the MNA component of the MI RA has identified additional groundwater plumes that may require treatment in order to meet the RAOs.

Compliance with the RAO is to be demonstrated for each groundwater plume on the MI. Compliance well networks (CWNs) are to be designated for each plume within 18 months of initiating injections in the treatment areas. The *Remedial Action Work Plan, Main Installation* (RAWP) (MACTEC, 2005) states that the *operating properly and successfully* (OPS) metric for the MNA component will be evaluated through demonstration of specified criteria from groundwater monitoring results. The RAWP also lists criteria for implementing contingency actions related to the MNA component based on groundwater monitoring results (e.g., chlorinated volatile organic compound [CVOC] concentrations persist or CVOCs are detected in sentinel wells).

2.0 MAIN INSTALLATION SOURCE AREAS EVALUATION

The *Main Installation Source Area Evaluation* (MI Evaluation) (e^2M, 2008) was conducted to recommend compliance well networks for the MI groundwater plumes and to review site information for potential source areas for the groundwater plumes. Based on the isoconcentration maps for tetrachloroethene (PCE) and trichloroethene (TCE) from the LTM sampling event completed in October 2007, seven groundwater plumes were identified based on the PCE and TCE isopleths and data from past LTM events. The plume designations are shown on Figures 2 and 3 and are listed with the primary CVOCs below.

Plume	CVOC
TTA-1 North	PCE
TTA-1 South	PCE, TCE
TTA-2	PCE, CT
West-Central	PCE
Sentinel	PCE
Bldg 835	TCE
North-Central	TCE

The MI Evaluation was limited to plumes with maximum CVOC concentrations greater than 100 micrograms per liter (µg/L) since that was the criteria used to select plumes for EBT in the MI RD. CVOCs detected within the North-Central and Sentinel Plumes have historically been below 100 µg/L, thus eliminating these two plumes from the Investigation. In addition, the Sentinel Plume is considered to be a result of CVOC migration from the fluvial aquifer. Monitoring wells MW-90 and MW-141, which are the core wells in this plume, are screened in the intermediate aquifer below the clay layer present in this area. Remediation of the adjacent groundwater plumes should also address the Sentinel Plume. There are four wells (MW-25A, MW-52, MW-97 and PZ-03) outside the designated plumes that have CVOC concentrations above MCLs in samples collected since the MI RA began. Further delineation of CVOC impacts at these wells is not planned at this time.

The MI Evaluation was performed for five groundwater plumes on the MI: TTA-1 North; TTA-1 South; TTA-2; West-Central, and Building 835. The MI Evaluation summarizes information on operations that historically occurred in the vicinity of each groundwater plume and previous soil sample results. The results from the MI Evaluation were used to develop the Work Plan. The CVOC isopleths for TTA-1 and TTA-2 plumes (Figures 2 and 3) are based on baseline EBT samples from August 2006 and LTM samples from October 2006 because of changes in the plumes due to the EBT. The CVOC isopleths for the West-Central and Building 835 plumes are based on sample results from September and October 2007.

3.0 INVESTIGATION ACTIVITIES

The Investigation will be performed to identify potential source areas for the MI groundwater plumes. The Investigation will be conducted in the eight Investigation grid areas highlighted on Figures 2 and 3. Primary CVOC isopleths associated with the groundwater plumes are outlined on Figures 4 thru 11. The Investigation will be conducted in a similar fashion to the MIP investigation that was completed at Dunn Field. The estimated number of MIP locations and confirmation soil samples that will be completed as part of the Investigation are summarized below. Additional MIP and soil sample locations may be added based on field conditions.

Plume Area	MIP Locations	Confirmation Soil Samples
TTA-1 North	40	10
TTA-1 South	41	10
TTA-2 North	55	14
TTA-2 South	35	9
West Central	66	16
Building 835	36	9
Total	**273**	**68**

The MIP survey will be performed by Columbia Technologies of Baltimore, Maryland (Columbia) under the direction of e^2M. The MIP is a screening tool with semi-quantitative capabilities acting as an interface between the CVOCs in the subsurface and gas phase detectors at the surface. A direct push drilling or cone penetration testing (CPT) system is used to advance a sensor through a soil column while collecting continuous data on CVOC concentrations in gas phase. The MIP system is comprised of a down-hole heating element that raises subsurface temperatures and volatilizes organic contaminants. The volatilized CVOCs permeate across a membrane at the probe tip and are brought to the surface in an inert carrier gas stream for analysis. MIP rigs are typically equipped with a flame ionization detector (FID), photoionization detector (PID), electron capture detector (ECD), and in some cases, a gas chromatograph (GC). The ECD analyzes the mass of a smaller set of organic chemicals that generally represent the CVOCs which are the target of the MI investigation. PID, FID, and ECD data, as well as the response from a soil conductivity detector, are collected continuously during advancement. The three detectors will be used to simultaneously evaluate and correlate the results obtained from each detector. The instrument response will be plotted versus depth to evaluate the concentration of CVOCs at each location. Details associated with the Investigation are further described in this section.

The MI Investigation will be similar to the Membrane Interface Probe (MIP) investigation performed by CH2M Hill as part of the Source Areas Remedial Design Investigation (RDI) at Dunn Field in 2005. That investigation was performed to increase soil data density in the four Dunn Field treatment areas in order to delineate CVOCs soil contamination laterally and vertically to a depth of approximately 30 feet below ground surface (bgs). An ECD response of 0.3 volts ($3x10^5$ microvolts) was estimated to be equivalent to the loess remediation goals (RGs) established for Dunn Field. While the Dunn Field RGs are not applicable to the MI, the 0.3 volt MIP ECD response will be considered the lower limit for potential source areas on the MI.

3.1 PRELIMINARY ACTIVITIES

Prior to initiating the Investigation, preliminary activities to be completed will include:

- An initial location survey;
- Utility marking; and
- Site preparation and mobilization.

The location survey and utility marking will require approximately two weeks. Mobilization of the MIP subcontractor will occur the weekend before initiating the Investigation.

3.1.1 Initial Survey

A Tennessee registered and licensed land surveyor (Allan and Hoshall) will survey and mark the proposed MIP locations to known northing and easting coordinates. MIP locations situated in asphalt or concrete will be marked with a survey PK nail and pin flags. Locations situated in grass will be marked with a stake and flag positioned at a sufficient height to be visible for mowing crews and Investigation personnel.

In addition to locating and marking the investigation locations, Allen and Hoshall will survey at least two corners of the buildings adjacent to the Investigation areas. The building corners will be tied into known northing and easting coordinates. The building coordinates will be utilized to confirm initial Investigation areas and preliminary building locations.

3.1.2 Utility Clearance

Field personnel will mark the proposed MIP locations approximately two weeks prior to commencement of the Investigation. All utilities will be marked by a professional utility locating service prior to the start of drilling. The preliminary MIP and confirmation soil boring locations are depicted on Figures 4 thru 11 and these locations may be shifted based on utility locations and conditions encountered in the field. The revised locations will be described in the field records.

3.1.3 Mobilization

The MIP drilling subcontractor, Columbia, will mobilize to the site in order to begin the Investigation on 25 August 2008. e^2M will provide oversight of equipment mobilization, supplies and personnel and will coordinate the mobilization schedule.

3.2 MEMBRANE INTERFACE PROBE INVESTIGATION

The overall strategy for the Investigation is to characterize the magnitude and extent of the primary CVOCs (TCE, PCE, carbon tetrachloride [CT] and chloroform [CF]) in the MI loess soils within the groundwater plumes using a semi-quantitative investigative method. The MIP data will be compared to data collected from the confirmation soil samples to will be collected in conjunction with the MIP drilling. The ECD has a detection limit of approximately 100 micrograms per kilogram (µg/kg) for both PCE and TCE. Other halogenated compounds have different ECD responses based primarily on boiling point and vapor pressure.

3.2.1 Drilling Technique

The MIP locations will be installed using a Direct Push Technology (DPT) drilling rig. Based on the site geology, a Geoprobe® 6020DT DPT rig will be utilized to advance the MIP locations to the base of the loess and underlying transition zone (approximately 30 to 35 feet below ground surface [bgs]). Prior to initiating drilling at each MIP location, concrete or asphalt that is present will be cored. At locations where the asphalt is at a minimal thickness, the coring mechanism of the DPT rig spindle will be utilized. At locations where the concrete or asphalt is estimated to be thicker than 8-inches, a separate coring contractor will be utilized to core the MIP location prior to initiating drilling. After each MIP boring is completed, the boring will be filled to either the base of concrete or asphalt or to six inches below ground

surface with bentonite-grout slurry to meet State of Tennessee boring abandonment requirements. The remainder of the boring will be filled with cement or soil to match the surrounding area.

3.2.2 MIP Location Grids

As shown on Figures 4 thru 11, a 40-foot by 40-foot spacing will be used to locate and identify the MIP locations five of the six Investigation grids. A 30-foot by 30-foot spacing will be utilized in grid TTA-1-N-N. Each of the MIP points will be advanced from ground surface to approximately 30 to 35 feet bgs (top of fluvial sands). The MIP borings will be terminated at the base of the loess (anticipated to be 30 to 35 feet bgs) as determined through previous drilling or when the electrical conductivity readings suggest that the MIP has begun to penetrate the underlying fluvial sands, or at refusal.

3.2.3 MIP Grid Nomenclature

All MIP locations will be provided a name based on an alphanumeric system. The system will be used to track the information generated at each MIP location during the drilling phase and also to provide a tracking mechanism when the MIP and soil sample locations are surveyed before and after the Investigation is completed. As indicated on the grids illustrated on Figures 4 thru 11, each MIP location name will be based on the groundwater plume area and the row and column in which it is located within that specific grid. The alphanumeric system is detailed below:

Example MIP Location: **TTA1N-N-B3**

TTA1N – MI Groundwater Plume Area

N – Subarea of the Groundwater Plume.

B – Row location within the grid. Each grid row starts with A on the north edge and increases within the alphabet going from north to south.

3 – Column location with the specific grid. The columns increase sequentially by number going from west to east.

Should additional MIP locations be necessary the row and column labeling convention will be maintained. Additional locations to the south and east will utilize the next letter or number, while those to the north and west will begin at Z going backwards through the alphabet or utilize negative numbers.

