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DUNN FIELD SOURCE AREAS LOESS/GROUNDWATER REMEDIAL ACTION WORK PLAN

Defense Depot Memphis, Tennessee

Prepared for:

Defense Logistics Agency

Solutions Today for a Sustainable Tomorrow

AFCEE

AFCEE Contract FA8903-04-D-8722
Task Order No. 0019

May 2008

Revision 3

DUNN FIELD SOURCE AREAS LOESS/GROUNDWATER REMEDIAL ACTION WORK PLAN REVISION 3

Defense Depot Memphis, Tennessee

Prepared for:

Air Force Center for Engineering and the Environment
Contract No. FA8903-04-D-8722
Task Order No. 0019

Prepared by:

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LIST OF ACRONYMS AND ABBREVIATIONS

acfm	actual cubic feet per minute
AFCEE	Air Force Center for Engineering and the Environment
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Material
AWS	air/water separator
BCT	BRAC Cleanup Team
bgs	below ground surface
BRAC	Base Realignment and Closure
BCT	BRAC Cleanup Team
CCE	Certifying Construction Engineer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	chloroform
COC	Chemical of Concern
CQAP	Construction Quality Assurance Plan
CT	carbon tetrachloride
CVOCs	chlorinated volatile organic compounds
CWM	Chemical Warfare Material
CWN	compliance well network
cDCE	cis-1,2-dichloroethene
tDCE	trans-1,2-dichloroethene
DCA	1,2-dichloroethane
DCE	1,1-dichloroethene
1,2-DCE	1,2-dichloroethene
DDMT	Defense Depot Memphis, Tennessee
DLA	Defense Logistics Agency
DO	dissolved oxygen
DOC	dissolved organic carbon
DoD	Department of Defense
DRC	Depot Redevelopment Corporation
DRI	Design Related Investigation
EBT	Enhanced Bioremediation Treatment
ECD	electron capture detector

LIST OF ACRONYMS AND ABBREVIATIONS
(CONTINUED)

EE/CA	engineering evaluation and cost analysis
e^{2}M	engineering-environmental Management, Inc.
EISR	Early Implementation of Selected Remedy
ESD	Explanation of Significant Difference
ET&D	excavation, transportation and disposal
FID	flame ionization detector
FS	Feasibility Study
FSP	Field Sampling Plan
FOST	Finding of Suitability to Transfer
FSP	Field Sampling Plan
GAC	granular activated carbon
GWRS	groundwater recovery system
gpm	gallon per minute
HASP	Site Specific Health and Safety Plan
HDPE	high density polyethylene
Hg	mercury
HSA	Health and Safety Addendum
IDW	Investigation Derived Waste
ISTD	in-situ thermal desorption
LDR	Land Disposal Restrictions
LTM	Long Term Monitoring
LUC	Land Use Controls
LUCIP	Land Use Control Implementation Plan
MCL	Maximum Contaminant Level
µg/L	micrograms per liter
mg/kg	milligram/kilogram
MI	Main Installation
MIP	membrane interface probe
MNA	monitoring natural attenuation
MLGW	Memphis Light Gas & Water
msl	mean sea level
mV	millivolts

LIST OF ACRONYMS AND ABBREVIATIONS
(CONTINUED)

MW	monitoring well
NPL	National Priorities List
NTP	Notice to Proceed
NTU	nephelometric turbidity units
O&M	Operation and Maintenance
OPS	Operating Properly and Successfully
ORP	oxidation-reduction potential
OSWER	Office of Solid Waste and Emergency Response
PCA	1,1,2,2 tetrachloroethane
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
PMP	Project Management Plan
POL	petroleum/oil/lubricants
POTW	publicly owned treatment works
PPE	personal protective equipment
ppm	parts per million
PRB	permeable reactive barrier
psi	pounds per square inch
PSVP	Performance Standards Verification Plan
PTFE	polytetrafluoroethylene
PVC	polyvinyl chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Remedial Action
RA-C	Remedial Action Construction
RACR	Remedial Action Completion Report
RAO	Remedial Action Objectives
RA-O	Remedial Action Operation
RASAP	Remedial Action Sampling and Analysis Plan
RAWP	Remedial Action Work Plan
RG	Remediation Goal

LIST OF ACRONYMS AND ABBREVIATIONS
(CONTINUED)

RGOs	remedial goal objectives
RI	Remedial Investigation
ROD	Record of Decision
ROW	right-of-way
scfm	standard cubic feet per minute
SOP	standard operating procedure
SU	standard units
SVE	Soil Vapor Extraction
SVOCs	semivolatile organic compounds
SWMU	Solid Waste Management Unit
TA	treatment area
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation
TM	Technical Memorandum
TMP	temperature monitoring probe
USACE	United States Army Corps of Engineers
USAESCH	United States Army Engineering and Support Center, Huntsville, Alabama
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
µg/L	micrograms per liter
VC	vinyl chloride
VMP	vapor monitoring point
VOC	volatile organic compound
WMP	Waste Management Plan
WTP	Work and Test Procedure
ZVI	zero valent iron

1.0 INTRODUCTION

This Remedial Action Work Plan (RAWP) was prepared by engineering-environmental Management, Inc. (e^2M) to describe the site specific tasks necessary for the Dunn Field Source Areas Loess/Groundwater Remedial Action (RA) at Defense Depot Memphis, Tennessee (DDMT). The RAWP is based on the *Memphis Depot Dunn Field Record of Decision* (ROD) (CH2M HILL, 2004a) and the *Memphis Depot Dunn Field Final Source Areas Remedial Design, Rev.4* (RD) (CH2M HILL, 2007). e^2M prepared this RAWP for the Defense Logistics Agency (DLA) under Air Force Center for Engineering and the Environment (AFCEE) contract number FA8903-04-D-8722, Task Order 19.

This RAWP is intended to comply with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidance for RA, as presented in the *Remedial Design/Remedial Action Handbook* (United States Environmental Protection Agency [USEPA], 1995a), as well as to satisfy requirements outlined by the Base Realignment and Closure (BRAC) Act set forth by the BRAC Cleanup Team (BCT) for DDMT. The BCT, which is composed of representatives of the DLA, Tennessee Department of Environment and Conservation (TDEC), and the USEPA, will monitor progress of the RA, and review documents prior to issuance. The DLA and Department of Defense (DoD) will implement the selected remedy and incur all associated costs. DDMT's USEPA Identification Number is TN4210020570.

1.1 RAWP OVERVIEW

This RAWP provides relevant background information and data, and a plan of action for completing RA activities in a safe and efficient manner. Implementation of the Fluvial SVE component of the Source Areas remedy was described in *Dunn Field Source Areas Fluvial SVE Remedial Action Work Plan* (e^2M, 2007). The BCT concurred at their November 2006 meeting that the Fluvial SVE component of the Source Areas remedial action should be implemented on an expedited basis.

This RAWP describes the work to be performed to implement the loess and groundwater components of the Source Areas remedial action and includes a schedule for implementation of the RA. Specifically, the RAWP addresses:

- Description of Site Conditions (Section 1.0)
- Summary of the RA (Section 2.0)
- RA Planning (Section 3.0)

- RA Construction (RA-C) (Section 4.0)
- RA Completion (Section 5.0)
- Contingencies (Section 6.0)

Secondary documents developed in conjunction with this RAWP include the Project Management Plan (PMP), Waste Management Plan (WMP), and Construction Quality Assurance Plan (CQAP), which are included as Appendices A, B, and C respectively. The PMP includes a schedule for implementation of the Loess/Groundwater RA, and addresses activities and elements cited in the RD/RA Handbook (USEPA, 1995a). Sampling and analytical activities necessary for the RA will be performed in accordance with the *Remedial Action Sampling and Analysis Plan* (RASAP) (MACTEC, 2005a). The *Remedial Action Health and Safety Plan* (HSP) (e²M, 2006) provides the basis for protection of site workers, and a Loess/Groundwater Health and Safety Addendum (HSA) will be prepared if necessary for activities not addressed in the HSP. To ensure consistency with the design, much of the text within this RAWP has been taken from the Source Areas RD and construction drawings relevant to the Loess/Groundwater RA are included in Appendix D.

1.2 SITE HISTORY AND DESCRIPTION

DDMT is located in southeastern Memphis, Tennessee (Figure 1). DDMT originated as a military facility in the early 1940s with an initial mission and function to provide stock control, material storage, and maintenance services for the U.S. Army. DDMT is located approximately five miles east of the Mississippi River, and just northeast of Interstate 240. The property consists of approximately 642 acres and includes two components: the Main Installation (MI), which includes open storage areas, warehouses, military family housing, and outdoor recreational areas; and Dunn Field, which includes former mineral storage and waste disposal areas. In 1995, DDMT was placed on the list of DoD facilities to be closed under BRAC Storage and distribution activities continued until DDMT closed in September 1997.

In 1990, USEPA identified 49 Solid Waste Management Units (SWMUs) and eight Areas of Concern (AOCs) at DDMT during a Resource Conservation and Recovery Act (RCRA) Facility Assessment; 25 SWMUs and seven AOC were located on the MI, and 24 SWMUs and one AOC were located at Dunn Field. During this same period, a Hazard Ranking Scoring Package for the facility was prepared, and in 1992, the Depot was added to the National Priorities List (NPL) (57 Federal Register 47180 No. 199). In March 1995, a Federal Facilities Agreement (FFA) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Section 120, and RCRA, Sections 3008(h) and 3004(u) and (v), was entered into by USEPA, TDEC, and DLA. The FFA outlined the process for site investigation and cleanup at DDMT under CERCLA. The lead agency for environmental restoration activities at DDMT is the DLA. The regulatory oversight agencies are USEPA Region IV and TDEC.

DDMT is divided into four Operable Units (OUs): Dunn Field, OU 1; Southwest Quadrant MI, OU 2, Southeastern Watershed and Golf Course, OU 3; and North-Central Area MI, OU 4. The Record of Decision (ROD) for the MI (CH2M HILL, 2001) includes OUs 2, 3, and 4. The ROD for Dunn Field (CH2M HILL, 2004a) addresses OU 1, the only known and documented waste burial area.

Dunn Field comprises approximately 64 acres of undeveloped land bounded by the Illinois Central Gulf Railroad and Person Avenue to the north, Hays Road to the east, and Dunn Avenue to the south. To the west, Dunn Field is bounded by Kyle Street, undeveloped property, a light industrial/warehouse facility, and a Memphis Light, Gas, and Water (MLGW) power line corridor, which bisects Dunn Field. Approximately two-thirds of Dunn Field is covered with grass, and the remaining area is covered with crushed rock and paved surfaces. Dunn Field is currently zoned for Light Industrial (I-L) use.

For investigation purposes, Dunn Field was divided into three exposure areas, as shown on Figure 2.

Northeast Open Area – The Northeast Open Area (approximately 20 acres) consists of a grassy area with a number of interspersed mature trees in the northeast quadrant of Dunn Field.

Disposal Area – The Disposal Area (approximately 14 acres) consists of former disposal pits and trenches in the northwestern quadrant of Dunn Field.

Stockpile Area – The Stockpile Area (approximately 30 acres) encompasses the former bauxite and fluorspar storage and burial areas in the eastern and southwestern portions of Dunn Field.

Forty-one sites are listed in the Defense Sites Environmental Restoration Tracking System within these three areas, as shown in Table 1. The sites were assigned priority levels for remedial action (high, medium, and low) with no remedial action considered necessary at low priority sites. The seventeen high and medium priority sites were investigated further for the *Dunn Field Disposal Sites Remedial Design* (CH2M HILL, 2004b) and five disposal sites were selected for remedial action, as described later in Section 1.7.1.

The Northeast Open Area was originally identified as future public open space while the remainder of Dunn Field was targeted for light industrial land use. The eastern portion of Dunn Field, including most of the Northeast Open Area, was designated for unrestricted use in the ROD and has been approved for transfer. The Finding of Suitability to Transfer (FOST) Number 4 document for this parcel was completed in February 2005. The City of Memphis declined to accept the FOST 4 property for public recreational use, and it is currently being offered for public sale.

1.3 HYDROGEOLOGY

The geologic units of interest at Dunn Field are (from youngest to oldest): loess, including surface soil; fluvial deposits; Jackson Formation/Upper Claiborne Group; and Memphis Sand.

The loess consists of wind-blown and deposited, brown to reddish-brown, low plasticity clayey silt to silty clay. The loess deposits are about 20 to 30 feet thick and are continuous throughout the Dunn Field area.

The fluvial (terrace) deposits consist of two general layers. The upper layer is a silty, sandy clay that transitions to a clayey sand and ranges from about 10 to 36 feet thick. The lower layer is composed of interlayered sand, sandy gravel, and gravelly sand, and has an average thickness of approximately 40 feet. The uppermost aquifer is the unconfined fluvial aquifer, consisting of saturated sands and gravelly sands in the lower portion of the deposits. The saturated thickness of the fluvial aquifer ranges from 3 to 50 feet and is controlled by the configuration of the uppermost clay in the Jackson Formation/Upper Claiborne Group.

The Jackson Formation/Upper Claiborne Group consists of clays, silts, and sands. The uppermost clay unit appears to be continuous, except in the southwestern area of Dunn Field. Off site, to the west and northwest of Dunn Field, there are possible gaps in the clay. Where present, these gaps create connections to the underlying intermediate aquifer from the fluvial deposits. The intermediate aquifer is locally developed in deposits of the Jackson Formation/Upper Claiborne Group.

The Memphis Sand primarily consists of thick bedded, white to brown or gray, very fine grained to gravelly, partly argillaceous and micaceous sand. Lignitic clay beds constitute a small percentage of the total thickness. The Memphis Sand ranges from 500 to 890 feet in thickness, and begins at a depth below ground surface (bgs) of approximately 120 to 300 feet. The Memphis aquifer is confined by overlying clays and silts in the Cook Mountain Formation (part of the Jackson/Upper Claiborne Group) and contains groundwater under strong artesian (confined) conditions regionally. The City of Memphis obtains the majority of its drinking water from this unit. The Allen Well Field, which is operated by Memphis Light, Gas and Water (MLGW), is located approximately two miles west of Dunn Field.

1.4 NATURE AND EXTENT OF CONTAMINATION

Historical information concerning disposal sites at Dunn Field is included in the *Dunn Field Remedial Investigation (RI) Report* (CH2M Hill, 2002) and *Dunn Field Feasibility Study (FS) Report* (CH2M Hill, 2003b). Records indicate that chemical warfare material (CWM), chlorinated lime, super tropical bleach, and calcium hypochlorite, food stocks, paints/thinners, petroleum/oil/lubricants (POL), acids, herbicides, mixed chemicals, and medical waste were reportedly destroyed or buried in pits and trenches at the Dunn Field disposal sites.

1.4.1 Subsurface Soil Contamination

Subsurface soil samples collected in 1999 for the RI showed significant levels of chlorinated volatile organic compounds (CVOCs): 1,1,2,2 tetrachloroethane (PCA); 1,2-dichloroethane (DCA); total 1,2-dichloroethene (1,2-DCE); carbon tetrachloride (CT); chloroform (CF); methylene chloride; tetrachloroethene (PCE); trichloroethene (TCE); and vinyl chloride. The highest concentrations detected in 1999 were from boring SBLEE in the northwest corner of Dunn Field: TCE at 460 milligrams per kilogram (mg/kg); PCA at 160 mg/kg; and 1,2-DCE at 190 mg/kg. These samples were collected within the loess at depths of 30 feet or less.

Further soil sampling was conducted October 2000 to February 2001 to delineate potential source areas. Sixteen soil borings were drilled in the Disposal Area and west of Dunn Field to the top of the clay below the water table, approximately 80 to 95 feet below ground surface (bgs), and soil samples were collected from the loess and fluvial deposits. TCE and PCA were the CVOCs most frequently detected in soil samples at concentrations above the remedial goals (RGs). The highest concentrations were detected in the fluvial deposits (PCA at 22.6 mg/kg in boring SBLCA-SB2 at a depth of 44 feet, and TCE at 0.888 mg/kg in boring SBLCA-SB11 at a depth of 81 feet). The only CVOC detected above RGs in the loess (at a depth of 30 feet or less) was vinyl chloride at 0.055 mg/kg in boring SBLEE-SB1 near MW-10 in Treatment Area 1.

A passive soil gas survey was conducted at Dunn Field to provide screening information on the potential sources of volatile organic compound (VOC) contamination in groundwater at Dunn Field. Phase 1 in August 1998 focused on the Disposal Area, and Phase 2 in October 1998 expanded the soil gas sampling grid to the east and north to further delineate soil gas anomalies identified in Phase 1. The investigation findings are provided in the *Dunn Field RI Report* (CH2M HILL, 2002). A soil gas investigation was also conducted by Parsons Engineering Science, Inc. (Parsons) in October 2000. Parsons collected soil gas samples using a SimulProbe™. This work was reported in the *Remedial Process Optimization (RPO) Phase II Evaluation Report, Defense Depot Memphis, Tennessee* (Parsons, 2001).

An investigation for the disposal sites remedial design was conducted to supplement existing chemical and physical data on the 17 former disposal sites on Dunn Field previously identified by the BCT as Priority Level A and Level B based upon the quantity of material within each site, potential hazards of the material, and form of the material (solid versus liquid). A geophysical survey was used to estimate the location and depths of the disposal sites. Trenches or test pits were excavated across the length of each site to collect soil samples and make visual observations of the buried materials. A total of 48 trenches and seven test pits were excavated to depths of ten feet or less. Excavation locations were based on available historical information and the geophysical survey data. While soil samples from the excavations were analyzed for VOCs, the results were not used to determine excavation limits since SVE was the selected remedy for VOCs in subsurface soils. The highest VOC concentrations were detected in a sample from Disposal Site 10 in the northwest corner of Dunn Field, PCA at 2,850 mg/kg, TCE at 671 mg/kg, and PCE at 35.7 mg/kg. Investigation results were presented in the *Disposal Sites Pre-Design Investigation Data Collection Technical Memorandum Rev. 2*, (TM) (CH2M Hill, 2004c).

1.4.2 Groundwater Contamination

The nature and extent of contamination in groundwater underlying Dunn Field were assessed based on chemical analyses of groundwater samples collected since January 1996. Groundwater samples have been analyzed for explosives, herbicides, metals (total), pesticides, polychlorinated biphenyls (PCBs), semivolatile organic compounds (SVOCs), and CVOCs. Groundwater samples were also analyzed for CWM breakdown products, including thiodiglycol, 1,4-oxathiane, 1,4-dithiane, and various geochemical and geotechnical parameters. CVOCs, SVOCs, and total metals were the most frequently detected analytical constituents in groundwater samples. Only CVOCs were determined to require remedial action for subsurface soils and groundwater.

The Dunn Field ROD identified three primary contaminant plumes in the fluvial aquifer underlying Dunn Field. Mixing and intermingling of the plumes have occurred due to the active groundwater extraction system and natural groundwater flow. The nine CVOCs listed below have been detected most frequently in past groundwater sampling events:

- Tetrachloroethene (PCE)
- Trichloroethene (TCE)
- cis-1,2-Dichloroethene (cDCE)
- trans-1,2-Dichloroethene (tDCE)
- 1,1-Dichloroethene (DCE)
- 1,1,2,2-Tetrachloroethane (PCA)
- 1,1,2-Trichloroethane (TCA)
- Carbon tetrachloride (CT)
- Chloroform (CF)

The highest groundwater contaminant concentrations have been detected in the central plume. The individual VOCs with the highest concentrations are PCA and TCE, with maximum concentrations up to 40,800 micrograms per liter (µg/L) for PCA and 7,110 µg/L for TCE (MW-73; 22 October 2003).

1.5 PAST REMEDIAL ACTIONS AT DUNN FIELD

1.5.1 Interim Groundwater Remedial Action

An interim ROD was signed in April 1996, with the objective of hydraulic containment to prevent further contaminant plume migration and reduce contaminant mass in groundwater. At the time, Dunn Field contaminants of concern (COCs) included CVOCs and metals. A groundwater extraction system consisting of seven recovery wells, was installed along the western Dunn Field boundary and began operation in November 1998. Four additional recovery wells were installed in late 1999 and early 2000.

From system startup in 1998 through December 2007, the extraction system pumped nearly 292 million gallons of groundwater from the fluvial aquifer and discharged to the City of Memphis publicly owned treatment works (POTW). Also through December 2007, approximately 906 pounds of CVOCs were removed, including approximately 366 pounds of TCE. Despite the contaminant mass removal, the *Memphis Depot Dunn Field Five-Year Review* (CH2M HILL, 2003a) concluded that the extraction system does not provide adequate control over groundwater flow and the westward spread of CVOCs in the fluvial aquifer.

1.5.2 Chemical Warfare Materiel Removal Action

Following completion of an engineering evaluation and cost analysis (EE/CA), a non-time critical removal action was conducted to reduce or eliminate the potential risk posed by CWM wastes at Sites 1, 24-A, and 24-B. The removal action was completed in March 2001 and documented in the *Final Chemical Warfare Materiel Investigation/Removal Action Report* (UXB, 2001). Approximately 914 cubic yards (yd^3) of soil contaminated with mustard degradation by-products, and 19 yd^3 of mustard-contaminated soil were excavated, transported, and disposed offsite. Twenty-nine bomb casings were recovered from Site 24-A.

1.5.3 Soil Removal Action at Site 60, Former Pistol Range

A non-time critical removal action to address lead contaminated surface soil at Site 60, a former pistol range in the Northeast Open Area, was completed in March 2003, pursuant to an EE/CA completed in July 2002. Approximately 930 yd^3 of lead contaminated surface soil was excavated, transported, and disposed offsite at an approved, permitted landfill.

1.6 REMEDIAL ACTION OBJECTIVES AND SELECTED REMEDY

Remedial action objectives (RAOs) are medium-specific goals that the RAs are expected to accomplish to protect human health and the environment. The RAOs were developed to reflect the anticipated future land use for Dunn Field in accordance with EPA Policy, *Land Use in the CERCLA Remedy Selection Process* (OSWER Directive No. 9355.7-04). The RAOs were developed during the RI phase and presented in the ROD. The development of the RAOs took into consideration the remedial goal objectives (RGOs) (permissible exposures to industrial workers and potential on-site residents assuming redevelopment of Dunn Field) and the clean up concentrations based upon the RGOs. The remedial goals (RGs) for the contaminants of concern in subsurface soils and groundwater at Dunn Field are listed in Table 2.

The following RAOs are from the ROD:

<u>Surface Soil</u>

- Limit use of the surface soil in the Disposal Area to activities consistent with light industrial land use and prevent residential use through land controls

<u>Disposal Sites</u>

- Prevent groundwater impacts from a release of buried containerized hazardous liquids and the leaching of contaminants from buried hazardous solids
- Prevent unacceptable risk of direct contact with buried hazardous liquids and/or solids due to intrusive activities during future land use or site development

<u>Subsurface Soil Impacted with VOCs</u>

- Prevent direct inhalation of indoor air vapors from subsurface soils in excess of industrial worker criteria
- Reduce or eliminate further impacts to the shallow fluvial aquifer from VOCs in the subsurface soil

<u>Groundwater</u>

- Prevent human exposure to contaminated groundwater (i.e., exceeding protective target concentrations)
- Prevent further off-site migration of VOCs in excess of protective target levels
- Remediate fluvial aquifer groundwater to drinking water quality to be protective of the deeper Memphis aquifer

The major components of the selected remedy for Dunn Field are:

- Excavation, transportation, and disposal of soil and material contained within disposal sites based upon results from a pre-design investigation
- Soil vapor extraction (SVE) to reduce VOC concentrations in subsurface soils to levels that are protective of the intended land use and groundwater
- Injection of zero valent iron (ZVI) within Dunn Field to treat CVOCs in the most contaminated part of the groundwater plume, and installation of a permeable reactive barrier (PRB) to remediate CVOCs within the off-site areas of the groundwater plume
- Monitored natural attenuation (MNA) and long-term monitoring (LTM) of groundwater to document changes in plume concentrations, detect potential plume migration to off-site areas or into deeper aquifers, and track progress toward remediation goals
- Implementation of land use controls, which consist of the following institutional controls: Deed and/or lease restrictions; Notice of Land Use Restrictions; City of Memphis/Shelby County zoning restrictions and the Memphis and Shelby County Health Department groundwater well restrictions.

Three RAs were planned to implement the selected remedies for OU 1, Dunn Field:

- Disposal Sites RA to address excavation, transportation, and disposal;
- Source Areas RA to address SVE in subsurface soils, ZVI injections at Dunn Field, and implementation of land use controls; and
- Off-Depot Groundwater RA to address installation of a PRB, MNA, and LTM

The Disposal Sites RA has been completed, as described in the following section. Plans for implementation of the remaining RAs have been revised since completion of the ROD. The sequencing of the Source Areas RA has been revised with the Fluvial SVE component expedited, and the other components (thermal-enhanced SVE in the loess, ZVI injections and LUCs) to follow. The Off Depot RD is in preparation; air sparging with soil vapor extraction is being proposed to replace the ZVI PRB. The Dunn Field ROD will be modified through a Revised Proposed Plan and ROD Amendment.

1.7 POST-ROD REMEDIAL ACTIONS

1.7.1 Disposal Sites Remedial Action

In accordance with the *Disposal Sites RD* (CH2M HILL, 2004b), *Dunn Field Disposal Sites Remedial Action Work Plan*, Rev. 1 (MACTEC, 2004a), and *Dunn Field Disposal Sites Remedial Action Work Plan* Addendum 1 Rev. 1 (MACTEC, 2006a), soil and debris including potential principal threat wastes (primarily drums and glass bottles) from Disposal Sites 3, 4.1, 10, 13, and 31 were excavated and transported for offsite disposal. Five disposal sites were determined to require RA based on the results of the Pre-Design Investigation.

- Disposal Site 3 – Mixed chemical burial site (ortho-toluidine dihydrochloride)
- Disposal Site 4.1 POL Burial Site (32 55-gallon drums of oil, grease, and paint)
- Disposal Site 10 – Solid Waste Burial Site (metal, glass, and trash)
- Disposal Site 13 – Mixed Chemical Burial (900 pounds of unnamed acid, and 8,100 pounds of unnamed solids)
- Disposal Site 31 - covered by the bauxite storage pile (Site 64), used for burning/disposal of smoke pots, tear gas grenades, and souvenir ordnance

The Disposal Sites RA was performed during two separate mobilizations. During the first mobilization from 14 March 2005 through 7 May 2005, Disposal Sites 4.1, 13, 31, and the majority of Disposal Site 10 were completed. An area of burn pit material that extended to the west of Disposal Site 10, and the presence of intact, unlabeled glass bottles encountered in Disposal Site 3 required additional remedial measures beyond the initial scope of work. The glass bottles contained a clear liquid that required further analysis to determine proper handling and disposal procedures; the liquid was identified as ortho-toluidine. Disposal Site 3 and the remaining materials from Disposal Site 10 were completed during the second mobilization, performed from 27 February through 8 March 2006. A total of 4,051 tons (approximately 2,700 yd^3) of non-hazardous materials from Disposal Sites 3, 4.1, 10, 13, and 31 were transported off-site and disposed of at the BFI South Shelby County Landfill. A total of 351 tons (approximately 234 yd^3) of hazardous materials from Disposal Site 3 were transported to the Clean Harbors Lambton Secure Landfill in Canada for disposal. The RAOs outlined in the ROD for these sites were achieved based on the confirmation sample results for each excavation. The RA is described in the *Dunn Field Disposal Site Remedial Action Completion Report* (MACTEC, 2006b).

1.7.2 Early Implementation of Selected Remedy

DLA determined that an Early Implementation of Selected Remedy (EISR) using the ZVI process should be taken at the leading edge of the high-concentration portion of the central plume in the fluvial aquifer. The EISR was a response to levels of contamination not observed at this distance from Dunn Field during the RI. The rationale and scope for this action were described in a technical memorandum, *Early Implementation of Selected Remedy Component to Address Groundwater Contamination West of Dunn Field* (CH2M HILL, 2004c), which was approved by the BCT on 21 October 2004. The overall objective of the EISR was to reduce contaminant mass downgradient of the planned PRB location in order to ensure that the portion of the plume slated for MNA in the ROD was not unduly extensive or high in concentration.

ZVI injections were made following procedures in the *EISR Work Plan* (MACTEC, 2004b) from 18 November 2004 through 8 January 2005. Injections were made in 14 borings at 2-foot intervals over the fluvial aquifer thickness, which averaged 21 feet; the injection locations were spaced approximately 60 to 80 feet apart. The depth of injection ranged from approximately 70 to 100 feet bgs. The total mass of ZVI injected was approximately 192,500 pounds.

The EISR is described in the *Early Implementation of Selected Remedy Interim Remedial Action Completion Report* (MACTEC, 2005b). The injections did not achieve the goal of 90 percent or greater reduction of TCE and PCA. TCE concentrations were reduced approximately 46 percent in the central injection area and up to 42 percent near the area boundary. PCA concentrations were reduced approximately 65 percent in the central injection area and up to 77 percent near the area boundary. Further treatment of CVOCs within the injection area is expected as groundwater comes into contact with ZVI over its effective life (up to two years). Groundwater monitoring in the EISR area is continuing. The report included recommendations for decreased spacing between injection locations to achieve increased reduction in CVOCs. Significant CVOC reduction appears to require ZVI injection at a suitable mass-to-soil ratio throughout the treatment area.

1.8 PLANNED REMEDIAL ACTIONS

Implementation of two additional RAs is planned for Dunn Field: Source Areas and Off-Depot Groundwater. The RD report has been completed for the Source Areas, while the RD for the Off-Depot Groundwater is currently being prepared. The following RA components are planned:

Source Areas

- Injection of ZVI to remediate CVOCs in groundwater beneath onsite vadose zone source areas
- Use of thermal-enhanced SVE in the loess and conventional SVE in the fluvial deposits to reduce CVOCs to levels that are protective of the intended land use and groundwater
- Excavation, transportation, and offsite disposal (ET&D) of soil and debris from shallow areas within the Disposal Area that have been identified since the Disposal Sites RA
- Implementation and enforcement of land and groundwater use controls in accordance with the Dunn Field Land Use Controls Implementation Plan (LUCIP)

Off-Depot Groundwater

- Installation of an air sparging with soil vapor extraction (AS/SVE) system for groundwater remediation in the Off-Depot plume
- MNA for portions of the plume with individual CVOC concentrations less than 50 (µg/L) and long-term groundwater monitoring to document remedy performance as indicated by changes in CVOC concentrations and/or changes in the lateral or vertical extent of the CVOC plume
- Institutional controls to prevent access to contaminated groundwater

The Fluvial SVE RAWP, Rev.1 (e^2M, 2007) was submitted to the BCT on 4 May 2007, and approved by USEPA on 3 July 2007. This RAWP includes the remaining components of the Source Areas remedy. ZVI injection in groundwater; thermal-enhanced SVE and ET&D in the loess; and land use controls. The Loess/Groundwater RAWP, Rev.1 was submitted to the BCT on 27 August 2007 and received partial approval from USEPA on 2 October 2007. The RAWP was approved with regard to construction and operation. The issue to be resolved was demonstration of attainment of the clean-up levels for the subsurface vadose zone soils. The Loess/Groundwater RAWP, Rev.2 was prepared to document the final revisions with regard to the attainment of clean-up levels, a flow chart for the thermal-enhanced SVE component, and an area of ET&D identified after completion of the Source Areas RD. The

Loess/Groundwater RAWP, Rev. 2 was approved by USEPA on 4 March 2008 with the caveat that the BCT agreement on use of non-detect results in evaluation of confirmation sample results, which was not included, would be documented. The RAWP, Rev. 2 was approved by TDEC on 2 April 2008. This Loess/Groundwater RAWP, Rev. 3 was prepared to document the agreement on use of non-detect results and the addition of confirmation samples in three areas with shallow (0 to 5 feet bgs) soils contamination. The remaining RAWP, to describe implementation of the Off Depot Groundwater RA, will be prepared following completion of the RD.

1.9 REMEDIAL DESIGN

Three studies were performed during development of the *Source Areas RD* (CH2M HILL, 2007) to aid the design of the loess and groundwater remedies. A field treatability study was conducted to evaluate the effectiveness of ZVI injection for *in situ* subsurface remediation of CVOCs. An SVE pilot study was performed to collect site-specific data for both the loess deposits and the unsaturated fluvial sands. A remedial design investigation (RDI) was performed to delineate CVOC concentrations in the loess and to collect additional groundwater samples. The results were used to estimate the extent of CVOC concentrations above Remediation Goals (RGs). Soil analytical data from the RDI and previous investigations were used to estimate the CVOC mass in the loess, which can be used to evaluate effectiveness of the RA.

1.9.1 ZVI Treatability Study

The ZVI field treatability study, utilizing pressurized pneumatic injection of ZVI powder into the saturated zone (fluvial aquifer) at Dunn Field, was conducted from 29 October to 14 November, 2003. The study included baseline and post-injection groundwater sampling performed from October 2003 to April 2004 near MW-73 in Treatment Area 2. The study was documented in a technical memorandum, *Results of an In Situ Chemical Reduction Treatability Study Using Zero-Valent Iron at Dunn Field, Memphis Depot, Tennessee, Revision 0* (CH2M HILL, 2004d). The Source Areas RD included additional groundwater analytical data from samples collected in October 2004 and November 2005, approximately one and two years following the ZVI injection.

The ZVI treatability study used Ferox^{SM} injection, a patented technology of ARS Technologies, Inc. (ARS), in which ZVI powder is suspended in potable water to create a slurry that is injected into the subsurface in a liquid, atomized form using nitrogen gas as a carrier fluid. In low permeability formations, pneumatic fracturing is conducted as a first step to maximize ZVI dispersal in the treatment zone. The ZVI powder is a "sponge" iron of high purity produced from iron ore in a gas reduction process.

Five new monitoring wells were installed for the study; four wells were within approximately 15 feet of the injection borings, and one well was installed approximately 40 feet upgradient. Four injection borings spaced 25 to 30 feet apart were drilled, and approximately 25,000 pounds of ZVI was injected at one to two-foot intervals spanning the approximately 13 foot saturated thickness of the fluvial aquifer at that location. The mass of ZVI injected was based on the goal of achieving a 0.5 percent ZVI-to-soil ratio within an expected injection radius of 17 feet.

ZVI distribution was inferred to extend 25 to 30 feet from the injection locations based on confirmation soil samples; fracture flow, as opposed to conventional channel flow, appeared to be the predominant mechanism for ZVI particulate distribution. Over the course of five confirmatory sampling events through April 2004, an 84 to 99 percent reduction of CVOCs was observed in the ZVI treatment zone. The treatability study results indicated a geochemical radius of influence up to 40 feet from the ZVI injection borings.

The later sampling events indicated CVOC rebounding at some wells possibly as the result of contaminant leaching from overlying soils; desorption of CVOCs not directly treated by iron emplacement, overall iron distribution and longevity, and/or transport of dissolved-phase CVOCs into treated areas.

1.9.2 SVE Pilot Study

The SVE treatability study was conducted in four phases to collect site-specific data for design of a full-scale system. Technical memoranda describing the test procedures and the results for each phase were included in Appendix C of the Source Areas RD.

Phase I of the SVE treatability study was conducted to determine whether a full-scale SVE system could be cost-effectively implemented to remediate CVOC contaminated vadose zone soil at Dunn Field. Separate tests were conducted for the loess deposits and the fluvial sands. The Phase I loess deposits test was conducted continuously over 72 hours in December 2001. Vapor extraction from the loess was compromised by atmospheric air short-circuiting, poor vacuum distribution (after 72 hours), limited flow (25 standard cubic feet per minute [scfm] or less), and high vacuum (25 inches mercury [Hg]). The fluvial sands test was conducted for a period of 96 hours in January 2002. The test results indicate remediation of the unsaturated fluvial deposits via SVE will be effective. A large vacuum distribution profile (minimum 100 foot radius) was established in the subsurface at high flow rates, greater than 250 scfm (2.2. inches Hg vacuum). At lower flow rates, with a minimum of 96 scfm, the vacuum radius of influence (ROI) decreased non-linearly to approximately 68 foot.

Phase II of the SVE treatability study was conducted in August 2004 to evaluate various engineered amendments to enhance the distribution and magnitude of flow near the vapor recovery well in the loess deposits. Phase II included two separate loess SVE tests. The first test included an 11-mil polyethylene liner installed to mitigate atmospheric short-circuiting and minimize surface water infiltration. Although a significant vacuum ROI (greater than 50 ft) was achieved, limited vapor purge rates (less than 50 scfm) and strong resistance to flow indicated by wellhead vacuum (24 to 25 inches Hg) was observed The second test utilized pneumatic fracturing to improve bulk permeability of dense soils, and improve air flow in the subsurface, and proppant injection to mitigate fracture collapse. The vacuum and flow monitoring data indicated partial or complete fracture collapse occurred in both test borings (propped and non-propped). Vapor extraction flow rates remained low (less than 50 scfm) with high applied vacuum (24 to 26 inches Hg). A short duration air injection (pressure) test was also conducted during Phase II. A flow rate of 170 scfm was achieved at a 15 pounds per square inch (psi) (30.5 inches Hg) injection pressure. Flow was sustained at this rate for approximately 10 minutes before the pump was deactivated. The loess soils are characterized by high moisture content that contribute to rapid fracture closure. A significant volume of water was released from the formation during fracturing at the non-propped well.

Phase III of the SVE treatability study was conducted in January 2005 to qualitatively evaluate modified proppant injection procedures and proppant effectiveness under vacuum. Test results indicated a 50 to 100 percent increase in flow and 200 to 300 percent increase in magnitude of vacuum response in the loess deposits, relative to lined, unfractured materials in Phase II. However, wellhead vacuum remained relatively high (21 inches Hg).

Phase IV of the SVE treatability study was conducted in February 2005 to evaluate the effectiveness of air injection relative to vapor extraction. The previous tests indicated that pneumatic fracturing has the potential to improve air permeability of the loess but that maintaining fracture dilation under strong vacuum and nearly saturated conditions was difficult. The results also suggested that air injection (instead of vapor extraction) could be used effectively to maintain fracture dilation and improve air permeability in the loess deposits. Six existing SVE wells associated with previous phases of work were pressure tested. Test data demonstrated the benefit of pneumatic fracturing to improve flow and pressure distribution in the loess with a reduction of injection pressure. Flow and pressure distribution at wells screened in non-fractured soil was significantly less than fractured materials. Significantly greater response at surrounding probes/wells indicated improved fracture flow and communication with the formation under pressurized conditions. The results did not indicate that proppant injection was significantly improved flow and pressure distribution.

1.9.3 Estimated Treatment Time for Conventional SVE - Loess

The time to achieve cleanup goals was estimated during the RD using data collected during the RI, and subsequent investigations, and the SVE treatability study. The estimates considered two CVOC concentrations, the geometric mean and maximum concentrations for PCA and TCE, and two vapor concentrations, the equilibrium vapor concentration, and the measured vapor concentration during Phase I of the SVE treatability study. The estimated treatment times for the loess were up to 235 years for PCA and up to 14 years for TCE.

1.9.4 Remedial Design Investigation

As described in the *Results of the Memphis Depot – Dunn Field Remedial Design Investigation* (CH2M HILL, 2006), the objectives for the RDI were:

- Increase soil data density for the four onsite soil treatment areas (TAs) to delineate CVOC soil contamination laterally and down to a depth of approximately 30 feet, where the loess deposits transitions to the fluvial sands
- Further delineate the CVOC groundwater plumes and provide additional monitoring locations for the full-scale groundwater remedy
- Collect additional data from the fluvial and intermediate aquifers to support the groundwater model that is being developed to estimate the effect of natural attenuation on the CVOC plumes and to determine the potential points of compliance for Dunn Field
- Collect additional lithologic and hydrogeologic data along a potential ZVI PRB alignment

A membrane interface probe (MIP) investigation was conducted to characterize the magnitude and extent of elevated CVOCs in the loess by using the semi-quantitative electron capture detector (ECD). A 40 by 40 foot grid was used to locate and identify the 237 proposed MIP locations in each of the four treatment areas. Based on the real-time results and the site's history not all of the proposed locations were probed. Soil samples were collected from select MIP locations for laboratory analysis to correlate the data sets and adequately delineate the areas with CVOC concentrations below the MIP detection limit but above the established Dunn Field RGs. Because the RG for PCA is relatively low, soil samples were also collected specifically to delineate the extent of PCA. Many of the perimeter soil samples were collected to complete the delineation of the treatment areas where the MIP, response was inconclusive. More than 160 locations were investigated with the MIP and more than 80 soil samples were collected during the two RDI phases conducted from 3 October to 18 November 2005, and 29-30 August 2006. The second phase of confirmatory soil sampling was conducted to further define the extent of contamination in a few areas, particularly the PCA concentrations.

Nine new monitoring wells were installed on Dunn Field, and five monitoring wells were installed Off-Depot west of Dunn Field from 10 October to 11 November 2005. Three additional monitoring wells were installed on Dunn Field in March 2006.

The RDI resulted in better delineation of the loess deposits requiring SVE treatment. The total area within the four treatment areas was reduced from 5.5 acres, as shown in the ROD, to 1.25 acres. The RDI also identified a small area with CVOCs exceedances in shallow soil (TA-1F) that will be excavated. The loess treatment areas and the excavation area are shown in Figure 3.

The highest concentrations detected in the loess soil samples from the four treatment areas are shown below:

Treatment Area	Depth Interval (feet, bgs)	CVOC Concentrations (µg/kg)					
		PCA	PCE	TCE	cDCE	CT	CF
TA1	6 - 12	953,000	20,800	564,000	174,000	3,350	8,080
TA2	10 - 14	1,850,000	21,100	170,000	2,240	ND	6
TA3	28 - 29	3,110	6	1,560	3,350	6	35
TA4	14 - 15	190,000	2,360	4,280	ND	1,850	96,200

1.9.5 CVOC Mass Estimate

The MIP-ECD responses and the soil sample analytical results were used to estimate the mass of CVOCs in the loess for the *Source Areas RD* (CH2M HILL, 2007). The CVOC mass remaining in the loess will provide a baseline for evaluation of the loess remedy.