3.2.4 MIP Boring Drilling Scenario

The MIP study will be conducted in 10-day shifts and approximately 5 locations are expected to be completed each day. The Investigation will begin at MIP locations in the central upgradient portion of each plume. Initial locations within all the plumes will be completed during the first shift. This strategy will provide a means for the MIP operator to understand the relative detector responses in all the plume areas. Each of the three detectors (PID, FID and ECD) respond differently to various compounds; a PID is best for aromatics, FIDs are best for aliphatic compounds and the ECD is best for chlorinated compounds. The ECD is therefore expected to be the most useful for the Investigation. Responses from the initial borings will help develop a "fingerprint" for the CVOCs of interest and assist with determining subsequent MIP locations within each grid. Figures 4 thru 11 indicate the initial MIP locations that will be completed first at each grid.

It is anticipated that the initial MIP borings will be completed within the various grids using the following order:

- TTA-1-N-N;
- TTA-1-N-S;
- TTA-1-S-W;
- TTA-1-S-E;
- TTA-2-W;
- TTA-2-E;
- West Central; and
- Building 835.

After completing the initial locations within each grid, the survey will be completed in each area using the same order above, beginning once again at TTA-1-N-N.

MIP borings will proceed outward from the central portion of each grid until the MIP response indicates that CVOC concentrations have decreased to de minimis levels based on the total CVOC readings on the FID, PID and ECD. Once the borings along a transect reach these levels, additional borings will be completed along another transect. Each additional transect will be started within the central portion of the Investigation grids or adjacent to a potential "source area", and continue until de minimis levels are reached in that transect.

3.2.5 MIP Data Generation

MIP logs will be generated in real time as each MIP boring is being completed. A hard copy of each MIP log will be provided to e^2M field personnel once the boring is completed. In addition, after the boring is completed, the MIP log will be emailed to the Columbia headquarters in Baltimore, Maryland where it will be uploaded to a secure project website where it can be reviewed within approximately 30 minutes by project personnel. Each log will contain six separate graphs of data; temperature, ECD, FID, PID, ROP, and conductivity. In general, lower conductivities are indicative of coarser grained particles such as sands and higher conductivities indicate finer grained particles such as silts and clays. The rate of penetration (ROP) can be used to evaluate the hardness of a stratum. The temperature graph can be useful in determining if groundwater is encountered. These graphs are illustrated on the example MIP log provided in Appendix A. This type MIP log will be generated by Columbia during the Investigation.

In addition to uploading all MIP logs to a secure project website, all MIP logs will be emailed to key project personnel. A copy of each log will be emailed to the following personnel:

- Tom Holmes – Project Manager;
- Kevin Sedlak – Task and Field Operations Manager; and
- Brandon Bruns – Project Engineer.

Mr. Sedlak who will be responsible for the MIP Investigation data management.

3.2.6 Confirmation Soil Sampling

As part of the MIP Investigation, up to 66 discrete soil samples, no more than 18 inches from select MIP borings, will be collected using standard DPT. Confirmation soil samples will be collected and sent to an off-site laboratory for analysis. Laboratory analyses will be completed using an expedited time frame during the Investigation so decisions for future drilling activities can be made while subcontractors are on site. The soil confirmation sample borings will be located within the MIP location grid. The confirmation soil sampling will be completed in three events after two preceding MIP drilling events have been completed.

Each soil sample location will be labeled utilizing the MIP location nomenclature detailed in Section 3.2.3. The soil sample location will be identified using the target MIP boring identification. In addition,

"SB" will be added to the soil sample identification to signify "soil boring" and the sample depth will be included in the designation. Field personnel will take distance and direction measurements from the associated MIP boring for each soil confirmation sample boring that is completed. All measurements will be detailed on the Investigation log book.

The MIP data will be compared to the soil data to correlate the data sets and to ultimately delineate potential groundwater plume source areas. Soil sample intervals will be selected based on MIP responses. The soil sample interval will be determined based on the highest average MIP log response (ECD, PID and FID results) along with field observations made by e^2M field personnel. If multiple intervals within the MIP boring show elevated MIP log responses, then a confirmation soil sample will be collected at the interval with the highest average MIP ECD response.

Each soil sample will be collected using a three-foot long DPT soil sample tube. The soil sample will be collected across the soil interval that exhibits the highest MIP log response. In each soil sample interval, three En Core® soil samples will be collected from the central portion of the sample tube. The three En Core® samples will be labeled using the corresponding soil sample identification and submitted to the laboratory for analysis. Soil samples may be collected a multiple depths in a single confirmation soil boring location based on MIP log responses.

3.2.7 Field Observations

Field observations will be summarized in the Investigation field log book, for each MIP and confirmation soil sample location. In addition, Columbia will provide copies of their field forms to e^2M at the end of each day.

3.3 HEALTH AND SAFETY

The *Site Safety and Health Plan, Main Installation* (SSHP) (e^2M, 2008) will provide the basis for protection of site workers while on the MI completing the Investigation. The SSHP includes a description of potential risks, responsible on-site personnel, site safety programs and procedures, contingency procedures, monitoring requirements, and spill prevention, control and countermeasures plan.

3.4 SCHEDULE

The schedule provided in Appendix B shows the planned activities and durations for the Investigation. It is anticipated that the MIP drilling portion of the Investigation will begin on 25 August 2008 and will be completed in six, 10-day stages. Each stage of drilling will be completed utilizing a work schedule of 10-days on and 4 days off. It is anticipated that the MIP drilling portion of the Investigation could take up to 54 days to complete. Confirmation soil sampling activities will be completed in three field events. The three events will be initiated at the beginning of MIP drilling stages Nos. 2 and 4 and 6 and could take approximately 13 days to complete. The Investigation schedule may be changed due to field conditions.

3.5 SAMPLING AND ANALYSIS

All confirmation soil samples will be analyzed for VOCs using EPA Method 8260B with a rapid turn-around-time (72 hours). All soil samples will be submitted to Microbac Laboratories in Marietta, Ohio (Microbac) for analysis. Based on requirements outlined in the *Remedial Action Sampling and Analysis Plan: Volume I – Field Sampling Plan* and *Volume II – Quality Assurance Project Plan* (MACTEC, 2005), a set number of duplicate samples and matrix spike/matrix spike duplicates (MS/MSDs) will be collected along with the confirmation soil samples. Confirmation soil samples will be collected in three events. The confirmation soil sample summary is detailed below.

Sampling Event	Number of Soil Samples (Estimated)	Sample Duplicates	MS/MSDs (1 Sample Each)	Total Samples
Sampling Event #1	26	2	2	30
Sampling Event #2	25	2	2	29
Sampling Event #3	17	2	2	21

Notes:
Confirmation soil sampling events will be initiated at the beginning of MIP drilling stages Nos. 2, 4 and 6.

To meet the sample holding times, soil samples will be shipped to Microbac at the end of each day that samples are collected. Sample containers will be quickly and adequately sealed; container rims and seals will be cleaned thoroughly before tightening the lids. Sample containers will be properly labeled using labels provided by Microbac and immediately cooled to ±4°C and this temperature will be maintained

throughout delivery to Microbac until the samples are analyzed. Each sample will be labeled using the nomenclature detailed in Sections 3.2.6. For duplicate soil samples, a double blind sample number will be utilized. MS/MSDs will be labeled by placing "MS/MSD" at the end of the sample number. Trip blanks will be designated with "TB".

3.6 POST INVESTIGATION SURVEY

After the Investigation has been completed, all soil sample locations and shifted MIP locations will be surveyed to known northing and easting coordinates by a Tennessee registered land surveyor from Allen and Hoshall. The final survey data will be used in the Investigation Summary Technical Memorandum.

3.7 INVESTIGATION SUMMARY TECHNICAL MEMORANDUM

A technical memorandum (TM) will be prepared once the Investigation is complete and all analytical data has been received and reviewed. Columbia will prepare and submit a summary report that will be included as an appendix in the TM. The Investigation data and Columbia report will be used to identify potential source areas for the MI groundwater plumes. e^2M will complete the TM according to the schedule provided in Appendix B. The TM will include but will not be limited to the following:

- Description of the Investigation procedure;
- Field measurement methods and data collected;
- Summary of field and analytical laboratory data;
- Variances in field procedures performed; and
- Recommendations and impact to the MI RA.

The TM will be submitted to the BCT for review and comment. The final TM will be presented in a revised MI RAWP.