The MIP-ECD response at each 0.05 foot interval in the sample nodes with RG exceedances was converted to a total CVOC concentration using the correlation between the MIP-ECD responses and the analytical results. Sample nodes without RG exceedances were not considered. The mass of CVOCs within each 0.05 ft by 1,600 ft^2 cell (area represented by each 40 foot by 40 foot sample node) was calculated and summed for each impacted sample node. The estimated CVOC mass for each impacted sample node within the treatment area was summed to estimate the mass in the treatment area. Because the MIP-ECD response-to-soil result correlation tended to underestimate the mass of CVOCs in the soil in delineated treatment areas, two correction factors were developed, the first based on specific sample results and MIP-ECD responses where available, and the second on sample results and MIP-ECD responses throughout each treatment area.

The results for the four treatment areas are summarized below.

Treatment Area	CVOC Mass without Correction Factor (lb)	CVOC Mass with Average Treatment Area Correction Factor (lb)	CVOC Mass with Location-Specific Correction Factor (lb)
TA1	750	6,400	10,100
TA2	250	2,200	4,000
TA3	<1	10	20
TA4	400	700	200
Total	**1,400**	**9,310**	**14,320**

1.9.6 Remedial Design Revisions

1.9.6.1 SVE

SVE was selected by DLA, USEPA, and TDEC in the *Dunn Field ROD* (CH2M HILL, 2004a) as the presumptive remedy for CVOCs in subsurface soil (the vadose zone) at Dunn Field. As this technology is commonly applied, air flow is induced through contaminated soil by applying a vacuum to SVE wells to create a pressure gradient in the targeted areas. As soil vapor migrates toward the extraction vents, contaminants are volatilized, transported out of subsurface soil, and collected and treated above ground. Per the *Dunn Field ROD* (CH2M HILL, 2004a), SVE treatment was expected to meet the RAOs in less than five years.

The impacted vadose zone at Dunn Field consists of two distinct geological units: a shallow, relatively low-permeability loess; and (two a deep, relatively high-permeability alluvium composed of sands, sands and gravels, and discontinuous layers of silt and clay that collectively have been referred to as the fluvial deposits. The loess, a semi-cohesive eolian deposit composed of silt, silty clay, silty fine sand, and mixtures thereof, extends from the ground surface to a depth of about 30 feet, bgs. Underlying the loess are several feet of sandy clay, followed by 30 to 75 ft of the fluvial sands, silt, and gravel.

The subsurface soil remedy has been revised from the plan presented in the Dunn Field ROD based on the SVE treatability study, RDI, and estimated time to achieve cleanup goals in the loess using conventional SVE. Conventional SVE is not considered likely to achieve the RGs for the loess in a reasonable time frame (five years). Therefore, thermal-enhanced SVE will be used for treatment of the loess and the underlying sandy clay, and conventional SVE will be applied to the unsaturated portion of the fluvial deposits.

1.9.6.2 ZVI

The primary differences between the initial source area groundwater remedy and the current approach is the areal extent of the treatment areas, which in total are approximately 85 percent smaller than the conceptual design presented in the Dunn Field ROD. The reduction is results from:

- Improvement in groundwater data density
- Exclusion of offsite ZVI injection from the Source Areas RA
- Focusing the ZVI injections inside the latest total CVOC 1000 µg/L contour

The 1000 µg/L total CVOC contour was selected as the boundary of the ZVI injection areas because it is indicative of source area concentrations. Based on the results of the ZVI treatability study and the EISR, t Ferox^{SM} technology is not a cost-effective remedy for groundwater at lower concentrations. The portion of the CVOC plume outside the ZVI injection area will either naturally attenuate or be treated by the Off-Depot groundwater remedy. Following the implementation of the Source Areas remedies, contingency groundwater remedies will be implemented in the event that groundwater outside the expected Off-Depot groundwater remedy treatment zone has individual CVOC concentrations greater than 50 µg/L.

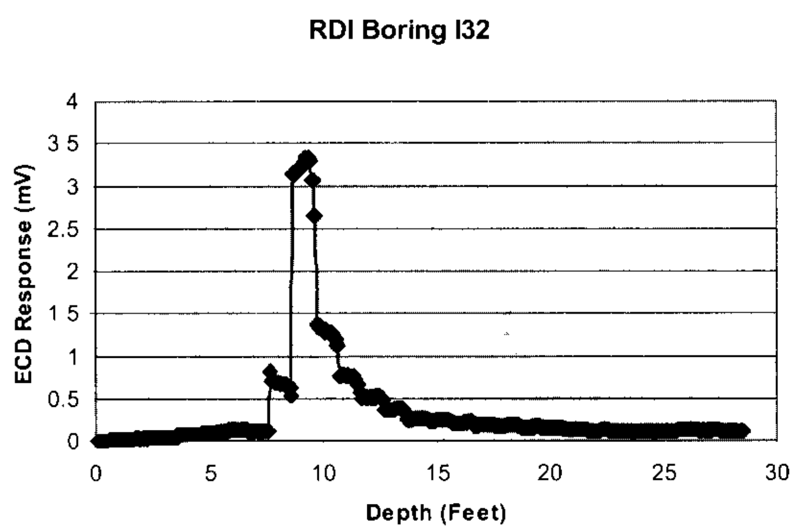
The sequencing of the ZVI injections relative to the other Source Areas RA remedies was also changed. The groundwater remedy will be implemented after installation and start-up of the fluvial SVE system and after completion of thermal-enhanced SVE in the loess. This change was made to minimize rebounding of CVOC concentrations in groundwater after injection due to leaching from the overlying source areas.

1.9.6.3 Excavation, transportation and off-site disposal (ET&D)

ET&D was the selected remedy for soil and debris from Disposal Sites 3, 4.1, 10, 13, and 31, as described in Section 1.7.1. Two areas have been identified for ET&D since completion of the Disposal Sites RA. One area with CVOCs above RGs (TA-1F) was identified during the RDI, and a second area with crushed, buried drums in TA-3 was identified during installation of the Fluvial SVE system. The two areas are shown in Figure 3.

TA-1F

A soil sample collected at a depth of 10 to 11 feet in RDI boring I32 contained chloroform at 1010 µg/kg, slightly above the RG of 917 µg/kg. The MIP response from the boring indicated the CVOCs were present at depths of 8.5 to 13 feet; the highest MIP response was at approximately 9.5 feet (refer to MIP Response graph below). None of the surrounding borings had elevated ECD responses. Based on the limited extent and depth, this area will be excavated rather than treated by thermal-enhanced SVE.



TA-3 Buried Drums

In June 2007, buried metallic debris was encountered at a depth of 2.5 feet bgs during hand-auguring prior to installation of Fluvial SVE vapor monitoring points in TA-3. A hand excavation of a few square feet was made and the metal debris was observed to be crushed metal drums with black viscous material remaining in the drums. Photographs are included in Appendix E-1. No odor was noticed and the photoionization detector (PID) measurement at ground surface above the excavation was zero parts per million (ppm). The soil was placed back in the excavation.

A grab sample (DUNN FIELD-1) of the waste material was collected on 12 June and submitted to Kemron for analysis of VOCs, SVOCs, Pesticides, Herbicides, PCBs, and metals. Analytical results are provided in Appendix E-2. Results of hydrocarbon analysis by Method 8015B were 0.303 milligrams per kilogram (mg/kg) of gasoline range organics, and 21,300 mg/kg of diesel range organics. Many petroleum-related VOCs were detected, but no CVOCs were detected above reporting limits. There were no detections of semi-volatile organic compounds, herbicides, pesticides, or polychlorinated biphenyls (PCBs) above reporting limits. Because of the nature of the sample, laboratory reporting limits were very elevated and quality assurance/quality controls standards for analysis were not met.

In June 2007 during trenching for installation of the vapor conveyance line in the same area of TA-3, additional crushed drums were encountered. The drums were observed along approximately 40 feet of trench, as shown in Figure 3.

The drums and soil were excavated to a depth of approximately three feet to allow installation of the conveyance line. Approximately 10 CY of crushed drums and soil were placed in a covered roll-off. One composite sample (DF-DRUMS-2) was collected on 11 July and submitted for hazardous waste analysis using the Toxicity Characteristic Leaching Procedure (TCLP). The results are provided in Appendix E-2. No organic constituents were detected above reporting limits, and metals detected were well below hazardous waste criteria. The roll-off was disposed of as non-hazardous waste at the Waste Management landfill in Tunica, MS.

The only identified disposal site in this area of Dunn Field is SWMU-23, Construction Debris and Food Burial Site. This site was designated as No Further Action in the *RCRA Facility Assessment* (A.T. Kearney, 1990). The SWMU 23 Assessment Report and location map from the Corrective Action Permit Application submitted 29 March 2004 is included in Appendix E-3. On 19 January 2005, TDEC issued a Denial to Reissue the Hazardous Waste Corrective Action Permit, which terminated the requirement for DDMT to continue corrective action under the hazardous waste management regulations, and noted that all corrective action activities would continue under CERCLA authority.

TA-3 is an open, grassy area that slopes from the site access road on the east, toward a tree-lined drainage ditch. Total relief is approximately 15 feet. A tree-shrub covered soil pile was located in the central portion of TA-3, east of the areas where drums were observed. The soil pile was removed in April 2007 during site preparations for the Fluvial SVE. Approximately 6,000 cubic yards of soil were graded into the slope south of TA-4. No drums were observed during removal of the soil pile, however small amounts of concrete rubble were observed.

A surface geophysical survey of TA-3 was conducted by FPM Geophysical & UXO Services (FPM) on 9 October, 2007. FPM investigated an approximately one-acre area using a Geonics EM61-MK2 high resolution time-domain electromagnetic metal detector (EM61) coupled to a Trimble Pathfinder Pro-XRS differential global positioning system. The FPM report is included as Appendix E-4.

The EM61 measurements in millivolts (mV) are shown in Figure 4, which includes the site topography and nearby monitoring wells, SVE wells and VPs. The typical EM61 response to a buried drum(s) is reported to vary from a few 10's to well over 1,000 mV, depending on the number, condition and depth of the drums. High-amplitude anomalies, interpreted to result from significant buried metal, were observed during the survey at TA-3. The tree line and rip-rap prevented expansion of the survey area further west. Pinflags were used to mark a broad area with measurements above 500 mV and two smaller areas with measurements above 3000 mV; these areas are shown in Figure 4. The large flagged area covers approximately 10,500 square feet while the two interior areas cover 2250 and 930 square feet respectively. The area requiring excavation is estimated to range from the two smaller areas, 3180 square feet to the entire flagged area, 10,500 sq. ft. Assuming the average depth of excavation is five feet, the volume to be excavated will range from 590 to 1950 CY.

2.0 SUMMARY OF REMEDIAL ACTION

The Source Areas Loess/Groundwater RA is summarized below; detailed discussion is provided in Section 4.0.

2.1 EXCAVATION, TRANSPORTATION AND DISPOSAL OF LOESS SOIL

Two areas, one in the northwest portion of TA-1 and the other in the western portion of TA-3, have been selected for remediation by ET&D. The areas are shown in Figure 3. TA-1F is estimated to contain approximately 120 cubic yards of CVOC-impacted soil. The TA-3 area, which is not yet delineated, is estimated to contain approximately 3,200 to 10,500 cubic yards of crushed, buried drums, associated soil and other debris. Additional material may be excavated from each area based on results of confirmation samples. Detailed discussion of ET&D activities is provided in Section 4.4. A brief summary is provided in the subsections below.

2.1.1 Site Preparation and Mobilization

Site preparation and mobilization activities will consist of:

- Site survey to mark the TA-1F excavation area, a single 20 by 20-foot at MIP location 321
- An initial site survey of the TA-3 area is not required since the excavation limits are estimated based on the geophysical survey
- Utility clearance to ensure excavation area is free of subsurface utilities and overhead obstructions
- Construction Kick-off Meeting
- Mobilization of excavation equipment and temporary facilities
- Soil samples collected from on-site source area (soil/rubble pile). Off-site source areas will be sampled, if necessary

2.1.2 Excavation Activities

Excavation activities will consist of:

- Establishment of exclusion, contamination reduction, and support zone
- Background ambient air monitoring (prior to excavation activities)
- Excavation of test pits in TA-3 to confirm the results of the geophysical survey and to confirm the buried drums and debris are consistent with previous observations
- Excavation of CVOC affected soil from a single 20 by 20-foot area to a depth of 15 feet
    - CVOC concentrations in the top 7 feet are considered below RGs and soil from zero to seven feet bgs will be segregated, stockpiled and used as backfill material
- Excavation of crushed, buried drums from TA-3
- Ambient air monitoring during excavation activities
- Soil confirmation samples from excavation floor and sidewalls
- Additional excavation, if necessary based on results of confirmation samples;
- Site survey of final excavation limits
- Backfill and compaction of excavation

2.1.3 Soil Disposal Activities

Disposal of CVOC impacted soil will consist of:

- Collection of waste characterization samples from excavated material
- Preparation of waste acceptance package and manifests
- Removal of material from Dunn Field and transportation to approved off-site disposal facility

2.1.4 Post Excavation RA Activities

Following excavation activities, the following tasks will be completed:

- Site restoration including grading and re-seeding of disturbed areas.
- Preparation of technical memorandum summarizing ET&D activities.
    - Laboratory analytical results will also be presented.

2.2 LOESS THERMAL-ENHANCED SVE CONSTRUCTION ACTIVITIES

The loess and underlying sandy clay will be treated with thermal-enhanced SVE using insitu thermal desorption (ISTD), which involves heating the subsurface to accelerate the mobilization of CVOCs and SVE to remove the CVOCs from the formation. Thermal-enhanced treatment areas are depicted in Figure 3. Detailed discussion of thermal-enhanced SVE activities is provided in Section 4.5. A flow chart illustrating the Thermal-enhanced SVE operations is provided on Figure 5 and a brief summary of the activities is provided in the subsections below.

2.2.1 Site Preparation and Mobilization

Site preparation and mobilization activities will consist of:

- Selection of thermal-enhanced SVE vendor
- Finalize thermal-enhanced SVE design, specifications, and contractor work plan
- Site survey to mark loess treatment areas, a total area of approximately 53,000 ft^2
- Utility clearance to ensure treatment areas are free of subsurface utilities and overhead obstructions
- Relocate/protect existing IRA groundwater recovery system (GWRS) conveyance line in areas TA-1C and TA-1E
- Establish power at location of thermal-enhanced SVE equipment
- Obtain permit to construct from Memphis and Shelby County Health Department;
- Construction kick-off meeting with subcontractors
- Mobilization of thermal-enhanced SVE equipment, supplies, and personnel

2.2.2 Thermal-Enhanced SVE Construction Activities

Thermal-enhanced SVE construction activities will consist of:

- Drilling and installation of heating elements, subsurface temperature probes, SVE wells and associated conveyance piping, system control and treatment facilities
  - Construction to be performed by thermal-enhanced SVE contractor
- Site survey of installed heating elements, SVE wells and monitoring points

- System testing and startup
- Technical memorandum summarizing construction and start-up activities

2.2.3 Thermal-Enhanced SVE Operations

Thermal-enhanced SVE operations will consist of:

- Full time operation and maintenance of thermal-enhanced SVE system including heating elements and treatment equipment
- Monitoring of subsurface temperatures
- Collection of samples from vapor and condensate, and calculation of CVOC mass removal rate
- Testing and disposal of condensate, if required
- Quarterly technical memoranda summarizing operations, field measurements, analytical laboratory results, COC recovery rates. The technical memoranda will also include an evaluation of the thermal-enhanced SVE operations and recommendations for additional treatment in targeted areas as necessary;
- Collection of soil samples to determine whether RGs have been met.
- Initial soil samples will be collected after approximately 70 percent of the planned treatment period has been completed, the soil temperature in the central areas reach 90°C, and vapor concentrations reach asymptotic levels below 100 ppm on PID measurements. Changes to thermal-enhanced SVE operations may be made based on the sample results
- Following additional treatment where necessary, soil samples will be collected at locations that exceeded RGs.

2.2.4 Post Thermal-Enhanced SVE Operations

Following thermal-enhanced SVE operations, the following activities will be completed:

- Demobilization of equipment and personnel from Dunn Field
- Removal of heater elements, SVE wells, and temperature probes, conveyance piping, system controls and treatment equipment
- Abandon heater element and SVE well borings
- Site restoration including grading and re-seeding disturbed areas

2.3 ZVI INJECTION

ZVI injections have been selected for remediation of groundwater on Dunn Field in areas with total CVOC concentrations greater than 1,000 µg/L, based on groundwater samples to be collected after thermal-enhanced SVE treatment of loess and underlying sandy clay. Recent Dunn Field groundwater concentrations and isopleths are depicted on Figure 6. Detailed discussion of ZVI injection activities is provided in Section 4.6. A brief summary is provided in the subsections below.

2.3.1 Site Preparation and Mobilization

- Install additional groundwater monitoring wells to define groundwater treatment areas (CVOC concentrations above 1,000 µg/L
- Site survey for installed monitoring wells
- Collect at least two rounds of pre-injection groundwater sampling
- Finalize ZVI injection locations based on groundwater monitoring data
- Perform site survey to locate ZVI injection locations
- Utility clearance to ensure injection locations are free of subsurface utilities and overhead obstructions;
- Construction kick-off meeting
- Prepare materials handling and storage areas for receipt of ZVI powder; and
- Mobilization of ZVI Injection equipment, supplies and personnel.

2.3.2 ZVI Injection Activities

The following activities will be performed as part of the ZVI Injections at Dunn Field:

- Perform ZVI injections at selected locations
  - Injection borings spaced on 30 foot centers in groundwater treatment areas.
  - Target iron to soil ratio of 0.5 percent, 1200 to 1300 pounds of ZVI for each two foot thick injection interval (20-foot radius of injection).
  - Estimated total treatment area of approximately 50,000 ft^2
- Collect and record injection parameters
- Soil confirmation borings to confirm injection radius of ZVI powder

- Site survey of ZVI injection and confirmation borings
- Abandon ZVI borings and soil confirmation borings

2.3.3 Post ZVI Injection Activities

Following ZVI injections at Dunn Field, the following activities will be completed:

- Demobilization of equipment and personnel from Dunn Field
- Evaluate effectiveness of ZVI injections by groundwater sampling for at least four quarters;
- Preparation of technical memoranda summarizing ZVI injections and post-injection groundwater analytical results
- Site restoration including grading and re-seeding disturbed areas

2.4 SYSTEM OPERATION AND MONITORING

Monitoring of the thermal-enhanced SVE system and ZVI injections will be performed during treatment. No long-term system operations or monitoring will be required for the Loess/Groundwater RA.

2.5 LAND USE CONTROLS

Land use controls (LUCs) will limit use of the Disposal Area to light industrial land uses, prevent residential use of Dunn Field, and prevent exposure to contaminated groundwater. The LUCs consist of the following institutional controls: deed and/or lease restrictions Notice of Land Use Restrictions, City of Memphis/Shelby County zoning restrictions and the Memphis and Shelby County Health Department groundwater well restrictions. The LUCIP is currently being developed by the Army (as landowner) and USEPA.

The U.S. Army will be responsible for monitoring of LUCs, either directly or by delegation. An annual inspection will be conducted to determine whether the required LUCs remain effective and that land use restrictions are being achieved.

The annual inspections will describe deficiencies or violations of the land use restrictions, and will describe proposed measures or corrective actions taken to remedy deficiencies or violations. The LUCIP includes an annual inspection checklist and certification form that the U.S. Army (or its representative) will complete, sign, and submit to the BCT within 30 days of the inspection.

In the unlikely event that there is a land use restriction deficiency or violation, the U.S. Army (or its representative) will inform the BCT within 72 hours. After consultation with the BCT, the U S. Army will exercise available legal authority and take appropriate action to enforce LUCs and correct the deficiency or violation.

LUCs will remain in place until concentrations of contaminants of concern (COCs) have been reduced to levels that allow for unlimited exposure and unrestricted use. In this case, particular LUCs will be modified or discontinued. A determination by the U.S. Army to modify or terminate LUCs would require approval from USEPA and TDEC. The U.S. Army may pursue an Explanation of Significant Difference (ESD) or Amendment to the Final ROD if the changes to the LUCs are deemed significant and affect the scope of the selected remedy.

2.6 FIVE-YEAR REVIEWS

Five-Year Reviews will evaluate:

- Whether the remedy is functioning as intended
- Whether the exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of the remedy selection are still valid
- Whether additional information has come to light that could call into question the protectiveness of the remedy

The second Five-Year Review was completed in January 2008. To comply with guidance from USEPA, the next Five-Year Review for DDMT will be completed by January 2013.

3.0 REMEDIAL ACTION PLANNING

The following section presents a summary of the remedial action planning to be completed prior to implementation of the RA. This section includes a discussion of the planning documents, subcontractor, and vendor procurement and permitting.

3.1 PLANNING DOCUMENTS

Implementation of the RA will begin following BCT concurrence with the RA planning documents, which include this RAWP and the PMP, WMP, CQAP, RASAP, and HSA.

3.1.1 Project Management Plan

The PMP is Appendix A to this RAWP and describes the project organization and responsibilities. The PMP also addresses administrative procedures, such as communications, records maintenance, quality control and reporting, and includes a schedule for implementation of the RA.

3.1.2 Waste Management Plan

The WMP is Appendix B to this RAWP, and describes waste management and waste minimization activities during the drilling for the loess treatment system, installation of monitoring wells, ZVI injections, operation of the thermal-enhanced SVE system, and ZVI injections. The WMP identifies the waste streams that will be generated during implementation of the RA and details plans for waste minimization, waste management strategies, and waste disposition.

3.1.3 Construction Quality Assurance Plan

The CQAP is Appendix C to this RAWP, and presents the quality assurance/quality control (QA/QC) procedures for RA construction activities and procedures to monitor and document the acceptability of construction and/or performance of the soil excavation, thermal-enhanced SVE system, and ZVI injections. The CQAP includes information on project meetings, construction activities, and document submittals.

3.1.4 Sampling and Analysis Plan

The RA SAP (MACTEC, 2005a) documents the procedural and analytical requirements for activities conducted during the RA. Volume I of the RA SAP presents the Field Sampling Plan (FSP) with information on project organization and responsibilities, field activities, field measurement, sample handling and documentation, and nonconformance/corrective actions for situations (if any) when requirements of the RA SAP are not met. Specific RA field activities addressed by the FSP are:

- Site reconnaissance, preparation, and restoration
- Borehole construction and soil sampling
- Well installation and development
- Groundwater sampling
- Surveying
- Equipment decontamination
- Disposal of investigation derived waste (IDW)

The field measurement section of the FSP addresses calibration and quality control of field measurement equipment and procedures for field monitoring measurements. Field performance and systems audits are also addressed in Volume I.

Work and Test Procedures (WTPs) in Appendix B of Volume I provide specific procedures for field activities and the formulation of project related documents. Besides the field activities listed above, the WTPs include sample control and documentation, sample containers and preservation, sample packing and shipping, decontamination of personal protective equipment, and health and safety monitoring.

Volume II of the RASAP includes the QAPP and addresses:

- Data quality program objectives
- Sampling procedures
- Screening and definitive analytical methods and calibration
- Methods for data reduction, review, verification, reporting, validation, and record keeping

Volume II also addresses performance/systems audits, preventive maintenance, and nonconformance/ corrective actions for situations (if any) when requirements of the QAAP are not met. Appendices to Volume II include the analytical laboratory quality manual and standard operating procedures (SOPs), calibration and QC procedures, and data quality SOPs.

3.1.5 Health and Safety Plan

The *Remedial Action Health and Safety Plan* (HSP) (e^2M, 2006) will provide the basis for protection of site workers. A Loess/Groundwater Health and Safety Addendum (HSA) will be prepared, if necessary, for activities not addressed in the HSP. The HSP includes:

- A description of potential risks
- Responsible on-site personnel
- Site safety program(s) and procedures, contingency procedures, air monitoring plan(s),
- Personnel monitoring
- Area and perimeter monitoring
- Spill prevention, control and countermeasures plan

3.1.6 Community Relations Plan

Community relations activities during the RA will be conducted in accordance with the *Community Involvement Plan* (MACTEC, 2005). The primary objectives relative to the RA are to notify nearby members of the community prior to construction activities, and provide routine updates on progress. These activities will be performed by e^2M and the community relations subcontractor under the direction of the DLA project manager.

3.2 SUBCONTRACTOR AND VENDOR PROCUREMENT

c²M will solicit, evaluate, select, and award the necessary subcontracts to implement the RA. Subcontracts will be awarded for:

- Initial and as-built surveys of treatment areas and drilling locations
- Location of utilities at drilling locations
- Installation of electric power for the thermal-enhanced SVE system
- Installation and operation of thermal-enhanced SVE system
- Installation of monitoring wells
- Borings for soil sampling
- ZVI injection
- Laboratory analyses of soil, vapor, and groundwater samples

3.3 PERMITTING

As this site is under CERCLA authority, permits are not required from local or state entities for actions that occur entirely onsite, however the substantive requirements of permits must be considered and incorporated within the RD and RA. CERCLA Section 121(d) specifies, in part, that remedial actions for cleanup of hazardous substances must either comply with, or justify waiver of, requirements and standards under federal or more stringent state environmental laws and applicable or relevant and appropriate regulations (ARARs) (see also 40 Code of Federal Regulations [CFR] 300.430(f)(1)(ii)(B)). ARARs include only federal and state environmental or facility siting laws and/or regulations and do not include occupational safety or worker protection requirements. In accordance with 40 CFR 300.400(g), the DLA, TDEC, and EPA have identified the specific ARARs for the selected remedy. Activities planned to meet ARARs are discussed below.

Requirements for the control of fugitive dust at TDEC Rule 1200-3-8-.01(1) and storm water runoff potentially provide ARARs for all construction, excavation, trenching, and site preparation activities. Reasonable precautions must be taken and include the use of best management practices for erosion control to prevent runoff and the application of water on exposed soil/debris surfaces to prevent particulate matter from becoming airborne.

Soil excavation and drilling for monitoring wells, and for SVE and ZVI treatment remedies, may result in the generation of remediation wastes that are considered RCRA characteristic hazardous waste due to elevated concentrations of hazardous constituents. The toxicity characteristic leaching procedure (TCLP) test, along with tests for reactivity, corrosivity, and ignitability will be conducted on representative remediation/secondary waste samples to determine whether they are considered RCRA characteristic hazardous waste. RCRA hazardous waste will be managed in accordance with the applicable TDEC hazardous waste management regulations, including those related to temporary storage of waste in containers and transportation offsite. Movement of hazardous remediation waste that contains RCRA-restricted waste offsite for disposal will trigger the RCRA LDRs. These wastes must meet the specified treatment standards at 40 CFR 268 et seq. prior to disposal in a RCRA Subtitle C hazardous waste landfill.

Any remediation wastes that are transferred offsite or transported in commerce along public rights-of-way (ROWs) must meet requirements for packaging, labeling, marking, manifesting, and placarding for hazardous materials. In addition, CERCLA Section 121(d)(3) provides that the offsite transfer of any hazardous substance, pollutant, or contaminant generated during CERCLA RAs be sent to a treatment, storage, or disposal facility that is in compliance with applicable federal and state laws, and has been approved by EPA for acceptance of CERCLA waste (see also the "Off-Site Rule" at 40 CFR 300.440 et seq.). e^2M will verify with the appropriate EPA regional contact that any needed offsite facility is acceptable for receipt of CERCLA wastes before transfer and will obtain written evidence of valid EPA Off-site Rule approval (40 CFR 300.440) from the offsite disposal facility.

Based on direction from the U.S. Army Regional Environmental Counsel and in accordance with CERCLA Section 121(e)(1), ZVI injections in the Source Areas will not require an Underground Injection Control Permit (State of Tennessee Rule 1200-4-6). However, injections will be performed in a manner that meets substantive requirements of such a permit, which address the following areas:

- Protection of Underground Sources of Drinking Water (1200-4-6-.04)
- Inspections, Monitoring, Retention of Records and Reporting (1200-4-6-.08)
- Well Abandonment (1200-4-6-.09)

The requirements are described in more detail in Attachment A to the CQAP (Appendix C).

Installation and operation of the thermal-enhanced SVE system will require a construction/operating application. The vendor work plan for the enhanced SVE system will address the substantive requirements of the air permit, which will likely have the following operating conditions:

- SVE systems can be operated only if the vapor treatment is functioning as designed
- Emissions to be determined by source testing
- Routine annual inspection to be conducted by the Minor Sources Branch of TDEC
- No emissions limit considered necessary
- Permit to be rescinded once actual pre-treatment emission rate drops below 0.1 lb/hr

4.0 REMEDIAL ACTION CONSTRUCTION

RA construction (RA-C) activities include site preparation, and mobilization of personnel, equipment, and supplies to perform the following RAs at Dunn Field:

- ET&D of soil and debris from two shallow areas within the Disposal Area
- Use of thermal-enhanced SVE to remove CVOCs from subsurface soils to levels that are protective of the intended land use and groundwater
- Injection of ZVI to target CVOC concentrations in groundwater greater than 1,000 µg/L beneath source areas

Construction activities associated with the RAs are described in the sections below.

4.1 NOTICE TO PROCEED

Award of a task order for the Loess/Groundwater RA by AFCEE will serve as NTP with construction activities. The award will mark the formal beginning of the construction phase and progress within the construction schedule will be measured by the date of the notice. The BCT will be notified when the award is made.

4.2 PRE-CONSTRUCTION CONFERENCE

A pre-construction conference will be held at the DDMT facility approximately four weeks after notice to proceed and before construction work begins. The conference will be attended by DLA, USEPA, TDEC, e^2M, Depot Redevelopment Corporation (DRC), subcontractors and other invited attendees. The pre-construction conference will include:

- Introducing team members and identifying the roles, relationships, and responsibilities of parties involved with the RA
- Discussing expectations of the BCT for the RA-C
- Reviewing the general project scope, final CQAP, HSA, work area security and safety, and project schedule
- Establishing a schedule for meetings and briefings
- Reviewing methods for documenting and reporting observation data and documenting control procedures

- Reviewing procedures for project completion including final system construction inspection

A site reconnaissance may be conducted as part of the pre-construction conference to view construction and staging areas. Specific areas to be viewed will include excavation area, treatment areas, and material and equipment storage areas; site access issues will also be reviewed. e^2M will document the names of conference attendees, issues discussed, clarifications made, special instructions issued, and other pertinent information and discussions. Although RA-C activities will occur in phases and performed at different times, it is anticipated that only one pre-construction meeting will be necessary before the onset of construction activities.

4.3 MOBILIZATION AND SITE PREPARATION

e^2M will provide oversight of equipment mobilization, supplies, and personnel, and will coordinate the schedules and progress of subcontractors and vendors. This section discusses general site preparation activities to be completed before the three RA activities. Individual site preparation activities pertinent to an individual RA phase are discussed in subsequent sections of the RAWP. The ET&D and thermal enhanced SVE RAs will be initiated shortly after NTP. ZVI injections will begin after completion of thermal-enhanced SVE.

4.3.1 Construction Kick-Off Meeting

At the beginning of each stage, a construction kick-off meeting will be held with subcontractors prior to the onset of construction activities. The meeting will occur at the former Memphis Depot. The purpose of the meeting is to verify that design criteria and specifications presented in this RAWP, site access issues, contract documents, and other pertinent project information are understood by all parties. e^2M will document the names of conference attendees and the discussion items.

4.3.2 General Site Preparation

e^2M will oversee the construction of temporary facilities at Dunn Field, including:

- Decontamination pads and facilities
- Equipment and supply staging area(s)
- IDW storage facilities or staging areas

Most field and construction activities will occur at Dunn Field, which is predominantly undeveloped. Construction activities should not interfere with Memphis Depot Business Park tenants Limited RA activities (staging of equipment, sub-contractor meetings, etc) will occur on the Main Installation at Building 265 (e^2M's Field Office).

Brush and vegetation will be cleared as necessary to provide unobstructed access to the individual RA areas (i.e., thermal-enhanced SVE well, treatment compound, excavation, and monitoring well locations, etc). Small trees and shrubs will be cut and mulched onsite. Larger brush and debris will be disposed at an appropriate off-site facility.

4.3.3 Site Survey and Utility Clearance

A Registered Professional Land Surveyor licensed in the State of Tennessee will survey and mark the boundaries of the thermal-enhanced SVE treatment areas, excavation areas, and staging and stockpile areas to guide field activities. All locations will be marked in accordance with the construction drawings and specifications, be highly visible, and have sufficient permanence to be identified for several weeks following completion of the surveying task.

Utilities at drilling locations (thermal-enhanced SVE wells, ZVI injection locations, and groundwater monitoring wells) and at construction areas (treatment compound) will be located through liaison with DRC staff and utility operators. All affected treatment areas will be cleared for underground utilities, general access, and overhead obstructions. The Tennessee One-Call System, Inc. will be utilized along with a private utility locator as necessary. Utilities to be located include, but are not limited to, underground and overhead power, telephone, cable television, fiber optic, and computer lines; and underground storm and sanitary sewers, water and gas lines. Clearance from the transmission lines crossing Dunn Field will be confirmed for all drilling locations with MLGW. No intrusive activities will be conducted until utilities have been located and clearances confirmed.

The BCT will be informed of adjustments greater than 15 feet prior to the onset of construction activities at that location.

Work limits will be established following the site survey and utility clearance. Work limits at drilling and construction locations will include the exclusion, contaminant reduction, and support zones; and space for equipment lay down

4.3.4 Site Access and Temporary Road Construction

Existing site access roads will be used to reach the individual ZVI injection, thermal-enhanced SVE wells, and remediation compound locations to the extent possible. If constructed, temporary access roads will be approximately 20 feet wide, and constructed with a six-inch crusher run layer overlying a stabilizing, geotextile fabric. All access roads will be constructed to allow surface water to drain and minimize the incidence of ruts.

4.3.5 Temporary Erosion and Sediment Controls

Erosion and sediment control measures will be taken to minimize erosion during construction activities in disturbed and soil stockpile areas. Erosion controls may include the use of silt fences, hay bales, grade work, diversion berms, and/or other measures to minimize storm water runoff and site erosion. Potable water will be sprayed on haul roads to limit dust, if considered necessary based on site observations.

4.4 EXCAVATION TRANSPORT AND DISPOSAL OF IMPACTED SOIL

Two areas, one in the northwest portion of TA-1 (TA-1F) and the other in the western portion of TA-3, have been selected for remediation by ET&D. TA-1F is estimated to contain approximately 120 cubic yards of CVOC-impacted soil The excavation area is shown in Figure 7. The TA-3 area is estimated to contain approximately 3,200 to 10,500 cubic yards of crushed, buried drums, associated soil and other debris The limits of excavation in TA-3 will be based on the extent of crushed, buried drums. Additional material may be excavated from either area based on results of confirmation samples. A discussion of excavation activities is provided in the subsections that follow.

4.4.1 Mobilization and Site Preparation

Personnel, equipment, and supplies will be mobilized to Dunn Field. Temporary facilities will be established consisting primarily of an equipment decontamination area, supply staging area or trailer, and portable sanitary facilities. The work areas (excavation, stockpiles, haul roads, etc) for site activities will be clearly marked and flagged.

Erosion control measures will be implemented for excavation and stockpile areas. Silt fence, hay bales, site modification for ditches, and/or other devices will be used to control storm water and erosion. As needed, potable water will be sprayed on haul roads to limit dust. Storm water that collects within excavations or inside runoff diversion berms will be containerized, characterized, and disposed of in accordance with the discharge permit.

On-site backfill material will be used if possible; sources will be the upper several feet of the TA-1F excavation area and the soil rubble pile. Grab samples of on-site source material will be collected at a frequency of once per 250 CY. If backfill from off-site sources is needed, grab samples will be collected at a frequency of once per 500 CY. The soil from the TA-1F excavation area will be analyzed for VOCs by Method 8260. Backfill from the soil/rubble pile and off-site sources will be analyzed for VOC, SVOCs, pesticides, PCBs, herbicides, and metals in accordance with the Performance Standards Verification Plan (PSVP) in Appendix D of the RD.

4.4.2 TA-1F Excavation

An exclusion zone will be established around the excavation area, and will be large enough to allow movement of equipment and stockpiling of excavated material. A contamination reduction zone will also be established and will consist of a contamination station that must be used to exit the exclusion zone. The station will have brushes and wash fluids necessary to decontaminate personnel and equipment leaving the exclusion zone. A support zone will be established outside the contamination reduction area to stage clean equipment from this area, and don protective clothing. A conceptual layout of the excavation area is included in Figure 7.

An excavator will be used to remove an initial area of 20 by 20 feet surrounding MIP location 321. CVOC-impacted soil within the loess formation is estimated to extend from seven to 15 feet bgs. Soil from the ground surface to seven feet bgs will be segregated from deeper soil. The excavation will utilize benches conforming to OSHA regulation (29 CFR 1926). Benches will have a maximum height of 5 feet and contain overall slopes no greater than ¾:1 (horizontal:vertical). Based on the slope requirements, it is estimated that the excavation limits will extend the total affected area to 42.5 by 42.5 feet. Shoring, bracing or other slope stability measures are not anticipated to be used during excavation activities.

If encountered, waste in bottle, drums, and/or bulk will be staged, segregated, and sampled to characterize for appropriate treatment/disposal method. Empty containers will be transported offsite for disposal. Drum and bottle excavation, handling, and characterization will be conducted in accordance with the PSVP.

Excavated material will be stockpiled onsite near the excavation location. All material will be placed on 20-mm polyvinyl chloride (PVC) liner or lined roll-off boxes Care will be taken not to tear the liner by ensuring the material is free of debris that may puncture the liner Once complete, or at the end of the work day, stockpiled material will be covered with a 10-mm PVC cover. A berm of clean soil or sand bags will be used to secure the top liner and divert storm water runoff.

The excavation is expected to remain open until confirmation sampling (described in Section 4.4.4) is performed. Temporary fencing will be installed and remain in place around the perimeter of the excavation while confirmation samples are being analyzed on an expedited basis.

Equipment to collect and store standing water from the excavation will be available during excavation, sampling, and backfill operations. Water will be disposed in accordance with the existing IRA discharge permit.

The e^{2}M field team leader will oversee excavation activities. Daily logs and digital photographs summarizing excavation activities including information on excavation depths, soil stockpiling, and confirmation sampling will be prepared. All daily logs will be placed in the central project file.

4.4.3 TA-3 Excavation

Work limits to be established prior to excavation will include the exclusion, contaminant reduction, and support zones; and space for equipment lay down. The exclusion zone will be established around the excavation area and will be large enough to allow movement of equipment and stockpiling of excavated material. The contamination reduction zone will consist of a contamination station that must be used to exit the exclusion zone. The station will have brushes and wash fluids necessary to decontaminate personnel and equipment leaving the exclusion zone. The support zone will be established outside the contamination reduction area to stage clean equipment from this area and don protective clothing.

Test pits will be excavated throughout the area suspected to contain crushed drums based on the geophysical survey. A tracked excavator will be used to excavate the test pits on a grid with a spacing of 30 to 40 feet, to be established by the site supervisor. At each location, the depth and appearance of buried debris will be recorded in the field log and by photographs; PID measurements will also be made for the excavated material. Waste characterization samples will be collected if excavated materials are substantially different from those observed in the previous Fluvial SVE trench excavation. Samples will be collected in accordance with the PSVP. The excavated material will be placed back in the pit when observations at each location are complete. The test pit observations will be used to develop an updated estimate of the volume of drums and soil to be excavated, and to determine whether additional equipment or site preparation is necessary. When all preparations are complete, the TA-3 excavation will commence.

If encountered in the test pits or during the following TA-3 excavation, waste in intact bottles and drums, or in bulk will be staged, segregated, and sampled to characterize for the appropriate treatment/ disposal method. Empty containers will be transported offsite for disposal. Drum and bottle excavation, handling, and characterization will be conducted in accordance with the PSVP.

Excavated material will be stockpiled onsite near the excavation location. All material will be placed in lined roll-off boxes. If sufficient roll-off boxes are not available, the material will be placed on 20-mm polyvinyl chloride (PVC) liner. Care will be taken not to tear the liner. At the end of the work day, stockpiled material will be covered with a 10-mm PVC cover. A berm of clean soil or sand bags will be used to secure the top liner and divert storm water runoff.

The excavation is expected to remain open until confirmation sampling is performed. Temporary fencing will be installed and remain in place around the perimeter of the excavation while confirmation samples are being analyzed on an expedited basis.

Equipment to collect and store standing water from the excavation will be available during excavation, sampling, and backfill operations. Water will be disposed in accordance with the existing IRA discharge permit.

The c²M field team leader will oversee excavation activities. Daily logs and digital photographs summarizing excavation activities including information on excavation depths, soil stockpiling, and confirmation sampling will be prepared. All daily logs will be placed in the central project file.

4.4.4 Ambient Air Monitoring During Excavation Operations

Ambient air monitoring will occur during excavation activities with instruments capable of measuring dust levels, and organic vapors. Background measurements will be recorded at site monitoring points (MPs) prior to the onsite of excavation activities. Air monitoring will include:

- Dust Monitoring – MPs will be established at the site perimeter (downwind of excavation) to ensure material is not wind-blown beyond site boundaries
- Organic Vapor Monitoring – A flame ionization detector (FID) will be used near the edge of the excavation and stockpile soil location

Air monitoring equipment will be calibrated daily in accordance with the manufacturer's instructions and recorded as part of the daily log. All measurements (including background measurements) will be recorded with the following information:

- Date and time
- Location of measurement
- Instrument measurement
- Observations or other pertinent information

4.4.5 Confirmation Sampling

Confirmation samples from both excavations will be collected in accordance with the State of Michigan DEQ *Verification of Soil Remediation Guidance Document* (Michigan DEQ, 1994). Based on the initial limits of the TA-1F excavation, the small site soil cleanup verification guidance will be used. Based on this guidance, a biased sampling approach will be used in which samples will be collected in areas that are most likely to exceed the cleanup criteria. These areas will be determined from observations made during excavation activities. Based on the guidance document, two floor and five sidewall samples will be collected from the excavation. The samples will be collected from the center of the excavator bucket; personnel will not enter the excavation. Initial proposed sampling locations are shown in Figure 7. Samples will be analyzed for VOCs by Method 8260 and results will be compared to the RGs shown in

Table 2. If RGs are exceeded in any sample, additional excavation and re-sampling will be performed along the sidewall or floor where the sample was collected.

The small site verification guidance may also be applicable for the TA-3 excavation. The current estimate of the area to be excavated is 3180 to 10,500 square feet., which is just below the recommended maximum area for small sites (10,890 sq. ft.). Biased samples will be collected from areas that are most likely to exceed the cleanup criteria as determined from observations made during excavation activities. The number of floor and sidewall samples will be determined from the guidance document once the area is known. If necessary, the medium site guidance will be used with sampling on a grid in accordance with the guidance document. Soil samples will be collected from the center of the excavator bucket; personnel will not enter the excavation. Samples will be analyzed for VOC, SVOCs, pesticides, PCBs, herbicides and metals. The analytical results will be compared to the remediation goals established in the Dunn Field ROD for Disposal Sites subsurface soils (Table 2-21C), and for VOCs in soil (Table 2-21G). Additional excavation and re-sampling will be performed if necessary based on comparison of analytical results with the RGs.

4.4.6 Soil Disposal

Representative samples will be collected from soil stockpiles and roll-off containers for waste characterization. Analytical parameters will be determined in coordination with the disposal facility, but at minimum will be analyzed for hazardous waste according to toxicity characteristic leachate procedure (TCLP) via EPA Method 1311 (VOCs only). Samples will also be analyzed for reactivity, corrosivity, and ignitability (RCI). Composite samples will be collected for every 250 cubic yards of excavated material. At least five aliquots will be collected from each batch using a clean stainless steel spoon or hand auger. Each of the aliquots will be transferred to a clean stainless steel bowl for mixing. The composite will be placed into the appropriate sample jars for transport to the laboratory for analysis.

Transportation and disposal of excavated material will be completed by a subcontractor under the direction of the e^2M field team leader. Following approval of the waste package, the material will be loaded and transported to a permitted disposal facility in compliance will applicable state soil waste or hazardous waste disposal requirements, and approved for off-site disposal of CERCLA waste. Material will leave the site via the main north/south access road adjacent to the excavation areas. Certificates of disposal and weigh tickets from state-certified scales will be used to document transportation activities. Signed facility manifests will also be used to document soil disposal.

4.4.7 Backfill and Site Restoration

Disturbed areas will be backfilled, graded, seeded, and mulched to minimize erosion. Backfill material will come from onsite sources if available. Backfill from on-site sources will be sampled at a frequency of once per 250 CY. Backfill from off-site sources will be sampled at a frequency of once per 500 CY. The soil excavated and stockpiled from the upper several feet of the excavated area and material used as part of benching activities will be analyzed for VOCs by Method 8260 using the sampling frequency as described above for material from onsite sources. Backfill from the soil/rubble pile and off-site sources will be analyzed for VOC, SVOCs, Pesticides, PCBs, herbicides and metals. Borrow material will be compacted in one foot lifts using a vibratory tamping device. Compaction test are not considered necessary. The moisture content of the compacted material will be maintained sufficient to achieve proper compaction. The areas will be compacted, and graded smooth and uniform with the surrounding areas. Large stone, debris, and materials will be removed and, if necessary, disposed offsite. Access roads and other areas of the site damaged by excavation activities will be repaired and/or restored, as necessary.

4.4.8 Demobilization

After excavation activities have been completed, and prior to backfilling, all excavation machinery and equipment will be cleaned of dirt and debris, which will be collected and characterized for disposal. Temporary facilities, utilities, and equipment will be removed from the site. Any debris or solid waste material generated during the excavation will be removed and disposed of properly.

4.5 THERMAL-ENHANCED SVE TREATMENT OF LOESS

The loess deposits will be treated with thermal-enhanced SVE using ISTD Treatment areas established in the RD are shown in Figures 3, and 8 to 10. The total treatment area (TA) encompasses nearly 1.25 acres; the treatment interval will incorporate the loess and underlying sandy clay. Based on the initial review of results from the RDI, CVOC concentrations in the upper five feet of soil in the treatment areas were below RGs. Therefore, five feet bgs was selected as the upper limit of the treatment interval. In most areas, the treatment interval will extend to approximately five feet above the sand-gravelly sand layer of the fluvial deposits at a depth of 30 to 35 feet bgs. Cross-sections showing the depth of the loess and sandy clay and the treatment interval are shown in Figures 11 to 16; TA-1D is not included because of its small size. The treatment interval in TA-1A is 20 feet based on shallow limits of contamination observed in the RDI. The treatment depth in the other areas is 30 feet. After completion of the Source Areas RD, the RD contractor determined that there were three RDI borings where CVOC concentrations exceeded the RGs above five feet bgs; the RDI borings were 32B in TA-1 and 3D and 3E in TA-3. Treatment of these areas with thermal-enhanced SVE would not be cost-effective. Shallow confirmation samples will be collected at these three locations. ET&D is the likely response if further remedial action is required for these shallow areas based on evaluation of confirmation sample results as described in Section 4.5.4.

A conceptual design was developed by the contractor, TerraTherm®, as part of the RD process based on soil data and RGs for Dunn Field. Following notice to proceed, TerraTherm will prepare a detailed work plan to be reviewed and approved by e^2M prior to the onset of construction activities.

TerraTherm will provide a turn-key service, including project design, installation, operation, and maintenance. Oversight and reporting of the thermal-enhanced SVE operations will be provided by the e^2M task manager. The subsections below describe mobilization and site preparation activities and a general description of thermal-enhanced SVE.

4.5.1 Mobilization and Site Preparation

Personnel, equipment, and supplies will be mobilized to Dunn Field and temporary facilities will be established. Treatment areas as marked by the site survey will be verified by the field team leader prior to construction activities.

Modifications to the IRA groundwater recovery system (GWRS) main conveyance line will be required prior to thermal-enhanced SVE operations. As shown in Figures 3 and 8, the IRA system discharge conveyance line crosses loess treatment areas TA-1C and TA-1E. The conveyance line, which is at a depth of approximately four feet, is made of high density polyethylene (HDPE) and will not withstand the high subsurface soil temperatures. The conveyance line and power/communication conduits within the two treatment areas will be protected by excavating the lines and wrapping them with thermal insulation.

4.5.2 Thermal-Enhanced SVE System Using In-situ Thermal Desorption (ISTD)

The ISTD technology heats subsurface soils via radiation and conductive heat transfer. Soil temperatures in the vicinity of the heaters are raised to near the boiling point of water by a 0.5-inch heating element inside the vertical heater wells. Steam is generated, contaminants are volatized, and vapors are removed by SVE. It is anticipated that the SVE wells will be co-located with half of the heater wells. The ground surface within treatment areas will be covered with an surface cover to prevent infiltration of precipitation that extends approximately 10 feet beyond the treatment zone. Key components to the system, as conceptually designed, are provided in the subsections below.

4.5.2.1 Power Requirements

The ISTD vendor will arrange for power supply (480 V, 3-phase) at Dunn Field. Total power demand is estimated at 13 million kWh. The transformer will be sized during the final design process.

4.5.2.2 Heater and Vapor Recovery Well Construction

Based on the preliminary design, 311 three- to four-inch diameter, steel cased vertical heater wells will be installed throughout the four treatment areas. The final layout would be completed as part of the final design. The depths of the heater would extend about four feet deeper than the target treatment depth to achieve the target temperature throughout the treatment depth. Spacing of the heater wells would vary between 15 to 19 feet depending on the surface-to-volume ratios. Each heater boring will contain a heater element and would be controlled by thermostats to deliver uniform wattage across the target depth interval. Design information provided by the ISTD vendor is provided in Table 3.

Vapor recovery will be completed using vertical SVE wells. Up to half the heater elements will have associated 1-inch diameter SVE wells. Drilling methods will be determined by the ISTD vendor and may include rotasonic, auger, or direct push methods. TerraTherm will provide specifications of the well screen and riser material as part of their work plan.

4.5.2.3 Subsurface Temperature Monitoring

Temperature monitoring points using thermocouples (Type-K) will be installed in 40 borings throughout the treatment areas. Each TMP will contain strings of thermocouples installed at five-foot intervals to span the treatment zone. Temperature data will provide a three dimensional profile of the subsurface temperature throughout the treatment period. The layout of the temperature monitoring boreholes will be determined by the ISTD vendor as part of the final design process.

4.5.2.4 Conveyance Piping and Trenching

All vapor conveyance piping will be made of stainless steel or fiberglass reinforced epoxy (FRE) with flush threaded joints. Individual SVE conveyance lines in each treatment area will be plumed to a single header. A single header will convey vapor from each of the four treatment areas to the loess SVE treatment compound. All SVE conveyance piping will be placed at grade If necessary, SVE conveyance piping will be buried in high traffic areas. Piping size will be determined by the ISTD contractor.

4.5.2.5 SVE System Components and Treatment Compound

TerraTherm will design, mobilize, and install the SVE system and treatment components. The treatment compound will be centrally located to minimize header piping runs. Other locations factors include access to power supply, condensate discharge, and vehicle access for maintenance activities. It is anticipated that e^2M will assist with construction and operation permits. A summary of key system equipment developed for the conceptual design is provided in the subsections below.

Remediation Equipment and Treatment. Vacuum blowers will be appropriately sized to extract vapors from the SVE wells at an estimated flowrate of 1,600 scfm. The vapor will be condensed prior to treatment The heat exchanger/condenser will reduce the temperature of the extracted vapor and water to remove steam and increase the efficiency of the water and vapor treatment. An air-water separator will be used to minimize the water content of the stream. The vapor treatment system will also include a chilling-compression unit that condenses the majority of the vapors into liquid water.. It is anticipated that the vapor stream would be treated with a thermal-oxidizer (ThOx) prior to discharge into the atmosphere. The exact treatment method will be determined by TerraTherm, and is dependent on subsurface concentrations and estimated total vapor mass.

Condensate Recovery. Condensate is expected to be recovered at five to six gpm and will be treated with liquid-phase GAC and prior to being discharged to the City of Memphis POTW through the existing IRA GWRS .

Equipment Housing. All equipment and controls associated with the loess SVE will be anchored to a skid and an associated concrete pad(s). If necessary, a sound wall will surround the concrete pad. All exterior controls and equipment will be weather resistant.

SVE System Controls. Equipment and controls will be housed at a central location as determined by TerraTherm. Blowers and GAC vessels will be skid mounted. Other equipment and associated piping will be appropriately secured to a concrete pad. Blowers and transfer pumps will be started from switches within a single control panel. Manual disconnect switches will allow the operator to isolate power to the blowers, condenser, and transfer pumps. The system will be installed with safety mechanisms to ensure safe and continuous operations. An auto-dialer will be installed to communicate with the operator when shutdowns occur.

Compound Security. An eight foot high chain link fence will be constructed around the concrete foundation with three strand barbed wire. The barbed wire will angle outward (away from the building) 45 degrees. Corner posts will be three inch outer diameter; line posts will be two inch outer diameter. Fencing will consist of two inch mesh six-gauge chain link galvanized fabric. Gates will be placed to allow personnel and equipment access. A security system may be installed as an enhanced security measure.

Power. Power will be brought in via an onsite source. An electrical service panel will be equipped with sufficient breakers necessary to power all electrical components. The entrance will be through the exterior wall for ease of hook-up. All electrical components will be U.L. listed and wired to the National Electrical Code standard.

4.5.3 Thermal-Enhanced SVE System Monitoring

Monitoring will consist of temperature and vacuum monitoring in the treatment zone and CVOC analyses of liquid and vapor phase effluent. A detailed system monitoring plan will be included in TerraTherm's work plan Once system monitoring results indicate that treatment goals have been met, soil samples will be collected to confirm that CVOC concentrations in soil are below RGs.

4.5.3.1 Temperature and Vacuum Monitoring

Terratherm will install temperature monitoring points (TMPs) to measure soil temperature at 5-foot intervals throughout the treatment zone. The TMPs will be installed several feet from heater elements to ensure that measurements are representative of soil throughout the treatment areas. If cool zones were detected, additional power could be delivered to these areas or additional electrodes/heater elements could be installed.

Vertical SVE wells in the treatment zone will be the primary means CVOC mass removal. Vacuum piezometers will be installed to verify that vacuum influence is established and maintained throughout the treatment period.

4.5.3.2 Vapor and Condensate Samples

Vapor and condensate samples will be collected routinely to evaluate the effectiveness of the SVE system and assess the need for system modifications. Field vapor concentrations will be measured regularly with a PID. Samples will be collected at the treatment system influent and effluent, from each treatment area, and if feasible, from discrete sections within the treatment areas. Vapor samples will be collected for laboratory analysis of VOCs during system start-up and at regular intervals thereafter. Condensate samples for VOC analysis will be collected at the same frequency.

Mass removal will be determined by a summation of the CVOC mass in three effluent streams: non-aqueous phase liquid (NAPL), condensate and vapor. The CVOC mass in condensate and vapor will be determined by periodic laboratory analyses and respective flow rates. The volume of NAPL will be measured directly. Sample location and frequency will be described in the vendor work plan.

If disposal of condensate is required, samples will be collected and analyzed for ph, VOCs, SVOCs, and metals in accordance with IRA discharge agreement. Each discharge will have to be approved separately unless a modification to the agreement is approved. Estimated discharge volumes and frequency will be described in the work plan.

4.5.3.3 Ambient Air Monitoring

Field screening using a PID will be performed on the periphery of the soil treatment areas to assess the presence of fugitive emissions. Screening will be performed weekly during the first month of operation and monthly thereafter. If ambient air VOC concentrations are one parts per million by volume above baseline total VOCs, formal ambient air monitoring will be performed as an interim response action. If necessary, ambient air samples will be collected using six-liter SUMMA canisters equipped with metering valves calibrated in the laboratory to allow eight hour time-weighted average sample collection. During each sampling event, samples will be collected at an upwind (background) location, one to three locations in the treatment area and one downwind location. Sampling and analysis will be performed in accordance with the PSVP.

If ambient air sampling indicates chlorinated VOC concentrations exceed the Occupational Safety and Health Administration (OSHA) action level or EPA Region 9 preliminary goals, the SVE system will be adjusted or deactivated until vapor mitigation can be addressed. All field measurements will be recorded in field logbooks, with the date, time, and location of the recording clearly noted.

4.5.4 Soil Confirmation Samples

System monitoring results will be reviewed to determine when initial confirmation soil sampling will be performed. As shown on the thermal-enhanced SVE flowchart (Figure 5), monitoring should indicate soil temperatures in the central areas at 90°C and vapor concentrations at asymptotic levels below 100 ppm on PID measurements. Based on discussion with TerraTherm, the initial samples are expected to be collected after approximately 70 percent of the target treatment period.

Forty-seven confirmation soil samples will be collected. The RD identified 27 sample locations and depths. Additional locations were selected to improve spatial distribution within the treatment areas and vertical distribution within the treatment interval. The final locations were approved at the January 2008 BCT meeting. Three samples were added at a depth of 2 to 3 feet bgs in borings LSB-22, LBS-23 and LSB-25 following identification of CVOC concentrations above RGs at 0 to 5 feet bgs in RDI borings at these locations. The confirmation sample locations and depths are shown on Table 4. The confirmation boring locations are shown in Figures 8 to 10 and the sample depths are shown in Figures 11 to 16. The RD notes the potential for additional baseline sampling during installation of the thermal-enhanced SVE system, but no additional sampling is planned due to the extensive sampling performed during the RDI.

Confirmation soil samples will be collected from direct-push borings advanced to the target depths in accordance with the RA SAP. The initial confirmation soil samples and the samples collected following completion of the planned treatment period will be collected as "hot" samples, with procedures modified as needed for the "Hot Soil Sampling Procedure" included in Appendix F. The samples will be submitted for analysis of VOCs using Method 8260. The samples will be analyzed with expedited (72hour) turn-around so that decisions regarding additional treatment can be made quickly. If an additional treatment period is required, the final confirmation samples will be collected following the cool-down period although soil temperatures will still be elevated.

To determine whether the RAOs for subsurface soil have been met, the sample results will be compared to the RGs shown in Table 2 for each treatment area. The RAO will be considered to have been met if the average concentration in a treatment area (defined as TA-1, TA-2 TA-3 and TA-4) for each CVOC is below the RG, and no individual sample result exceeds the RG by a factor of 10 or more. For samples that are non-detect, the average will be calculated using one-half the sample quantitation limit. Some consideration may be required in the case of elevated detection limits in samples (e.g., sample preparation, re-analysis or re-sampling) or any other instances where the sample integrity is in question. When the subsurface soil RAO has been met for all CVOCs, the loess remedial action will be complete.

Results of the initial confirmation soil samples will likely indicate that RGs have been achieved in some areas and not in others. Modifications to the thermal-enhanced SVE system will be made and the planned treatment period will be completed, at which time a second round of samples, will be collected. Samples will be collected at locations where the RGs were exceeded in individual samples and may also be collected at locations where samples were detected above reporting limits. If the RGs are still exceeded in the second round samples, the effectiveness of the thermal-enhanced SVE system will be reviewed and a decision made as to whether an additional treatment period of up to 30 days is warranted. If additional treatment with thermal-enhanced SVE is performed, a final round of soil confirmation samples will be collected following the cool-down phase and demobilization.

4.5.5 Demobilization

Following completion of the thermal-enhanced SVE installation, all drill rigs and other construction equipment will be decontaminated prior to leaving the site. Debris and rinsate will be collected and characterized for disposal.

Following completion of thermal-enhanced SVE treatment, heater elements, SVE wells, temperature probes, conveyance piping, system controls, and treatment equipment will be removed, and borings will be abandoned. Other temporary facilities, utilities, and equipment will also be removed from the site. Disturbed areas will be graded smooth and uniform with surrounding areas. Access roads and other areas of the site disturbed by treatment activities will be repaired and/or restored, as necessary. Any debris or solid waste material generated during construction will be removed and disposed of properly.

4.6 ZVI INJECTION

ZVI injection will occur after the thermal-enhanced SVE system has been decommissioned, and the fluvial sands SVE system is installed and operating properly. The injections will target groundwater with total VOC concentrations greater than 1,000 μg/L.

4.6.1 Pre-Injection Groundwater Sampling

Groundwater monitoring results will be used to establish the extent of ZVI injections prior to mobilization. Two groundwater monitoring events will be performed prior to completion of the thermal-enhanced SVE component:

- Baseline event before construction of the Fluvial SVE system
- One sampling event during the operation of the thermal-enhanced SVE system (during the initial soil confirmation sampling)

The baseline event will include 26 existing monitoring wells and nine new wells (MW-A to MW-I) installed as part of the Fluvial SVE RA. Eight existing wells will be abandoned prior to thermal-enhanced SVE construction. The new and existing wells, and the wells to be abandoned, are listed on Table 5 and the locations are shown in Figures 17 to 19. Samples will be analyzed for VOCs and MNA parameters as listed inTable 6.

Additional monitoring wells will be installed after completion of the thermal-enhanced SVE treatment in the loess to improve delineation of the ZVI injection areas. The number and locations of additional wells will be determined from the first two pre-injection sampling events. Ten preliminary locations (MW-J through MW-S) are listed in Table 5 and shown on Figures 17 to 19.

Following installation of the loess post-treatment wells, two groundwater sampling events will be performed. The first event will occur within one month following demobilization of the thermal-enhanced SVE contractor, and the second event will be performed three months later. The sampling events are shown in Table 5.

A trend analysis using the Mann-Kendall test will be conducted using groundwater analytical data from the four pre-injection sampling events; only wells with four data sets will be used. If a decreasing trend is indicated for a treatment area, then additional quarterly sampling events will be conducted before the ZVI locations are determined. Final ZVI locations will be determined no later than one year following completion of the thermal-enhanced SVE treatment in the loess.

4.6.1.1 Well Installation and Development

The monitoring wells will be installed in six inch boreholes advanced using rotasonic drilling method. Lithologic samples will be collected continuously in 10 foot intervals beginning at the ground surface. The borings will be drilled seven to 10 feet into the gray clay of the Jackson Formation/Upper Claiborne Group to confirm that the base of the fluvial aquifer is reached. The boreholes will be backfilled to approximately one foot below the top of the clay, and one foot of filter sand will be placed in the borehole before installing the well The top of clay marking the base of the fluvial aquifer is approximately 75 to 90 feet bgs and the aquifer thickness is four to 18 feet at Dunn Field.

Well construction materials will be selected based on ground temperature measurements after completion of the thermal-enhanced SVE treatment. Where necessary, wells will be constructed with stainless steel or FRE well materials and high temperature grout, otherwise Schedule 40 PVC and standard grout will be used. The monitoring wells will be constructed of new two inch diameter casing and 0.010-inch screens using flush-fitting, internally-threaded joints. The well screens will be 15 to 20 feet long and span the fluvial aquifer. Centralizers will be used above and below the well screen.

Filter pack will be placed in the annular space around the well screen. The filter pack material will be washed and bagged sand with a grain size distribution curve that meets the 10-20 gradation specification. The filter pack will be gravity-placed through the six-inch outer drill casing in lifts of one to two feet. Care will be taken to prevent bridging by measuring the thickness of the filter pack as it is placed. The drill casing will be vibrated as it is withdrawn between lifts to compact the sand filter pack. The filter pack will extend from the bottom of the borehole below the screen interval to approximately five feet above the top of the well screen.

A seal of hydrated bentonite with a thickness of approximately five feet will be placed above the filter pack at each well. The 100 percent sodium bentonite seal will consist of ¼-inch or ⅜-inch diameter dry bentonite pellets or chips. The bentonite seal will be placed using gravity methods, or by the tremie method if the pellets or chips bridge in the borehole annulus. If the bentonite seal is placed above the water table, sufficient water will be added to allow complete hydration of the bentonite. The bentonite seal will be allowed to hydrate for two to four hours prior to the installation of cement grout.

A bentonite-cement grout seal will be placed in the annular space above the bentonite seal. The grout will be placed using a side discharge tremie pipe and will be continuously pumped until grout returns to the ground surface. The grout will be allowed to cure for a minimum of eight hours before further grouting or well construction. Prior to installation of the surface completion, grout in the borehole will be topped-off to the bottom of the well vault. Well development will be performed at least 24 hours after grouting is completed. Well will have flush mount completions with an 8-inch ID manhole set within a three-foot by three-foot by 0.5-foot thick concrete pad.

Monitoring wells will be developed using a combination of pumping and surging until clear, sand free formation water is produced. No air, detergents, soaps, bleaches, or additives will be used during well development. Development will continue until well water is clear to the unaided eye, and measurements of pH, temperature, turbidity, and specific conductance have stabilized. In general, field parameters are stable when nephelometric turbidity units (NTUs) are less than 10, pH is within 0.1 standard unit (SU) on three consecutive readings, and temperature and specific conductance are within 10 percent of the three previous readings. Well development will be discontinued after six hours of pumping and surging, or bailing the well (including recharge time for wells with slow recharge), with the concurrence of the field team leader.

The e^{2}M field geologist will prepare boring logs, construction diagrams, and development records for the newly constructed wells. The soil core from the capillary fringe and aquifer will be archived in labeled cardboard core boxes.

4.6.1.2 Groundwater Sampling

The wells will be sampled using low-flow sampling methods at least 24 hours after development of new wells. Samples will be collected in accordance with the RA SAP. Groundwater samples will be analyzed for VOCs and MNA parameters as listed in Table 6.

Groundwater level measurements will be made in wells at Dunn Field and the surrounding Off-Depot area prior to sampling. Measurements will be taken using Solinist Model 101 water level meters with electronic sensors and tapes graduated in 0.01-foot increments.

Wells will be sampled using a stainless steel bladder pump equipped with disposable Teflon bladders and tubing using low flow purging methods to minimize sample turbidity. Water quality parameters will be measured at 10 minute intervals using a flow-through cell. Purging will continue until parameters meet stabilization criteria, three successive readings within ±0.1 for pH, ±10 millivolts (mV) for oxidation-reduction potential (ORP), ±3 percent for specific conductance, <20 NTUs for turbidity, ±10 percent for dissolved oxygen (DO). Temperature will also be recorded but will not be used as a stabilization parameter. Samples will be collected as soon as stabilization criteria are met. If stabilization criteria are not met after two hours purging, the field team leader will determine whether to collect the sample or to continue purging.

HACH field test kits will be used to measure ferrous iron and carbon dioxide in groundwater. The samples will be collected according to the manufacturer's instructions included in the test kits.

4.6.2 Injection Planning and Preparation

Preliminary ZVI injection locations were selected in the RD based on recent groundwater data and the results of the ZVI treatability study and the EISR. The layout of 44 injection borings is shown on Sheets

13 and 14 of the construction drawings (Appendix D). The final ZVI layout is expected to change due to the SVE treatment in the fluvial vadose zone and the thermal-enhanced SVE treatment in the loess. The final layout will be based on groundwater sampling results after the loess thermal-enhanced SVE system has been completed. An injection layout will be provided with the initial post-loess treatment sample results and the layout will be updated as additional sample events are performed.

Assuming an iron-to-soil mass ratio of a 0.5 percent for each injection point and soil density of approximately 100 pounds per cubic foot, approximately 600 to 650 pounds of ZVI will be required to treat each one-ft thick, 20-ft radius interval. Based on an average saturated thickness of 13 ft over the entire targeted area, approximately 288 two-ft thick injection intervals and nearly 360,000 pounds of ZVI will be required to complete the 44 injection borings estimated in the RD.

4.6.3 Mobilization and Site Preparation

Personnel, equipment and supplies will be mobilized to Dunn Field by the ZVI injection contractor. Temporary facilities will be established consisting of the materials handling and storage areas for receipt of ZVI powder, supply trailers and portable sanitary facilities. Final ZVI injection locations will be located by a registered land surveyor.

4.6.4 Injection Borings

Modified rotasonic drilling methods will be used to advance the injection borings. Unlike traditional rotasonic drilling method where both an outer and inner core barrels are used, drilling will be completed using only a four-inch rotasonic (inner) casing. Clean water will be used to fill the casing and displace cutting as the cutting shoe advances to the target depth. This method has been found to increase drilling productivity and limit the volume of soil cuttings. If the modified method is not practical at an individual location, the contractor will switch to conventional rotasonic drilling. For example, if casing lockup occurs during drilling advancement and / or between AVI injections, a six-inch override will be advanced to retrieve the 4-inch casing; the injections will then take place within the six-inch override.

At each injection location, the boring will be advanced to the clay at the base of the fluvial aquifer. The depth will be based on measured elevations at adjacent wells and by observations during drilling. Injections will proceed from the base of the aquifer to the capillary fringe above the water table. The injections borings will be sequenced from the perimeter inward towards the center at each treatment area to minimize outward displacement of contamination. Each boring will be grouted to the surface upon completion of injections and the next boring will be spaced sufficiently to limit pressure at the previous boring while the grout sets.

4.6.5 ZVI Injection

As currently designed, ZVI injections will occur at 44 locations in TAs 1, 2, and 4. ZVI injection procedures will follow those employed during the treatability study. Prior to injections, ZVI will be transferred from the Super Sacks® and placed in a hopper located in the ZVI Mixing/Injection Trailer. The hopper will be equipped with an auger-type conveyance system that will add the ZVI to a batch mixing tank until the mass of iron meets the operator determined water-iron ratio. ZVI injection will be conducted from the bottom up in two-foot intervals, beginning at the top of the confining clay unit (Jackson Formation / Upper Claiborne Group).

The ZVI / water slurry will be blended directly into a nitrogen gas stream (approximately 2,500 psi), and then transferred down-hole through conveyance piping. No packers will be used to seal the borehole during the injection process; the displaced soil will serve as lower and upper seals. However, a single packer will be used to prevent injection fluid from flowing preferentially up the 4.5-inch sonic casing. The ZVI injection subcontractor will need to optimize injection parameters including iron/water ratio, nitrogen gas pressure and flow rate, and nozzle configuration to limit problems experienced during the treatability study; particulate iron bridging (clogging) in down-hole injection equipment and/or the formation; drill casing seizure; and annular seal failure.

Following the injection process, the packer will be depressurized and the casing and the injection tool will be raised for the next 2-foot interval. This injection process will continue to the top of the treatment zone, typically at the estimated water table or in the capillary fringe. The aquifer thickness, or treatment zone, is approximately 10 to 14 feet in Treatment Area 1, 15 to 16 feet in Treatment Area 2 and eight feet in Treatment Area 4.

If the design ZVI mass (1250 pounds per two-foot interval) cannot be injected on one or more of the fracture intervals, surplus mass will be injected into an overlying interval up to 150 percent of the targeted mass. A replacement boring (less than 15 feet away) will be required under the following circumstances: less than 75 percent of the design ZVI mass for the entire location is injected; or more than two consecutive injection intervals receive less than 25 percent of the design ZVI mass. Only one offset location will be attempted for each planned injection boring. Injections will be made at adjacent planned locations prior to the offset boring in order to select the offset location.

4.6.6 ZVI Injection Monitoring

System operational parameters will be monitored during each injection interval to evaluate injection effectiveness. Parameters will be recorded by the ZVI contractor and provided in weekly summary reports.

- The quantity of slurry injected and the duration of injection will be monitored for each injection interval. The slurry volume will be gauged by metering at the pump and checked visually by measuring the amount of liquid that is displaced in the slurry holding tank
- Nitrogen gas flow rate will be monitored by recoding the start and finish times of the injection and nitrogen gas flow rate
- Pressure transducers and data-logging equipment will be used to record pressure data at frequent intervals (every 0.5 seconds or less) within nearby MWs for each injection interval. The resulting pressure-time data plot, interpretation/determination of fracture initiation pressure, and facture maintenance pressure will be used to modify the injection process, as necessary to ensure uniform horizontal and vertical distribution of ZVI
- Ground surface heave will be monitored during each injection using surveying transits, heave rods, and / or inclinometers. The heave rod will be placed at locations of varying radial distance from the injection well. During each injection event, the rod will be observed for the maximum amount of upward motion (surface heave) and the post-injection resting position (residual heave). Ground surface heave monitoring data will provide additional information that can be used to assess the distance and orientation of injection fluid propagation

4.6.7 Soil Confirmation Borings

Soil confirmation borings will be collected after every eight ZVI injection locations to confirm that the ZVI is adequately distributed. Soil samples will be collected from the injection zone to detect the presence of ZVI powder through both visual and laboratory analysis.

Confirmation borings will be drilled at three radial distances (for example 5, 10, and 20 feet) from the injection boring. Boring depths will range 70 to 90 feet below ground surface. Depending on the saturated thickness and injection intervals, one or two 10-foot long soil cores will be collected from each boring and visually examined. Digital photographs will be made of each soil core. At least two grab samples will be collected from each boring for both laboratory and field analysis. The soil core not selected for analysis will be archived.

Soil samples will be submitted for laboratory analysis of total iron (EPA SW6010B). Natural iron content of the soils in the fluvial aquifer ranges from 2,000 to 4,000 milligrams per kilogram (mg/kg). If ZVI powder is delivered uniformly by the Ferox^{SM} injections, the soil analysis should show an average increase of 5,000 mg/kg (based on a target iron to soil mass ratio of 0.5 percent).

Two field techniques will also be used to screen for the presence of ZVI. In the first technique, soil cores will be inspected for the presence of ZVI while collecting the grab sample. The Ferox^{SM} slurry should cause a distinctive black staining that may be visually detected in soil cores. Once oxidized, the powder will turn to reddish brown, which may also be detected if the natural soil color is a lighter color. The second method is magnetic separation, which relies on the difference in magnetic property between the natural iron mineral and the ZVI powder. The soil core will be dried, crushed, and scanned with a powerful magnet. The magnet will pick up the Ferox^{SM} iron powder, thereby providing empirical evidence of effective dispersion from the injection well. The magnetic test procedures provided in the RD are included in Appendix F.

4.6.8 Boring Abandonment

ZVI injection borings and confirmation soil borings will be abandoned in accordance with applicable rules and regulations of the State of Tennessee (Rules of TDEC, Division of Water Supply, Chapter 1200-4-1, Well Construction and Abandonment Standards). Each injection boring will be grouted to the surface upon completion of injections at that location. Confirmation borings will be grouted to the surface upon completion of sampling from the three borings in each set. Grouting operations will be completed using standard tremie grouting techniques as described in the RA SAP. The portion of the boring in the fluvial deposits may collapse after the casing is withdrawn. Grout will be placed in the open section which should extend to the base of the loess deposits at a depth of approximately 30 feet; this is expected to provide an effective surface seal.

4.6.9 Demobilization and Site Restoration

Following completion of the ZVI injection excavation activities, and prior to demobilization, all drill rigs, injection mixers and other equipment will be decontaminated using a pressure washer. Debris and rinsate will be collected and characterized for disposal. Temporary facilities, utilities, and equipment will be removed from the site. Any debris or solid waste material generated during ZVI injections will be removed and disposed of properly.

Disturbed areas will be graded to approximate the original grade and re-seeded Access roads and other areas of the site damaged by injection actives will be repaired and/or restored, as necessary.

4.6.10 Post ZVI Injection Groundwater Monitoring

CVOC concentration reduction in the source areas is the performance metric for ZVI injections. Based on the results of the ZVI treatability study, significant CVOC concentration reduction (greater than 90 percent) is expected in the first month following treatment. Geochemical parameters, such as DO and ORP, and other MNA parameters will also be measured to assess aquifer conditions. Concentrations of DO below 0.5 milligrams per liter (mg/L) and ORP levels below -200 mV would indicate strong reducing conditions in the treatment zone. However, geochemical parameters are not considered success criteria for the ZVI injections.

Following the completion of the ZVI injection, the monitoring wells sampled during pre-injection groundwater sampling (Section 4.6.1) will be sampled over four quarterly events. The initial sample event will be performed one month after injections have been completed. Samples will be collected using low-flow sampling methods in accordance with the RA SAP and as described in Section 4.6.1.2. The wells to be samples are listed on Table 5. Samples will be analyzed for VOCs and MNA parameters as listed on Table 6.

The sample results will be used to evaluate the effectiveness of ZVI injections to the fluvial aquifer beneath Dunn Field and to assess the need for strategic additional injections. Additional monitoring will be conducted if additional ZVI injections are made. Long-term groundwater monitoring will be conducted as part of the Off –Depot Groundwater RA.

4.7 MANAGEMENT OF INVESTIGATION DERIVED WASTE

The waste generated during this RA will be classified as either non-investigative waste or IDW. Non-investigative waste, such as packaging materials, personal protective equipment, disposable sampling supplies, and other inert refuse, will be collected, containerized, and transported to a designated collection bin for disposal at a Subtitle D landfill. IDW will be managed in accordance with procedures outlined in the WMP (Appendix B).

IDW will include, but is not limited to:

- Soil cuttings generated from borings for thermal-enhanced SVE wells/heater elements, temperature monitoring points, monitoring wells, ZVI injection borings and confirmation soil borings
- Runoff collected in trenches and excavations

- Liquids and soils generated during decontamination of drilling rigs and other construction equipment;
- Liquids generated during decontamination of sampling equipment

4.8 AS-BUILT SURVEY

As construction/installation of remedial activities are completed, a Registered Land Surveyor in the State of Tennessee will determine as-built locations. This will include final limits of excavation, location of thermal-enhanced SVE components (heating elements, SVE wells and monitoring points) and location of ZVI injection and confirmation borings. Newly constructed monitoring wells will also be surveyed Horizontal control will be within 0.1 foot and vertical control will be within 0.01 foot. The survey results will be included in the Interim Remedial Action Completion Report (IRACR).

4.9 FINAL CONSTRUCTION INSPECTION

Final inspection of the Loess /Groundwater RA will be limited to review of site restoration. Each of the actions will be completed as discrete treatment remedies with effectiveness judged by whether the treatment goals were met. There will be no continuing operations. There will be opportunities for field inspections while the remedies are underway during BCT meetings in Memphis and at other times convenient to DLA, USEPA and TDEC.

4.10 REPORTING DURING REMEDIAL ACTION

Quarterly summary reports are specified in the Federal Facilities Agreement (USEPA, 1995b) to identify and describe completed and scheduled activities. Reporting during the loess/groundwater RA operation (RA-O) will consist of status and summary data presentations at BCT meetings, quarterly summaries, and separate technical memoranda (TMs) prepared for each RA component. Quarterly summaries will be submitted to the BCT within eight weeks of the end of the quarter. The TMs will be used for preparation of the Interim Remedial Action Completion report (IRACR). The IRACR will be prepared following completion of all RA components and at least one year of operation of the Fluvial SVE system. The following subsections describe information to be included in updates provided to the BCT with respect to the loess/groundwater RA components.

4.10.1 ET&D

A single TM will be prepared following the ET&D RA activities. Due to the expected short duration of the RA, quarterly reports will not be needed. The TM will contain the following information:

- Description of ET&D site preparation activities, including site survey, utility clearance activities and construction of new vehicle access gate and roads
- Excavation activities including description of extent, depth, and volume of material excavated, stockpiled and removed from site
- Analytical results from soil samples collected from confirmation sampling
- Analytical results from backfill soil sampling taken prior to backfilling operations
- Waste characterization sampling results
- Transportation and disposal of VOC impacted soil
- Site restoration activities
- Deviations from this RAWP

4.10.2 Thermal-Enhanced SVE

An initial TM will be prepared following the thermal-enhanced SVE construction and will contain the following information:

- Description of thermal-enhanced SVE RA site preparation activities including summary of site survey and utility clearance activities
- Surveyed location of heater elements and SVE wells relative to treatment area boundaries
- Thermal-enhanced SVE construction activities including electrodes/heaters, SVE wells, system controls and treatment equipment
- Demobilization and site restoration activities
- Deviations from this RAWP

Subsequent TMs will be produced on a quarterly basis to describe thermal-enhanced SVE operations. TMs will contain the following information:

- Summary of system operations during the quarter and estimated mass removal for each treatment area

- System down-time, if any, and maintenance activities
- Summary of field measurements including flow rate, subsurface temperature, power usage, and condensate flow rate
- Results of vapor sample analyses
- Results of condensate sample analyses;
- Trends in vapor concentrations at system influent;
- Recommendations for modifications to system operations based on analytical results and system measurements; and
- Deviations from this RAWP.

4.10.3 ZVI Injection

A TM will be prepared following each pre-injection groundwater monitoring event. The baseline sampling event will be reported as described in the Fluvial SVE RAWP. The TMs will contain the following information:

- Sampling procedures and field measurements
- Analytical results and total CVOC isopleths
- Preliminary ZVI injection locations

A TM will be prepared following completion of the ZVI Injections. The TM will contain the following information:

- Description of ZVI Injection site preparation activities including summary of site survey and utility clearance activities
- Summary of analytical results from pre-injection groundwater samples
- Rationale used for selection of ZVI injection locations
- Field monitoring data collected during injections
- Results from soil confirmation borings;
- Surveyed location of injection borings and confirmation borings
- Sampling procedures, field measurements and analytical results for the initial post-injection sample event

- Demobilization and site restoration activities
- Deviations from this RAWP

A TM will be prepared following each post-injection groundwater monitoring event. The TMs will contain the following information:

- Sampling procedures and field measurements;
- Analytical results and total CVOC isopleths; and
- Evaluation of the ZVI injections and recommendations for additional action, if necessary.

4.10.4 Additional Reporting

Additional reporting may be required from the City of Memphis for wastewater discharges and by MSCHD for air permit requirements. Reporting requirements will include volume of condensate discharged to POTW and mass emission rates from the thermal-enhanced SVE system, respectively.

5.0 REMEDIAL ACTION COMPLETION

5.1 OPERATIONS AND MONITORING

Each of the Loess/Groundwater actions will be completed as discrete treatment remedies and there will be no continuing operations. Monitoring will be performed during treatment implementation as described in Section 4.0. Long-term monitoring of groundwater in the Dunn Field area and achievement of RAOs in groundwater will be described in the Off Depot Groundwater Remedial Design, currently being prepared by CH2M HILL.

5.2 MOTHBALLING IRA GROUNDWATER RECOVERY SYSTEM

The IRA GWRS will remain in operation and will not be dismantled until the subsurface soil and groundwater remedies have been implemented and their effectiveness evaluated because of its potential future use to facilitate continued aquifer remediation. Mothballing procedures will follow those described in Appendix G of the RD. The activities will include:

- Disconnecting electrical system
- Draining transfer pipes into individual wells;
- Removing and storing submersible pumps and level transducer;
- Sealing all wells with sanitary well seal, threaded plug or blind flange;
- Weatherizing and securing all electrical panels, control building, and wellhead enclosure boxes
- Dewatering IRA pipeline from RW-9 to the sampling and flow monitoring station (near discharge point)
- Removing effluent totalizer.

5.3 INTERIM REMEDIAL ACTION COMPLETION REPORT

An IRACR will be prepared following construction completion and initial monitoring for the Source Area RA, including Fluvial SVE, thermal-enhanced SVE in loess, ZVI injections and implementation of LUCs. The purpose of the IRACR will be to document that the Source Areas RA components were constructed as designed and that the remedy is operating as intended to meet RAOs established in the ROD. The report will be prepared in accordance with requirements of the RD/RA Handbook (USEPA, 1995a) and the USEPA Close Out Procedures for National Priorities List Sites (USEPA, 2000). A summary of project costs including the Final ROD estimate of capital and O&M costs, construction costs for each remedy, the total RA-C cost, and estimated annual O&M costs will be included. The IRACR will contain sufficient information to support a determination by USEPA that the remedy is operating properly and successfully (OPS).