4.0 REFERENCES

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FIGURES

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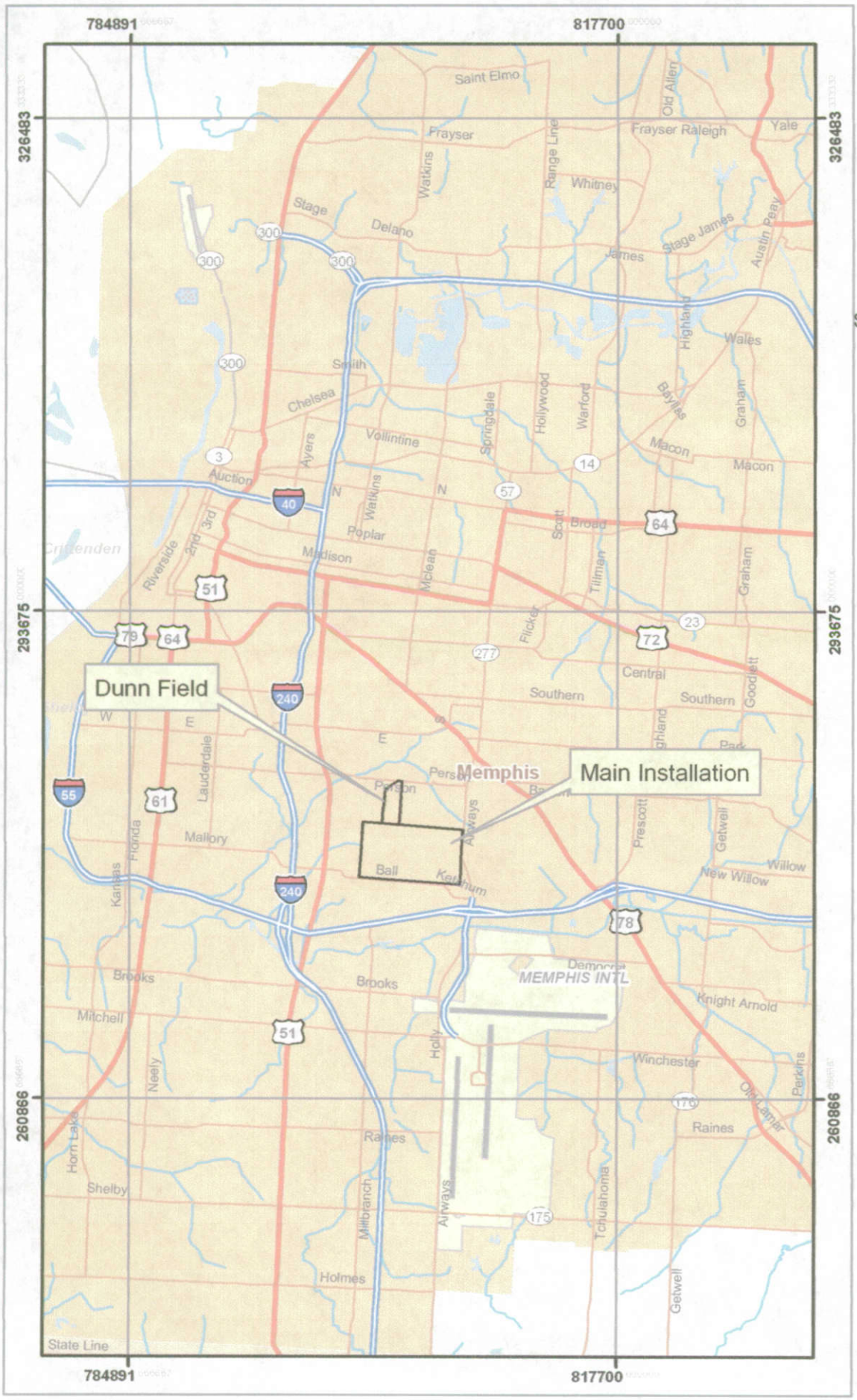

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Figure 1

SITE LOCATION MAP

MAIN INSTALLATION
SOURCE AREA INVESTIGATION

DEFENSE DEPOT
MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 0.4 0.8 1.2 1.6 2 Miles

Installation Location
Memphis, Tennessee

Date: August 2008
Edition: Rev 0

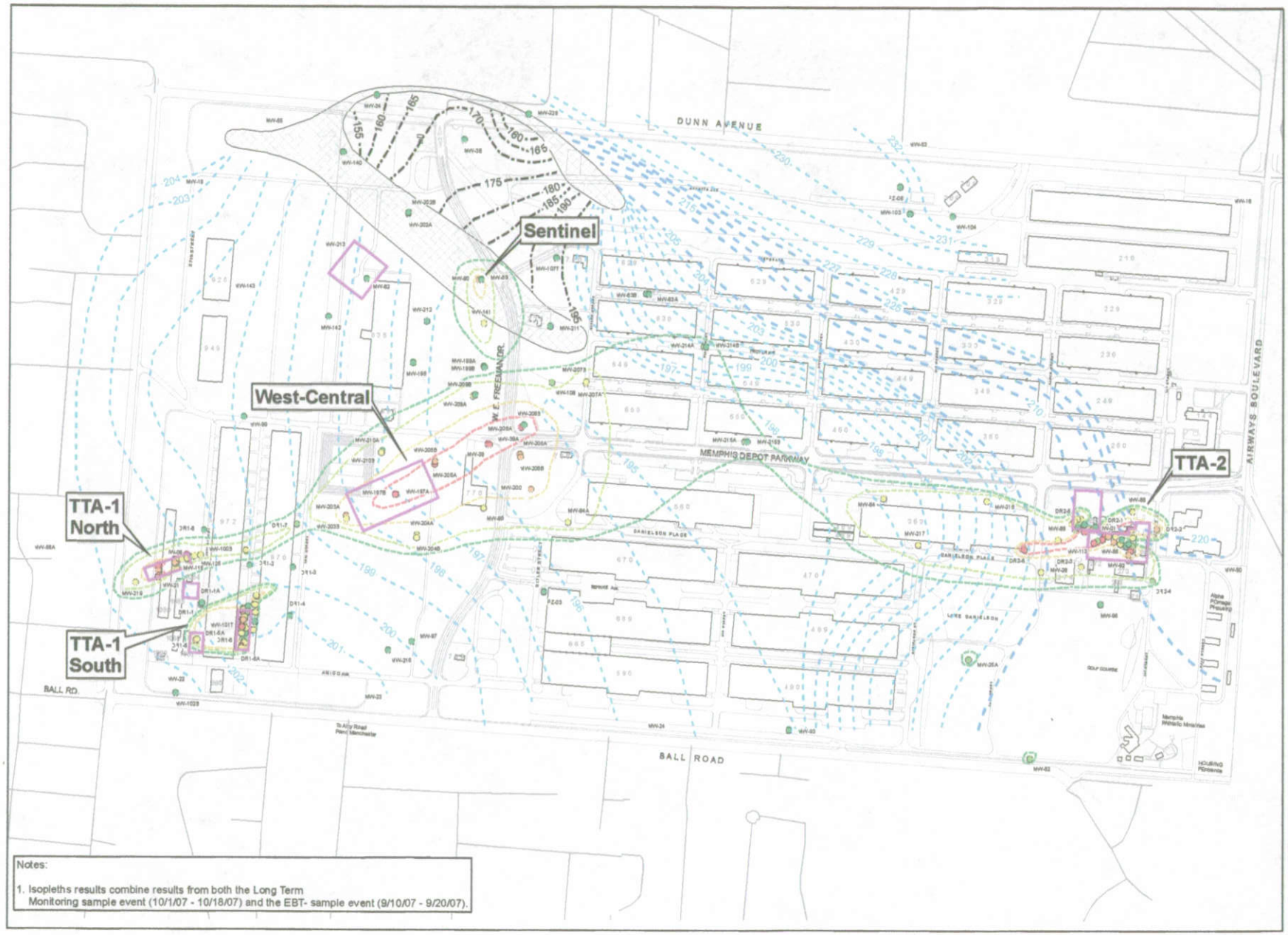

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Figure 2

MI GROUNDWATER PLUMES - PCE OCTOBER 2007

MAIN INSTALLATION
SOURCE AREA INVESTIGATION

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
- 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
- MIP Survey Areas
- Clay Elevation Exceeds Groundwater Elevation

947 23

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 200 400 800
Feet

Installation Location
Memphis, Tennessee

Date: August 2008
Edition: Rev 0

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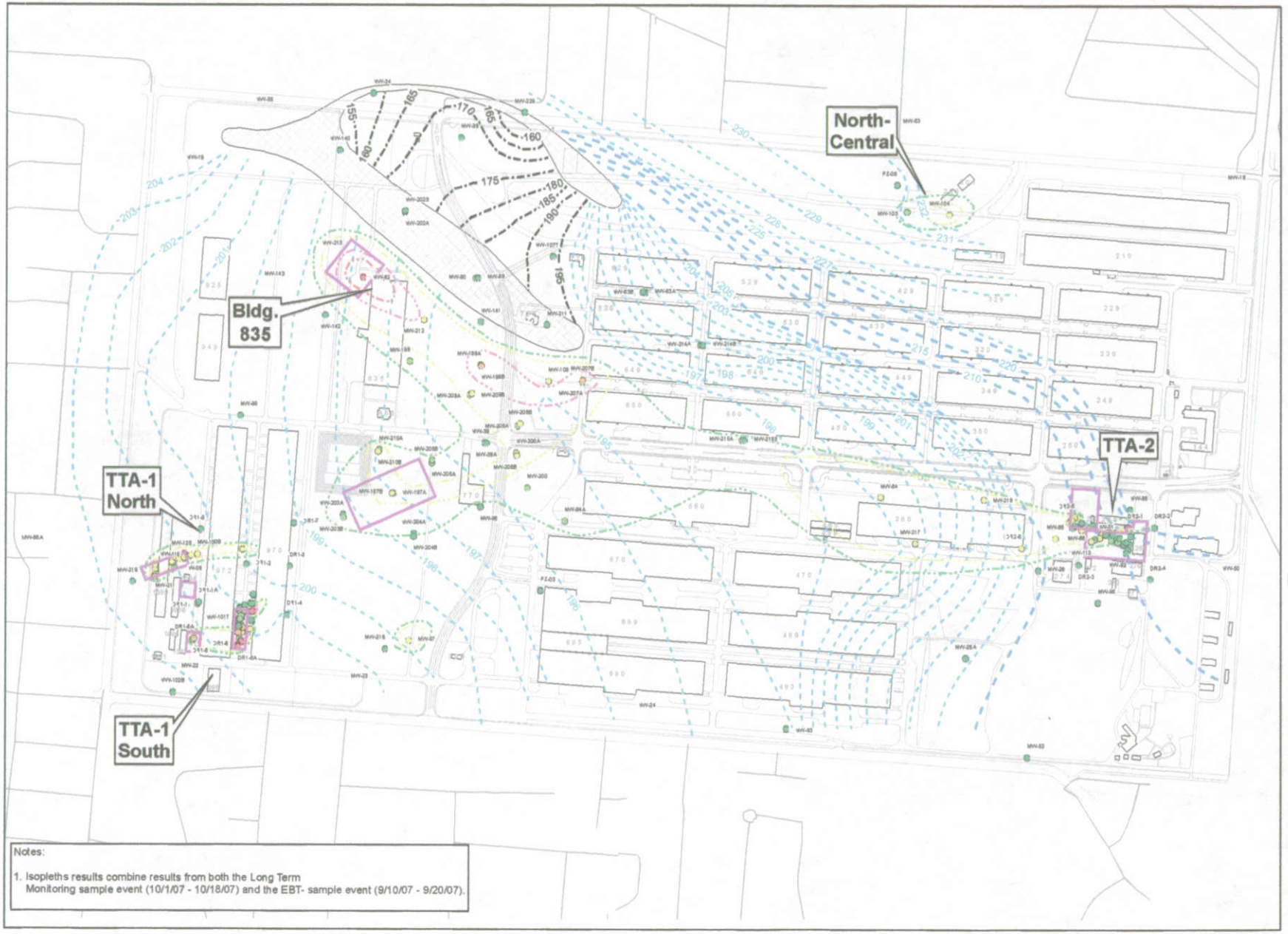