OPS metrics for the Fluvial SVE component were described in the Fluvial SVE RAWP (e^2M, 2007). Since there are no continuing operations for the soil excavation, thermal-enhanced SVE and ZVI components, OPS determination is not necessary. Successful implementation for these remedies will be determined as follows:

<u>Excavation</u>

- CVOC concentrations in confirmations soil samples below RGs.

<u>Thermal-Enhanced SVE</u>

- CVOC concentrations in confirmation soil samples below RGs based on comparison with average CVOC concentrations for each treatment area and no individual samples with CVOC concentrations exceeding an RG by a factor of 10 or more.

<u>ZVI Injections</u>

- Groundwater concentrations in Source Areas are reduced by 90% without significant rebound in concentrations during post-ZVI monitoring. Reduction in groundwater concentrations to below MCLs throughout the plume will be achieved through the Off Depot Groundwater RA.

6.0 CONTINGENCIES

Some degree of uncertainty exists within environmental restoration projects and contingency planning is conducted so that there is a process for identifying deviations from expected conditions so that the RA can be appropriately modified. Expected conditions, potential contingencies and responses to the planned RA were described in the RD; the contingencies and responses are summarized below.

Potential Contingency	**Possible Responses**
Groundwater Remedy – ZVI Injections	
Less than 75percent of the design ZVI mass is injected or more than 2 consecutive injection intervals receive less than 25percent of the design ZVI mass.	Offset injection location and re-inject. Alternatively, injection 100percent to 150 percent of target ZVI mass in adjacent intervals
Zone of influence is less than expected or adequately reducing conditions are not achieved to reductively dechlorinate CVOCs	Strategic ZVI re-injection, enhanced bioremediation, continuation of IRA GWRS, or other viable remedial responses considering location and magnitude of residual groundwater impacted, loess and fluvial RA effectiveness, groundwater data trends, Off-depot groundwater remedy effectiveness, and other factors
Groundwater monitoring indicates source area not targeted during ZVI application	Further plume delineation and strategic ZVI re-injection. Additional loess remediation may also be required
Contaminants in areas designated for natural attenuation show persistent or stable levels	Characterize long-term impact through installation of additional monitoring wells. Consider groundwater transport model. Additional strategic RA
Rebound of CVOCs above RGs within treatment zones	Additional source area delineation through installation of soil borings or monitoring wells. Strategic SVE installation or ZVI re-injection
Daughter produces do not decrease below MCLs and no declining trends within aquifer	Verify source of daughter products. Strategic ZVI re-injection. Consider alternative remedies

Potential Contingency	Possible Responses
Vadose Zone Remedy – Thermal-Enhanced SVE	
Thermal-enhanced SVE system results in "cool zones" with poor mass transfer and removal	Install additional heater wells or electrodes. Apply more power (heat) to recalcitrant zones. Optimize SVE operation
Short-circuiting in the loess is indicated by uneven vacuum distribution. Poor air flow due to soil moisture. Cool zones persist; additional energy is required	Install vapor/moisture barrier system.
The subsurface requires additional heating time to achieve RGs	Additional heating time is required. Alternative RAs (for example, capping or excavation of recalcitrant areas) could be considered. Alternative RGs may be considered

7.0 REFERENCES

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TABLES

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TABLE 1
DUNN FIELD SITES
SOURCE AREAS LOESS/GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

INSTALLATION RESTORATION SITE NUMBER	DSERTS SITE NUMBER(a)	PRIORITY LEVEL(b)	SITE TYPE	SITE DESCRIPTION
Northeast Open Area				
19	19	C	SS	Former Tear Gas Canister Burn Site [c]
20	20	C	SS	Probable Asphalt Burial Site
21	21	C	SS	XXCC-3 Impregnite Burial Site (300,000 Pounds)
50	50	C	SS	Dunn Field Northeastern Quadrant Drainage Ditch
60	60	Remediated	SS	Pistol Range Impact Area/Bullet Stop
62	62	C	SS	Bauxite Storage
85	85	Remediated	RI	Old Pistol Range Building 1184/Temporary Pesticide Storage
Disposal Area				
1	1	Remediated	CWM	Mustard and Lewisite Training Sets Burial Site (1955)
2	2	C	RI	Ammonia Hydroxide (7 Pounds) and Acetic Acid (1-Gallon) Burial Site (1955)
3	3	B	RI	Mixed Chemical Burial Site (Orthotouidine Dihydrochloride) (1955)
4	4	A	RI	POL Burial Site (13, 55-Gallon Drums of Oil, Grease and Paint)
4 1	90	A	RI	POL Burial Site (32 55-Gallon Drums of Oil, Grease and Thinner)
5	5	C	RI	Methyl Bromide Burial Site A (3 Cubic Feet) (1955)
6	6	C	RI	40,037 Units of Eye Ointment Burial Site (1955)
7	7	A	RI	Nitric Acid Burial Site (1,700 Quart Bottles) (1954)
8	8	A	RI	Methl Bromide Burial Site B (Burning Pit Refuse) (1954)
9	9	C	RI	Ashes and Metal Burial Site (Burning Pit Refuse) (1955)
10	10	B	RI	Solid Waste Burial Site (Near MW-10) (Metal, Glass, Trash, etc)
11	11	B	RI	Trichloroacetic Acid Burial Site (1,433, 1-ounce Bottles) (1965)
12 & 12 1	12	B	RI	Sulfuric Acid and Hydrochloric Acid Burial (1967)
13	13	A	RI	Mixed Chemical Burial (Acid, 900 Pounds, Unnamed Solids, 8,100 Pounds)
14	14	C	RI	Municipal Waste Burial Site B (Near MW-12) (Food, Paper Products)
15	15	B	RI	Sodium Burial Sites (1968)
15 1	91	B	RI	Sodium Phosphate Burial (1968)
15 2	92	B	RI	14 Burial Pits Na2PO4, Sodium, Acid, Medical Supplies, and Chlorinated Lime
16	16	B	RI	Unknown Acid Burial Site (1969)
16 1	93	B	RI	Acid Burial Site
17	17	B	RI	Mixed Chemical Burial Site C (1969)
18	18		Proposed NFA	Plane Crash Residue
22	22		Proposed NFA	Hardware Burial Site (Nuts and Bolts)
23	23	C	Proposed NFA	Construction Debris and Food Burial Site
24-A	24	Remediated	CWM	Bomb Casing Burial Site (29 Bomb Casings used to Transport Mustard Agent)
61	61	C	SS	Buried Drain Pipe
63	63	C	Proposed NFA	Aboveground Fluorspar Storage
64	64	C	Proposed NFA	Aboveground Bauxite Storage (1942 to 1972)
86	86	C	RI	Food Supplies
Stockpile Area [d]				
24-A	24	Remediated	CWM	Neutralization Pit for the Contents of the 29 Bomb Casing used to Transport Mustard Agent
62	62	C	SS	Aboveground Bauxite Storage
63	63	C	Proposed NFA	Aboveground Fluorspar Storage
64	64	C	SS	Aboveground Bauxite Storage (1949 to 1972)
--	64[e]	B	--	CC-2 Impregnite Burial Site (86,100 Pounds in 1947)
--	64[e]	B	--	Installation Assessment Site 31 Burning and Disposal Site

Notes

SS	Screening Site
RI	Remedial Investigation
RA	Remedial Action
NFA	No Further Action
CWM	Chemical Warefare Material
Na2PO4	Sodium Phosphate
POL	Petroleum, Oil, and Lubricants
XXCC-3/CC-2	Stabilized/Unstabilized Impregnite for Inpregnating Clothing Used to Protected Personnel against the Action of Vesicant-Type Chemical Agents

[a] Defense Site Environmental Restoration Tracking System (DoD Database)

[b] Priority levels were establshed for Installation Restoration Sites Number/DSERT Site Number Areas where remedial action would be required with some investigatory effort to determine extent of area Levels are as follows A - Highest Priority, B - Medium Priority; C - Lowest Priority (no RA likely) Designation was based on described quantity of material, potential hazard to human health and the environment, and form of material (solid or liquid) A pre-design investigation was conducted at Priority Sites A and B Remedial Action was required at Sites 3, 4 1, 10, 13 and 64 (Installation Assessment Site 31)

[c] According to the available information, burning in this area dated back to the 1940s and included chloroacetophenone (CN) canisters, fuses, and smokes, in addition to sanitary wastes Operations were conducted in pits and incorporated the weekly cleanup of residue and garbage in addition to material The ash was then allegedly buried in the north end of Dunn Field

[d] According to available information USATHAMA (1982) Installation Assessment Site 31 is located in the southwest portion of Dunn Field This site was reportedly used for burning/disposal of smoke pots, CN (tear gas) grenades and souvenir ordnance, which included a 3 2 mortar round This area was covered by the bauxite storage pile (Site 64) Installation Site 31 was not designated as an IRP site or given a DSERTS site number However, the site is now included in DSERTS Site 64

[e] According to an April 15, 2003 email from the Defense Logistics Agency - DDC (New Cumberland) to DDC (Memphis) and CEHNC, DSERTS Site 64 will include the CC-2 Impregnite Burial Site and Installation Assessment Site 31 as a result of the proximity of all three sites and because Site 64 encompasses both of the other two sites

TABLE 2
REMEDIAL GOALS FROM DUNN FIELD RECORD OF DECISION
SOURCE AREAS LOESS/GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

	Remedial Goal Objectives				
	Site-Specific Soil Screening Levels to be Protective of Groundwater		Protective Soil Vapor Concentration		Groundwater Target Concentrations at 10-4 Target Risk Levels and Target HI=1 0 (µg/L)
Parameter	Loess Specific Values (mg/kg)	Fluvial Deposit Specific Values (mg/kg)	Loess Specific Values (ppbv)	Fluvial Deposit Specific Values (ppbv)	
Carbon Tetrachloride	0 2150	0.1086	28.14	14.22	3 0
Chloroform	0 9170	0.4860	61.57	32.63	12.0
Dichloroethane, 1,2-	0.0329	0 0189	1.12	0.64	—
Dichloroethene, 1,1-	0.1500	0 0764	57.00	29 03	7/340
Dichloroethene, cis-1,2-	0 7550	0 4040	73.86	39 52	35 0
Dichloroethene, trans-1,2-	1 5200	0 7910	256.53	133 50	50 0
Methylene Chloride	0 0305	0.0169	5.14	2 85	
Tetrachloroethane, 1,1,2,2-	0 0112	0 0066	0 03	0 55	2 2
Tetrachloroethene	0 1806	0.0920	15 18	0 99	2 5
Trichloroethane, 1,1,2	0 0627	0.0355	0.84	2 03	1.9
Trichloroethene	0 1820	0.0932	10 56	2 06	5 0
Vinyl Chloride	0.0294	0.0150	28 94	14.77	—

Notes:

mg/kg = milligrams per kilogram

µg/L = micrograms per liter

ppbv = parts per billion per volume

MCL = maximum contaminant level

HI = hazard index

— = Not available for groundwater cleanup goals because of low number of detections or detected values consistently less than MCLs

TABLE 3
CONCEPTUAL ISTD DESIGN
SOURCE AREAS LOESS/GROUNDWATER RA WORK PLAN
Dunn Field- Defense Depot Memphis, Tennessee

Design Element	TA1	TA2	TA3	TA4	Total
Treatment area (ft2)	20,400	13,700	6,900	12,600	53,600
Top of treatment zone (ft bgs)	5	5	5	5	--
Bottom of treatment zone (ft bgs)	30	30	30	30	--
Treatment volume (CY)	18,900	12,700	6,400	11,700	49,700
Number of ISTD heater borings	331				
ISTD heater boring spacing (ft)	17 (larger areas may be higher)				
Number of horizontal wells	15				
Number of vapor collectors	166				
Number of monitoring boreholes	40				
Power input rate (kW)	3,279				
Percent of injected power extracted as steam	25				
Steam extracted, average (lbs/hr)	2,798				
Energy in (BTU/hr)	11,190,717				
Steam out (BTU/hr)	2,797,679				
Net injection (BTU/hr)	8,393,038				
Heating per day, saturated (°F/day)	3.4				
Start temperature (°F)	50				
Target temperature (°F)	212				
Estimated heat loss, worst case (°F)	40				
Heat to target (days)	68				
Continued boiling period (days)	86				
Cool-down/polishing (days)	15				
Total operating time (days)	183				

TABLE 4
THERMAL-ENHANCED SVE CONFIRMATION SAMPLE LOCATIONS
SOURCE AREAS LOESS/GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Treatment Area	MIP Location ID	Soil Boring ID	Northing (ft)	Easting (ft)	Sample Depth (ft)	Analytical Results (µg/kg)
TA1	30B	LSB-1	281315 36	802101 93	29-30	TCE - 182
TA1	31B	LSB-2	281355 31	802104 81	21-22	TCE- 712
TA1	31B	LSB-2	281355 31	802104 81	29-30	TCE- 2420
TA1	37D	LSB-3	281589 20	802201 24	26-27	1,1,2,2-PCA - 131
TA1	38C	LSB-4	281631 85	802164 24	10-11	1,1,2,2-PCA - 950,000, TCE - 541,000, cDCE - 174,000
TA1	38C	LSB-4	281631 85	802164 24	23-24	ECD Response at 15V from 7 to 26 feet
TA1	38D	LSB-5	281629 05	802204 03	13-14	ECD Response at 12-15V from 12 to 23 feet
TA1	38D	LSB-5	281629 05	802204 03	18-19	1,1,2,2-PCA - 47,700, TCE - 47,100, cDCE - 23,000
TA1	38F	LSB-6	281623 51	802283 88	6-7	cDCE - 123,000, TCE - 21,500, PCE - 20,800
TA1	38I	LSB-7	281615 18	802403 54	11-12	CF - 8,080, CT - 3,350
TA1	39I	LSB-8	281655 05	802406 31	7-8	CF - 4,570, CT - 360
TA2	20C	LSB-9	280913 60	802114 08	28-29	TCE - 1,110
TA2	20D	LSB-10	280910 79	802154 03	19-20	TCE - 1,780
TA2	21B	LSB-11	280956 27	802076 95	29-30	TCE - 935
TA2	21C	LSB-12	280953 50	802116 92	29-30	TCE - 2,050
TA2	21D	LSB-13	280950 65	802156 81	29-30	TCE - 380
TA2	22D	LSB-14	280990 56	802159 57	13-14	1,1,2,2-PCA - 1,850,000, TCE - 170,000, PCE - 21,100
TA2	22D	LSB-14	280990 56	802159 57	29-30	TCE - 47,000, 1,1,2,2-PCA - 36,400, PCE - 851
TA2	22E	LSB-15	280987 81	802199 47	29-30	TCE - 943
TA2	23D	LSB-16	281030 53	802162 39	15-16	ECD Response increases from 2V at 11 feet to 14V at 24 feet
TA2	23D	LSB-16	281030 53	802162 39	25-26	1,1,2,2-PCA - 163,000, TCE - 23,600, PCE - 599
TA3	12E	LSB-17	280588 78	802171 75	28-29	cDCE - 3,350, 1,1,2,2-PCA - 3,110, TCE - 1,560
TA3	12F	LSB-18	280582 97	802219 15	27-28	cDCE - 948, TCE - 294
TA3	12F offset	LSB-19	280580 58	802237 05	12-13	cDCE - 1,200
TA3	12F offset	LSB-19	280580 58	802237 05	27-28	cDCE - 889
TA3	12H	LSB-20	280573 07	802302 09	12-13	TCE - 386, 1,1,2,2-PCA - 57 5
TA3	12H offset	LSB-21	280570 62	802316 48	27-28	TCE - 358, 1,1,2,2-PCA - 133
TA4	3D	LSB-22	280232 40	802106 79	2-3	ECD Response - 0 88V at 2 feet bgs to 0 94V at 3 feet bgs
TA4	3D	LSB-22	280232 40	802106 79	22-23	CF - 2,180, TCE - 968, CT - 527
TA4	3E	LSB-23	280229 64	802146 71	2-3	ECD Response - 15 8 at 2 to 3 feet bgs
TA4	3E	LSB-23	280229 64	802146 71	14-15	1,1,2,2-PCA - 190,000, CF - 96,200, TCE - 4,280
TA4	3E	LSB-23	280229 64	802146 71	28-29	ECD Response at 15V from 1 to 29 feet
TA4	4C	LSB-24	280275 07	802069 67	12-13	CT - 239
TA1	32B	LSB-25	281395 21	802107 69	2-3	ECD Response - 3 9V at 2 feet bgs to 5 8V at 3 feet bgs
TA1	32B	LSB-25	281395 21	802107 69	10-11	Maximum ECD Response - 16V (from 6 to 28 7 feet bgs)
TA1	32B	LSB-25	281395 21	802107 69	20-21	Maximum ECD Response - 16V (from 6 to 28 7 feet bgs)
TA1	32C	LSB-26	281392 33	802147 58	24-25	Maximum ECD Response - 5 8V (from 24 3 to 24 4 feet bgs)
TA1	33B	LSB-27	281435 10	802110 56	27-28	Maximum ECD Response - 3 3V (from 27 5 to 27 6 feet bgs)
TA1	na	LSB-28	281422 42	802171 89	9-10	RI Boring SBLDG DCE - 17,000 (at 8 to 10 feet bgs)
TA1	na	LSB-29	281519 54	802186 53	15-16	RI Boring SBLEF 1,1,2,2 PCA - 32 (at 14 to 16 feet bgs)
TA1	na	LSB-30	281611 11	802180 77	11-12	DS RD Sample DS10_8_T1 1,1,2,2-PCA - 2,850,000, TCE - 671,000, cDCE - 199,000 (at 6 to 8 feet bgs)
TA1	na	LSB-30	281611 11	802180 77	25-26	No sample data
TA1	na	LSB-31	281594 05	802418 91	9-10	RI Boring SBLFG, CF - 14,000 ug/kg, CT - 6,800 (at 8 to 10 feet bgs)
TA4	2E	LSB-32	280189 70	802144 53	11-12	Maximum ECD Response - 2 2V (from 11 3 to 11 5 feet bgs)
TA4	3F	LSB-33	280226 88	802186 61	23-24	Maximum ECD Response - 2 2V (from 23 3 to 23 9 feet bgs)
TA4	4E	LSB-34	280269 54	802149 47	20-21	Maximum ECD Response - 1 0V (from 19 9 to 21 0 feet bgs)
TA4	4F	LSB-35	280266 79	802189 37	13-14	Maximum ECD Response - 1 1V (from 13 6 to 13 7 feet bgs)

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TABLE 5
GROUNDWATER MONITORING EVENTS
SOURCE AREAS LOESS/GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well	Northing (ft)	Easting (ft)	Ground Elev. (ft msl)	TOC (ft msl)	Baseline	Loess Treatment	Pre-Injection 1	Pre-Injection 2	Post-Injection 1	Post-Injection 2	Post-Injection 3	Post-Injection 4
Existing Monitoring Wells												
MW-03	281596 25	802100 69	290 40	292 35	P	P	P	P	P	P	P	P
MW-06	280604 17	802069 13	288 10	289 11	P	P	P	P	P	P	P	P
MW-07	281839 88	802481 70	293 10	295 10	P	P	P	P	P	P	P	P
MW-10	281662 55	802201 26	289 20	288 79	P	P	P	P	P	P	P	P
MW-11	281353 10	802099 00	299 59	299 47	P	-	-	-	-	-	-	-
MW-15	280348 88	801985 36	295 23	295 12	P	P	P	P	P	P	P	P
MW-57	280184 05	802006 19	291 10	290 77	P	P	P	P	P	P	P	P
MW-68	281500 76	802040 04	291 60	291 69	P	P	P	P	P	P	P	P
MW-73	280989 42	802144 95	301 10	300 65	P	-	-	-	-	-	-	-
MW-74	280991 20	802044 29	304 00	303 68	P	P	P	P	P	P	P	P
MW-131	280972 56	802175 27	300 83	300 64	P	-	-	-	-	-	-	-
MW-132	281006 28	802129 10	301 05	300 73	P	P	P	P	P	P	P	P
MW-133	280978 32	802126 31	301 08	300 89	P	-	-	-	-	-	-	-
MW-134	281012 74	802102 58	301 05	300 81	P	P	P	P	P	P	P	P
MW-135	280983 62	802100 29	300 76	300 53	P	P	P	P	P	P	P	P
MW-172	280213 31	802221 98	300 94	300 28	P	P	P	P	P	P	P	P
MW-173	280251 21	802079 28	296 52	296 30	P	-	-	-	-	-	-	-
MW-174	280352 00	802092 07	296 83	296 56	P	P	P	P	P	P	P	P
MW-175	280618 49	802175 36	291 93	291 63	P	P	P	P	P	P	P	P
MW-177	280911 35	802097 43	300 28	300 11	P	-	-	-	-	-	-	-
MW-178	280982 81	802227 34	300 57	300 26	P	P	P	P	P	P	P	P
MW-179	281075 70	802158 65	301 32	301 16	P	P	P	P	P	P	P	P
MW-180	281476 43	802131 85	296 39	296 14	P	P	P	P	P	P	P	P
MW-181	281600 05	802217 69	291 51	291 14	P	-	-	-	-	-	-	-
MW-187	280563 18	802348 09	303 21	302 74	P	P	P	P	P	P	P	P
MW-188	280916 38	802163 48	300 50	300 11	P	-	-	-	-	-	-	-
New Baseline Monitoring Wells												
MW-A	281614	802168	TBD	TBD	P	P	P	P	P	P	P	P
MW-B	281399	802100	TBD	TBD	P	P	P	P	P	P	P	P
MW-C	280986	802145	TBD	TBD	P	P	P	P	P	P	P	P
MW-D	280913	802104	TBD	TBD	P	P	P	P	P	P	P	P
MW-E	281018	802181	TBD	TBD	P	P	P	P	P	P	P	P
MW-F	280945	802075	TBD	TBD	P	P	P	P	P	P	P	P
MW-G	280928	802145	TBD	TBD	P	P	P	P	P	P	P	P
MW-H	280258	802081	TBD	TBD	P	P	P	P	P	P	P	P
MW-I	280251	802157	TBD	TBD	P	P	P	P	P	P	P	P
New Post-Treatment Monitoring Wells												
MW-J	281659	802175	TBD	TBD	-	-	P	P	P	P	P	P
MW-K	281573	802135	TBD	TBD	-	-	P	P	P	P	P	P
MW-L	281544	802084	TBD	TBD	-	-	P	P	P	P	P	P
MW-M	281410	802136	TBD	TBD	-	-	P	P	P	P	P	P
MW-N	281042	802039	TBD	TBD	-	-	P	P	P	P	P	P
MW-O	280897	802040	TBD	TBD	-	-	P	P	P	P	P	P
MW-P	280854	802089	TBD	TBD	-	-	P	P	P	P	P	P
MW-Q	280331	802039	TBD	TBD	-	-	P	P	P	P	P	P
MW-R	280247	802031	TBD	TBD	-	-	P	P	P	P	P	P
MW-S	280201	802118	TBD	TBD	-	-	P	P	P	P	P	P

Notes:

ft msl ft msl - feet above mean sea level
ft bgs ft bgs - feet below ground surface
FL FL - flush mount
SU SU - stick up
TOC TOC - top of casing
TBD TBD - To be determined - new well
P Sample planned
\- Sample not collected or not planned
X Sample collected
1) Wells to be abandoned after baseline event are in italics

TABLE 6
ANALYTICAL PARAMETERS
SOURCE AREAS LOESS/GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Method	Analyte
SW8260B	**Volatile Organic Compounds**
	Monitored Natural Attenuation Parameters
E300.0	Anions - Chloride, Nitrate, Nitrite, Sulfate
E310.2	Alkalinity
SW9030	Sulfide
SW9060	Total Organic Carbon
SW6010B	Metals - Manganese
RSK175	Dissolved Gases - Ethane, Ethene, Methane

FIGURES

936 90

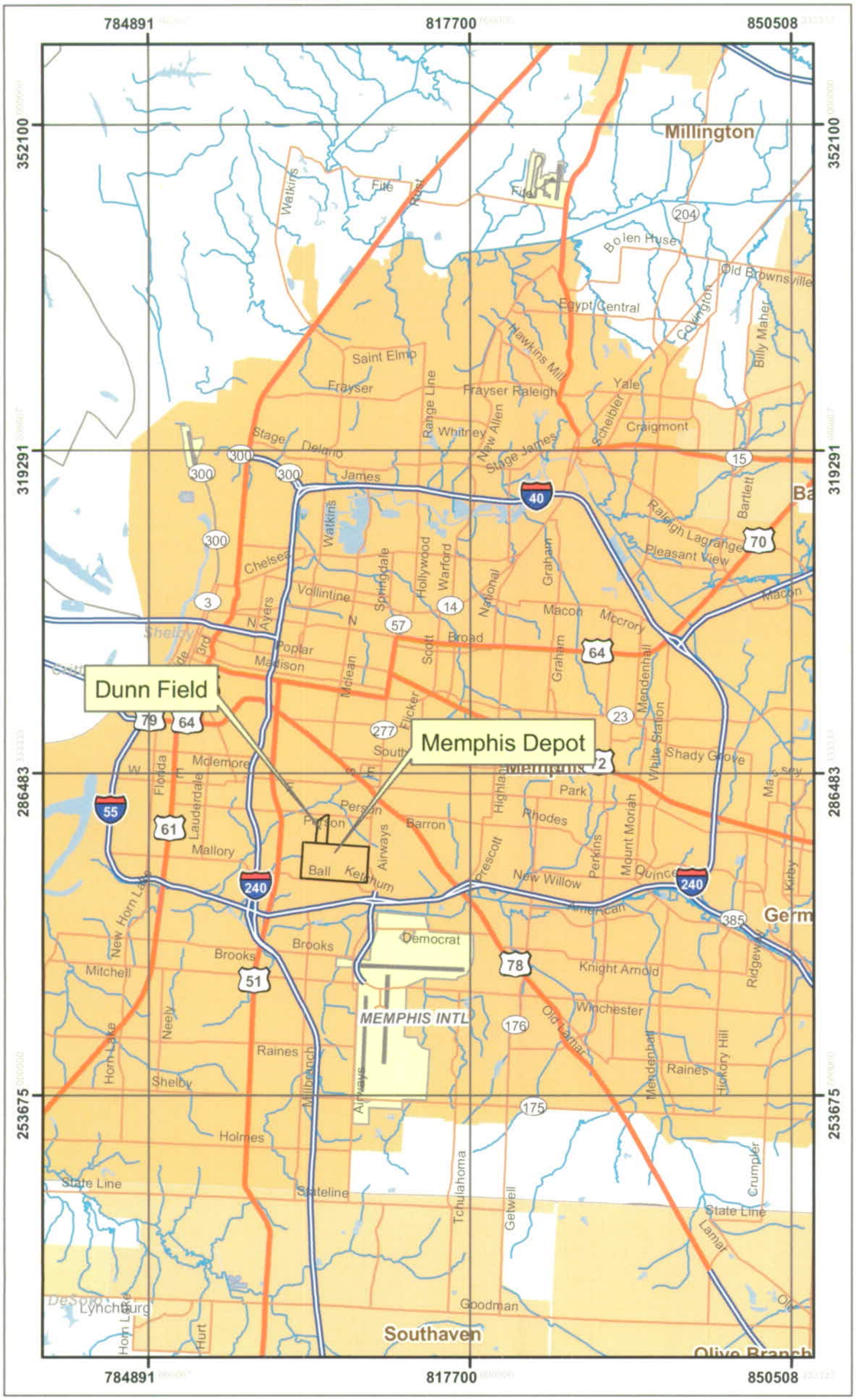


Figure 1

SITE LOCATION MAP

LOESS / GROUNDWATER
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Datum : WGS 84
Units: Feet

0 0.6 1.2 1.8 2.4 3 Miles

Installation Location
Memphis, Tennessee

Date: February 2008
Edition: Rev 2

N W E S

Figure 2

DUNN FIELD AERIAL PHOTOGRAPH

LOESS / GROUNDWATER REMEDIAL ACTION WORK PLAN

DUNN FIELD DEFENSE DEPOT MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Datum : WGS 84
Units: Feet

0 125 250 500
Feet

Installation Location
Memphis, Tennessee

Date: February 2008
Edition: Rev 2

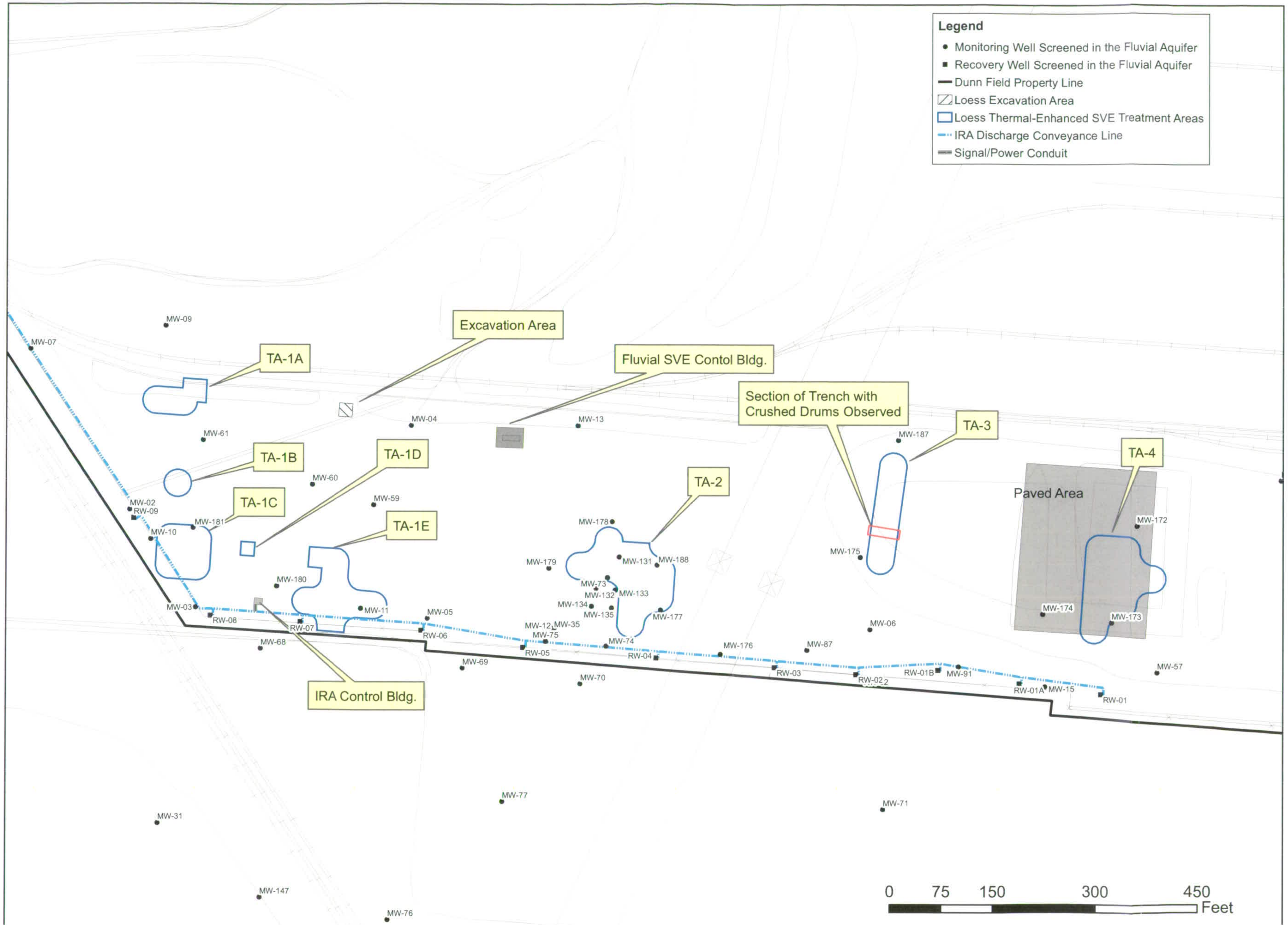


Figure 3

LOESS REMEDIAL ACTION

LOESS / GROUNDWATER REMEDIAL ACTION WORK PLAN

DUNN FIELD DEFENSE DEPOT MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Datum : WGS 84
Units: Feet

Date: February 2008
Edition: Rev 2

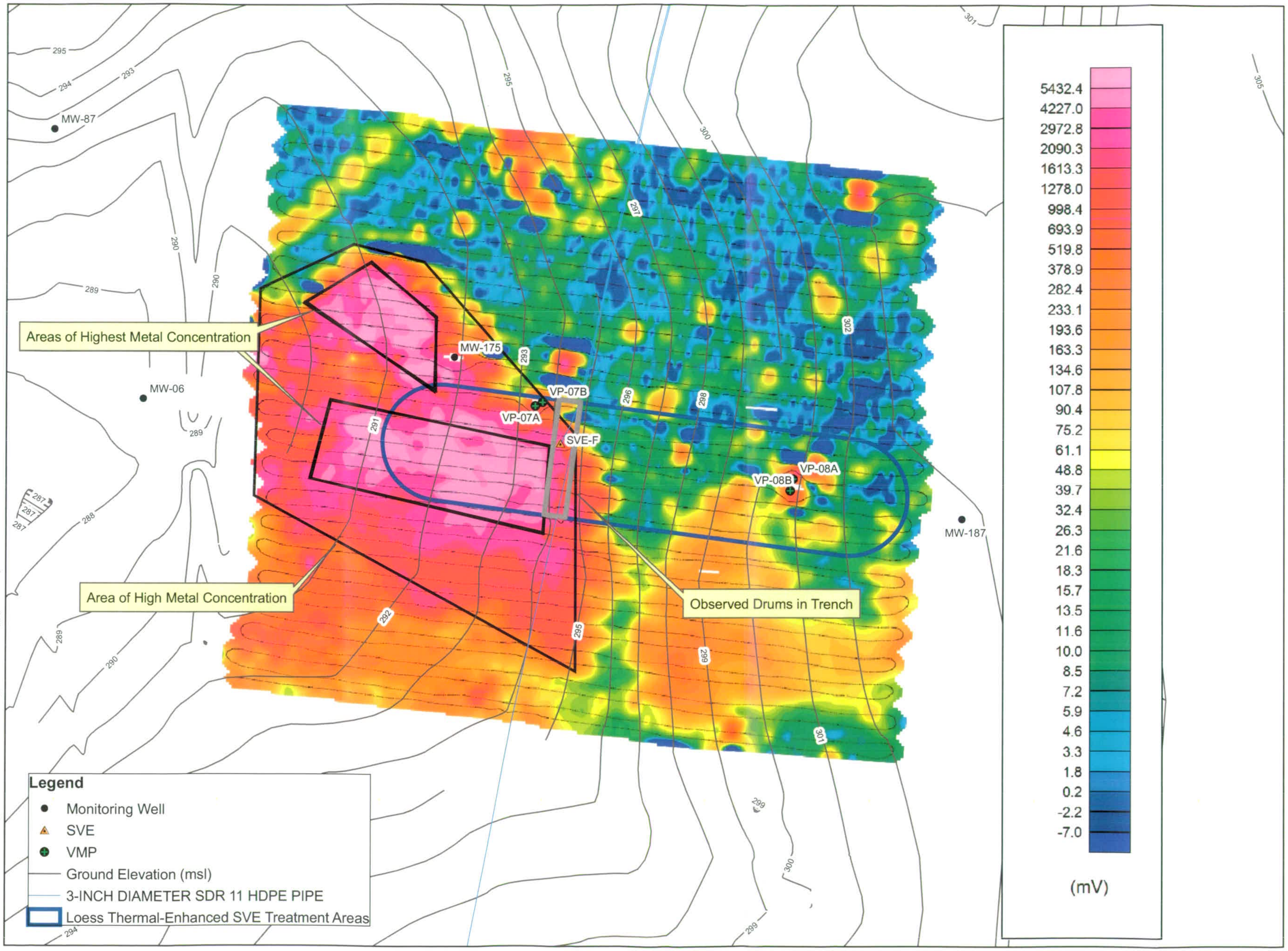
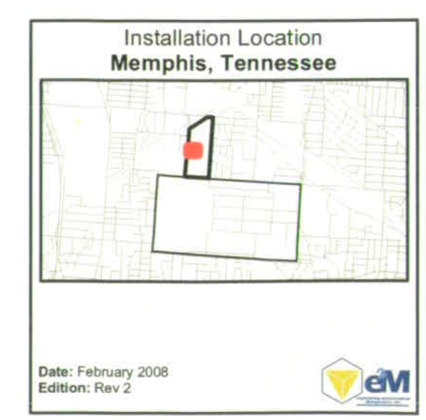


Figure 4

TA-3 GEOPHYSICAL SURVEY RESULTS

LOESS / GROUNDWATER
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE



G:\3202\019\01-15\Loess_GW RAWP Rev 2\GIS\Figure 4 TA-3 Gpyys Survey .mxd

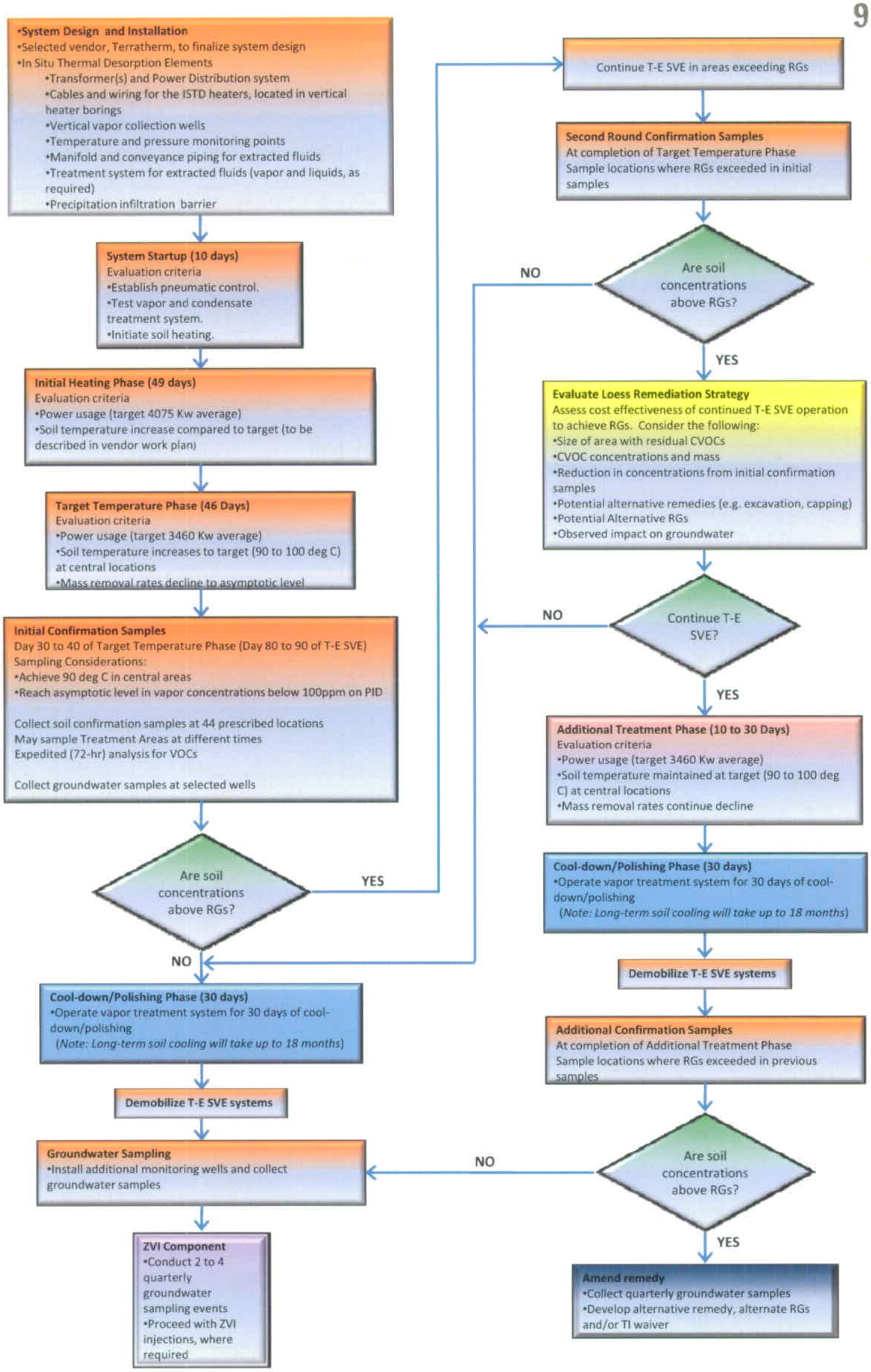


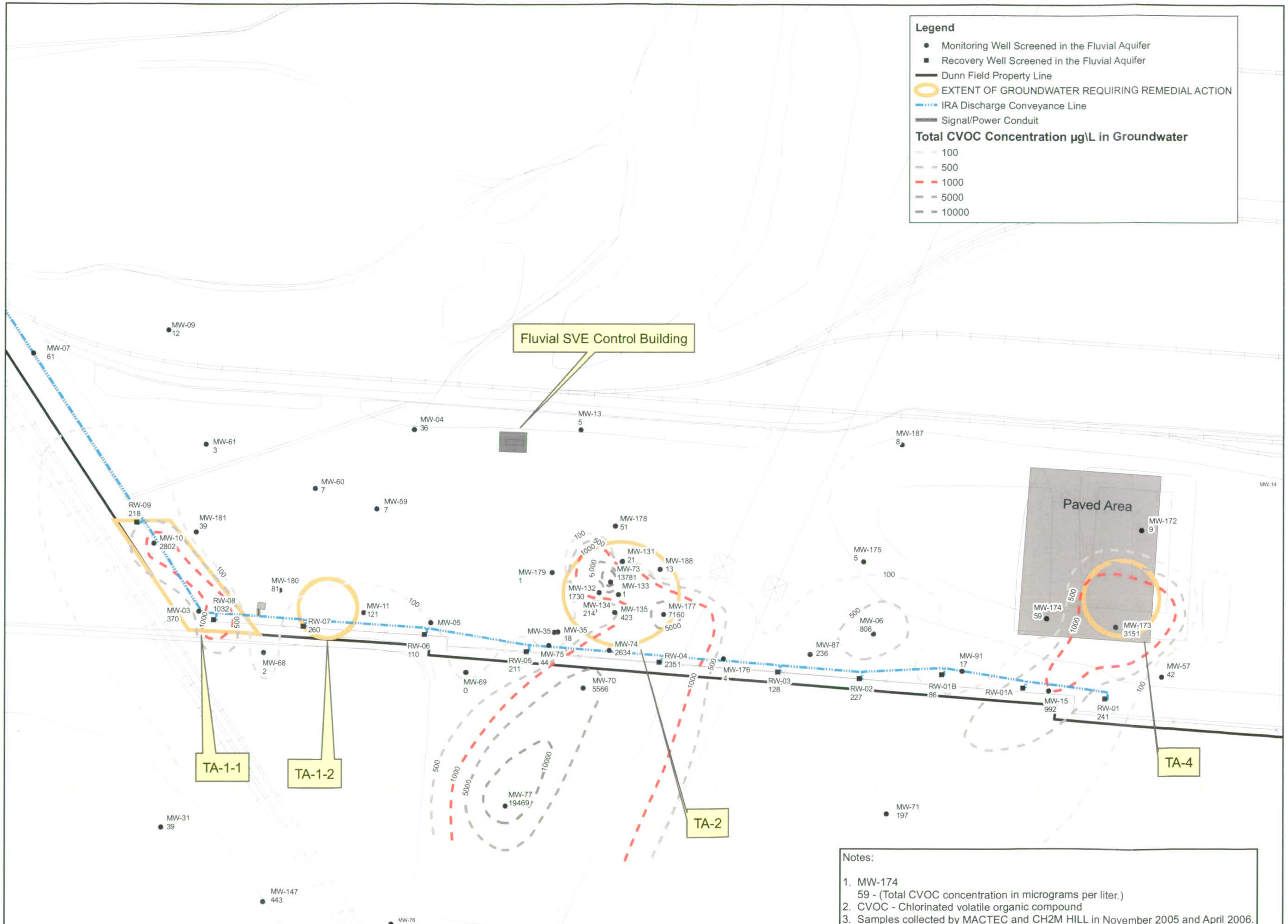
Figure 5

THERMAL-ENHANCED SVE FLOWCHART

LOESS / GROUNDWATER
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Date: February 2008
Edition: Rev 2



Notes:

1. MW-174
   59 - (Total CVOC concentration in micrograms per liter.)
2. CVOC - Chlorinated volatile organic compound
3. Samples collected by MACTEC and CH2M HILL in November 2005 and April 2006.