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Figure 3

MI GROUNDWATER PLUMES - TCE OCTOBER 2007

MAIN INSTALLATION
SOURCE AREA INVESTIGATION

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
- 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
- MIP Survey Areas
- Clay Elevation Exceeds Groundwater Elevation

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 200 400 800
Feet

Installation Location
Memphis, Tennessee

Date: August 2008
Edition: Rev 0

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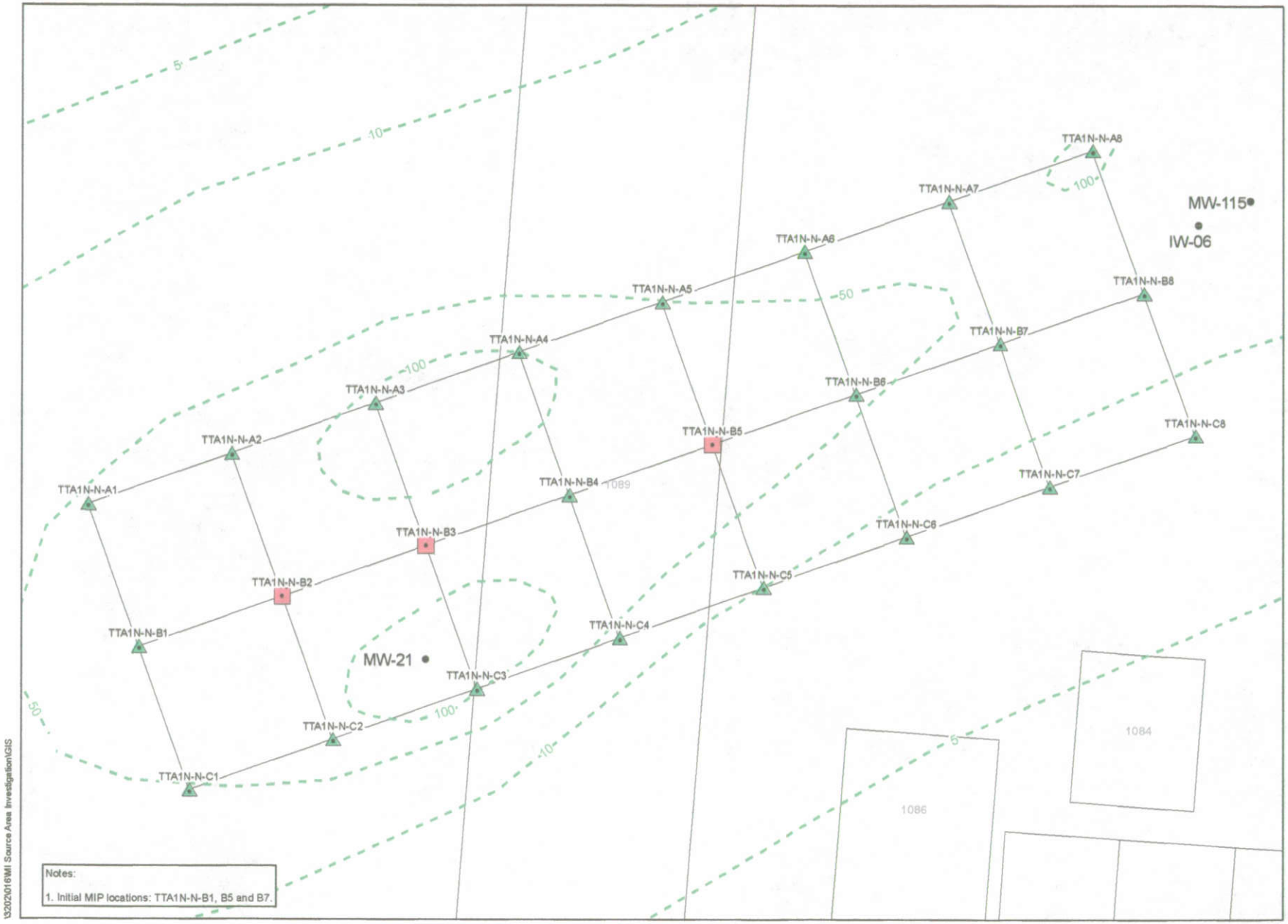

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Figure 4

INVESTIGATION SAMPLE GRID - TTA1N-N

MAIN INSTALLATION
SOURCE AREA INVESTIGATION

DEFENSE DEPOT
MEMPHIS, TENNESSEE

947 25

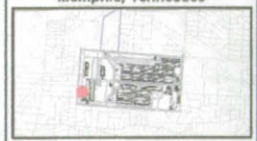
Legend

- Initial MIP Location
- MIP Location
- Sample Grid
- Monitoring Well Screened in the Fluvial Aquifer
- PCE Isopleth ug/L (October 2007)

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 10 20 30 40
Feet

Installation Location
Memphis, Tennessee



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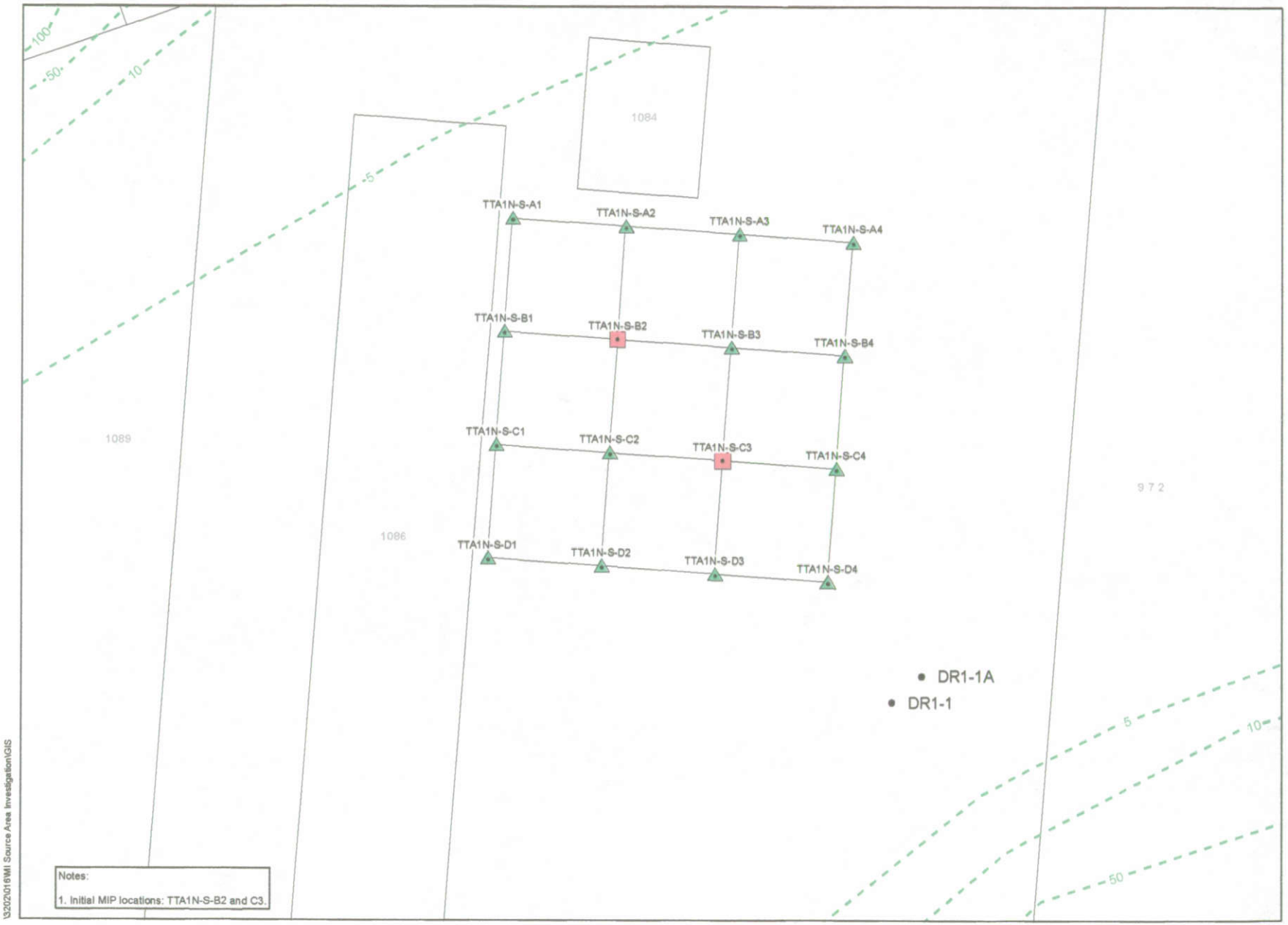

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Figure 5

INVESTIGATION SAMPLE GRID - TTA1N-S

MAIN INSTALLATION
SOURCE AREA INVESTIGATION

DEFENSE DEPOT
MEMPHIS, TENNESSEE

947 926

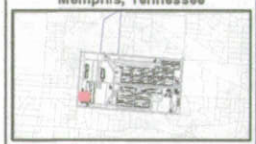
Legend

- Initial MIP Location
- MIP Location
- Sample Grid
- Monitoring Well Screened in the Fluvial Aquifer
- PCE isopleth ug/L (October 2007)