Figure 6

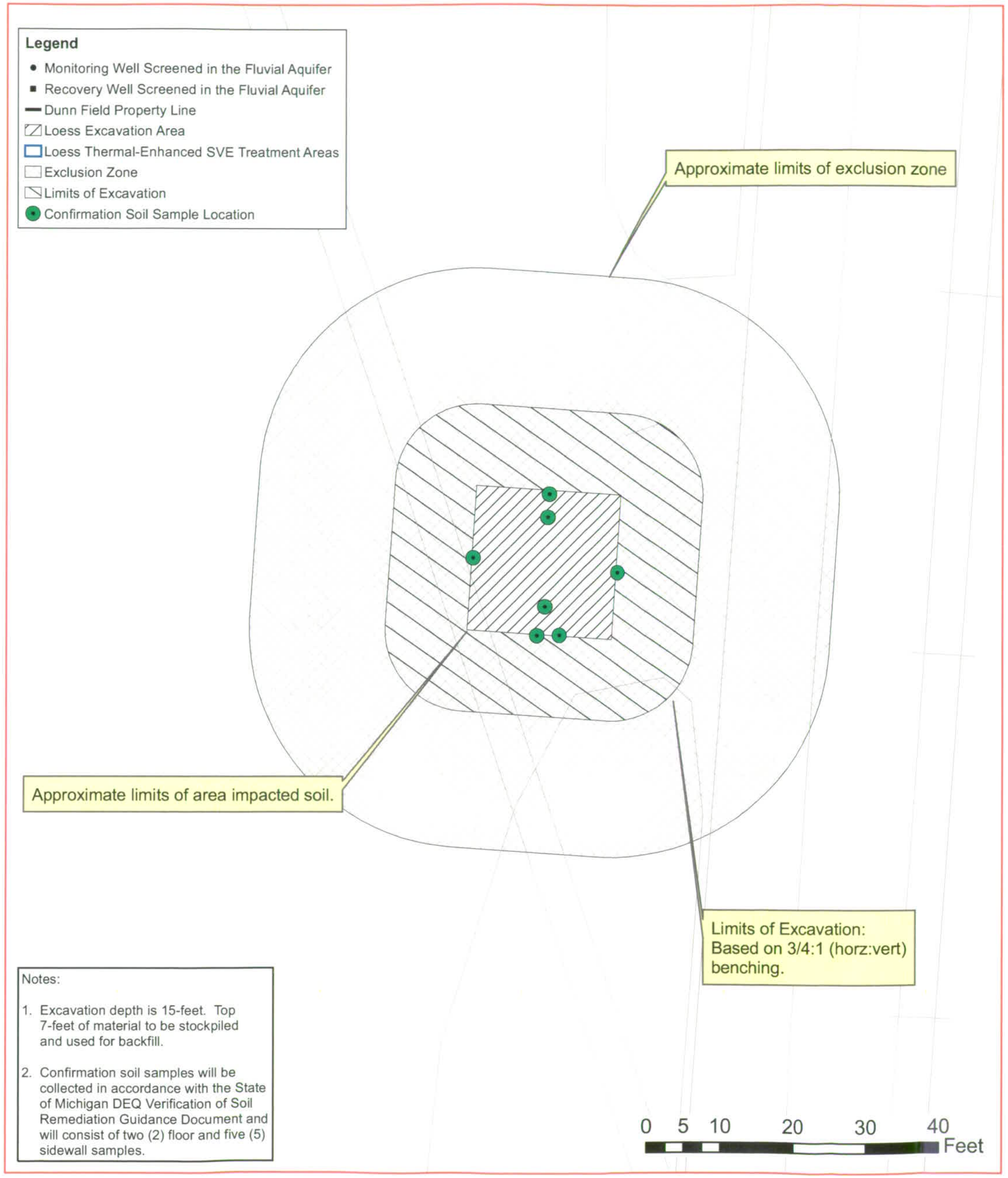
TOTAL CVOC CONCENTRATIONS, GROUNDWATER

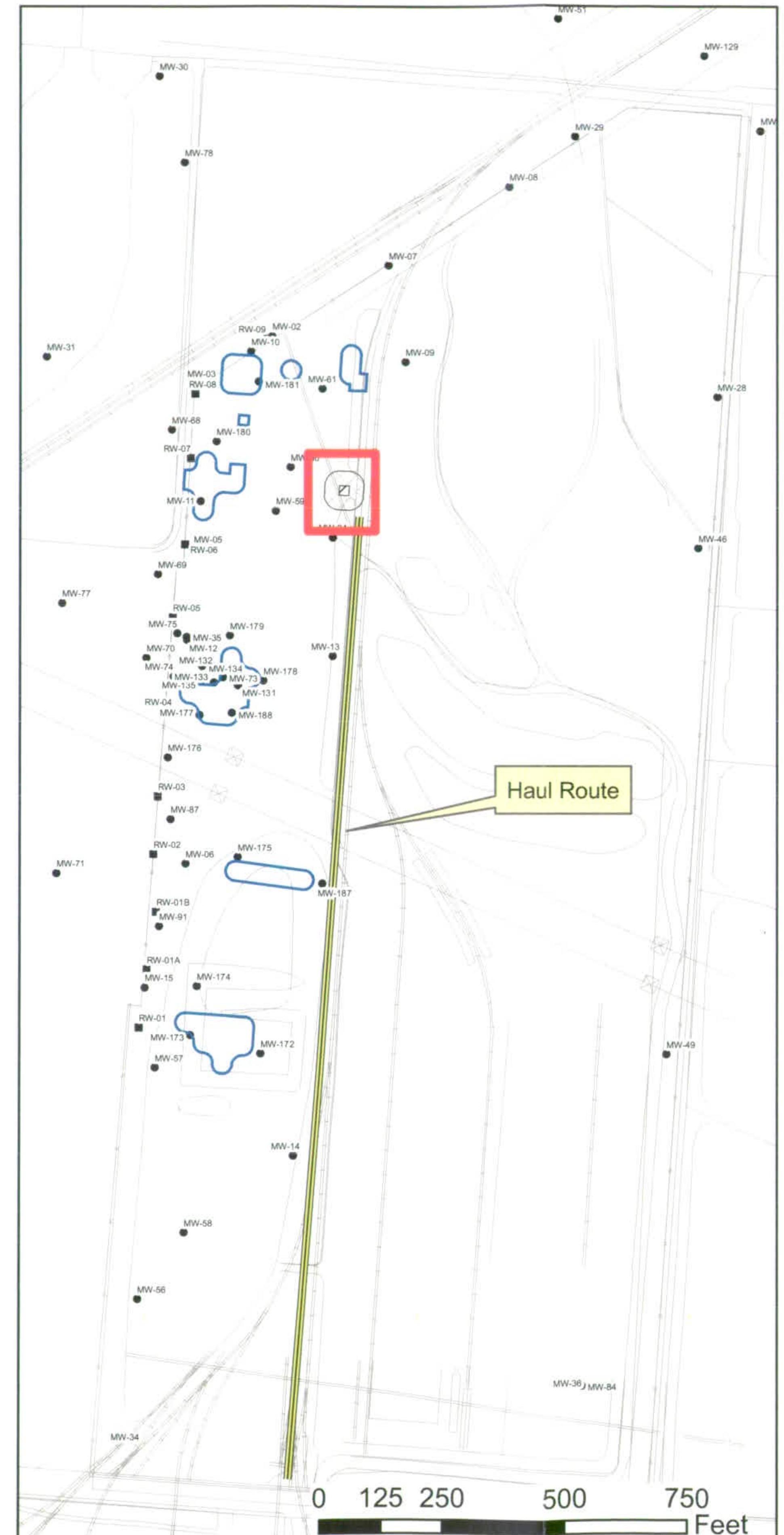
LOESS / GROUNDWATER REMEDIAL ACTION WORK PLAN

DUNN FIELD DEFENSE DEPOT MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Datum : WGS 84
Units: Feet

G:\3202\019\01-15\Loess_GW RAWP Rev 2\GIS\Fig 6 Total CVOC in GW.mxd





N
W E
S

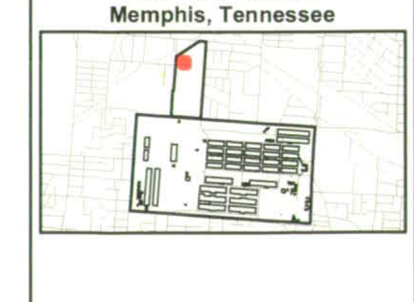
Figure 7

TA-1F SOIL EXCAVATION AREA

LOESS / GROUNDWATER
REMEDIAL ACTION
WORK PLAN

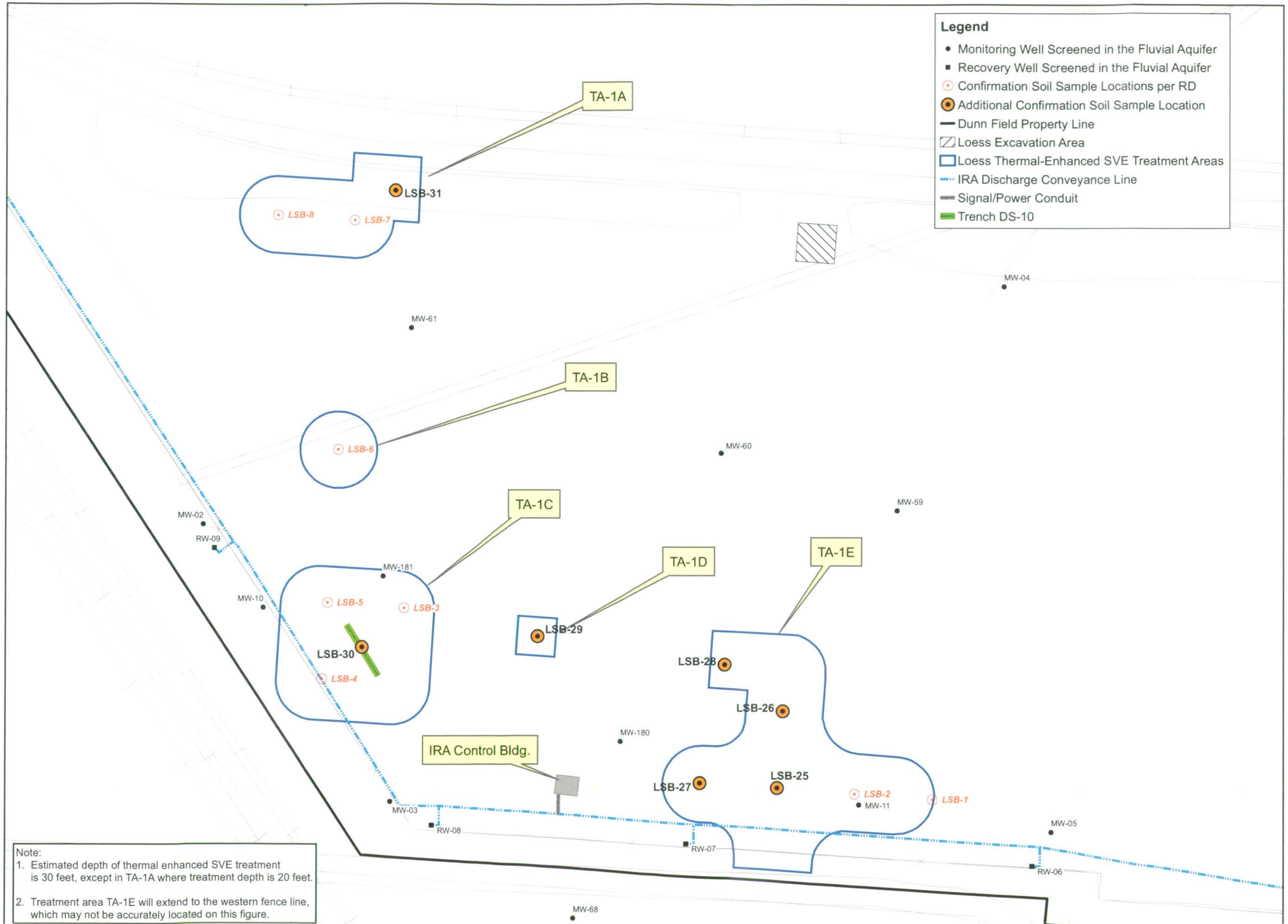
DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Datum : WGS 84
Units: Feet



Date: February 2008
Edition: Rev 2

G:\3202\0190\01-15\Loess_GW RAWP Rev 2\GIS\Fig 7 TA-1F Soil Excavation Area.mxd



Note:
1. Estimated depth of thermal enhanced SVE treatment is 30 feet, except in TA-1A where treatment depth is 20 feet.
2. Treatment area TA-1E will extend to the western fence line, which may not be accurately located on this figure.

G:\3202\0191\01-15\Loess_GW RAWP Rev 2\GIS\Fig 8 TA-1.mxd

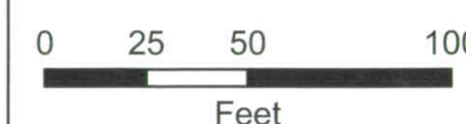
Figure 8

TREATMENT AREA 1 LOESS

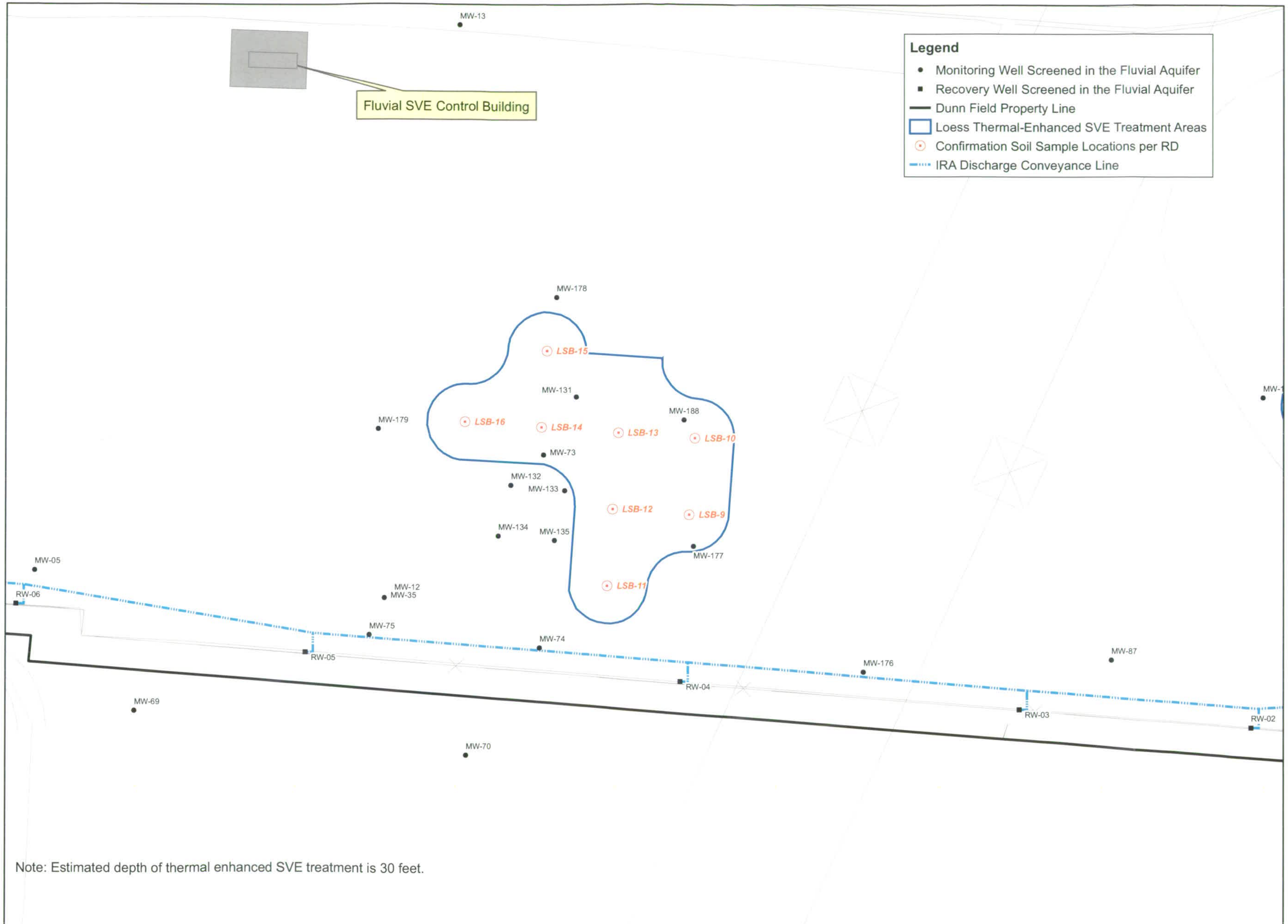
LOESS / GROUNDWATER REMEDIAL ACTION WORK PLAN

DUNN FIELD DEFENSE DEPOT MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Datum : WGS 84
Units: Feet



Date: February 2008
Edition: Rev 2



Note: Estimated depth of thermal enhanced SVE treatment is 30 feet.

Figure 9

TREATMENT AREA 2 LOESS

LOESS / GROUNDWATER REMEDIAL ACTION WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Datum : WGS 84
Units: Feet

Date: February 2008
Edition: Rev 2

G:\3202\019\01-15\Loess_GW RAWP Rev 2\GIS\Fig 9 TA-2.mxd

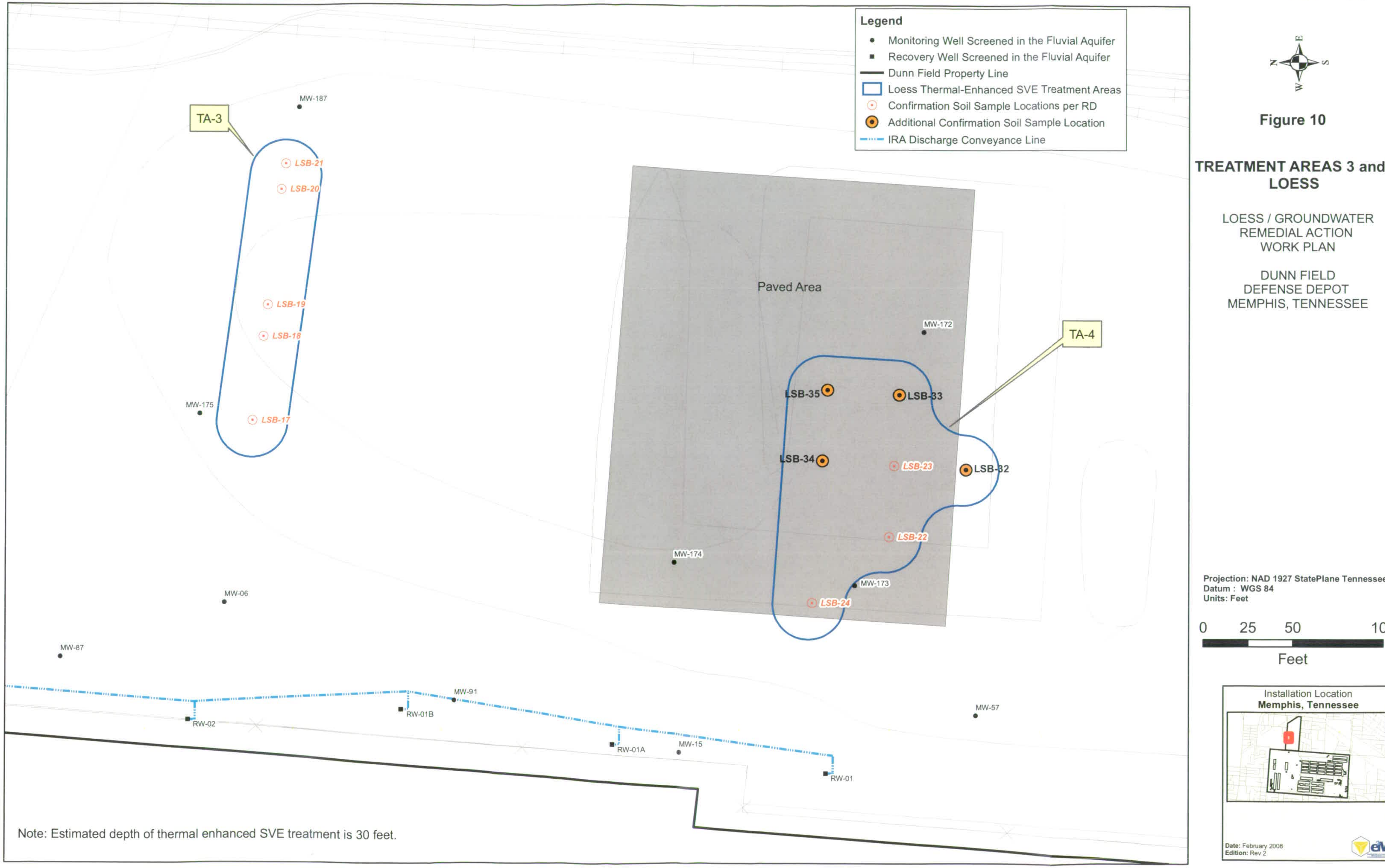


Figure 10

TREATMENT AREAS 3 and 4 LOESS

LOESS / GROUNDWATER REMEDIAL ACTION WORK PLAN

DUNN FIELD DEFENSE DEPOT MEMPHIS, TENNESSEE

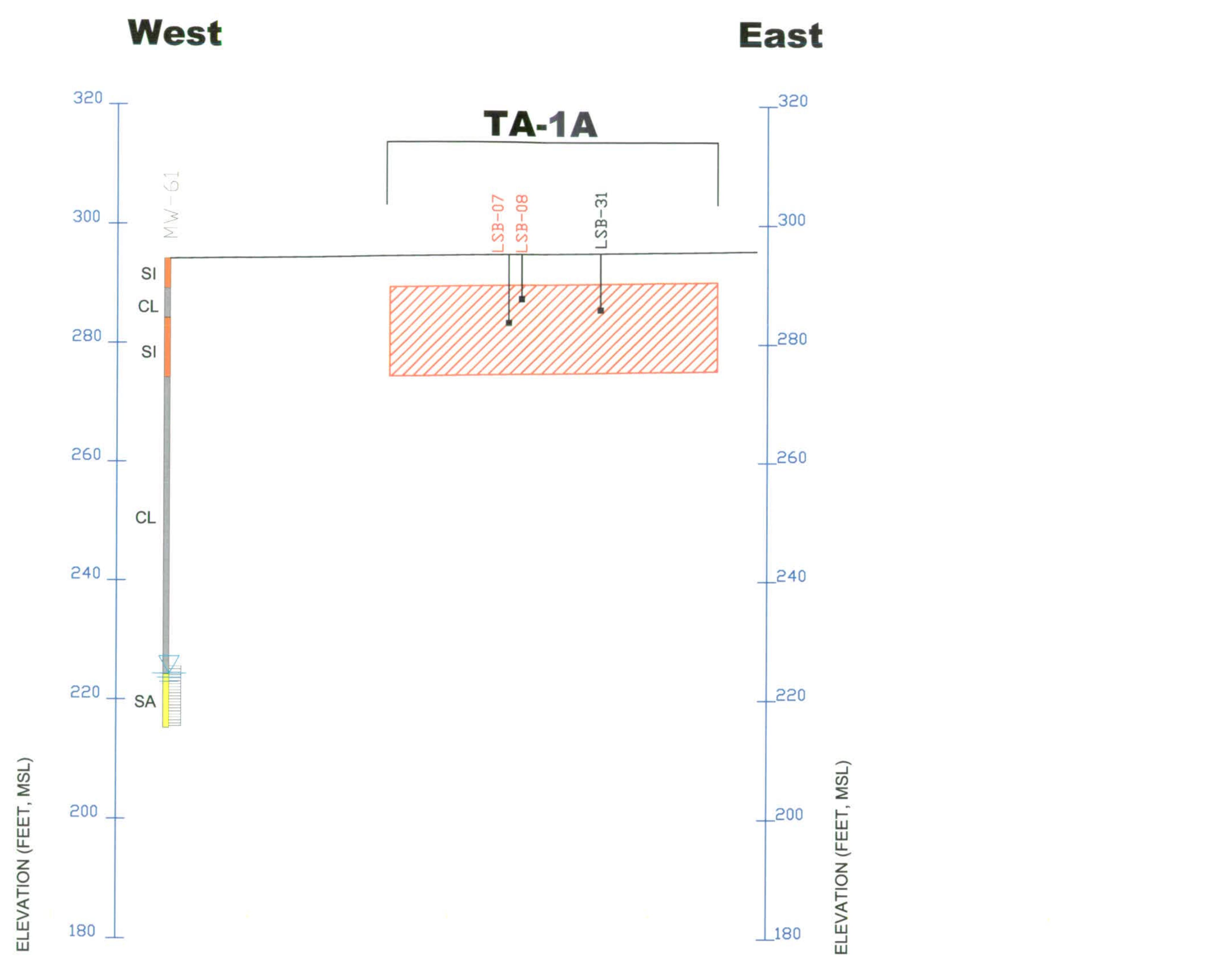


Figure 11

TA-1A
LITHOLOGIC
CROSS-SECTION

LOESS / GROUNDWATER
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Date: February 2008
Edition: Rev 2

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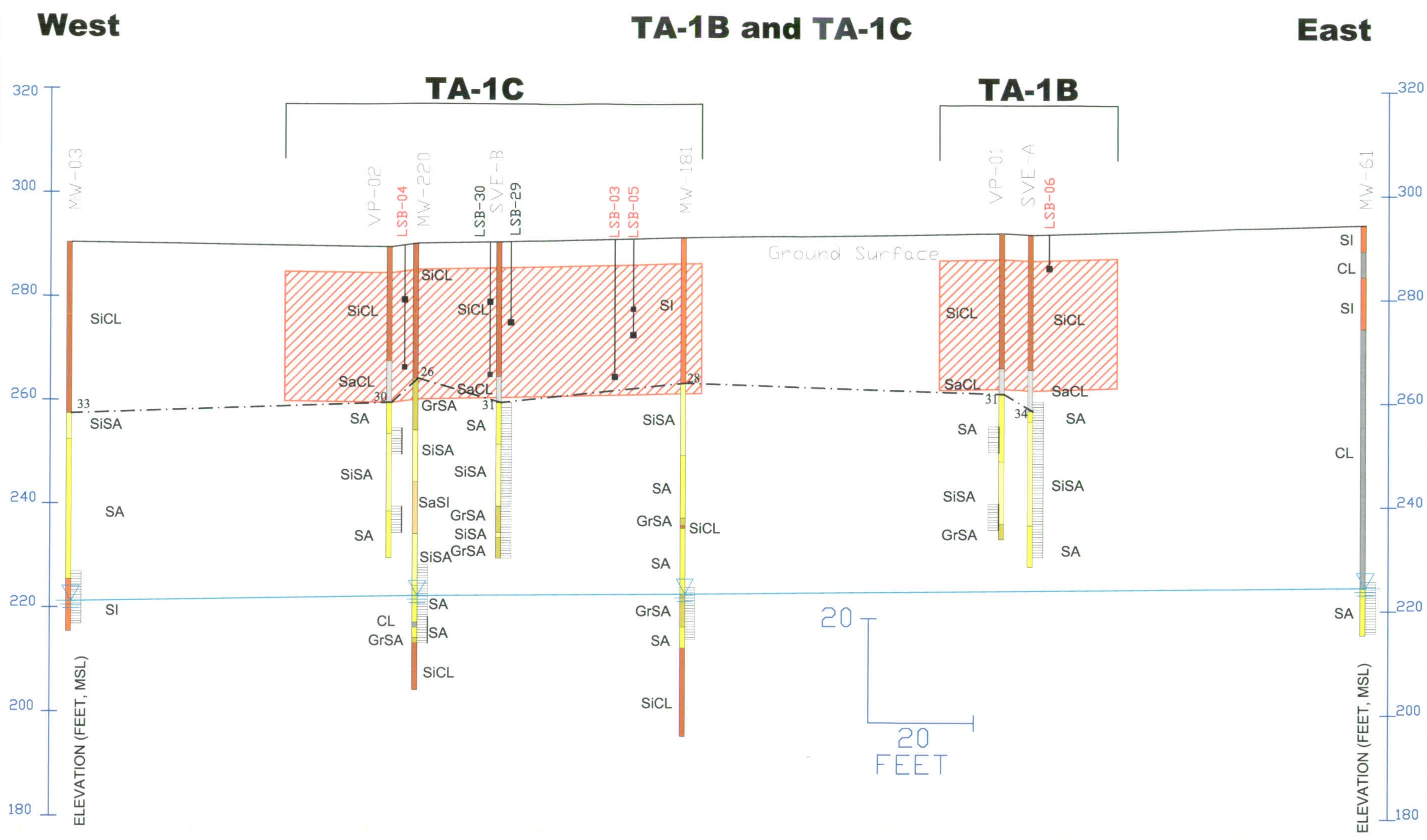

Figure 12
TA-1B and TA-1C LITHOLOGIC CROSS-SECTION

LOESS / GROUNDWATER REMEDIAL ACTION WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Loess Treatment

26 — Depth of Loess and Transition Zone (feet)

Groundwater Elevation Fluvial Aquifer

Well Screen Interval

Proposed Sample Interval

Date: February 2008
Edition: Rev 2

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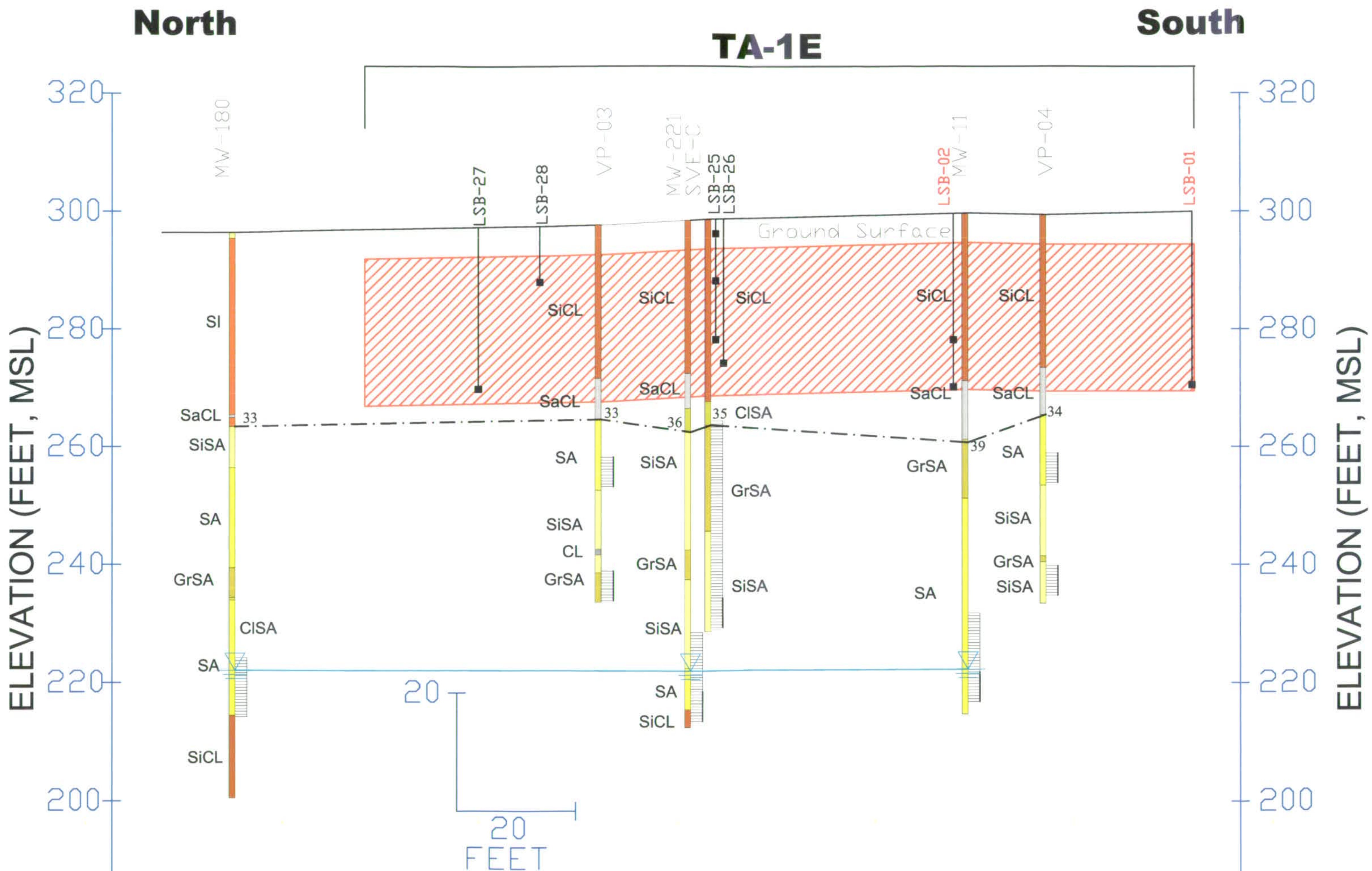

Figure 13

TA-1E LITHOLOGIC CROSS-SECTION

LOESS / GROUNDWATER REMEDIAL ACTION WORK PLAN

DUNN FIELD DEFENSE DEPOT MEMPHIS, TENNESSEE

Loess Treatment

26 Depth of Loess and Transition Zone (feet)

Groundwater Elevation Fluvial Aquifer

Well Screen Interval

Proposed Sample Interval

Date: May 2008
Edition: Rev 3

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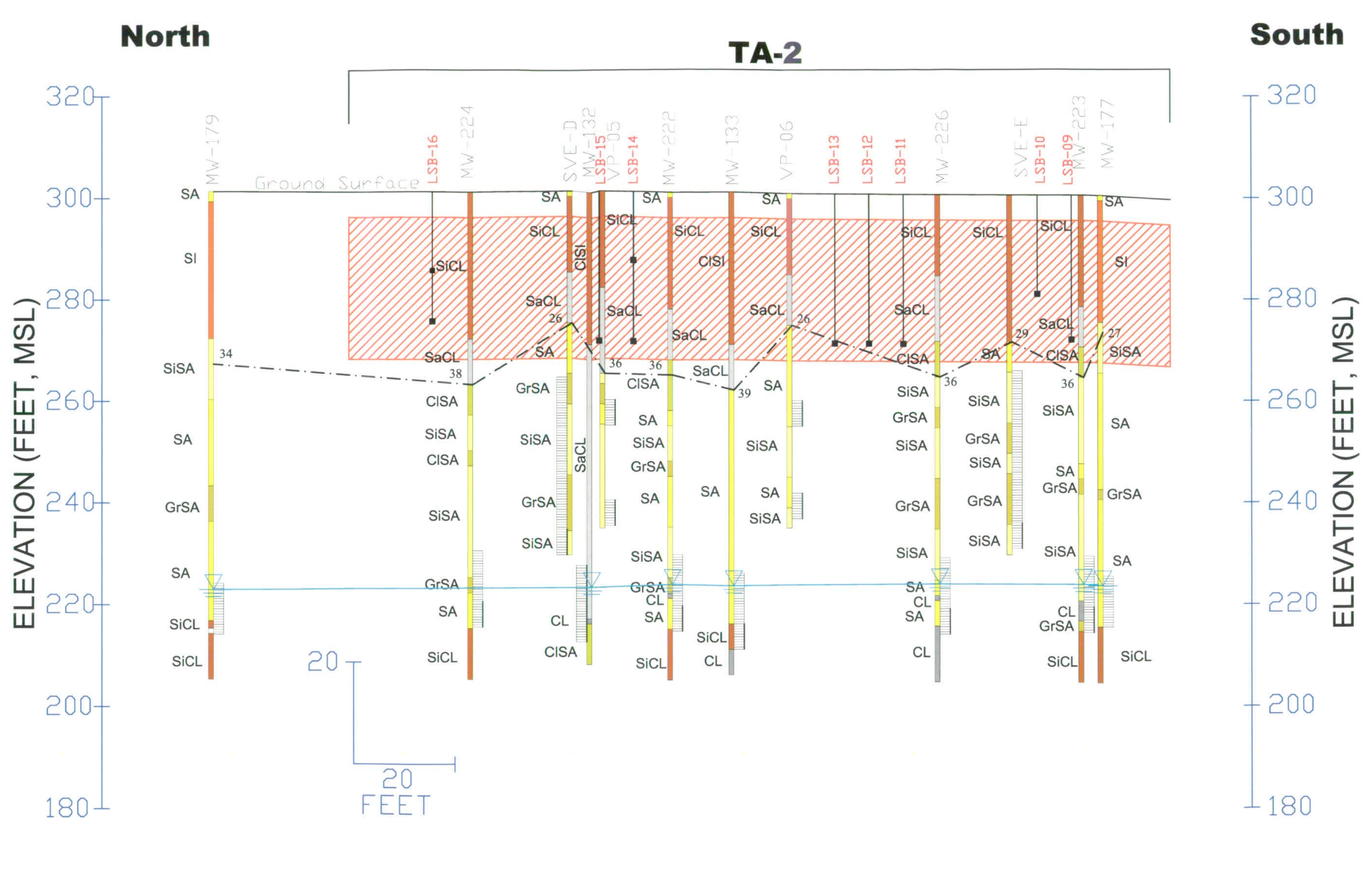

Figure 14

TA-2
LITHOLOGIC
CROSS-SECTION

LOESS / GROUNDWATER
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

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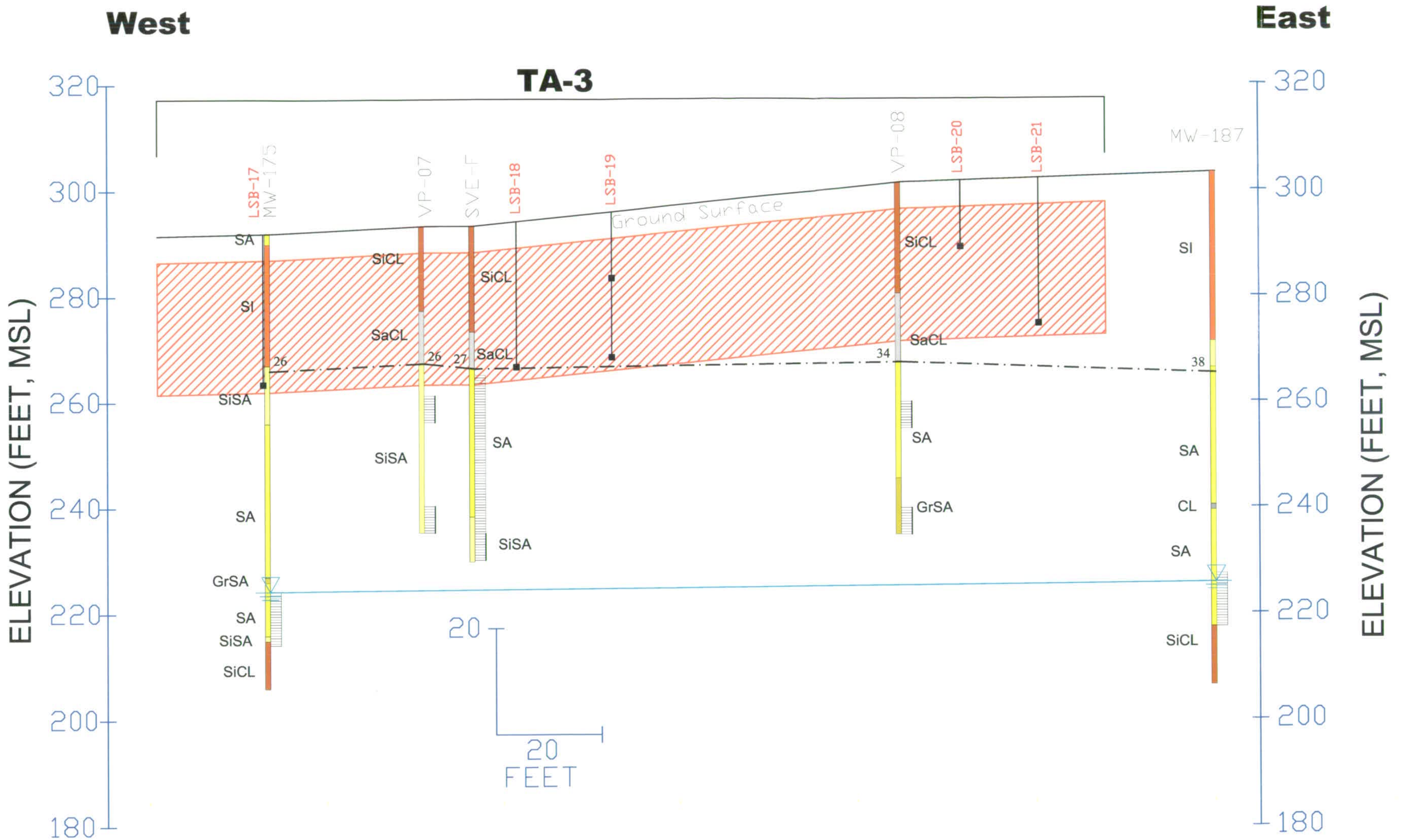

Figure 15

TA-3
LITHOLOGIC
CROSS-SECTION

LOESS / GROUNDWATER
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Loess Treatment

26 — Depth of Loess and Transition Zone (feet)

Groundwater Elevation Fluvial Aquifer

Well Screen Interval

Proposed Sample Interval

Date: February 2008
Edition: Rev 2

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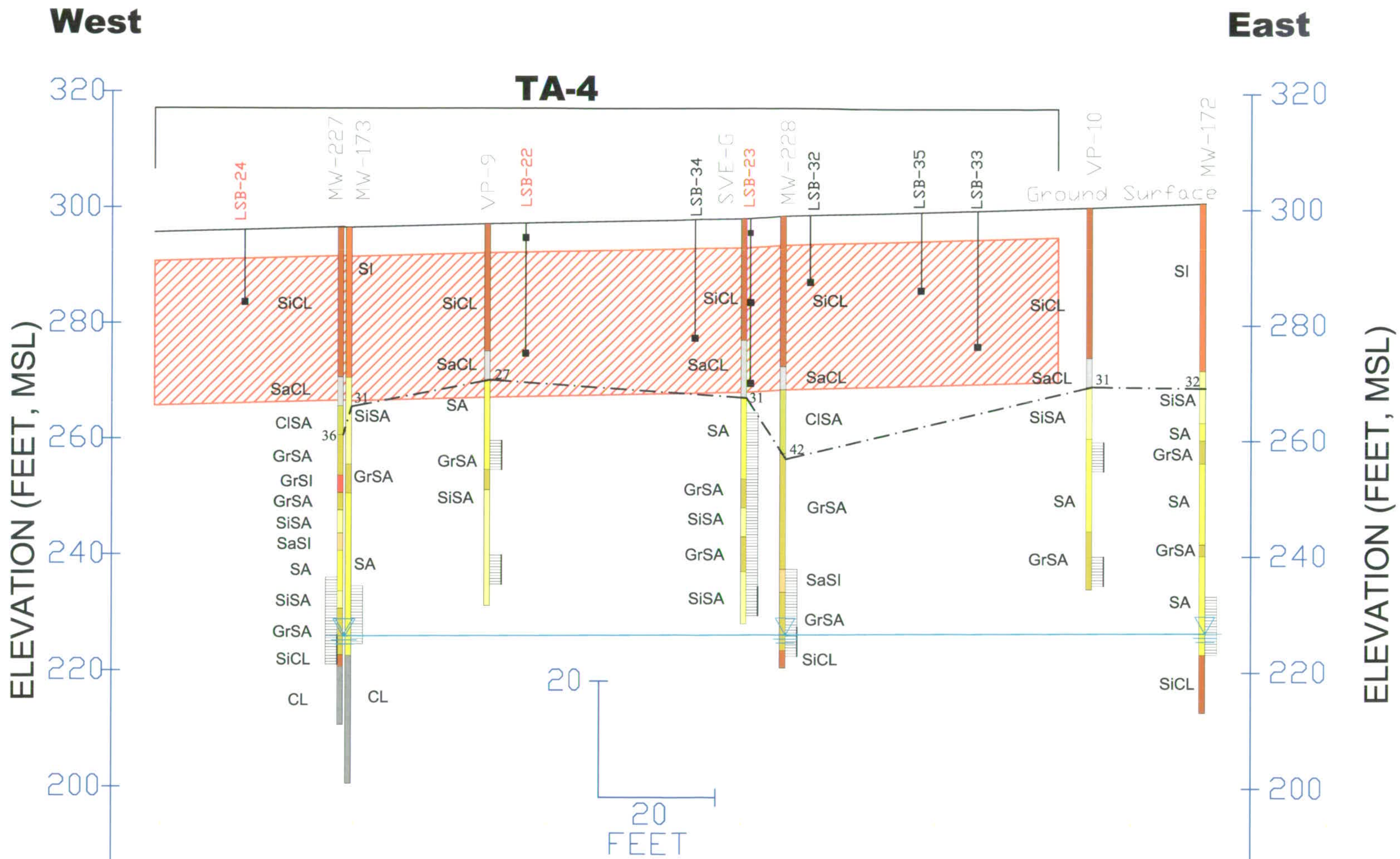

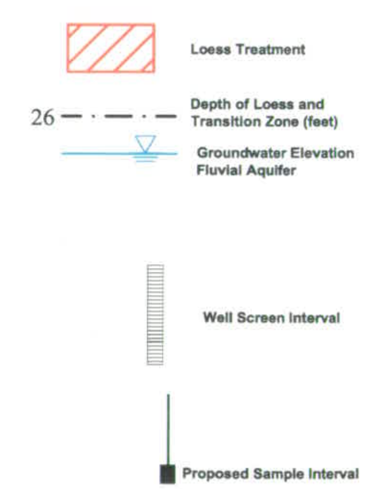

Figure 16

TA-4
LITHOLOGIC
CROSS-SECTION

LOESS / GROUNDWATER
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

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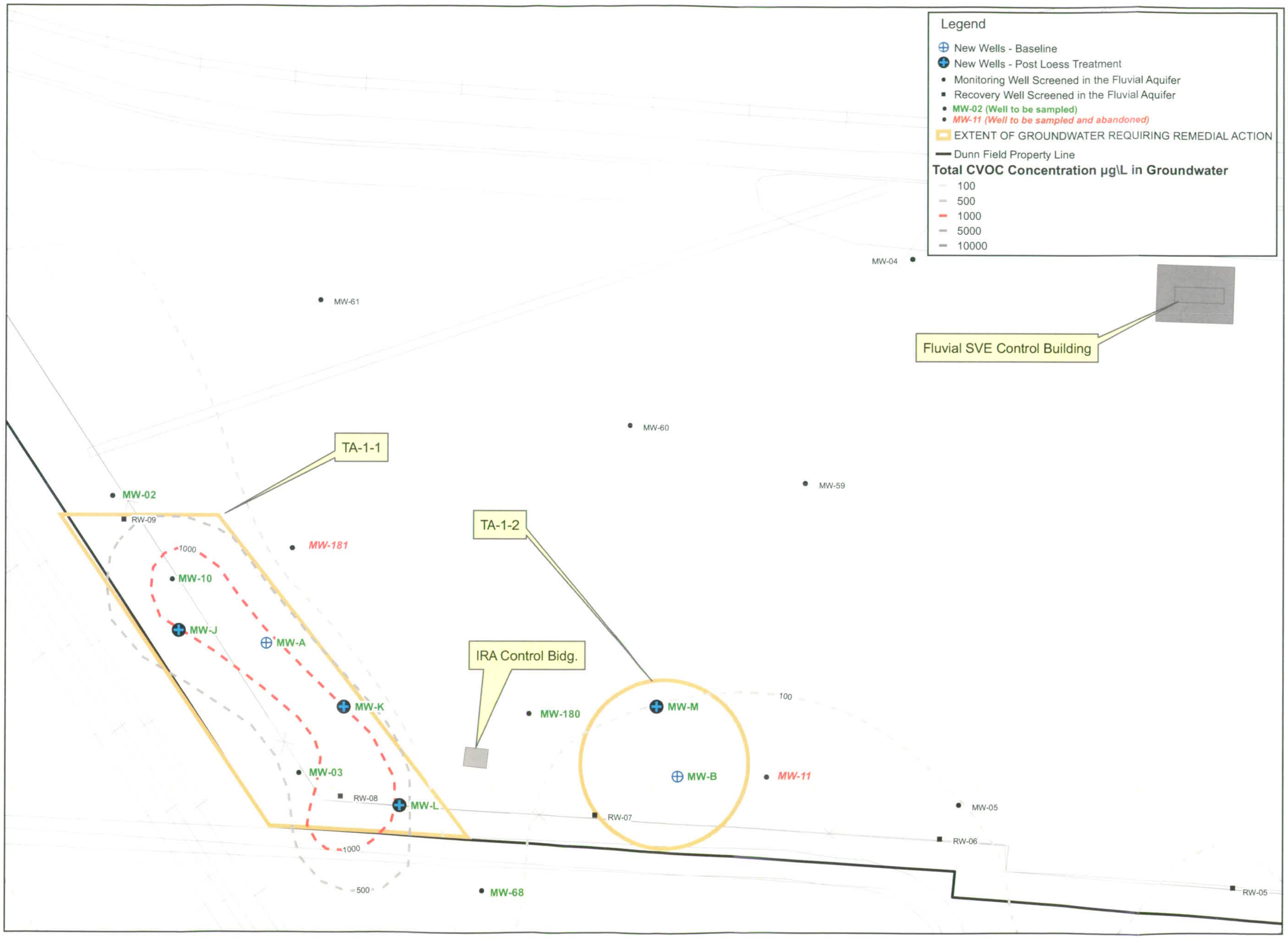

Figure 17

TREATMENT AREA 1 GROUNDWATER

LOESS / GROUNDWATER
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Datum : WGS 84
Units: Feet

Date: February 2008
Edition: Rev 2

G:\32020\019\01-15\Loess_GW RAWP Rev 2\GIS\Fig 17 TA-1 GW.mxd

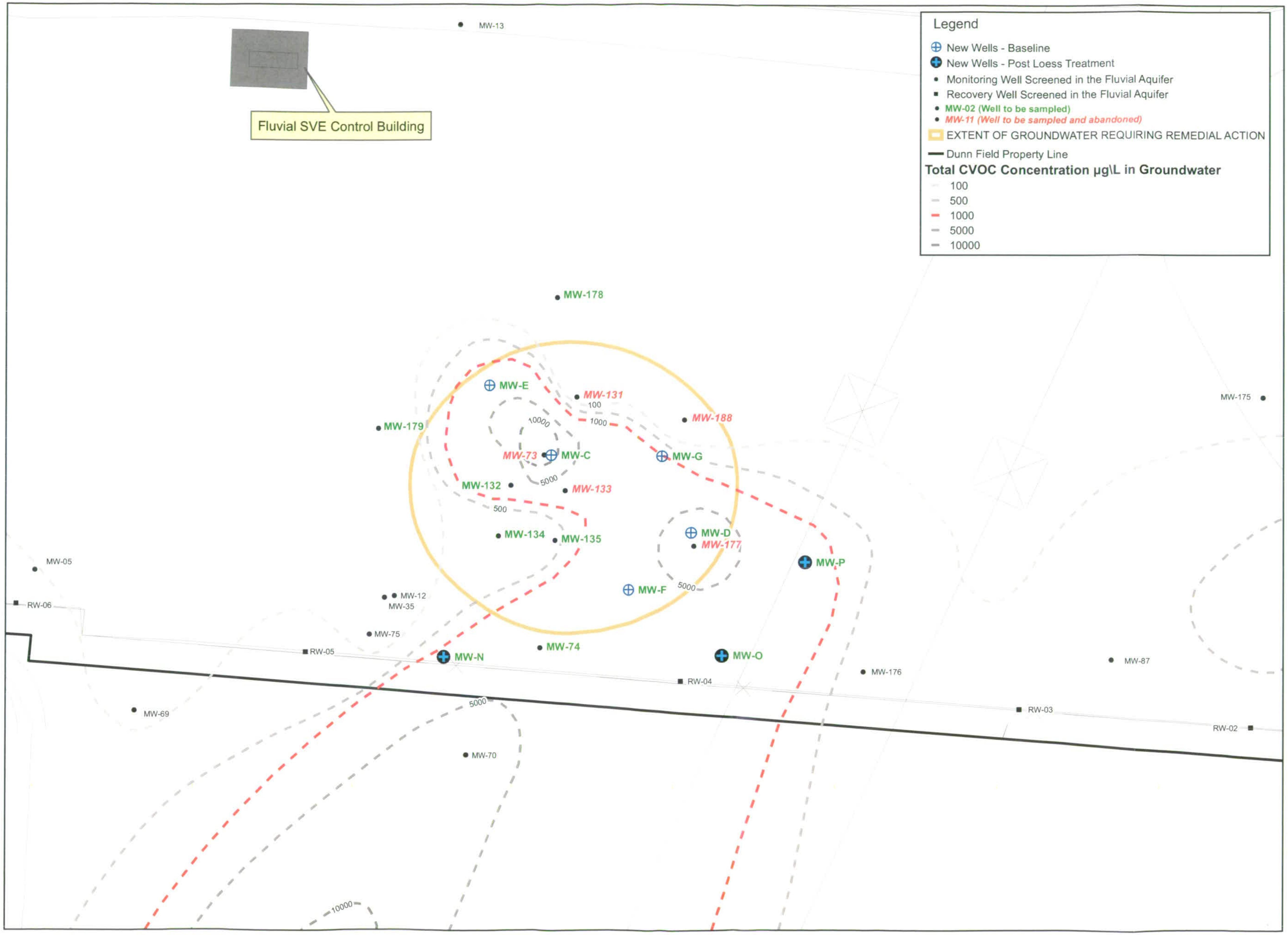

Figure 18

TREATMENT AREA 2 GROUNDWATER

LOESS / GROUNDWATER
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Datum : WGS 84
Units: Feet

0 25 50 100
Feet

Installation Location
Memphis, Tennessee

Date: February 2008
Edition: Rev 2

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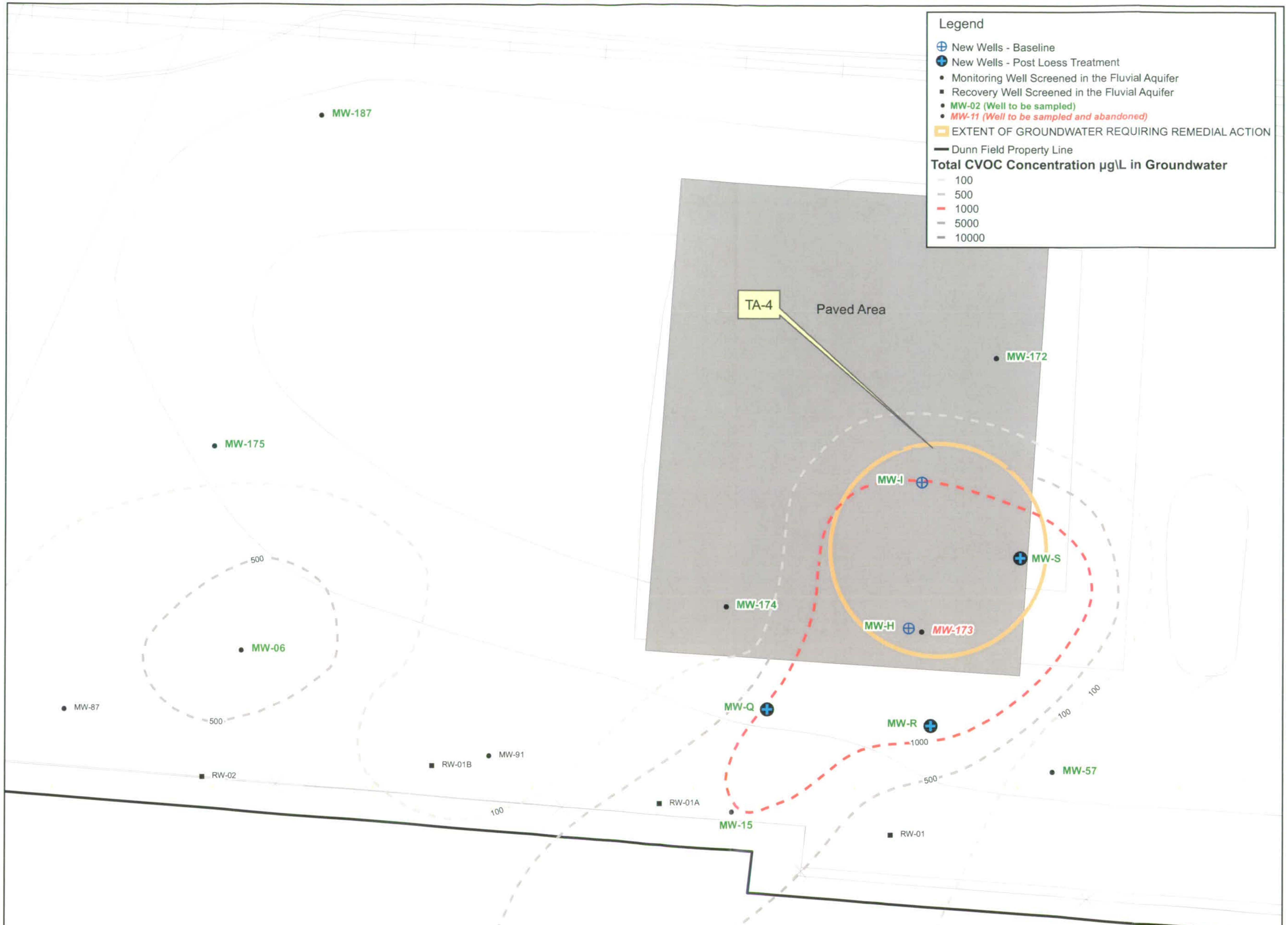


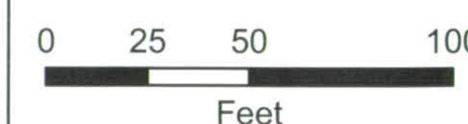
Figure 19

TREATMENT AREA 4 GROUNDWATER

LOESS / GROUNDWATER REMEDIAL ACTION WORK PLAN

DUNN FIELD DEFENSE DEPOT MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Datum : WGS 84
Units: Feet



Date: February 2008
Edition: Rev 2

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APPENDIX A

PROJECT MANAGEMENT PLAN

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TABLE OF CONTENTS

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LIST OF FIGURES

Figures

LIST OF ACRONYMS AND ABBREVIATIONS

AFCEE	Air Force Center for Environmental Excellence
BCT	BRAC Cleanup Team
BRAC	Base Realignment and Closure
CCE	Certifying Construction Engineer
COR	Contracting Officer Representative
CQAP	Construction Quality Assurance Plan
DLA	Defense Logistics Agency
e^2M	engineering-environmental Management, Inc.
H&S	Health and Safety
IRACR	Interim Remedial Action Completion Report
O&M	Operations and Maintenance
PMP	Project Management Plan
POC	Point of Contact
RA	Remedial Action
RA-C	Remedial Action Construction
RA-O	Remedial Action Operation
RASAP	Remedial Action Sampling and Analysis Plan
RAWP	Remedial Action Work Plan
RD	Remedial Design
SVE	Soil vapor extraction
TDEC	Tennessee Department of Environment and Conservation
USEPA	United States Environmental Protection Agency

1.0 PROJECT RESPONSIBILITY AND AUTHORITY

The organization chart for the Source Areas Loess/Groundwater Remedial Action (RA) personnel is shown on Figure A-1. The project team consists of management, task leaders and field personnel to implement the Source Areas Loess/Groundwater Remedial Action.

1.1 BASE REALIGMENT AND CLOSURE CLEANUP

The Base Realignment and Closure (BRAC) Cleanup Team (BCT) includes representatives of the Defense Logistics Agency (DLA), the United States Environmental Protection Agency (USEPA), and the Tennessee Department of Environment and Conservation (TDEC). The BCT will monitor the progress of remedial action (RA) and will review and approve documents submitted during the RA activities including progress updates, schedules, and status reports. Mr. Michael Dobbs of the DLA will be responsible for overall project direction, project funding, and implementing the responsibilities identified in the Federal Facilities Agreement (USEPA, 1995).

1.2 AIR FORCE CENTER FOR ENGINEERING AND THE ENVIRONMENT

The Air Force Center for Engineering and the Environment (AFCEE) will be the service agency for e^{2}M's contract during the RA. The AFCEE Contracting Officer Representative (COR), Mr. Brian Renaghan, will oversee all contractual matters in consultation with DLA.

1.3 ENGINEERING-ENVIRONMENTAL MANAGEMENT, INC. (E^{2}M)

Mr Glen Turney is e^{2}M's Program Manager for the AFCEE contract and will be the Construction Certifying Engineer (CCE). As Program Manager, Mr. Turney will conduct routine project reviews of the financial, schedule, and technical performance. As CCE, Mr. Turney will ensure that each phase of the RA is performed in accordance with specifications in the *Source Areas Remedial Design* (RD) (CH2M HILL, 2007) and subsequent specifications provided to subcontractors. The CCE will communicate with the project manager and task manager during RA to ensure conformance with provisions of the Construction Quality Assurance Plan (CQAP). Changes will be communicated by the CCE to field personnel and subcontractors through the RA Task Manager. Mr. Turney is a registered Professional Engineer in the State of Tennessee with over 20 years of experience in environmental engineering.

Mr. Tom Holmes will serve as e²M's Project Manager and designated POC for the project. Mr. Holmes will have the primary responsibility for managing the Loess/Groundwater RA. He will provide technical coordination with Mr. Renaghan, the AFCEE COR, and Mr. Dobbs of the DLA. Mr. Holmes will monitor the RA to manage contractual and administrative requirements for the project, provide regular updates to the AFCEE and DLA during the RA, and oversee preparation of the reports including technical memoranda and the Interim Remedial Action Completion report (IRACR). Mr. Holmes is a registered Professional Geologist with over 25 years of engineering and environmental experience.

Mr. Brandon Bruns, P.E. is e²M's Loess/Groundwater RA Task Manager and will be responsible for implementing each RA component at Dunn Field. He will coordinate activities of the field teams and subcontractors and will work with the CCE to address technical issues that arise. Mr. Bruns is a registered Professional Engineer with over six years of experience in environmental engineering.

Mr. Kevin Sedlak is e²M's Field Team Leader for all RA activities at DDMT. RA-C activities will include oversight of surveying activities, installation of monitoring wells, installation of the thermal-enhanced SVE system including heating elements, SVE wells and associated piping, control building and treatment compound, ZVI groundwater injections and the excavation, transportation, and disposal of soils. Mr. Sedlak will assist the Task Manager in directing field technicians for groundwater monitoring and confirmation sampling tasks. Mr. Sedlak is a licensed professional geologist in the State of Tennessee and has over 18 years of field experience.

Mr. David Wineman will oversee excavation transportation and disposal activities. Mr. Wineman is a registered Professional Geologist with over 30 years of experience in environmental restoration.

Lance Hines, Ph.D. is the Project Chemist and will support the Field Support team to ensure sampling activities are conducted in accordance with the Remedial Action Sampling and Analysis Plan (RASAP) (MACTEC, 2005). He will be the technical POC with the analytical subcontractor and will supervise evaluation of analytical laboratory data. Dr. Hines has over 20 years of laboratory and environmental consulting experience.

Rob Klawitter is e²M's Health and Safety (H&S) Manager will provide oversight to ensure that field activities are performed in a safe manner and in accordance with the project-specific health and safety plan. Mr.

Klawitter will support the RA Task Manager on H&S issues and will provide the field team with H&S information related to RA-C and RA-O.

1.4 FIELD TEAMS

Construction activities during RA will include:

- Excavation of soils in Treatment Areas 1 and 3;
- Installation of groundwater monitoring wells;
- Installation of thermal-enhanced SVE system including heater elements, SVE wells and associated piping, control building, and remediation compound; and
- Injection of ZVI into the Fluvial aquifer.

A field geologist will oversee the drilling, installation and developing of monitoring wells, injection of ZVI into groundwater, monitoring activities and soil excavation. Construction of the thermal-enhanced SVE system will be overseen by c^{2}M-site personnel who will verify that heating elements, SVE well locations and system construction conforms to provisions of the RD and the CQAP Weekly reports will be submitted to the Project Manager listing field activities and schedule status. Post RA-C activities will be managed by the field team leader.

1.5 SUBCONTRACTORS

Subcontractors will be used to perform the following RA-activities:

- Pre- and post-construction surveys of construction and drilling locations. These include new monitoring well, ZVI injection locations, soil excavation and thermal-enhanced SVE system locations;
- Transportation and disposal of soils in Treatment Area 1;
- Drilling activities for installation of monitoring wells;
- Construction and operation of thermal-enhanced SVE system including heater elements, SVE wells and associated piping, control building and treatment equipment; and
- ZVI injections, including drilling injection and confirmation borings.

Subcontractors will be evaluated on technical capabilities and their capacity to perform the required work and will be procured in accordance with procedures outlined in the Federal Acquisition Regulations. Subcontractors will be directed by the technical POCs with oversight by the RA Task Manager.

2.0 REMEDIAL ACTION SCHEDULE

A schedule for Loess/Groundwater SVE RA implementation is presented in Figure A-2. The schedule presents timelines and milestones for the RA. The schedule for Loess/Groundwater RA implementation is consistent with the DDMT master schedule presented in the *BRAC Cleanup Plan, V.11* (e2M, 2008) The schedule will be updated as needed and updated schedules (if any) will be included in the quarterly reports submitted to the BCT.

3.0 ADMINISTRATIVE PROCEDURES

3.1 COMMUNICATION

Clear lines of communication will be maintained to avoid duplication of effort and misunderstandings among project personnel. The primary line of communication will be from the AFCEE COR to, in sequence, the e^{2}M Project Manager, the e^{2}M RA Task Manager, field personnel and subcontractors. Subcontractors will be directed by the technical POCs with oversight by the RA Task Manager. Issues regarding scope of work, schedule, budget, meetings, and reports will initially be discussed internally with the e^{2}M Project Manager and externally with Mr. Dobbs of DLA and Mr. Sands of AFCEE.

3.2 MAINTENANCE OF RECORDS

A central file was established in e^{2}M's San Antonio office during earlier stages of the project and will continue to be maintained so that documents pertaining to the RA work can be referenced as necessary. Separate sections of the central file are maintained for correspondence, memos, confirmation summaries, invoices, subcontracts, technical data, and reports. Personnel working on the project will forward copies of project documents to the central files. Original field log books, data sheets, geologic logs, well construction diagrams, well development logs, field records generated during injection events, and sampling forms will be placed in the central files.

Field data will be recorded in indelible ink and legibly written. Errors will be crossed out, initialed, and dated. No documents will be discarded or destroyed. Information that should be recorded in site logbooks, field logbooks, equipment logbooks, data forms, chain-of-custody forms, materials certificates, and records of variance is described in the RAWP and the RA SAP. Records will be completed by field personnel, originals of the records will be sent to the RA Task Manager or his designee, and copies of records will be maintained on-site.

Following project completion, copies of project records including correspondence, memorandums, trip reports, confirmation notices, sampling plans, test results, submittals, photographs and other records or documents generated as a result of the project will be retained in the central files.

3.3 IMPLEMENTATION OF CONSTRUCTION QUALITY ASSURANCE PLAN

The CQAP will be implemented under the direction of the CCE. The CCE and/or the RA Task Manager will discuss RA-C activities on a weekly basis with the Field Team Leader. The CCE will direct the RA Task Manager to modify RA-C activities if and when the CCE determines that construction is not being performed in accordance with specifications in the RD and RAWP, or that construction is not being done in conformance to provisions in the CQAP.

3.4 REPORTING

The e^{2}M Project Manager will use written reports, telecommunications, and direct personal communication with AFCEE and DLA to ensure that project objectives are met and that the project is kept on schedule and within the budget. Reporting during the loess/groundwater RA will consist of status and summary data presentations at BCT meetings, quarterly summaries, and separate technical memoranda (TMs) prepared for each RA component. Quarterly summaries will be submitted to the BCT within eight weeks of the end of the quarter. Technical memoranda will be completed following completion of each RA component. Information from the technical memoranda will be used in preparation of the IRACR. The IRACR will be prepared following completion of all loess/groundwater RA components and at least 1 year of operation of the Fluvial SVE system.

4.0 REFERENCES

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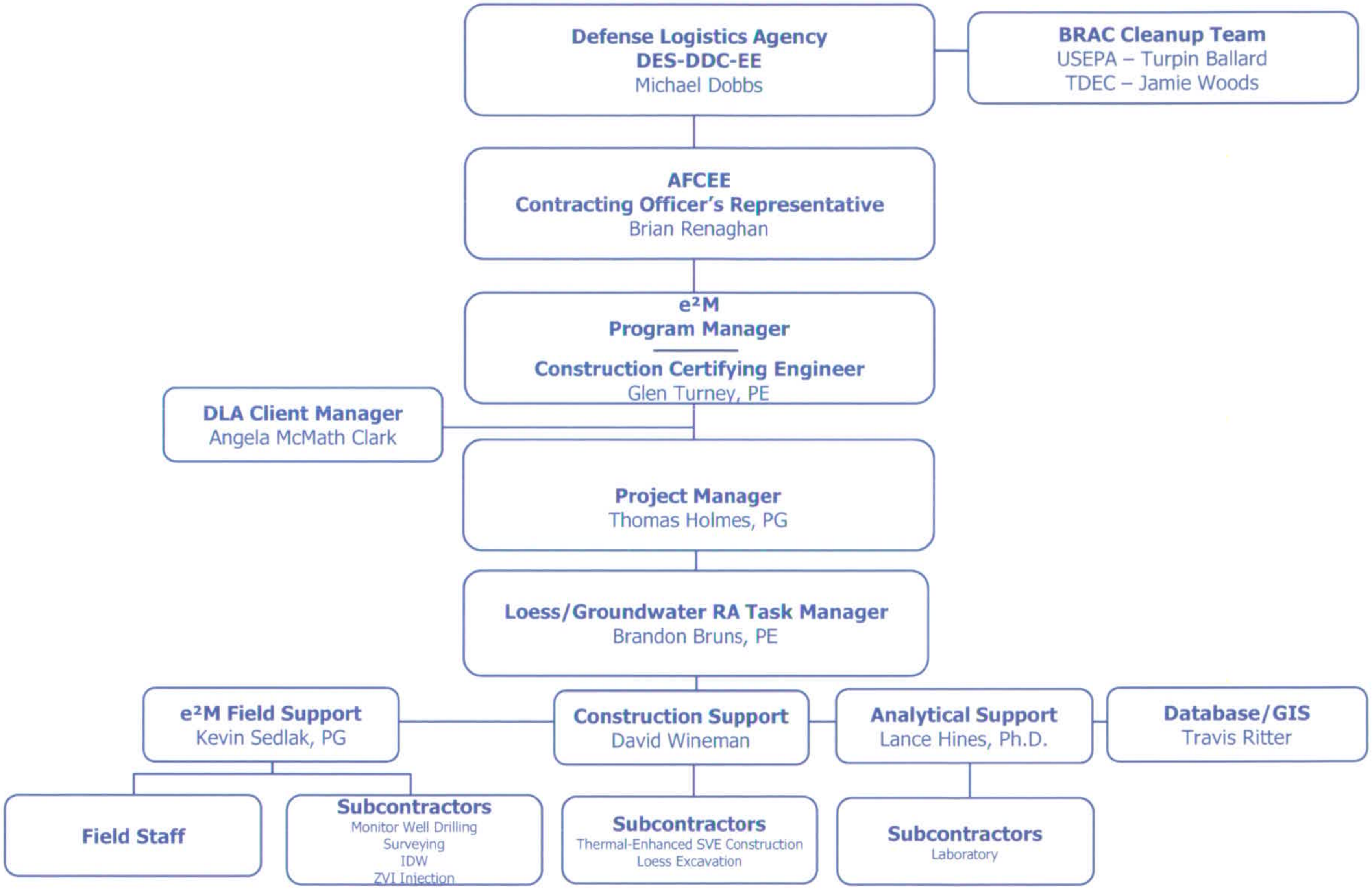
USEPA, 1995b. Federal Facilities Agreement Between USEPA Region IV, TDEC, and Defense Logistics Agency at Defense Distribution Depot Memphis, Tennessee. Effective March 6, 1995.



Contract No. FA8903-04-D-8722
Task Order 0019

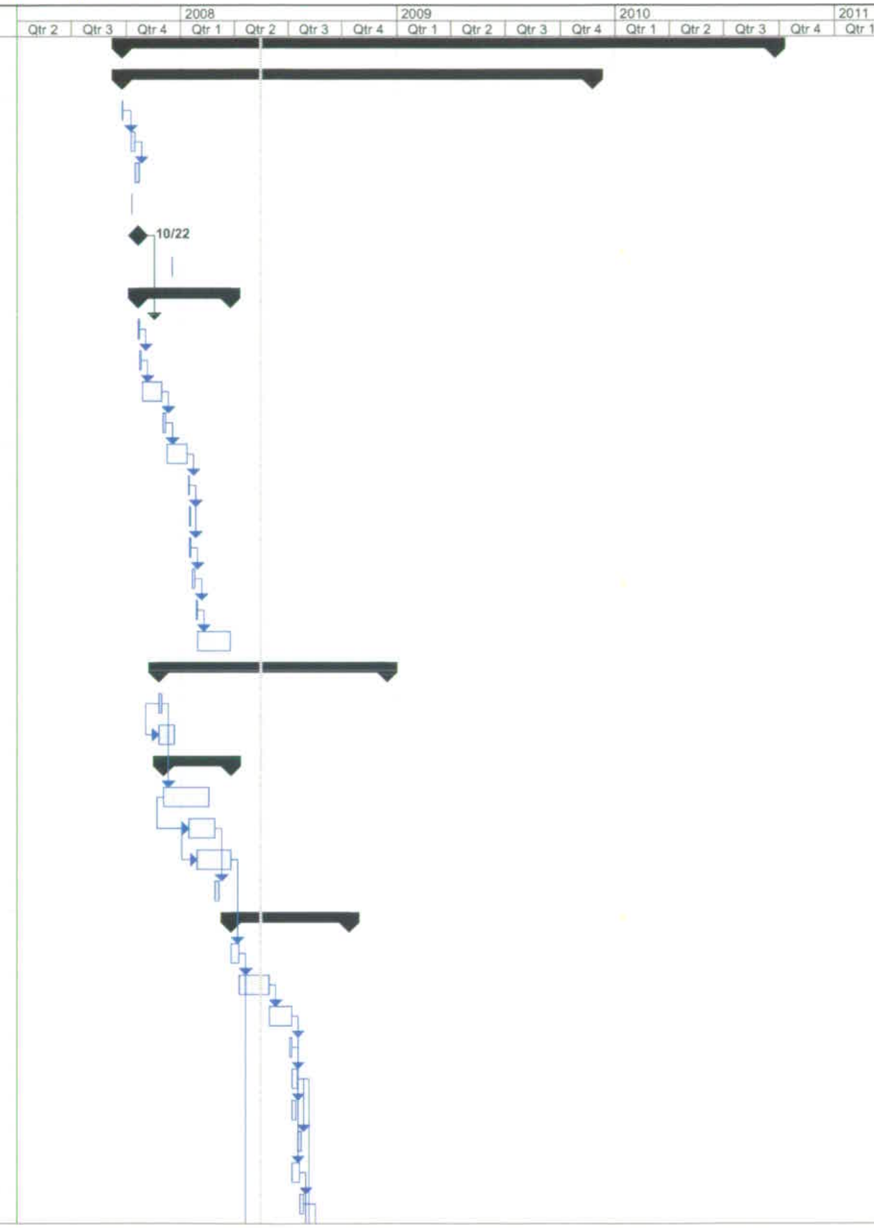
Figure A-1
Source Areas Loess/Groundwater Remedial Action Project Organization Chart

936 118

Figure A-2

Source Areas Loess/Groundwater Remedial Action Project Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Dunn Field Source Areas Loess/Groundwater Remedial Action**	**784 days**	**Tue 9/25/07**	**Fri 9/24/10**	
2	**Dunn Field Loess/Groundwater Remedial Action Implementation**	**566 days**	**Tue 9/25/07**	**Tue 11/24/09**	
3	Notice to proceed	1 day	Tue 9/25/07	Tue 9/25/07	
4	Survey Loess Treatment & Excavation Areas	5 days	Wed 10/10/07	Tue 10/16/07	3FS+10 days
5	Utility Clearance	5 days	Wed 10/17/07	Tue 10/23/07	4
6	Preconstruction Conference	1 day	Thu 10/11/07	Thu 10/11/07	
7	Begin Mobilization for ET&D and Thermal-enhanced SVE	0 days	Mon 10/22/07	Mon 10/22/07	
8	Notice of Loess/Groundwater RA Implementation	1 day	Tue 12/18/07	Tue 12/18/07	
9	**Excavation Transport and Disposal**	**112 days**	**Mon 10/22/07**	**Tue 3/25/08**	
10	Mobilization of Equipment & Personnel, Collect Backfill Samples	2 days	Mon 10/22/07	Tue 10/23/07	7
11	Establish Exclusion Zones and Stockpile Areas, Background Air Mc	3 days	Wed 10/24/07	Fri 10/26/07	10
12	Excavation - TA-1F and TA-3 Drums	25 days	Mon 10/29/07	Fri 11/30/07	11
13	Confirmation and Characterization Samples	5 days	Mon 12/3/07	Fri 12/7/07	12
14	Additional Soil Excavation	25 days	Mon 12/10/07	Fri 1/11/08	13
15	Additional Confirmation and Characterization Samples	2 days	Mon 1/14/08	Tue 1/15/08	14
16	Survey Final Excavation Limits	2 days	Wed 1/16/08	Thu 1/17/08	15
17	Transportation and Off-site Disposal	3 days	Wed 1/16/08	Fri 1/18/08	15
18	Backfill & Site Restoration	5 days	Mon 1/21/08	Fri 1/25/08	17
19	Demobilization for ET&D	2 days	Mon 1/28/08	Tue 1/29/08	18
20	**ET&D Summary TM**	40 days	Wed 1/30/08	Tue 3/25/08	19
21	**Loess Thermal-enhanced (ERH/ISTD) SVE**	**276 days**	**Mon 11/26/07**	**Mon 12/15/08**	
22	Mobilization of Equipment & Personnel	5 days	Mon 11/26/07	Fri 11/30/07	
23	Site Preparation	20 days	Mon 11/26/07	Fri 12/21/07	22SS
24	**System Construction**	**82 days**	**Tue 12/4/07**	**Wed 3/26/08**	
25	Drill and Install Heaters and SVE Wells	55 days	Tue 12/4/07	Mon 2/18/08	22
26	Install Surface Cover	33 days	Tue 1/15/08	Thu 2/28/08	25SS+30 days
27	Mechanical and Electrical Construction	42 days	Tue 1/29/08	Wed 3/26/08	26SS+10 days
28	As-Built Survey	5 days	Fri 2/29/08	Thu 3/6/08	26
29	**Thermal-enhanced SVE Operation**	**143 days**	**Thu 3/27/08**	**Mon 10/13/08**	
30	System Start-up and Optimizaton	10 days	Thu 3/27/08	Wed 4/9/08	27
31	Soil Heating	36 days	Thu 4/10/08	Thu 5/29/08	30
32	Steady State Operation - Phase 1	27 days	Fri 5/30/08	Mon 7/7/08	31
33	Stake Confirmation Sample Locations	2 days	Fri 7/4/08	Mon 7/7/08	32FS-2 days
34	Initial Confirmation Samples	8 days	Tue 7/8/08	Thu 7/17/08	33
35	Interim Groundwater Samples	5 days	Tue 7/8/08	Mon 7/14/08	33
36	Survey Sample Locations	5 days	Fri 7/18/08	Thu 7/24/08	34
37	Steady State Operation - Phase 2	10 days	Tue 7/8/08	Mon 7/21/08	32
38	Second Round Confirmation Samples	5 days	Tue 7/22/08	Mon 7/28/08	37