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 10 20 30 40
Feet

Installation Location
Memphis, Tennessee



Date: August 2008
Edition: Rev 0

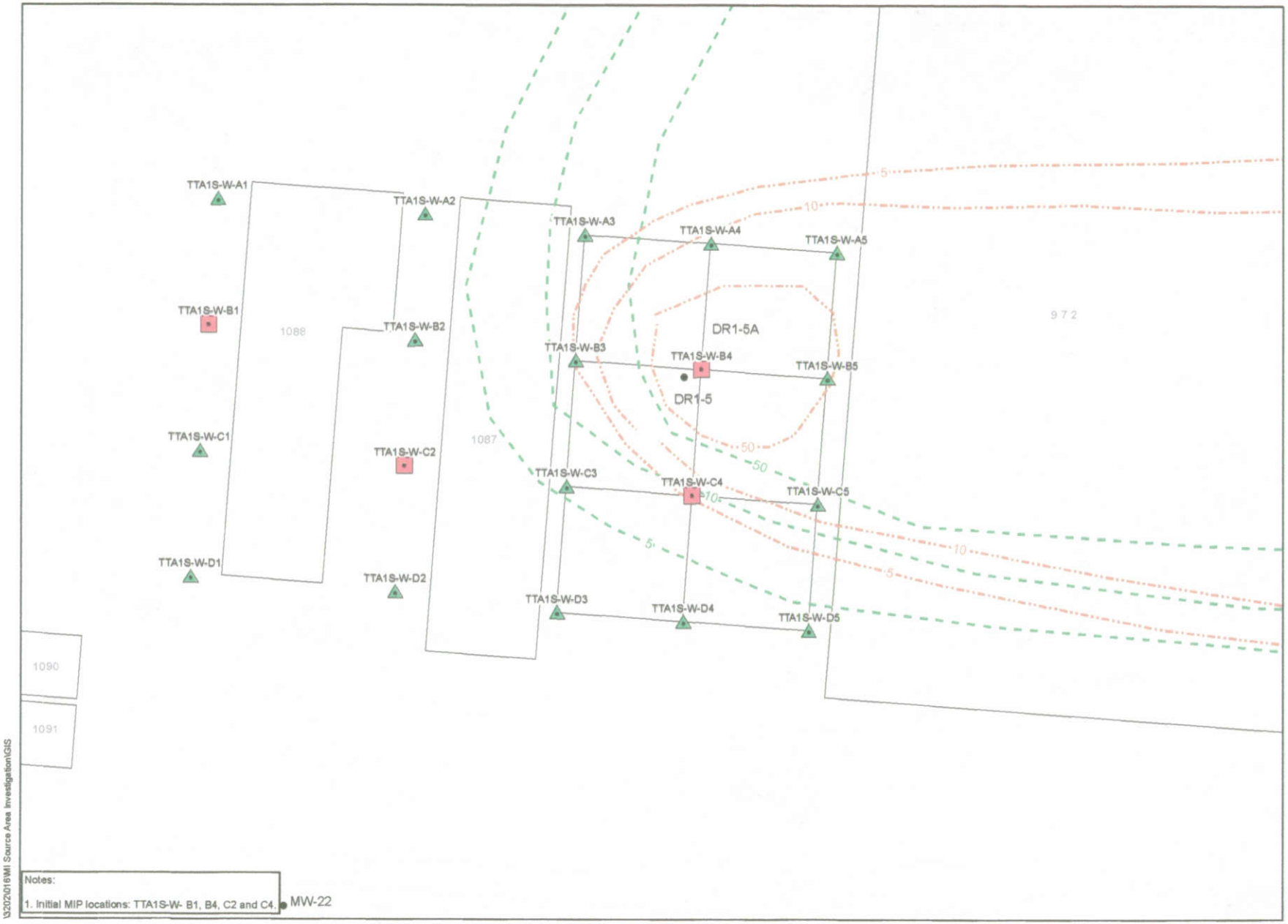


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Figure 6

INVESTIGATION SAMPLE GRID - TTA1S-W

MAIN INSTALLATION
SOURCE AREA INVESTIGATION

DEFENSE DEPOT
MEMPHIS, TENNESSEE

947 27

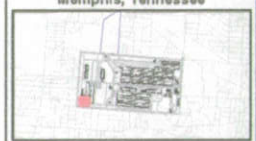
Legend

- Initial MIP Location
- MIP Location
- Sample Grid
- Monitoring Well Screened in the Fluvial Aquifer
- PCE Isopleth ug/L (October 2007)
- TCE Isopleth ug/L (October 2007)

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 10 20 30 40
Feet

Installation Location
Memphis, Tennessee



Date: August 2008
Edition: Rev 0

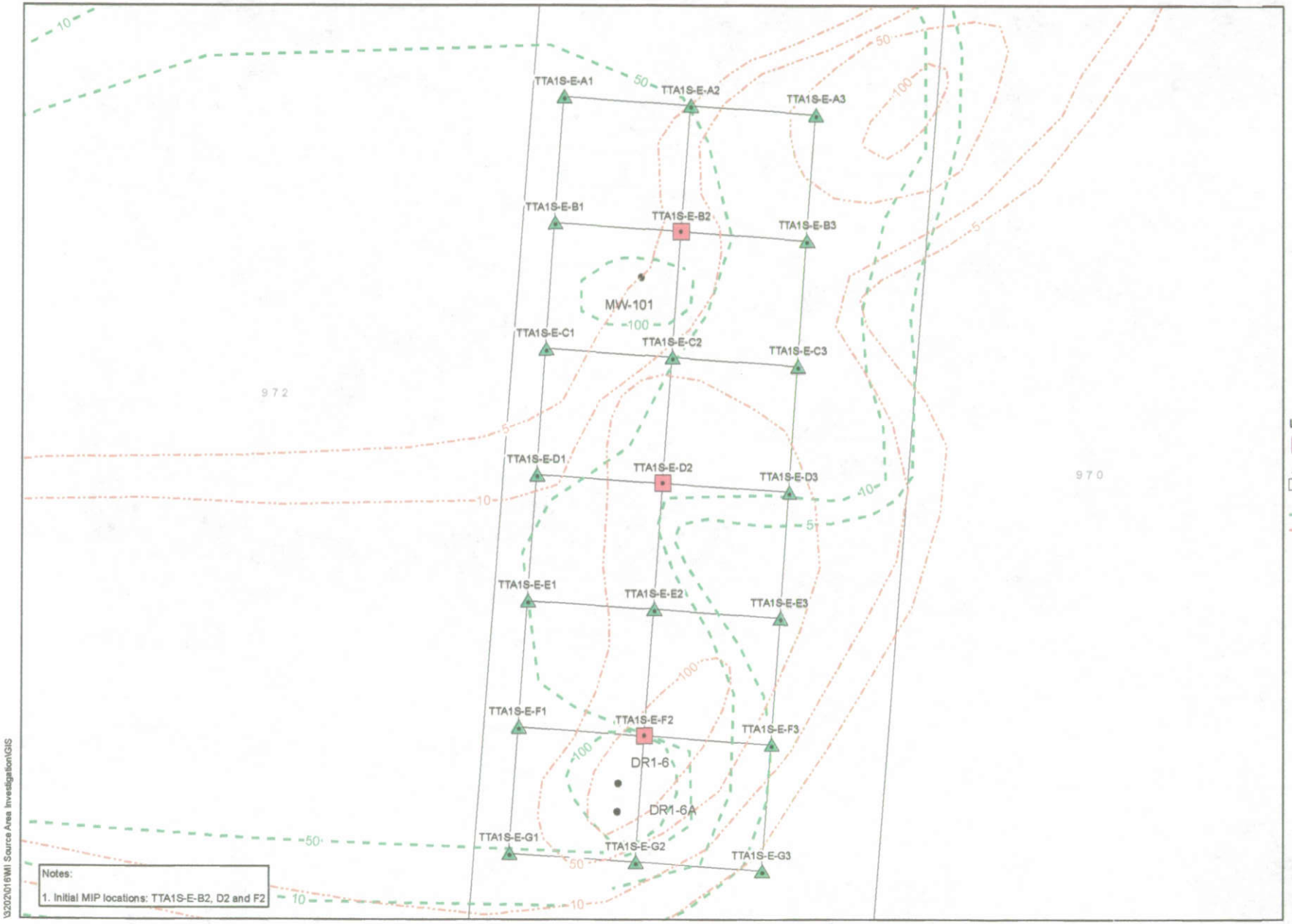


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Figure 7

INVESTIGATION SAMPLE GRID - TTA1S-E

MAIN INSTALLATION
SOURCE AREA INVESTIGATION

DEFENSE DEPOT
MEMPHIS, TENNESSEE

917 928

Legend

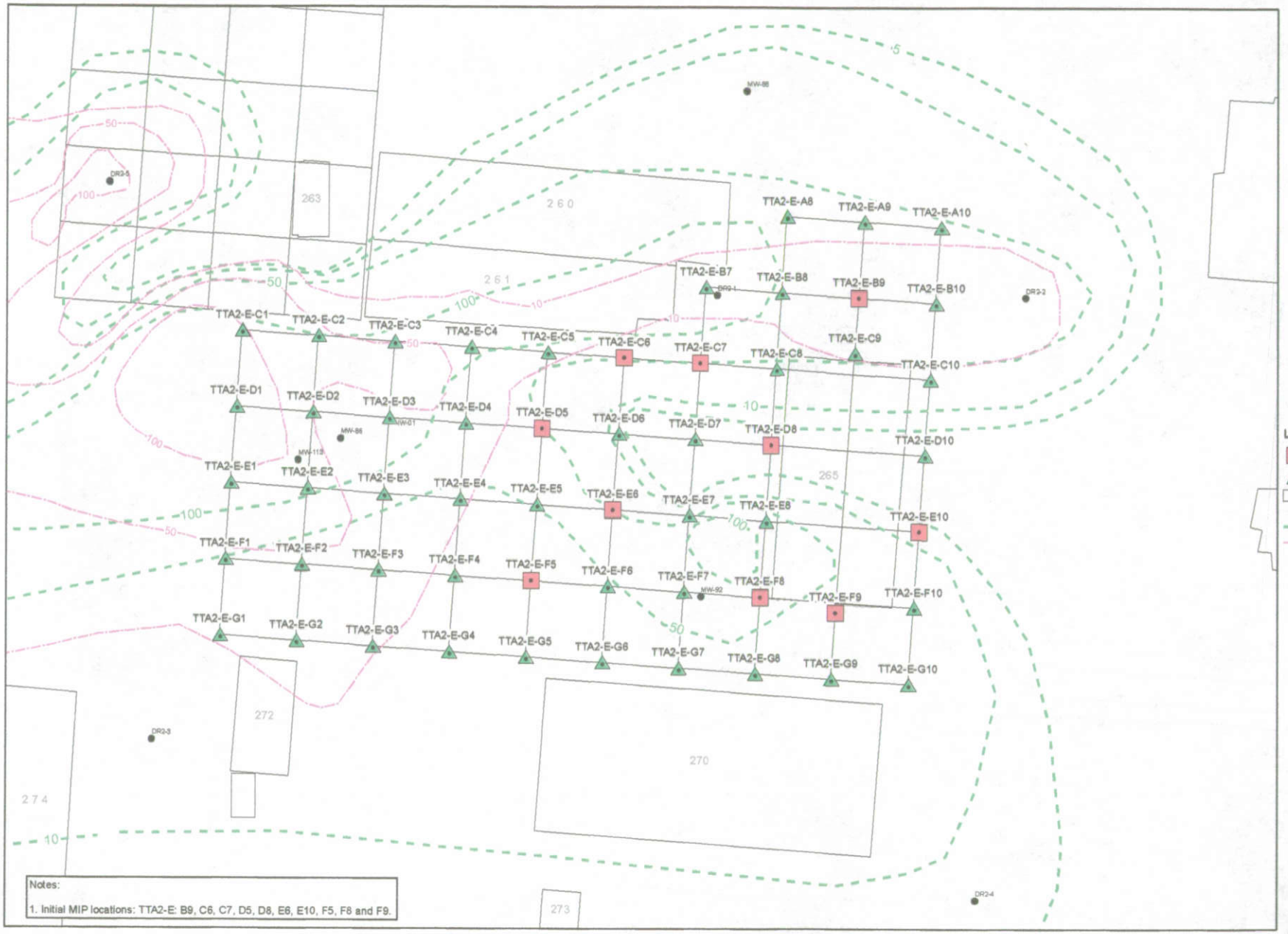
- Initial MIP Location
- MIP Location
- Sample Grid
- Monitoring Well Screened in the Fluvial Aquifer
- PCE Isopleth ug/L (October 2007)
- TCE Isopleth ug/L (October 2007)