Project: Loess-GW RA Rev 3
Date: Wed 5/14/08

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

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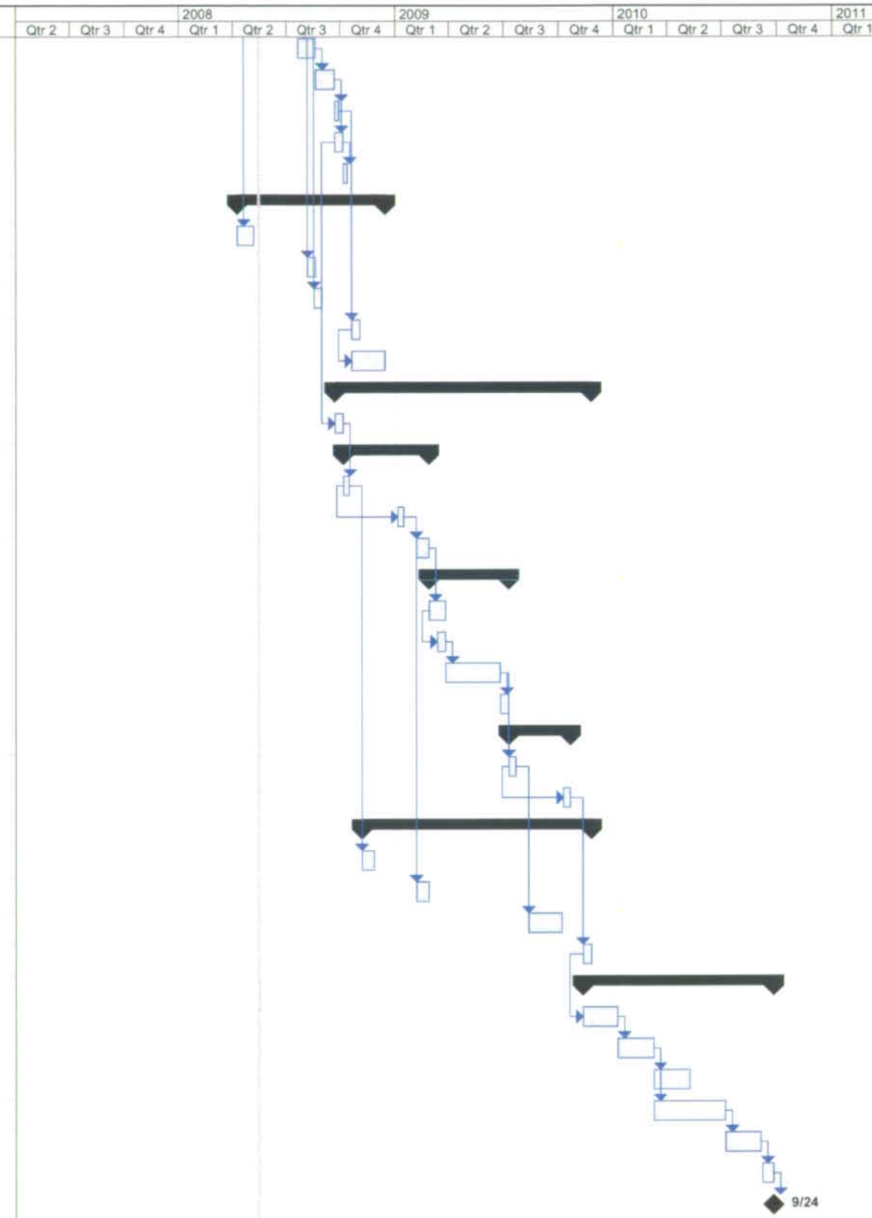
936 120

Figure A-2
Source Areas Loess/Groundwater Remedial Action Project Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
39	Extended System Operations	23 days	Tue 7/22/08	Thu 8/21/08	37
40	Cool-down Period with Vapor Treatment	22 days	Fri 8/22/08	Mon 9/22/08	39
41	Final Confirmation Samples	5 days	Tue 9/23/08	Mon 9/29/08	40
42	Demobilization for Thermal-enhanced SVE	10 days	Tue 9/23/08	Mon 10/6/08	40
43	Site Restoration	5 days	Tue 10/7/08	Mon 10/13/08	42
44	**Thermal-enhanced SVE Reports**	**178 days**	**Thu 4/10/08**	**Mon 12/15/08**	
45	System Installation TM	20 days	Thu 4/10/08	Wed 5/7/08	30
46	Quarter 1 Summary TM- Initial Confirmation samples	10 days	Fri 8/8/08	Thu 8/21/08	34FS+15 days
47	Second Round Confirmation samples TM	10 days	Tue 8/19/08	Mon 9/1/08	38FS+15 days
48	Quarter 2 Summary TM- Final Confirmation samples	10 days	Tue 10/21/08	Mon 11/3/08	41FS+15 days
49	**Thermal-enhanced SVE Summary TM**	40 days	Tue 10/21/08	Mon 12/15/08	48SS
50	**Source Areas Groundwater - ZVI Injections**	**306 days**	**Tue 9/23/08**	**Tue 11/24/09**	
51	Install Post-Loess Treatment Wells	10 days	Tue 9/23/08	Mon 10/6/08	42SS
52	**Pre-Injection Groundwater Sampling**	**103 days**	**Tue 10/7/08**	**Thu 2/26/09**	
53	1st Quarter	8 days	Tue 10/7/08	Thu 10/16/08	51
54	2nd Quarter	8 days	Tue 1/6/09	Thu 1/15/09	53SS+65 days
55	Confirm ZVI Injection Locations	15 days	Fri 2/6/09	Thu 2/26/09	54FS+15 days
56	**Injections**	**95 days**	**Fri 2/27/09**	**Thu 7/9/09**	
57	ZVI Order and Shipping, Site Preparation	20 days	Fri 2/27/09	Thu 3/26/09	55
58	Mobilization of Equipment & Personnel	10 days	Fri 3/13/09	Thu 3/26/09	57SS+10 days
59	ZVI Injection	65 days	Fri 3/27/09	Thu 6/25/09	58
60	Demobilization and Site Restoration	10 days	Fri 6/26/09	Thu 7/9/09	59
61	**Post-Injection Groundwater Sampling**	**73 days**	**Fri 7/10/09**	**Tue 10/20/09**	
62	1st Quarter	8 days	Fri 7/10/09	Tue 7/21/09	59FS+10 days
63	2nd Quarter	8 days	Fri 10/9/09	Tue 10/20/09	62SS+65 days
64	**ZVI Reporting**	**273 days**	**Fri 11/7/08**	**Tue 11/24/09**	
65	1st Quarter Pre-injection Sampling and ZVI Location TM	15 days	Fri 11/7/08	Thu 11/27/08	53FS+15 days
66	2nd Quarter Pre-injection Sampling and ZVI Location TM	15 days	Fri 2/6/09	Thu 2/26/09	54FS+15 days
67	**ZVI Injection Summary and 1st Quarter Sample TM**	40 days	Wed 8/12/09	Tue 10/6/09	62FS+15 days
68	2nd Quarter Post-Injection Sampling TM	10 days	Wed 11/11/09	Tue 11/24/09	63FS+15 days
69	**Source Areas Interim RA Completion Report with OPS**	**228 days**	**Wed 11/11/09**	**Fri 9/24/10**	
70	Prepare & Submit Rev. 0 Source Areas RACR to BCT	42 days	Wed 11/11/09	Thu 1/7/10	68SS
71	BCT Review & Submit Comments on Rev. 0 Source Areas RACR	42 days	Fri 1/8/10	Mon 3/8/10	70
72	Respond to BCT Comments on Rev. 0 Source Areas RACR	44 days	Tue 3/9/10	Fri 5/7/10	71
73	Prepare & Submit Rev. 1 Source Areas RACR	86 days	Tue 3/9/10	Tue 7/6/10	71
74	BCT Review of Rev. 1 Source Areas RACR w/ Concurrence	43 days	Wed 7/7/10	Fri 9/3/10	73
75	EPA Approval of Source Areas Final RACR and OPS Determination	15 days	Mon 9/6/10	Fri 9/24/10	74
76	**Source Areas RA Complete / Remedy in Place**	0 days	Fri 9/24/10	Fri 9/24/10	75



Project: Loess-GW RA Rev 3 Date: Wed 5/14/08	Task		Progress		Summary		External Tasks	Deadline
	Split		Milestone		Project Summary		External Milestone	

APPENDIX B

WASTE MANAGEMENT PLAN

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LIST OF ACRONYMS AND ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DDMT	Defense Depot Memphis, Tennessee
DLA	Defense Logistics Agency
GAC	granular activated carbon
IDW	Investigation Derived Waste
POTW	publicly owned treatment works
PPE	personal protective equipment
RA	Remedial Action
RA-C	Remedial Action Construction
RA-O	Remedial Action Operation
RCRA	Resource Conservation and Recovery Act
SVE	Soil Vapor Extraction
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation
USEPA	United States Environmental Protection Agency
VMP	vapor monitoring point
VOC	volatile organic compound
WMP	Waste Management Plan

1.0 INTRODUCTION

This Waste Management Plan (WMP) describes waste characterization, management, and minimization activities for the Dunn Field Source Areas Loess/Groundwater Remedial Action (RA) at Defense Depot Memphis, Tennessee (DDMT). The RA consists of the following:

- Excavation, transportation, and offsite disposal of shallow soils in TA-1F (chlorinated volatile organic compounds [CVOCs]) and in TA-3 (crushed, buried drums);
- Thermal-enhanced soil vapor extraction (SVE) to remediate CVOCs from subsurface soils to levels that are protective of the intended land use and groundwater; and
- Zero-valent iron (ZVI) injection targeting CVOC concentrations in groundwater greater than 1,000 µg/L in source areas.

The primary objective of this WMP is to properly identify the waste types that are anticipated to be generated during RA and to present a general strategy for managing waste in compliance with local, state, and federal regulations.

2.0 WASTE IDENTIFICATION

Wastes generated during RA will include, but not be limited to:

- Soil cuttings from soil borings for installation of groundwater monitoring wells; thermal-enhanced SVE heater elements/electrodes, associated SVE wells and monitoring points; and ZVI confirmation samples;
- Purge water generated during development and sampling of monitoring wells;
- Liquids and solids generated during decontamination of drilling rigs and other construction equipment;
- Liquids generated during decontamination of sampling equipment; and
- Used personal protective equipment (PPE).
- Condensate from the extracted vapors.
- Spent granular activated carbon (GAC) from vapor treatment and, if necessary, condensate treatment.
- Soil and debris from loess excavation areas.

Based on previous investigations conducted at DDMT it is expected that soil and groundwater generated during RA will not be classified as Resource Conservation and Recovery Act (RCRA) hazardous waste. Waste characterization samples will be collected but it is planned to manage and disposed of these wastes as non-hazardous solid waste. It is anticipated that spent GAC (used for vapor treatment) will be classified as a RCRA hazardous waste. Wastes generated during the RA will be sampled, profiled, and disposed following federal, state, and local regulations. Waste manifests will identify the Defense Logistics Agency (DLA) as the generator.

Soil cuttings will be placed into roll-off boxes before disposal at a landfill permitted to receive Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) off-site waste. If characterization samples indicate soil cuttings require classified as RCRA hazardous waste, the cuttings will be transported to a permitted RCRA hazardous waste facility for disposal.

Wastewater generated during equipment decontamination, development of monitoring wells, purging of wells for sampling will be contained in a storage tank at Dunn Field, and sampled for discharge permit parameters. Development and purge water generated during previous investigations has met permit limits and been discharged directly to the publicly owned treatment works (POTW).

Spent PPE generated during RA-C and RA-O will be placed in collection bins disposed as non-hazardous waste.

Condensate will be collected within the treatment compound and sampled for discharge permit parameters. The condensate will be treated if necessary to meet requirements for discharge to publicly owned treatment works (POTW).

Spent GAC will be appropriately profiled and transported offsite to a recycling facility.

3.0 GENERAL REQUIREMENTS

3.1 WASTE CHARACTERIZATION

Drill cuttings and excavated soil/debris will be placed into roll-off boxes and sampled for analyses of volatile organic compounds (VOCs) by the Toxicity Characteristic Leaching Procedure (TCLP). Sampling and analysis will be conducted in accordance with requirements of the waste disposal contractor. Further characterization will be performed if required to meet waste acceptance criteria (WAC) of off-site disposal facilities.

Grab samples of water and condensate will be collected from each storage tank and analyzed for VOCs, semi-volatile organic compounds and metals in accordance with City of Memphis discharge permit. Spent GAC will be profiled from samples collected from GAC vessels and will be sampled for analysis of VOCs by TCLP methods. Sampling and profiling activities will be performed by the thermal-SVE vendor.

3.2 WASTE MANAGEMENT

Wastes that are transported off-site along public right-of-ways will meet applicable transportation requirements. These include, but are not limited to, packaging, labeling, marking, manifesting, and placarding requirements. CERCLA Section 121(d)(3) provides that the offsite transfer of hazardous substances, pollutants, or contaminants generated during CERCLA response actions be sent to a treatment, storage, or disposal facility that is in compliance with applicable federal and state laws and has been approved by the United States Environmental Protection Agency (USEPA) for acceptance of CERCLA waste (see also the "Off-Site Rule" at 40 CFR 300.440 et. seq.). Documentation of USEPA approval will be obtained for facilities selected for off-site disposal.

3.2.1 Management of Non-Investigative Waste

Non-investigative waste, such as litter and construction debris, will be collected on an as-needed basis to maintain the site in a clean and orderly manner. This waste will be containerized for transport to the designated sanitary landfill or collection bin. Acceptable containers will be sealed containers or plastic garbage bags.

3.2.2 Management of Non-Hazardous Waste

Soil cuttings and excavated soil/debris generated during RA-C are expected to be non-hazardous and will be placed into roll-off boxes. The drilling subcontractor will label the roll-off boxes with a weatherproof label, signifying the dates, site number, and well numbers. The drilling subcontractor will provide a sufficient quantity of roll-off boxes to manage drill cuttings generated during RA-C.

3.2.3 Management of Hazardous Waste

Most wastes generated during RA-C and RA-O are not expected to be hazardous with the exception of spent GAC from SVE operations. Following proper profiling, it is anticipated that the GAC will be transported to the an appropriate recycling facility. Otherwise, GAC will be managed and disposed of in accordance with appropriate hazardous waste disposal requirements.

3.3 WASTE MINIMIZATION AND SEGREGATION

Wherever possible, generation of waste will be minimized through design and planning to ensure efficient operations that will not generate unnecessary waste. Emphasis will be placed on waste minimization during the pre-construction conference and field personnel will be encouraged to improve methods for minimizing waste generation. The field-generated waste will be segregated at the site according to the matrix (solid, including soil, sediment, and PPE, or liquid, such as waste water) and means of derivation (drill cuttings and decontamination fluids). Waste minimization practices will include, but not be limited to:

- Use of rotasonic rather than mud-rotary drilling techniques to avoid generation of waste drilling mud.
- Using disposable items when the decontamination process would generate a waste stream that would be more costly to characterize and dispose.
- Reusing items when practical.

APPENDIX C
CONSTRUCTION QUALITY ASSURANCE PLAN

TABLE OF CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

CCE	Construction Certifying Engineer
CQAP	Construction Quality Assurance Plan
EBT	Enhanced Bioremediation Technology
e^2M	engineering-environmental Management, Inc.
H&S	Health & Safety
gpm	gallons per minute
MI	Main Installation
PM	Project Manager
PMP	Project Management Plan
psi	pounds per square inch
PSVP	Performance Standards Verification Plan
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RA-C	Remedial Action Construction
RACR	Remedial Action Completion Report
RAO	Remedial Action Objectives
RASAP	Remedial Action Sampling and Analysis Plan
RAWP	Remedial Action Work Plan
RD	Remedial Design
TDEC	Tennessee Department of Environment and Conservation
WMP	Waste Management Plan
ZVI	Zero-Valent iron

1.0 INTRODUCTION

This Construction Quality Assurance Plan (CQAP) describes quality assurance/quality control (QA/QC) activities during construction associated with Source Areas Groundwater/Loess Remedial Action (RA) on Dunn Field at Defense Depot, Memphis, Tennessee (DDMT). This CQAP addresses Remedial Action Construction (RA-C) activities related to installation/construction of the thermal-enhanced SVE components (heater elements, wells, control building, and remediation wells), groundwater monitoring wells, and zero-valent iron (ZVI) injections. The QA/QC activities will aid in completing the RA-C in accordance with specifications and procedures presented in the *Memphis Depot Final Source Areas Remedial Design* (RD) (CH2M HILL, 2007) and achieving the following objectives:

- Removal of shallow soils containing CVOCs above RGs in TA-1F (around MIP Boring I-32) and crushed buried drums in TA-3;
- Installation of additional groundwater monitoring wells;
- Installation of thermal-enhanced SVE system including heater elements/ and SVE wells at the proper locations and depths;
- Installation of vapor and condensate treatment systems to achieve discharge limits;
- Disposal of RA-C wastes in accordance with the Waste Management Plan (WMP);
- Injection of ZVI in groundwater beneath source areas;
- Collection of soil and groundwater confirmation samples; and
- Documentation of construction activities in technical memoranda and the Interim Remedial Action Construction Report.

2.0 CQAP IMPLEMENTATION

2.1 RESPONSIBILITY AND AUTHORITY

The RA project organization is divided into management and field teams as described in the Project Management Plan (PMP). The Construction Certifying Engineer (CCE) is the project team member responsible for construction QA/QC activities during RA-C. The CCE will communicate changes to be made during RA-C (if any) to field personnel and subcontractors through the Project Manager and the Loess/Groundwater RA Task Manager.

The CCE, Mr. Glen Turney, a Tennessee-Registered Professional Engineer, will have the authority to certify that work has been conducted in accordance with the plans and specifications in the RD and the RAWP Mr. Turney will:

- Provide technical support to the RA Task Manager in directions to field personnel;
- Review field inspection teams, including evaluation of field inspection personnel qualifications and monitoring field documentation;
- Evaluate construction subcontractor or supplier QA/QC documentation, protocols, or plans before the mobilization;
- Ensure that work is performed in accordance with the construction drawings and specifications, and approve modifications, if necessary;
- Identify construction completion acceptance criteria or measures of performance;
- Ensure compliance with cost and schedule constraints or document reasons for non-compliance;

The team leaders for field and construction support will communicate with Mr. Turney, the Project Manager and RA Task Manager through telephone and e-mail communication daily and weekly activity reports during RA-C. Personnel responsibilities are described in the PMP

2.2 PROJECT MEETINGS

2.2.1 Pre-Construction Meeting

A pre-construction conference will be held before RA-C begins. Conference attendees are listed in Section 4.2 of the RAWP. A portion of the conference will be dedicated to QA/QC issues including:

- The responsibilities of each organization for QA/QC;
- The authority of regulatory agency representatives and project and field team members to order work stoppages;
- Lines of authority and communication for each organization;
- Understanding of the RAWP and CQAP by field staff and of the availability of the RAWP and CQAP to field staff during RA-C;
- Procedures or protocols for observations and tests, including sampling strategies;
- Procedures or protocols for handling construction deficiencies, repairs, and retesting, including "stop work" conditions;
- Methods for documenting and reporting inspection data;
- Methods for distributing and storing documents and reports;
- Work area security and safety protocols; and
- Procedures for the location and protection of construction materials and for the prevention of damage of the materials from inclement weather or other adverse events;

2.2.2 Problem or Work Deficiency Meetings

Meetings will be convened if needed to address construction or inspection deficiencies or non-conformances with the RD, RAWP, CQAP, or subsequent specifications submitted to or from subcontractors. Deficiencies or non-conformances will be brought to the attention of the CCE and the Project Manager. Deficiencies and non-conformances will be tracked in the field log books maintained by field personnel. Field personnel will prepare brief summary reports of deficiencies or non-conformances and resolution of deficiencies or non-conformances will be documented in a field report sent to the CCE immediately upon resolution of the situation. Originals of these reports will be placed in the project central files and copies of the reports will be maintained on-site.

3.0 IMPLEMENTATION OF REMEDIAL ACTION CONSTRUCTION

3.1 EXCAVATION, TRANSPORT AND DISPOSAL OF IMPACTED SOIL

Soil ET&D is described in Section 4.4 of the RAWP and the location is shown on the construction drawings. Excavation and sampling activities will be performed by e^2M. QA/QC activities will include:

- Providing written authorization to begin work and the anticipated work schedule to subcontractors in the format of an email transmission, facsimile transmission, or letter.
- Certifying Health and Safety (H&S) training and medical monitoring for field staff.
- Ensure benching and sloping is conducted following OSHA regulations.
- Ensure confirmation and backfill sampling complies with the RA Sampling and Analysis Plan (RASAP). The field team leader will verify soil sample labels and Chain of Custody (COC) forms are filled out completely and accurately.
- Ensuring instruments used for ambient air monitoring are calibrated following manufacturer's instructions.
- Obtaining documentation ensuring that the transportation subcontractor is licensed to transport excavated material.
- Obtaining documentation that the disposal facility is approved for off-site disposal of waste from CERCLA sites

3.2 MONITORING WELLS

The locations, numbers, and depths of new groundwater monitoring wells are presented in Sections 4.6 of the RAWP. Specifications for the wells are provided in the RD and the RAWP. QA/QC activities will include:

- Obtaining documentation that the drilling subcontractor is licensed and insured to install wells in the State of Tennessee and is familiar with all applicable federal, state, county and local laws and regulations, including but not limited to the Tennessee Department of Environment and Conservation (TDEC) Water Well Licensing Regulations and Well Construction Standards (Chapter 1200-4-9) and the Shelby County Rules and Regulations of Wells.
- Providing written authorization to begin work and the anticipated work schedule to subcontractors in the format of an email transmission, facsimile transmission, or letter.
- Certifying Health and Safety (H&S) training and medical monitoring for the drilling subcontractor's workers.
- Listing materials and the material suppliers that will be used during monitoring well construction.
- Obtaining lot numbers and manufacturers specification sheets for the well casing and screen materials.
- Confirming boring and well installation depths provided by the drilling subcontractor meet specifications as outlined in the RD.

- Obtaining sieve analyses of the well filter pack material to document that the grain-size distributions meet the 10-20 gradation specification.
- Certifying that the well filter pack material is contaminant-free.
- Verifying that cement grout mixtures conform to manufacturer's specifications by measurement with a pressurized mud balance and conform to specifications in the RD and the RAWP.
- Ensure sampling complies with the RA Sampling and Analysis Plan (RASAP). The field geologist will verify sample labels and Chain of Custody (COC) forms are filled out completely and accurately.

The c^2M field geologist will be a registered Professional Geologist in Tennessee. The geologist will confirm drilling depths and well screen placements.

The drilling subcontractor is required to submit daily logs for the previous day's activities to the field geologist by noon the following day. The daily logs will contain information on drilling depths for each well, sampling, well casing and screen installations, and other information requested by the field geologist.

3.3 THERMAL-ENHANCED SVE SYSTEM CONSTRUCTION

The selected thermal-enhanced SVE vendor will finalize the locations, numbers, and depths of heater elements/electrodes, wells and treatment equipment. The final design will consist of the installation of heating elements and SVE wells capable of heating the subsurface and mobilizing and volatizing subsurface CVOCs which will be extracted by an associated vacuum blower(s). Extracted vapor will be treated with a treatment system prior to discharge to the atmosphere. Treatment technology will be chosen by the thermal-enhanced SVE vendor based on VOC vapor concentrations and mass estimates. Conceptual design details are presented in Section 4.5 of the RAWP. QA/QC activities will include.

- Ensure the thermal-enhanced SVE heater element and well layout is designed to achieve site RA-Os.
- Providing written authorization to begin work and the anticipated work schedule to the vendor representative in the format of an email transmission, facsimile transmission, or letter.
- Verification that thermal treatment areas are accurately surveyed and marked according to the RAWP and construction drawings.
- The Subcontractor will submit documentation that it is licensed to conduct the specified plumbing and electrical work

- The completed facility will meet the National Electrical Code and applicable local codes and documentation of an inspection will be provided

- Vendor will submit the layout, manufacturer's data, and dimensional information for all equipment and supplies provided or constructed for the facility ("as-built" drawings), for verification by the CCE or his designated representative.

- Confirming heater elements and SVE well installation meets specifications spelled out in the vendor-submitted work plan and RD.

- Upon completion of system installation, the thermal-enhanced SVE system will be tested to identify potential performance issues. Testing will include proper motor rotations, float switch operations, valve operations, gauge operations, and general PLC sequencing. Upon successful completion of system tests, the system will be brought online.

- Subsurface temperatures will be monitored to confirm target temperatures are met.

- Air sampling will be conducted on influent and effluent vapor samples. Samples will be collected during startup and at regular intervals during operation to track CVOC mass removal and destruction rates.

- System operations and performance data will be collected to assess removal rates and capture zones and to provide a basis for system modifications and enhancements.

The e^{2}M field engineer will provide oversight during construction activities. Field notes and observations will be made in a bound log book. Photos will also be taken to document construction progress.

The thermal-enhanced SVE subcontractor is required to submit weekly construction reports documenting the previous week's construction activities. The construction report will contain information on construction progress, milestones completed, and upcoming construction activities.

3.4 ZERO VALENT IRON GROUNDWATER INJECTIONS

ZVI injections will target groundwater beneath the source areas with total VOC concentrations greater than 1,000 μg/L. Injections will be performed by a subcontractor with oversight by e^{2}M field personnel. Final ZVI locations will be determined within one year following completion of the thermal-enhanced SVE treatment in the loess. QA/QC activities will include:

- Verification that ZVI injection locations are accurately surveyed and marked.

- Obtaining documentation that the drilling subcontractor is licensed and insured to install wells perform ZVI injections in the State of Tennessee and is familiar with all applicable federal, state, county and local laws and regulations, including but not limited to the Tennessee Department of

Environment and Conservation (TDEC) Underground Injection Control Rules (Attachment A of this CQAP), the TDEC Water Well Licensing Regulations and Well Construction Standards (Chapter 1200-4-9), and the Shelby County Rules and Regulations of Wells.

- Providing written authorization to begin work and the anticipated work schedule to subcontractors in the format of an email transmission, facsimile transmission, or letter.
- Certifying Health and Safety (H&S) training and medical monitoring for the drilling subcontractor's workers.
- Ensure that ZVI mixing and injection procedures follow those as outlined in the RD and RAWP. If target ZVI volumes are not able to be injected, contingency plans for additional injection volumes of ZVI product in subsequent locations and/or new injection locations will be adhered to.
- Ensure system operational parameters are monitored as outlined in the RAWP. Monitoring will include readings from pressure transducers (to ensure uniform horizontal and vertical distribution of ZVI monitoring) and adjacent ground surface monitoring.
- Ensure confirmation borings are collected following the scheduled outlined in the RAWP. A set of three confirmation borings will be collected after every eight ZVI injections and will confirm ZVI injection . Soil samples collected from borings will follow RASAP procedures.
- Qualitatively verify the emplacement of the ZVI in the subsurface using field screening techniques as outlined in the RAWP. These include visually inspection the soil cores and following the Magnetic Separation Test Procedure.
- Ensure that ZVI injection borings and confirmation soil borings are abandoned in accordance with applicable rules and regulations of the State of Tennessee (Rules of TDEC, Division of Water Supply, Chapter 1200-4-1, Well Construction and Abandonment Standards)

The c^2M field geologist will be a registered Professional Geologist in Tennessee. The geologist will confirm ZVI injection depths and volumes.

4.0 REFERENCES

CH2M Hill, 2007. Rev. 4 Memphis Depot, Dunn Field Source Areas Final Remedial Design. Prepared for the U S. Army Engineering and Support Center, Huntsville, Alabama. April 2007

ATTACHMENT A

SUBSTANTIVE REQUIREMENTS FOR UNDERGROUND INJECTION CONTROL

The substantive requirements of a TDEC Underground Injection Control permit are listed below, in accordance with the Rules of the TDEC Division of Water Supply, Rules of Water Quality Control Board, Chapter 1200-4-6, Underground Injection Control.

Rule 1200-4-6-.04, Prevention of Pollution of Ground Water.

Protection of Underground Sources of Drinking Water (USDWs)

- An injection well cannot cause or allow the movement of fluid containing any contaminant that would result in the pollution of USDWs.

Rule 1200-4-6-.08 Authorization by Permit for Injection Wells Not Authorized by Rule.

Inspections

- TDEC personnel, or an authorized TDEC representative shall be allowed, upon the presentation of credentials, to:
    - enter upon the premises where the activity is conducted, or where records must be kept;
    - have access to and copy, at reasonable times, operational records;
    - inspect at reasonable times the facility, equipment (including monitoring and control
    - equipment), practices, or operations, and;
    - sample or monitor at reasonable times, any substances or parameters at any location.

Monitoring

- The operator of the injection system shall monitor injection fluids, injection operations, and local ground water supplies, in accordance with the requirements for Class V wells stated in rule 1200-4-6-.14.

Retention of Records

- The operator shall retain records of all monitoring information for a period of least three years. Records of the nature and composition of all injected fluids will be retained until three years after the completion of any plugging and abandonment procedures.

Reporting

- The operator shall report, orally within 24 hours after the time the operator becomes aware of the circumstances, any noncompliance which may endanger health or the environment, including:
    - any monitoring or other information which indicates that any contaminant may cause an endangerment to USDWs, or
    - any malfunction of the injection system which may cause fluid migration into or between USDWs.

Rule 1200-4-6-.09 General Standards and Methods

Well Abandonment

- Any well that is to be permanently plugged and abandoned shall be completely filled and sealed in such a manner that vertical movement of fluid either into or between formation(s) containing USDWs through the bore hole is not allowed.

APPENDIX D

REMEDIAL DESIGN CONSTRUCTION DRAWINGS

936 142

MEMPHIS DEPOT DUNN FIELD SOURCE AREAS REMEDIAL DESIGN MEMPHIS, TENNESSEE

LOCATION MAP
NTS

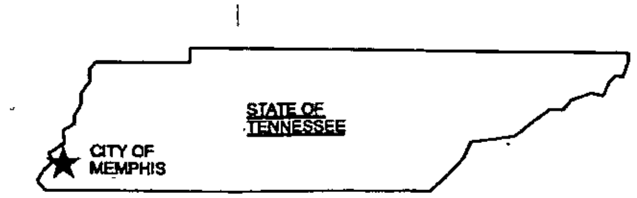
N

MICHAEL WILLIAM PERLMUTTER REGISTERED ENGINEER AGRICULTURE COMMERCE No. 00107703 STATE OF TENNESSEE
4-12-07

U.S. Army Engineering and Support Center, Huntsville

INDEX TO DRAWINGS

SHEET No.	DRAWING No.	TITLE
1	G-1	TITLE SHEET, LOCATION MAP, AND INDEX TO DRAWINGS
2	G-2	SITE MAP
3	F-1	SVE SYSTEM LAYOUT
4	F-2	CONVEYANCE PIPING CROSS SECTIONS
5	F-3	PROCESS FLOW DIAGRAM
6	F-4	PROCESS AND INSTRUMENTATION DIAGRAM
7	F-5	EQUIPMENT COMPOUND
8	F-6	BUILDING DETAILS
9	F-7	FENCE DETAIL
10	F-8	DETAILS
11	L-1	NORTH LOESS TREATMENT AREAS
12	L-2	SOUTH LOESS TREATMENT AREAS
13	GW-1	NORTH ZVI INJECTION LOCATIONS
14	GW-2	SOUTH ZVI INJECTION LOCATIONS



VICINITY MAP
NTS

NO.	DATE	REVISION	BY	APVD

DSGN M. PERLMUTTER | DR E. GRIGGS | CHK M. STRONG | APVD D. NELSON

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

GENERAL
TITLE SHEET, LOCATION MAP, AND INDEX TO DRAWINGS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEPTEMBER, 2006
PROJ	177356
DWG	G-1
SHEET	1

USER: EGRIGGS TAB: LAYOUT1
ATL/PROJ/148071 DDMT/SARD 2006
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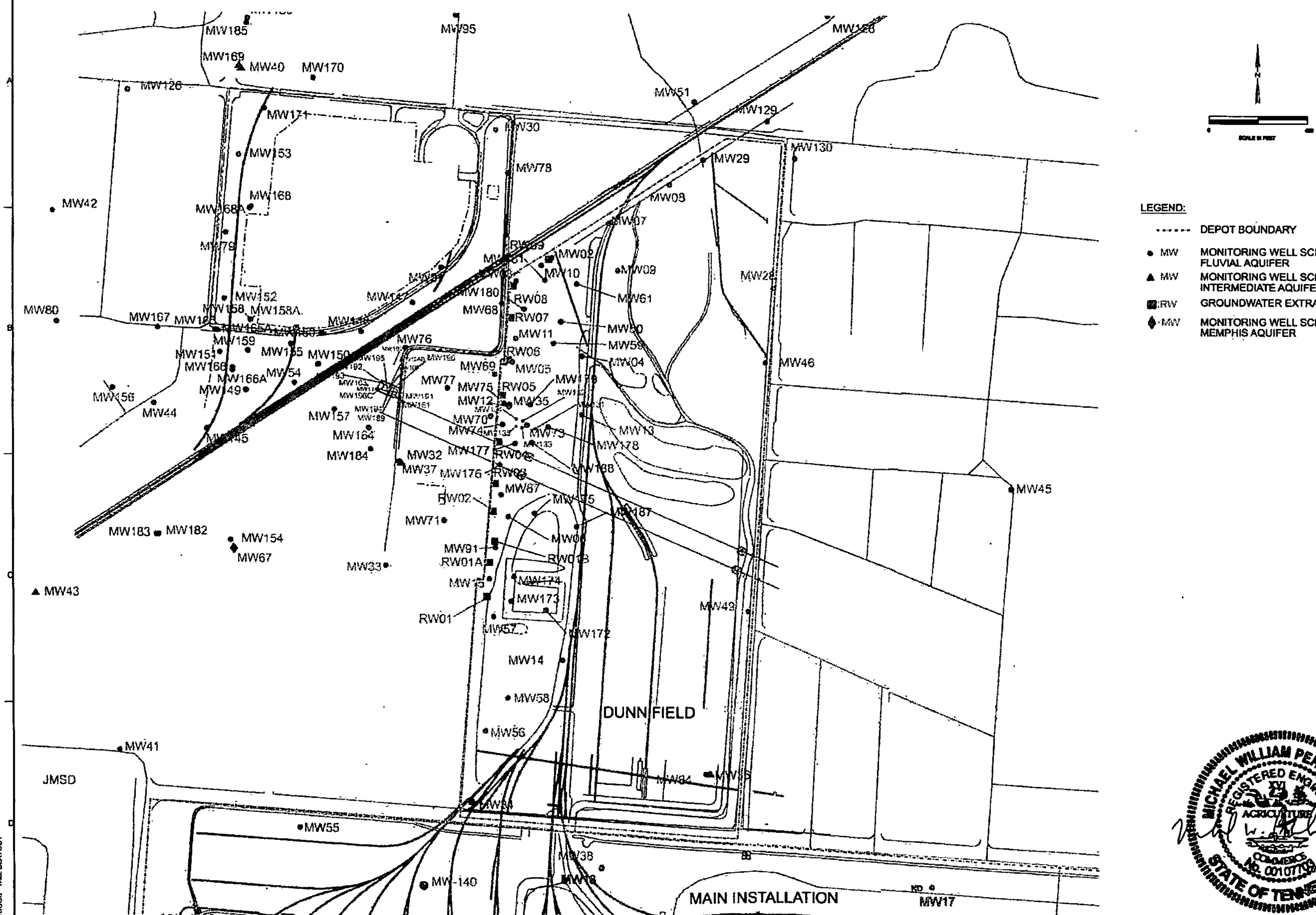
936 143



LEGEND:

- DEPOT BOUNDARY
- ● MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- ▲ MW MONITORING WELL SCREENED IN INTERMEDIATE AQUIFER
- RW GROUNDWATER EXTRACTION WELL
- ◆ MW MONITORING WELL SCREENED IN MEMPHIS AQUIFER

MICHAEL WILLIAM PERLMUTTER
REGISTERED ENGINEER
AGRICULTURE COMMERCE
NO. 00107703
STATE OF TENNESSEE

4-12-07

USER: EGRIGGS TAB: DLAYOUT

ATL/PROJ/148071 DDMT/SARD 2006

FILENAME: SHEET 2 SITE MAP.DWG

PLOT DATE: 7-Jul-06

PLOT TIME: 1:10:40 PM

NO.	DATE	REVISION	BY	APVD

DSGN N. PERLMUTTER | DR E. GRIGGS | CHK N. STRONG | APVD D. NELSON

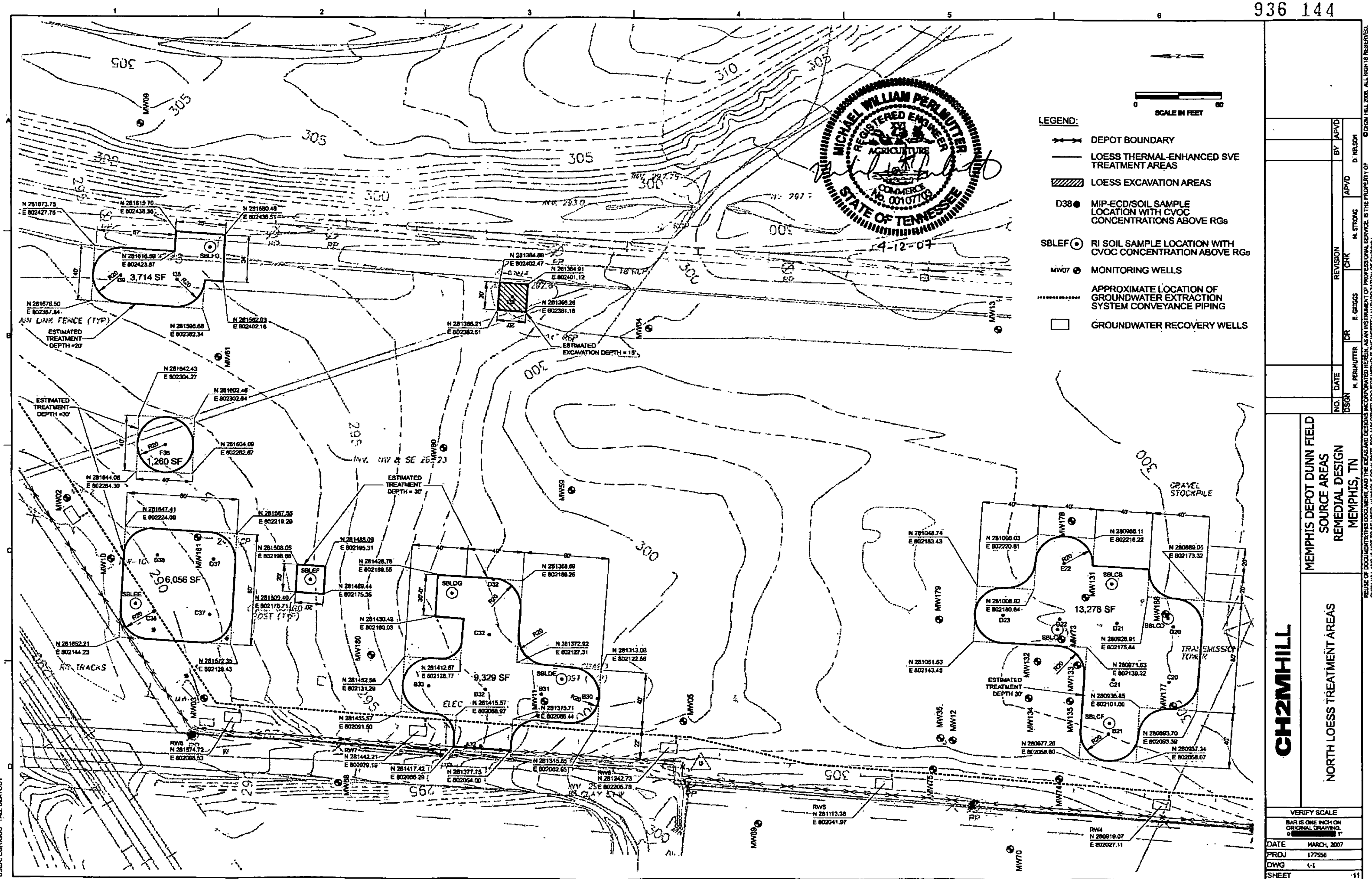
MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

GENERAL
SITE MAP

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEPTEMBER, 2006
PROJ	177556
DWG	G-2
SHEET	2



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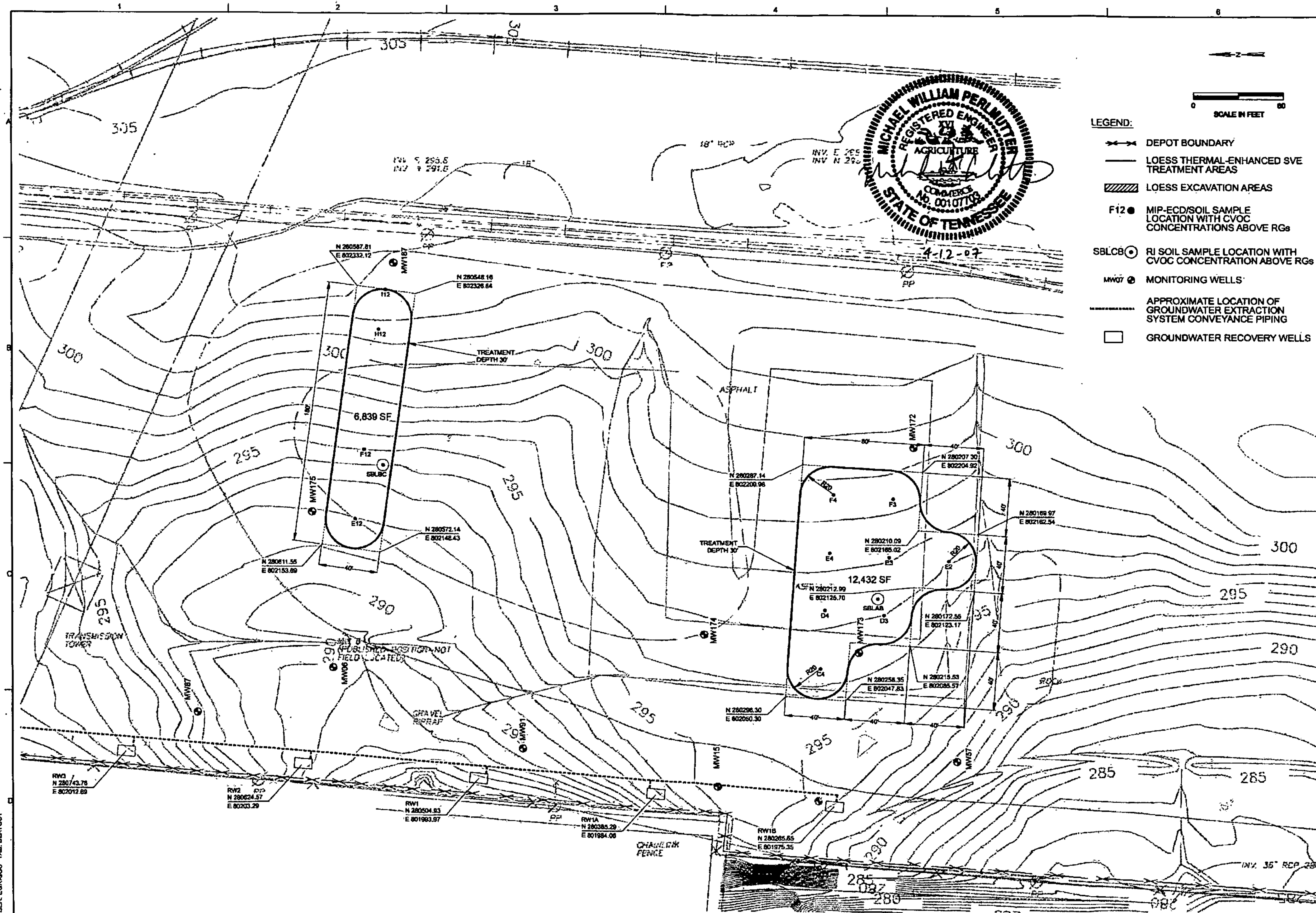
FILENAME: SVE SYSTEM LAYOUT.DWG PLOT DATE: 8-Mar-07 PLOT TIME: 5:06:19 PM