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 10 20 30 40
Feet

Installation Location
Memphis, Tennessee

Date: August 2008
Edition: Rev 0



Notes:

1. Initial MIP locations: TTA2-E: B9, C6, C7, D5, D8, E6, E10, F5, F8 and F9.

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Figure 8

INVESTIGATION SAMPLE GRID - TTA2-E

MAIN INSTALLATION
SOURCE AREA INVESTIGATION

DEFENSE DEPOT
MEMPHIS, TENNESSEE

947 29

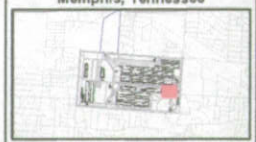
Legend

- Initial MIP Location
- MIP Location
- Sample Grid
- Monitoring Well Screened in the Fluvial Aquifer
- PCE Isopleth ug/L (October 2007)
- CT Isopleth ug/L (October 2007)

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 10203040
Feet

Installation Location
Memphis, Tennessee



Date: August 2008
Edition: Rev 0

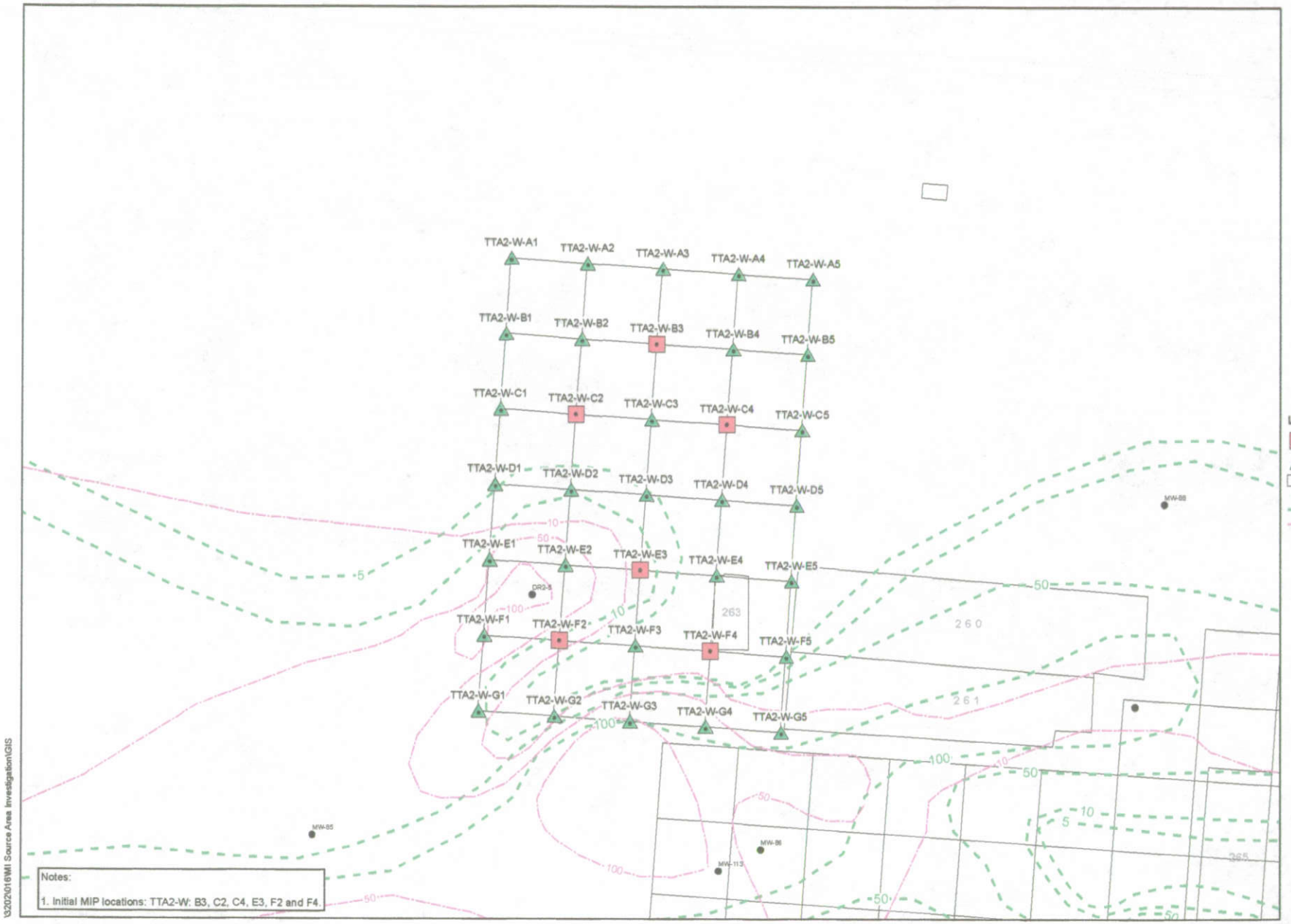


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Figure 9

INVESTIGATION SAMPLE GRID - TTA2-W

MAIN INSTALLATION
SOURCE AREA INVESTIGATION

DEFENSE DEPOT
MEMPHIS, TENNESSEE

947 30

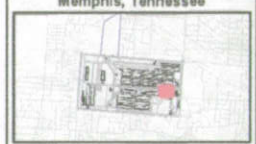
Legend

- Initial MIP Location
- MIP Location
- Sample Grid
- Monitoring Well Screened in the Fluvial Aquifer
- PCE Isopleth ug/L (October 2007)
- CT Isopleth (October 2007)

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 10 20 30 40
Feet

Installation Location
Memphis, Tennessee



Date: August 2008
Edition: Rev 0

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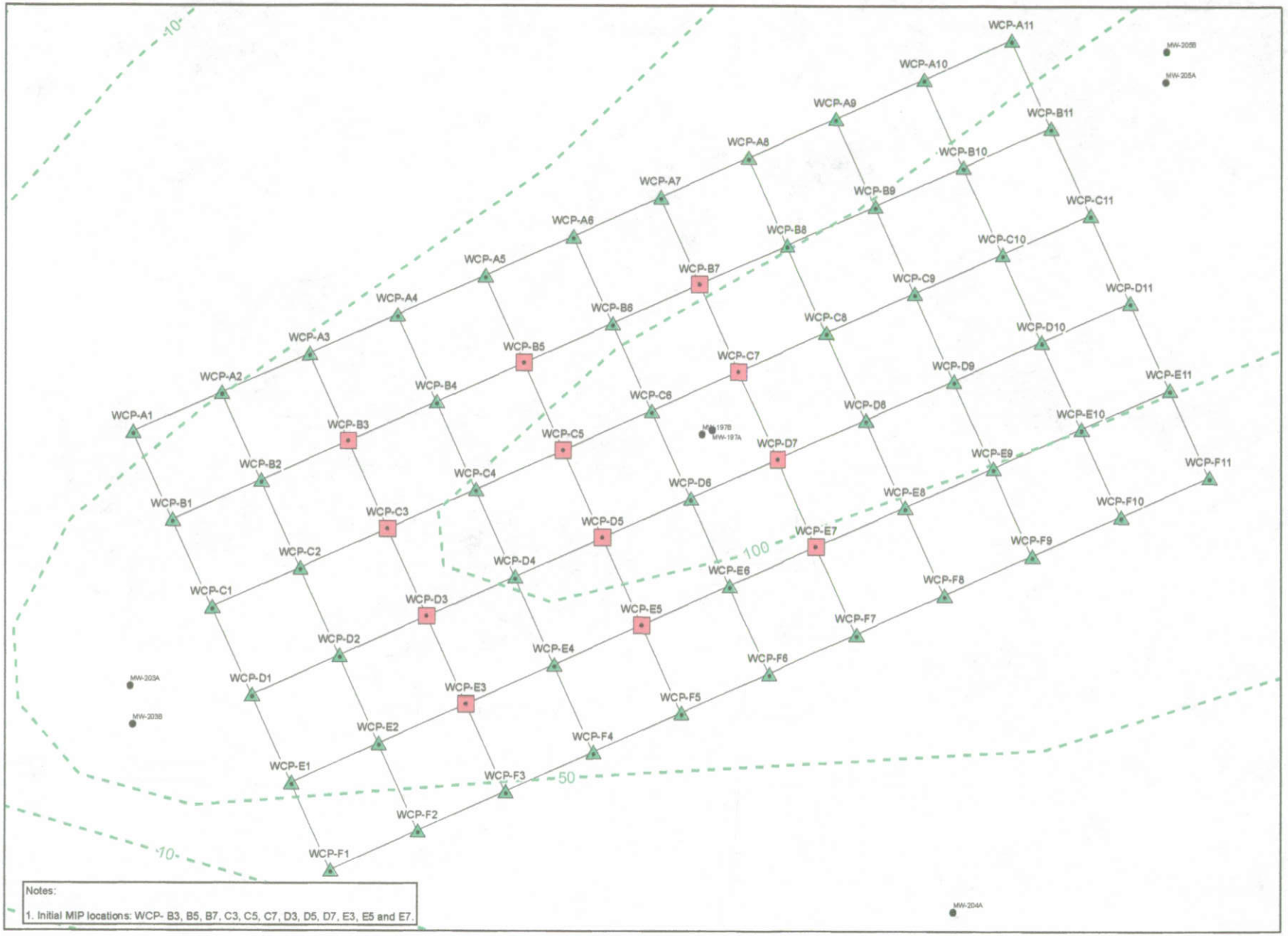

Notes:

1. Initial MIP locations: WCP- B3, B5, B7, C3, C5, C7, D3, D5, D7, E3, E5 and E7.

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Figure 10

INVESTIGATION SAMPLE GRID - WCP

MAIN INSTALLATION
SOURCE AREA INVESTIGATION

DEFENSE DEPOT
MEMPHIS, TENNESSEE

617 31

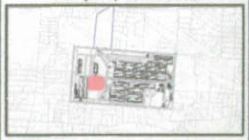
Legend

- Initial MIP Location
- MIP Location
- Sample Grid
- Monitoring Well Screened in the Fluvial Aquifer
- PCE Isopleth (October 2007)

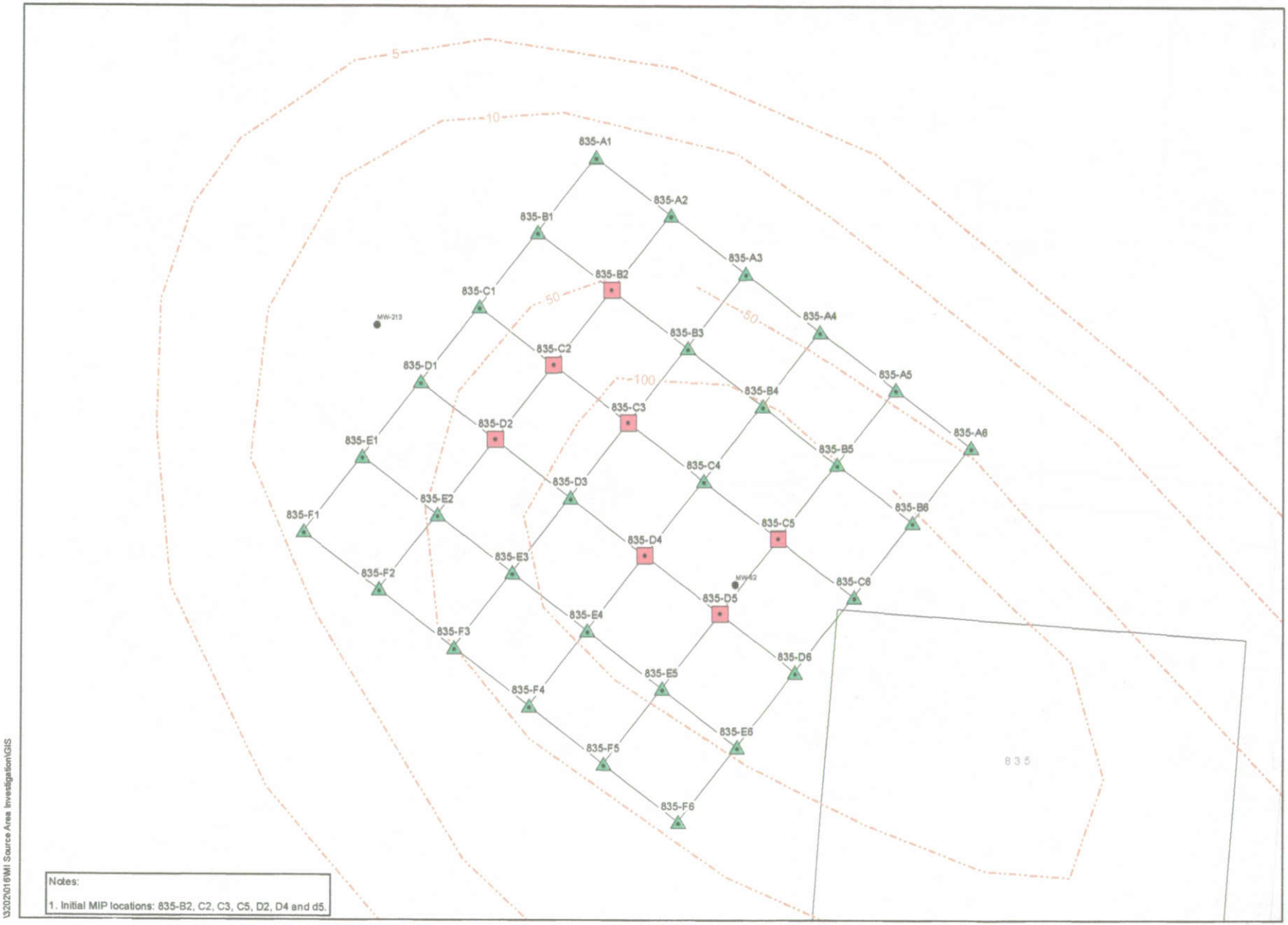
Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 10203040
Feet

Installation Location
Memphis, Tennessee



Date: August 2008
Edition: Rev 0



Notes:

1. Initial MIP locations: 835-B2, C2, C3, C5, D2, D4 and d5.

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Figure 11

INVESTIGATION SAMPLE GRID - BLDG. 835

MAIN INSTALLATION
SOURCE AREA INVESTIGATION

DEFENSE DEPOT
MEMPHIS, TENNESSEE

947 32

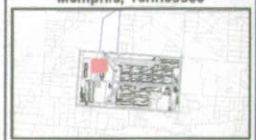
Legend

- Initial MIP Location
- MIP Location
- Sample Grid
- Monitoring Well Screened in the Fluvial Aquifer
- TCE Isopleth ug/L (October 2007)