CH2MHILL

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

SOUTH LOESS TREATMENT AREAS

NO.	DATE	REVISION	BY	APVD

DSGN: M. PERLMUTTER | DR: E. GRIGGS | CHK: N. STRONG | APVD: D. NELSON

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH, 2007
PROJ	177556
DWG	L-2
SHEET	12

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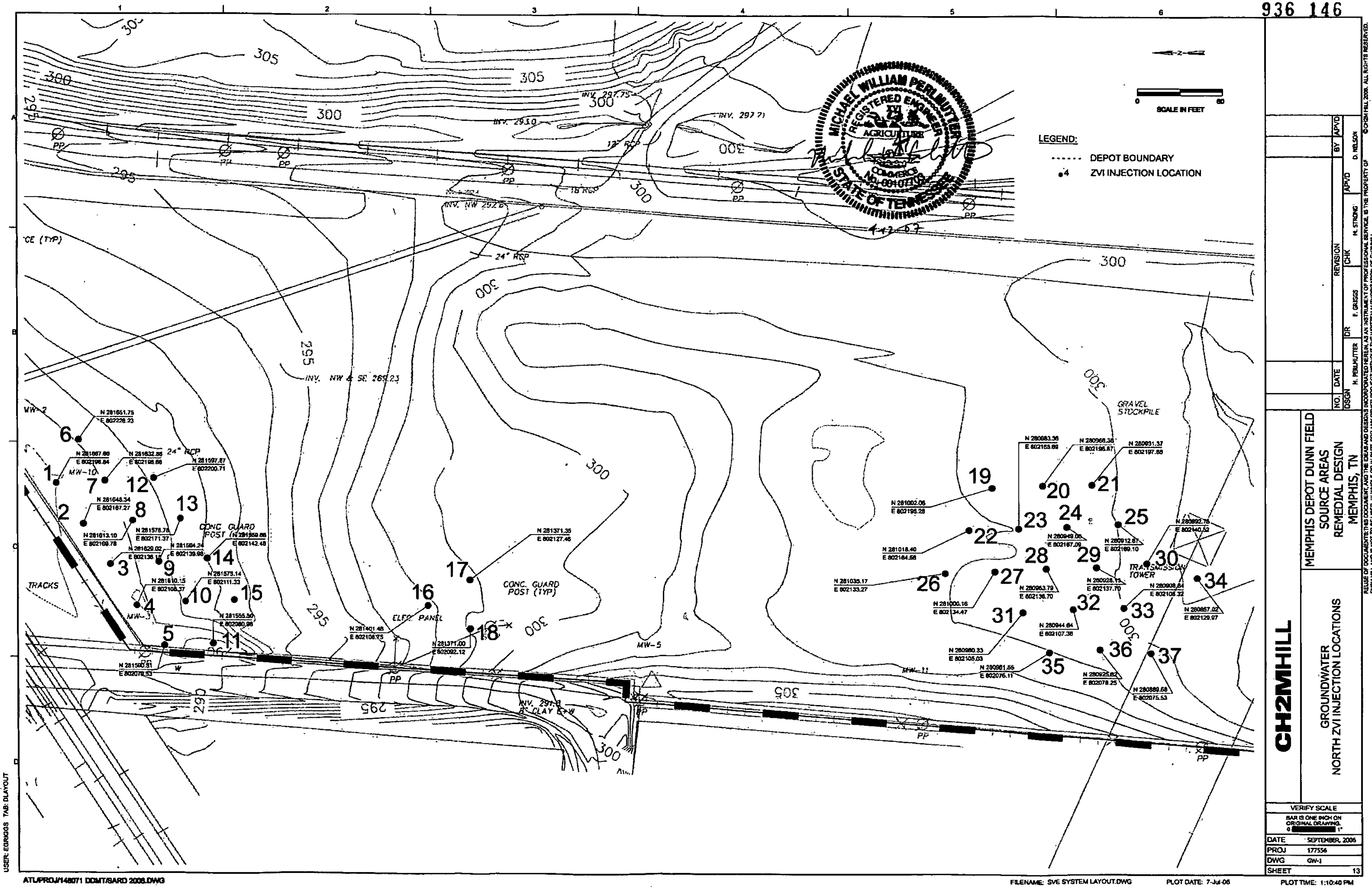
936 146


LEGEND:
DEPOT BOUNDARY
ZVI INJECTION LOCATION
SCALE IN FEET
0
60
MICHAEL WILLIAM PERLMUTTER
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
STATE OF TENNESSEE
GRAVEL STOCKPILE
TRANSMISSION TOWER
CONC. GUARD POST (TYP)
ELEC. PANEL
TRACKS
24" RCP
18" RCP
INV. NW & SE 269.23
MW-2
MW-3
MW-5
MW-10
MW-11
PP
CH2MHILL
GROUNDWATER
NORTH ZVI INJECTION LOCATIONS
MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN
REVISION
DSGN H. PERLMUTTER
DR E. GRIGGS
CHK N. STRONG
APVD D. NELSON
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
DATE SEPTEMBER, 2006
PROJ 177556
DWG GW-1
SHEET 13
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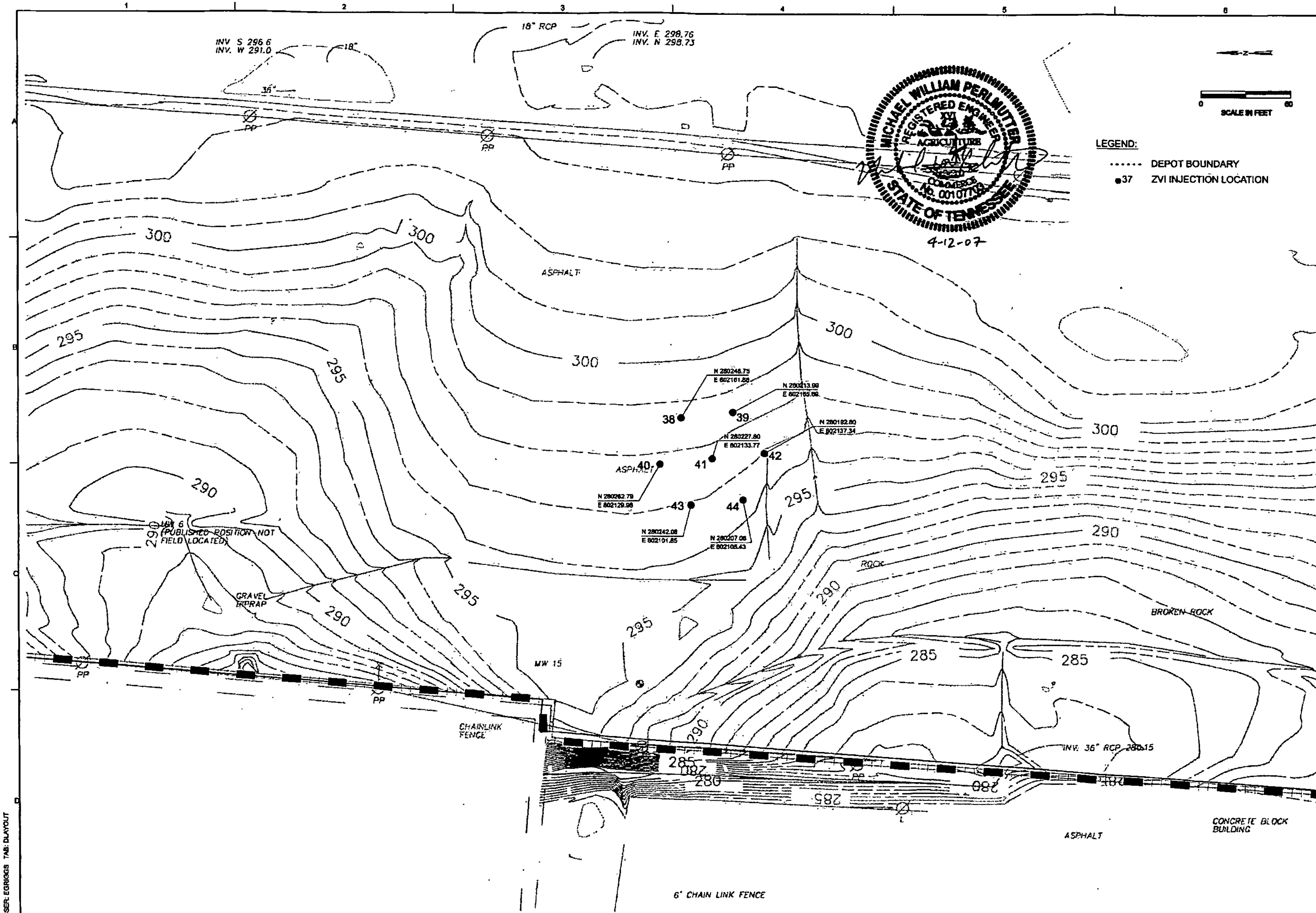
USER: EGRIGGS TAB: DLAYOUT
ATU/PROJ/146071 DDMT/SARD 2006.DWG
FILENAME: SVE SYSTEM LAYOUT.DWG
PLOT DATE: 7-Jul-06
PLOT TIME: 1:10:40 PM

936 147



CH2MHILL

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

GROUNDWATER
SOUTH ZVI INJECTION LOCATIONS

NO.	DATE	REVISION	BY	APVD

DSGN M. PERLMUTTER | DR E. GRIGGS | CHK M. STRONG | APVD D. NELSON

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

DATE	SEPTEMBER, 2006
PROJ	177556
DWG	GW-2
SHEET	14

USER: EGRIGGS TAB: DLAYOUT

ATL/PROJ/148071 DDMT/SARD 2006.DWG

FILENAME: SVE SYSTEM LAYOUT.DWG PLOT DATE: 7-Jul-06 PLOT TIME: 1:10:40 PM

APPENDIX E
DISCOVERY OF CRUSHED, BURIED DRUMS, TA-3

E-1 Site Photographs – 12 June 2007

E-2 Laboratory Analyses

E-3 SWMU 23 Assessment Report and Location Map

E-4 FPM Geophysical Report

Site Photographs – 12 June 2007

1) Crushed metal drums in hand excavation at planned location of VP-7 in TA-3.

2) Viscous material remaining in crushed drums

LABORATORY REPORT

L0706296

06/18/07 16:39

Submitted By

KEMRON Environmental Services
156 Starlite Drive
Marietta , OH 45750
(740) 373 - 4071

For

Account Name: Engineering-Environmental Management
184 Creekside Park
Suite 100
Spring Branch, TX 78070
Attention: Lance Hines

Account Number: 2886
Work ID: DEFENSE DEPOT MEMPHIS DEPOT

Sample Summary

Client ID	Lab ID	Date Collected	Date Received
DUNN FIELD-1	L0706296-01	06/12/2007 11:30	06/13/2007

936 151

KEMRON ENVIRONMENTAL SERVICES

Report Number: L0706296

Report Date : June 18, 2007

Sample Number: L0706296-01
Client ID: DUNN FIELD-1
Matrix: Solidwaste
Workgroup Number: WG242829
Collect Date: 06/12/2007 11:30
Sample Tag: DL01

PrePrep Method: NONE
Prep Method 3550B
Analytical Method: 8082
Analyst: ECL
Dilution: 400
Units ug/kg

Instrument: HP9
Prep Date: 06/14/2007 08:00
Cal Date: 03/01/2007 13:56
Run Date: 06/18/2007 09:56
File ID: 9GR40107.R

Analyte	CAS. Number	Result	Qual	RL	MDL
Aroclor-1016	12674-11-2		U	6500	3250
Aroclor-1221	11104-28-2		U	6500	3250
Aroclor-1232	11141-16-5		U	6500	3250
Aroclor-1242	53469-21-9		U	6500	3250
Aroclor-1248	12672-29-6		U	6500	3250
Aroclor-1254	11097-69-1		U	6500	3250
Aroclor-1260	11096-82-5		U	6500	3250

Surrogate	% Recovery	Lower	Upper	Qual
2,4,5,6-Tetrachloro-M-Xylene		29	133	*
Decachlorobiphenyl		58	125	*

U Undetected; the analyte was analyzed for, but not detected.
* This surrogate or spike analyte was diluted out.

Sample Number: L0706296-01
Client ID: DUNN FIELD-1
Matrix. Solidwaste
Workgroup Number: WG242608
Collect Date 06/12/2007 11:30
Sample Tag: 01

PrePrep Method. NONE
Prep Method: 5030B
Analytical Method· 8015B
Analyst. SMH
Dilution: 1
Units ug/kg

Instrument: HP5
Prep Date· 06/14/2007 14:33
Cal Date: 09/27/2006 14:30
Run Date: 06/14/2007 14:33
File ID· 5G305367

Analyte	CAS. Number	Result	Qual	RL	MDL
Gasoline Range Organics	8006-61-9	303		100	45.2

Surrogate	% Recovery	Lower	Upper	Qual
Chlorobenzene(s)	94.1	64	148	

Sample Number: L0706296-01
Client ID: DUNN FIELD-1
Matrix Solidwaste
Workgroup Number· WG242598
Collect Date: 06/12/2007 11:30
Sample Tag DL01

PrePrep Method: NONE
Prep Method: 5030B
Analytical Method 8260B
Analyst: MES
Dilution· 50
Units ug/kg

Instrument: HPMS10
Prep Date: 06/14/2007 17:15
Cal Date: 05/17/2007 15:55
Run Date: 06/14/2007 17:15
File ID: 10M56110

Analyte	CAS. Number	Result	Qual	RL	MDL
Acetone	67-64-1	652	F	1010	506
Benzene	71-43-2		U	506	50.6
Bromobenzene	108-86-1		U	506	50.6
Bromochloromethane	74-97-5		U	506	50.6
Bromodichloromethane	75-27-4		U	506	50.6
Bromoform	75-25-2		U	506	50.6
Bromomethane	74-83-9		U	1010	101
2-Butanone	78-93-3		U	1010	253
n-Butylbenzene	104-51-8	203	F	506	50.6
sec-Butylbenzene	135-98-8	92.3	F	506	50.6
tert-Butylbenzene	98-06-6		U	506	50.6
Carbon disulfide	75-15-0		U	506	50.6
Carbon tetrachloride	56-23-5		U	506	50.6
Chlorobenzene	108-90-7		U	506	50.6

KEMRON ENVIRONMENTAL SERVICES

Report Number: L0706296
Report Date : June 18, 2007

Sample Number: L0706296-01
Client ID DUNN FIELD-1
Matrix Solidwaste
Workgroup Number. WG242598
Collect Date: 06/12/2007 11:30
Sample Tag: DL01

PrePrep Method: NONE
Prep Method: 5030B
Analytical Method: 8260B
Analyst MES
Dilution 50
Units ug/kg

Instrument: HPMS10
Prep Date 06/14/2007 17:15
Cal Date: 05/17/2007 15:55
Run Date: 06/14/2007 17:15
File ID: 10M56110

Analyte	CAS. Number	Result	Qual	RL	MDL
Chlorodibromomethane	124-48-1		U	506	50.6
Chloroethane	75-00-3		U	1010	101
2-Chloroethyl vinyl ether	110-75-8		Q	1010	202
Chloroform	67-66-3		U	506	50.6
Chloromethane	74-87-3		U	1010	202
2-Chlorotoluene	95-49-8		U	506	50.6
4-Chlorotoluene	106-43-4		U	506	50.6
1,2-Dibromo-3-chloropropane	96-12-8		Q	506	202
1,2-Dibromoethane	106-93-4		U	506	50.6
Dibromomethane	74-95-3		U	506	50.6
1,2-Dichlorobenzene	95-50-1		U	506	50.6
1,3-Dichlorobenzene	541-73-1		U	506	50.6
1,4-Dichlorobenzene	106-46-7		U	506	50.6
Dichlorodifluoromethane	75-71-8		U	1010	101
1,1-Dichloroethane	75-34-3		U	506	101
1,2-Dichloroethane	107-06-2		U	506	50.6
1,1-Dichloroethene	75-35-4		U	506	50.6
cis-1,2-Dichloroethene	156-59-2		U	506	50.6
trans-1,2-Dichloroethene	156-60-5		U	506	50.6
1,2-Dichloropropane	78-87-5		U	506	50.6
1,3-Dichloropropane	142-28-9		U	506	50.6
2,2-Dichloropropane	594-20-7		U	506	50.6
cis-1,3-Dichloropropene	10061-01-5		U	506	50.6
trans-1,3-Dichloropropene	10061-02-6		U	506	50.6
1,1-Dichloropropene	563-58-6		U	506	50.6
Ethylbenzene	100-41-4	287	F	506	50.6
2-Hexanone	591-78-6		U	1010	253
Hexachlorobutadiene	87-68-3		U	506	50.6
Isopropylbenzene	98-82-8	144	F	506	50.6
p-Isopropyltoluene	99-87-6	145	F	506	50.6
4-Methyl-2-pentanone	108-10-1		U	1010	253
Methylene chloride	75-09-2		U	506	101
Naphthalene	91-20-3	186	F	1010	50.6
n-Propylbenzene	103-65-1	275	F	506	50.6
Styrene	100-42-5		U	506	50.6
1,1,1,2-Tetrachloroethane	630-20-6		U	506	50.6
1,1,2,2-Tetrachloroethane	79-34-5		U	506	50.6
Tetrachloroethene	127-18-4		U	506	50.6
Toluene	108-88-3	248	F	506	50.6
1,2,3-Trichlorobenzene	87-61-6		U	506	50.6
1,2,4-Trichlorobenzene	120-82-1		U	506	50.6
1,1,1-Trichloroethane	71-55-6		U	506	50.6
1,1,2-Trichloroethane	79-00-5		U	506	50.6
Trichloroethene	79-01-6		U	506	50.6
Trichlorofluoromethane	75-69-4		U	1010	101
1,2,3-Trichloropropane	96-18-4		U	506	101
1,2,4-Trimethylbenzene	95-63-6	1030		506	50.6
1,3,5-Trimethylbenzene	108-67-8	547		506	50.6

KEMRON ENVIRONMENTAL SERVICES

Report Number:L0706296

Report Date :June 18, 2007

Sample Number L0706296-01
Client ID:DUNN FIELD-1
Matrix:Solidwaste
Workgroup Number:WG242598
Collect Date:06/12/2007 11:30
Sample Tag:DL01

PrePrep Method:NONE
Prep Method:5030B
Analytical Method 8260B
Analyst MES
Dilution 50
Units ug/kg

Instrument:HPMS10
Prep Date:06/14/2007 17:15
Cal Date:05/17/2007 15:55
Run Date 06/14/2007 17:15
File ID:10M56110

Analyte	CAS. Number	Result	Qual	RL	MDL
Vinyl acetate	108-05-4		Q	1010	101
Vinyl chloride	75-01-4		U	1010	101
o-Xylene	95-47-6	756		506	50.6
m-,p-Xylene	136777-61-2	1930		506	50.6

Surrogate	% Recovery	Lower	Upper	Qual
Dibromofluoromethane	77.4	65	135	
1,2-Dichloroethane-d4	76.2	52	149	
Toluene-d8	79.5	84	116	*
4-Bromofluorobenzene	86.8	84	118	

U Undetected; the analyte was analyzed for, but not detected.
Q One or more quality control criteria failed. See narrative.
* Surrogate or spike compound out of range
F Found; the analyte was positively identified with concentration above MDL but below RL.

Sample Number L0706296-01
Client ID DUNN FIELD-1
Matrix:Solidwaste
Workgroup Number·WG242739
Collect Date:06/12/2007 11:30
Sample Tag:P1

PrePrep Method:NONE
Prep Method:3550B
Analytical Method.8270C
Analyst:ASP
Dilution·100
Units:ug/kg

Instrument:HPMS5
Prep Date:06/13/2007 13:30
Cal Date:06/07/2007 16:04
Run Date:06/14/2007 23:18
File ID·5M46632

Analyte	CAS. Number	Result	Qual	RL	MDL
Phenol	108-95-2		U	129000	64500
Bis(2-Chloroethyl)ether	111-44-4		U	129000	64500
2-Chlorophenol	95-57-8		U	129000	64500
1,3-Dichlorobenzene	541-73-1		U	129000	64500
1,4-Dichlorobenzene	106-46-7		U	129000	64500
Benzyl alcohol	100-51-6		U	129000	64500
1,2-Dichlorobenzene	95-50-1		U	129000	64500
2-Methylphenol	95-48-7		U	129000	64500
3-,4-Methylphenol	106-44-5		U	129000	64500
bis(2-Chloroisopropyl)ether	39638-32-9		U	129000	64500
N-Nitrosodipropylamine	621-64-7		U	129000	64500
Hexachloroethane	67-72-1		U	129000	64500
Nitrobenzene	98-95-3		U	129000	64500
Isophorone	78-59-1		U	129000	64500
2-Nitrophenol	88-75-5		U	129000	64500
2,4-Dimethylphenol	105-67-9		U	129000	64500
Benzoic acid	65-85-0		U	645000	258000
Bis(2-Chloroethoxy)Methane	111-91-1		U	129000	64500
2,4-Dichlorophenol	120-83-2		U	129000	64500
1,2,4-Trichlorobenzene	120-82-1		U	129000	64500
Naphthalene	91-20-3		U	129000	64500
4-Chloroaniline	106-47-8		U	129000	64500
Hexachlorobutadiene	87-68-3		U	129000	64500
4-Chloro-3-methylphenol	59-50-7		U	129000	64500
2-Methylnaphthalene	91-57-6		U	129000	64500
Hexachlorocyclopentadiene	77-47-4		U	129000	64500

KEMRON ENVIRONMENTAL SERVICES

Report Number: L0706296
Report Date · June 18, 2007

Sample Number L0706296-01
Client ID·DUNN FIELD-1
Matrix: Solidwaste
Workgroup Number: WG242739
Collect Date: 06/12/2007 11:30
Sample Tag: P1

PrePrep Method. NONE
Prep Method 3550B
Analytical Method: 8270C
Analyst: ASP
Dilution·100
Units: ug/kg

Instrument·HPMS5
Prep Date: 06/13/2007 13:30
Cal Date: 06/07/2007 16:04
Run Date 06/14/2007 23:18
File ID: 5M46632

Analyte	CAS. Number	Result	Qual	RL	MDL
2,4,6-Trichlorophenol	88-06-2		U	129000	64500
2,4,5-Trichlorophenol	95-95-4		U	129000	64500
2-Chloronaphthalene	91-58-7		U	129000	64500
2-Nitroaniline	88-74-4		U	645000	258000
Dimethylphthalate	131-11-3		U	129000	64500
Acenaphthylene	208-96-8		U	129000	64500
2,6-Dinitrotoluene	606-20-2		U	129000	64500
3-Nitroaniline	99-09-2		U	645000	258000
Acenaphthene	83-32-9		U	129000	64500
2,4-Dinitrophenol	51-28-5		U	645000	258000
4-Nitrophenol	100-02-7		U	645000	258000
Dibenzofuran	132-64-9		U	129000	64500
2,4-Dinitrotoluene	121-14-2		U	129000	64500
Diethylphthalate	84-66-2		U	129000	64500
4-Chlorophenyl-phenyl ether	7005-72-3		U	129000	64500
Fluorene	86-73-7		U	129000	64500
4-Nitroaniline	100-01-6		U	645000	258000
4,6-Dinitro-2-methylphenol	534-52-1		U	645000	258000
N-Nitrosodiphenylamine	86-30-6		U	129000	64500
4-Bromophenyl-phenylether	101-55-3		U	129000	64500
Hexachlorobenzene	118-74-1		U	129000	64500
Pentachlorophenol	87-86-5		U	645000	258000
Phenanthrene	85-01-8		U	129000	64500
Anthracene	120-12-7		U	129000	64500
Di-N-Butylphthalate	84-74-2		U	129000	64500
Fluoranthene	206-44-0		U	129000	64500
Pyrene	129-00-0		U	129000	64500
Butylbenzylphthalate	85-68-7		U	129000	64500
3,3'-Dichlorobenzidine	91-94-1		U	258000	129000
Benzo(a)anthracene	56-55-3		U	129000	64500
Chrysene	218-01-9		U	129000	64500
bis(2-Ethylhexyl)phthalate	117-81-7		U	129000	64500
Di-n-octylphthalate	117-84-0		U	129000	64500
Benzo(b)fluoranthene	205-99-2		U	129000	64500
Benzo(k)fluoranthene	207-08-9		U	129000	64500
Benzo(a)pyrene	50-32-8		U	129000	64500
Indeno(1,2,3-cd)pyrene	193-39-5		U	129000	64500
Dibenzo(a,h)Anthracene	53-70-3		U	129000	64500
Benzo(g,h,i)Perylene	191-24-2		U	129000	64500

Surrogate	% Recovery	Lower	Upper	Qual
2-Fluorophenol		37	120	*
Phenol-d5		40	120	*
Nitrobenzene-d5		37	120	*
2-Fluorobiphenyl		43	120	*
2,4,6-Tribromophenol		36	126	*
p-Terphenyl-d14		32	120	*

U Undetected; the analyte was analyzed for, but not detected.
* This surrogate or spike analyte was diluted out.

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KEMRON ENVIRONMENTAL SERVICES

Report Number: L0706296

Report Date : June 18, 2007

Sample Number: L0706296-01
Client ID DUNN FIELD-1
Matrix: Solidwaste
Workgroup Number: WG242726
Collect Date: 06/12/2007 11:30
Sample Tag: DL01

PrePrep Method: NONE
Prep Method 3550B
Analytical Method 8015B
Analyst HAV
Dilution 20
Units: ug/kg

Instrument: HP14
Prep Date: 06/13/2007 13:30
Cal Date: 06/11/2007 13:55
Run Date: 06/15/2007 09:44
File ID: 14G15174.R

Analyte	CAS. Number	Result	Qual	RL	MDL
Diesel Range (C10-C28)	68334-30-5	21300000		957000	239000

Surrogate	% Recovery	Lower	Upper	Qual
o-Terphenyl		47	142	*
Octacosane		25	162	*

* This surrogate or spike analyte was diluted out.

Sample Number: L0706296-01
Client ID DUNN FIELD-1
Matrix Solidwaste
Workgroup Number WG242753
Collect Date: 06/12/2007 11:30
Sample Tag DL01

PrePrep Method: NONE
Prep Method: 3550B
Analytical Method: 8081A
Analyst: ECL
Dilution: 400
Units: ug/kg

Instrument: HP15
Prep Date 06/14/2007 08:00
Cal Date: 06/14/2007 16:23
Run Date: 06/15/2007 17:55
File ID: 15G9987.F

Analyte	CAS. Number	Result	Qual	RL	MDL
alpha-BHC	319-84-6		U	650	130
beta-BHC	319-85-7		U	650	130
delta-BHC	319-86-8		U	650	130
gamma-BHC (Lindane)	58-89-9		U	650	130
Heptachlor	76-44-8		U	650	130
Aldrin	309-00-2		U	650	130
Heptachlor epoxide	1024-57-3		U	650	130
Endosulfan I	959-98-8		U	650	130
Dieldrin	60-57-1		U	650	130
4,4'-DDE	72-55-9		U	650	130
Endrin	72-20-8		U	650	130
Endosulfan II	33213-65-9		U	650	130
4,4'-DDD	72-54-8		U	650	130
Endosulfan sulfate	1031-07-8		U	650	130
4,4'-DDT	50-29-3		U	650	130
Methoxychlor	72-43-5		U	650	130
Endrin ketone	53494-70-5		U	650	130
Endrin aldehyde	7421-93-4		U	650	130
alpha Chlordane	5103-71-9		U	650	130
gamma Chlordane	5103-74-2		U	650	130
Toxaphene	8001-35-2		U	13000	6580

Surrogate	% Recovery	Lower	Upper	Qual
2,4,5,6-Tetrachloro-m-xylene		69	124	*
Decachlorobiphenyl		56	132	*

U Undetected; the analyte was analyzed for, but not detected.
* This surrogate or spike analyte was diluted out.

KEMRON ENVIRONMENTAL SERVICES

Report Number: L0706296
Report Date : June 18, 2007

Sample Number: L0706296-01
Client ID DUNN FIELD-1
Matrix: Solidwaste
Workgroup Number: WG242751
Collect Date: 06/12/2007 11:30
Sample Tag DL01

PrePrep Method NONE
Prep Method: METHOD
Analytical Method: 8151A
Analyst: ECL
Dilution: 100
Units. ug/kg

Instrument HP9
Prep Date. 06/14/2007 08:00
Cal Date: 04/04/2007 16:05
Run Date 06/15/2007 19:17
File ID: 9G40099.R

Analyte	CAS. Number	Result	Qual	RL	MDL
2,4-D	94-75-7		U	15900	7960
2,4-DB	94-82-6		U	15900	7960
2,4,5-T	93-76-5		U	1590	796
2,4,5-TP (Silvex)	93-72-1		U	1190	597
Dalapon	75-99-0		U	39800	19900
Dicamba	1918-00-9		U	1590	796
Dichloroprop	120-36-5		U	15900	7960
Dinoseb	88-85-7		U	7960	3980
MCPA	94-74-6		U	1590000	796000
MCPP	93-65-2		U	1590000	796000
Pentachlorophenol	87-86-5		U	1590	796

Surrogate	% Recovery	Lower	Upper	Qual
2,4-Dichlorophenylacetic acid		45	140	*

U Undetected; the analyte was analyzed for, but not detected.
* This surrogate or spike analyte was diluted out.

Sample Number: L0706296-01
Client ID DUNN FIELD-1
Matrix: Solidwaste
Workgroup Number: WG242652
Collect Date: 06/12/2007 11:30
Sample Tag: 01

PrePrep Method. NONE
Prep Method: METHOD
Analytical Method: 7471A
Analyst: KHR
Dilution: 1
Units: mg/kg

Instrument HYDRA
Prep Date: 06/14/2007 11:20
Cal Date. 06/14/2007 15:53
Run Date 06/14/2007 16:39
File ID: HY.061407.163901
Percent Solid: 100

Analyte	CAS. Number	Result	Qual	RL	MDL
Mercury, Total	7439-97-6	0.0506	F	0.399	0.00992

F Found; the analyte was positively identified with concentration above MDL but below RL.

Sample Number: L0706296-01
Client ID DUNN FIELD-1
Matrix: Solidwaste
Workgroup Number: WG242598
Collect Date: 06/12/2007 11:30
Sample Tag. DL01

PrePrep Method. NONE
Prep Method: 5030B
Analytical Method: 8260B
Analyst: MES
Dilution: 50
Units. ug/kg

Instrument. HPMS10
Prep Date: 06/14/2007 17:15
Cal Date: 05/17/2007 15:55
Run Date 06/14/2007 17:15
File ID: 10M56110

Analyte	CAS. Number	Result	Qual	Ret Time
Heptane, 2-methyl-	592-27-8	738		11.86
Heptane, 3-methyl-	589-81-1	670		12.08
unknown		2190		12.6
unknown		2270		13.83
Octane, 3-methyl-	2216-33-3	783		13.99
Nonane	111-84-2	1280		14.48
Benzene, 1-ethyl-3-methyl-	620-14-4	1280		16.51
Benzene, 1-methyl-2-(1-methylethyl	527-84-4	605		17.4
unknown		1000		19.78
The second isomer tricyclopentadie	1000222-21-1	1650		21.52

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KEMRON ENVIRONMENTAL SERVICES

Report Number: L0706296

Report Date : June 18, 2007

Sample Number: L0706296-01
Client ID: DUNN FIELD-1
Matrix: Solidwaste
Workgroup Number: WG242809
Collect Date: 06/12/2007 11:30
Sample Tag: 01

PrePrep Method: NONE
Prep Method: 3050B
Analytical Method: 6010B
Analyst: KHR
Dilution: 1
Units: mg/kg

Instrument: IRIS-ICP
Prep Date: 06/14/2007 06:45
Cal Date: 06/18/2007 08:28
Run Date: 06/18/2007 13:30
File ID: IR.061807.133000

Analyte	CAS. Number	Result	Qual	RL	MDL
Aluminum, Total	7429-90-5	679		15.3	7.63
Silver, Total	7440-22-4	1.14	F	1.53	0.191
Arsenic, Total	7440-38-2	2.80	F	3.82	0.382
Barium, Total	7440-39-3	131		0.382	0.0763
Beryllium, Total	7440-41-7	0.0668	F	0.382	0.00916
Calcium, Total	7440-70-2	958		7.63	3.82
Cadmium, Total	7440-43-9	0.736		0.382	0.0382
Cobalt, Total	7440-48-4	11.6		0.763	0.0916
Chromium, Total	7440-47-3	9.60		0.763	0.0916
Copper, Total	7440-50-8	17.0		0.763	0.382
Potassium, Total	7440-09-7	38.6		38.2	19.1
Magnesium, Total	7439-95-4	127		19.1	9.16
Manganese, Total	7439-96-5	31.1		0.382	0.0763
Sodium, Total	7440-23-5	28.0		19.1	3.82
Nickel, Total	7440-02-0	0.910	F	1.53	0.382
Lead, Total	7439-92-1	15.7		3.82	0.382
Antimony, Total	7440-36-0	15.7		7.63	0.382
Thallium, Total	7440-28-0		U	19.1	0.763
Vanadium, Total	7440-62-2	1.16		0.382	0.191

U Undetected; the analyte was analyzed for, but not detected.
F Found; the analyte was positively identified with concentration above MDL but below RL.

Sample Number L0706296-01
Client ID: DUNN FIELD-1
Matrix Solidwaste
Workgroup Number: WG242809
Collect Date. 06/12/2007 11:30
Sample Tag: DL01

PrePrep Method. NONE
Prep Method: 3050B
Analytical Method: 6010B
Analyst: KHR
Dilution. 100
Units. mg/kg

Instrument: IRIS-ICP
Prep Date. 06/14/2007 06:45
Cal Date: 06/18/2007 08:28
Run Date: 06/18/2007 14:11
File ID. IR.061807.141100

Analyte	CAS. Number	Result	Qual	RL	MDL
Iron, Total	7439-89-6	32000		153	76.3
Zinc, Total	7440-66-6	45200		76.3	38.2

Sample Number· L0706296-01
Client ID: DUNN FIELD-1
Matrix: Solidwaste
Workgroup Number: WG242809
Collect Date 06/12/2007 11:30
Sample Tag: DL02

PrePrep Method: NONE
Prep Method: 3050B
Analytical Method· 6010B
Analyst KHR
Dilution· 500
Units: mg/kg

Instrument: IRIS-ICP
Prep Date· 06/14/2007 06:45
Cal Date: 06/18/2007 08:28
Run Date: 06/18/2007 14:23
File ID: IR.061807.142300

Analyte	CAS. Number	Result	Qual	RL	MDL
Selenium, Total	7782-49-2		U	1910	191

U Undetected; the analyte was analyzed for, but not detected.

e2M Engineering-Environmental Mngmt Inc

Lab Name:TestAmerica Laboratories, Inc. (fka SDG Number:

Matrix: (soil/water) SO
Lab Sample ID:D7G120198 001
Method: SW846 8260B
Volatile Organics, GC/MS (8260B)

Sample WT/Vol: 2 / mL
Work Order: J2P951AC
Dilution factor: 1

Date Received: 07/12/07
Date Extracted:07/13/07
Date Analyzed: 07/13/07

QC Batch: 7197037

Client Sample Id: DF-DRUMS-2

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/kg) mg/L	Q
71-43-2	Benzene	0.010	U
78-93-3	2-Butanone	0.050	U
56-23-5	Carbon tetrachloride	0.010	U
108-90-7	Chlorobenzene	0.010	U
67-66-3	Chloroform	0.010	U
107-06-2	1,2-Dichloroethane	0.010	U
75-35-4	1,1-Dichloroethene	0.010	U
127-18-4	Tetrachloroethene	0.010	U
79-01-6	Trichloroethene	0.010	U
75-01-4	Vinyl chloride	0.010	U

SURROGATE RECOVERY	%	ACCEPTABLE LIMITS
Dibromofluoromethane	87	(79 - 119)
1,2-Dichloroethane-d4	88	(64 - 129)
4-Bromofluorobenzene	101	(78 - 121)
Toluene-d8	105	(78 - 120)

FORM I

e2M Engineering-Environmental Mngmt Inc

Lab Name:TestAmerica Laboratories, Inc. (fka SDG Number:

Matrix: (soil/water) SO
Method: SW846 8270C
Base/Neutrals and Acids (8270C)

Lab Sample ID:D7G120198 001

Sample WT/Vol: 199 / mL
Work Order: J2P951AU
Dilution factor: 1

Date Received: 07/12/07
Date Extracted:07/13/07
Date Analyzed: 07/17/07

QC Batch: 7194602

Client Sample Id: DF-DRUMS-2

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/kg) mg/L	Q
106-46-7	1,4-Dichlorobenzene	0.10	U
121-14-2	2,4-Dinitrotoluene	0.10	U
118-74-1	Hexachlorobenzene	0.10	U
87-68-3	Hexachlorobutadiene	0.10	U
67-72-1	Hexachloroethane	0.10	U
95-48-7	2-Methylphenol	0.10	U
98-95-3	Nitrobenzene	0.10	U
87-86-5	Pentachlorophenol	0.50	U
110-86-1	Pyridine	0.20	U
95-95-4	2,4,5-Trichlorophenol	0.10	U
88-06-2	2,4,6-Trichlorophenol	0.10	U
65794-96-9	3-Methylphenol & 4-Methylphe	0.10	U

SURROGATE RECOVERY	%	ACCEPTABLE LIMITS
2-Fluorobiphenyl	79	(49 - 120)
2-Fluorophenol	81	(50 - 120)
2,4,6-Tribromophenol	87	(51 - 120)
Nitrobenzene-d5	86	(51 - 120)
Phenol-d5	78	(47 - 120)
Terphenyl-d14	85	(56 - 120)

FORM I

e2M Engineering-Environmental Mngmt Inc

Lab Name:TestAmerica Laboratories, Inc. (fka SDG Number:

Matrix: (soil/water) SO
Method: SW846 8081A
Pesticides (8081A)

Lab Sample ID:D7G120198 001

Sample WT/Vol: 102 / mL
Work Order: J2P951AD
Dilution factor: 1

Date Received: 07/12/07
Date Extracted:07/13/07
Date Analyzed: 07/17/07

QC Batch: 7194601

Client Sample Id: DF-DRUMS-2

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/kg) mg/L	Q
58-89-9	gamma-BHC (Lindane)	0.00050	U
57-74-9	Chlordane (technical)	0.0050	U
72-20-8	Endrin	0.00050	U
76-44-8	Heptachlor	0.00050	U
1024-57-3	Heptachlor epoxide	0.00050	U
72-43-5	Methoxychlor	0.020	U
8001-35-2	Toxaphene	0.020	U
5103-71-9	alpha-Chlordane	0.00050	U
5103-74-2	gamma-Chlordane	0.00050	U

SURROGATE RECOVERY	%	ACCEPTABLE LIMITS
Decachlorobiphenyl	95	(50 - 151)
Tetrachloro-m-xylene	91	(64 - 131)

FORM I

e2M Engineering-Environmental Mngmt Inc

Lab Name:TestAmerica Laboratories, Inc. (fka SDG Number:

Matrix: (soil/water) SO
Method: SW846 8151A
Herbicides (8151A)

Lab Sample ID:D7G120198 001

Sample WT/Vol: 107 / mL
Work Order: J2P951AE
Dilution factor: 0.93

Date Received: 07/12/07
Date Extracted:07/17/07
Date Analyzed: 07/18/07

QC Batch: 7198172

Client Sample Id: DF-DRUMS-2

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/kg) mg/L	Q
94-75-7	2,4-D	0.037	U
93-72-1	2,4,5-TP (Silvex)	0.0093	U

SURROGATE RECOVERY	%	ACCEPTABLE LIMITS
DCAA	57	(10 - 131)

FORM I

STL

e2M Engineering-Environmental Mngmt Inc

TCLP Analysis Data Sheet

Lab Name:	TESTAMERICA DENVER	**Client Sample ID:**	DF-DRUMS-2
Lot/SDG Number:	D7G120198	**Lab Sample ID:**	D7G120198-001
Matrix:	WATER	**Lab WorkOrder:**	J2P95
% Moisture:	N/A	**Date/Time Collected:**	07/11/07 10 27
Basis:	Wet	**Date/Time Received:**	07/12/07 08.30
Analysis Method:	6010B	**Date Leached:**	07/13/07 00 00
Unit:	mg L	**Date/Time Extracted:**	07/16/07 07:00
QC Batch ID:	7194598	**Date/Time Analyzed:**	07/16/07 15.29
Sample Aliquot:	50 mL	**Instrument ID:**	016
Dilution Factor:	1		

CAS No.	