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

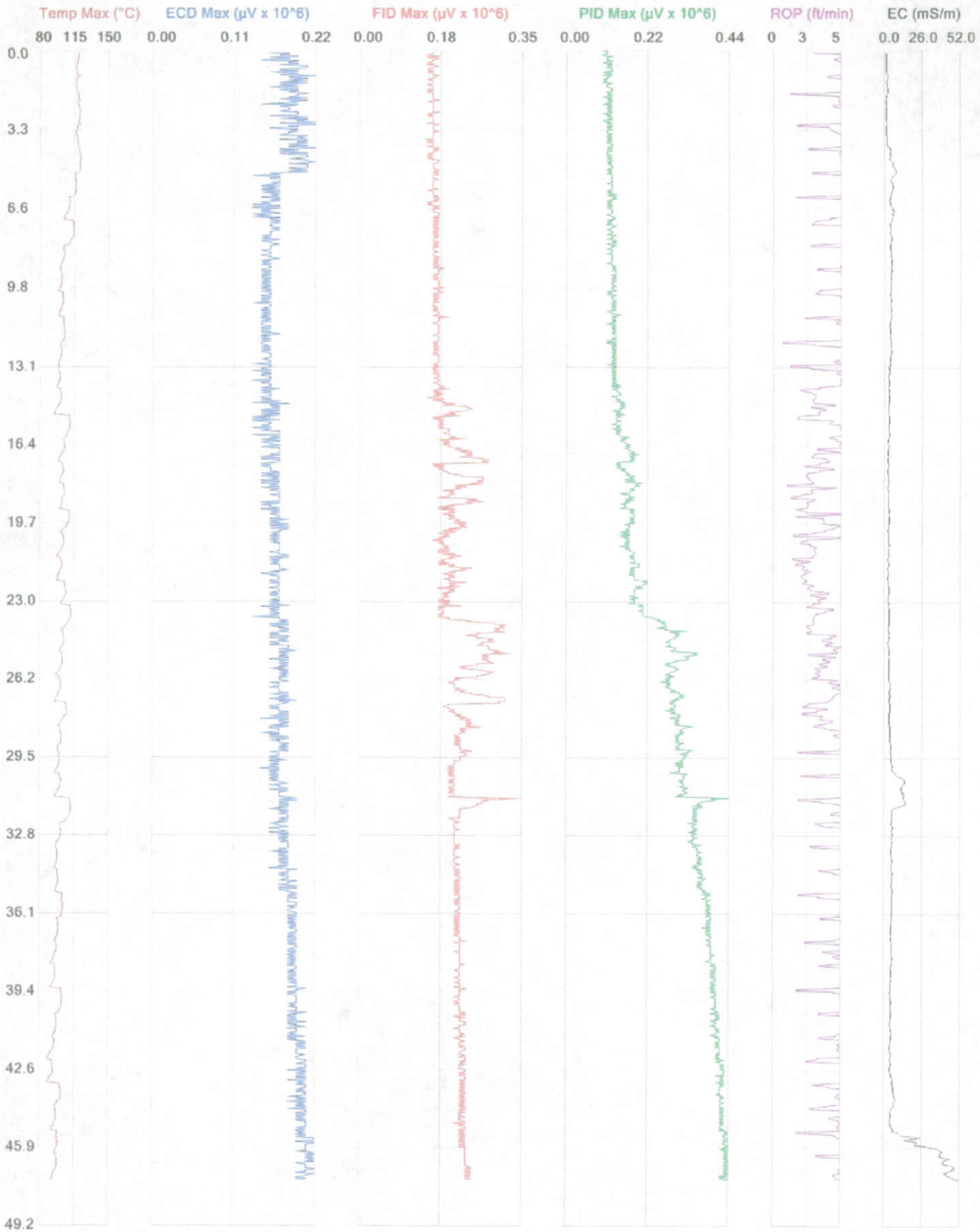
0 10203040
Feet

Installation Location
Memphis, Tennessee



Date: August 2008
Edition: Rev 0

APPENDIX A
EXAMPLE MEMBRANE INTERFACE PROBE LOG



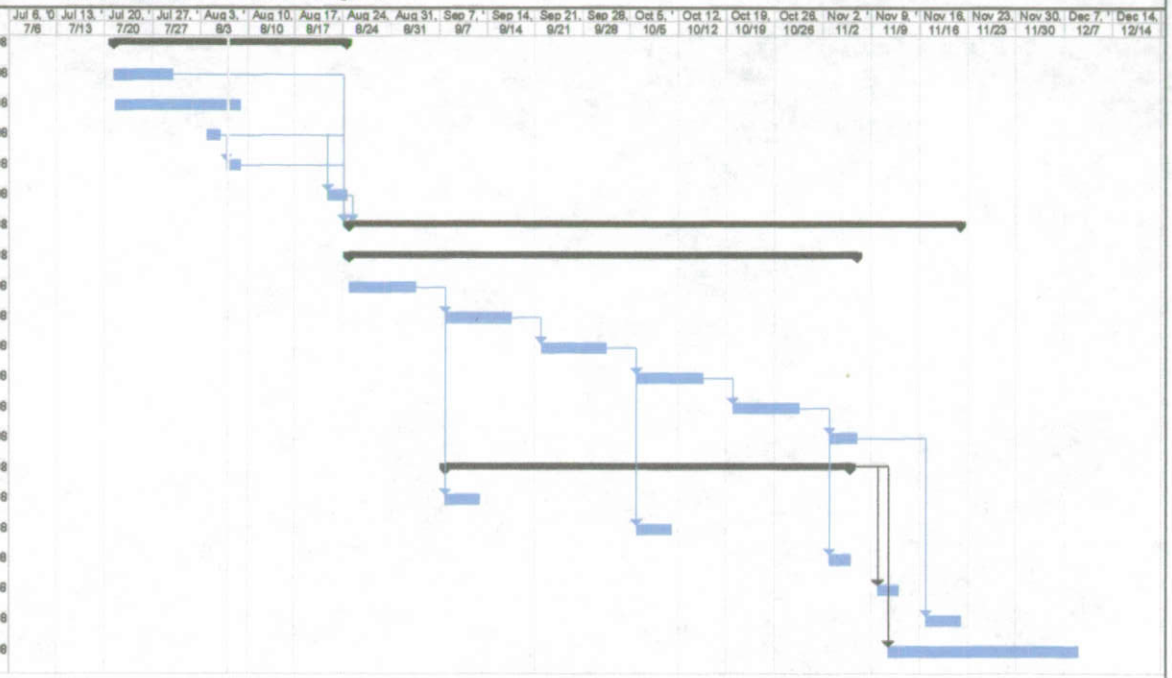
COLUMBIA TECHNOLOGIES

	File: MIP-13
Client: Demo Corp	Date: 5/24/2006
Project ID: Hotel Laundry	Location:

APPENDIX B
INVESTIGATION SCHEDULE

Memphis Defense Depot
Main Installation Source Area Investigation

ID	Task Name	Duration	Start	Finish
1	**Site Preparation**	**31.13 days**	**Mon 7/21/08**	**Sun 8/24/08**
2	Work Plan Preparation	9 days	Mon 7/21/08	Tue 7/29/08
3	Subcontracts and Procurement	17 days	Mon 7/21/08	Fri 8/8/08
4	Survey in MIP Locations	2 days	Mon 8/4/08	Tue 8/5/08
5	Utility Locate	2 days	Thu 8/7/08	Fri 8/8/08
6	Subcontractor Mobilization	2 days	Fri 8/22/08	Sun 8/24/08
7	**MIP Investigation**	**81.5 days**	**Mon 8/25/08**	**Fri 11/21/08**
8	**MIP Drilling**	**67.75 days**	**Mon 8/25/08**	**Thu 11/6/08**
9	Stage 1 Drilling - Initial Evaluation (51 Borings)	9 days	Mon 8/25/08	Wed 9/3/08
10	Stage 2 Drilling (50 Borings)	9 days	Mon 9/8/08	Wed 9/17/08
11	Stage 3 Drilling (50 Borings)	9 days	Mon 9/22/08	Wed 10/1/08
12	Stage 4 Drilling (50 Borings)	9 days	Mon 10/6/08	Wed 10/15/08
13	Stage 5 Drilling (50 Borings)	9 days	Mon 10/20/08	Wed 10/29/08
14	Stage 6 Drilling (22 Borings)	4 days	Mon 11/3/08	Thu 11/6/08
15	**Confirmation Soil Sampling**	**54 days**	**Mon 9/8/08**	**Wed 11/5/08**
16	First Round of Confirmation Soil Sampling (26 Borings)	5 days	Mon 9/8/08	Fri 9/12/08
17	Second Round of Confirmation Soil Sampling (25 Borings)	5 days	Mon 10/6/08	Fri 10/10/08
18	Third Round of Confirmation Soil Sampling (17 Borings)	3 days	Mon 11/3/08	Wed 11/5/08
19	**Final Survey**	3 days	Mon 11/10/08	Wed 11/12/08
20	**MIP Summary Report - Columbia**	5 days	Mon 11/17/08	Fri 11/21/08
21	**Summary Report - e2M**	25 days	Tue 11/11/08	Mon 12/8/08



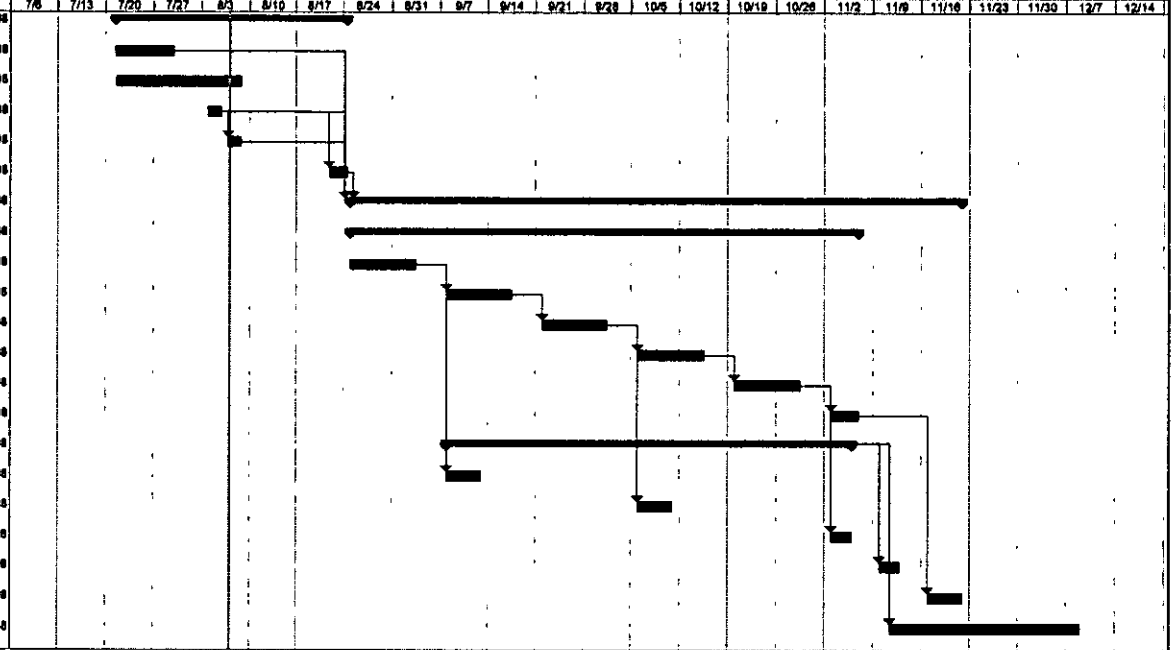
Project: MI SA Investigation Schedule
Date: Thu 8/7/08

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

APPENDIX B
INVESTIGATION SCHEDULE

Memphis Defense Depot
Main Installation Source Area Investigation

ID	Task Name	Duration	Start	Finish
1	Site Preparation	31.13 days	Mon 7/21/08	Sun 8/24/08
2	Work Plan Preparation	8 days	Mon 7/21/08	Tue 7/29/08
3	Subcontracts and Procurement	17 days	Mon 7/21/08	Fri 8/8/08
4	Survey in MIP Locations	2 days	Mon 8/4/08	Tue 8/5/08
5	Utility Locate	2 days	Thu 8/7/08	Fri 8/8/08
6	Subcontractor Mobilization	2 days	Fri 8/22/08	Sun 8/24/08
7	MIP Investigation	81.8 days	Mon 8/25/08	Fri 11/21/08
8	MIP Drilling	67.75 days	Mon 8/25/08	Thu 11/6/08
9	Stage 1 Drilling - Initial Evaluation (51 Borings)	9 days	Mon 8/25/08	Wed 9/3/08
10	Stage 2 Drilling (50 Borings)	9 days	Mon 9/8/08	Wed 9/17/08
11	Stage 3 Drilling (50 Borings)	9 days	Mon 9/22/08	Wed 10/1/08
12	Stage 4 Drilling (50 Borings)	9 days	Mon 10/6/08	Wed 10/15/08
13	Stage 5 Drilling (50 Borings)	9 days	Mon 10/20/08	Wed 10/29/08
14	Stage 6 Drilling (22 Borings)	4 days	Mon 11/3/08	Thu 11/6/08
15	Confirmation Soil Sampling	64 days	Mon 9/8/08	Wed 11/5/08
16	First Round of Confirmation Soil Sampling (25 Borings)	5 days	Mon 9/8/08	Fri 9/12/08
17	Second Round of Confirmation Soil Sampling (25 Borings)	5 days	Mon 10/6/08	Fri 10/10/08
18	Third Round of Confirmation Soil Sampling (17 Borings)	3 days	Mon 11/3/08	Wed 11/5/08
19	Final Survey	3 days	Mon 11/10/08	Wed 11/12/08
20	MIP Summary Report - Columbia	5 days	Mon 11/17/08	Fri 11/21/08
21	Summary Report - e2M	25 days	Tue 11/11/08	Mon 12/8/08



Project: MI SA Investigation Schedule
Date: Thu 8/7/08

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE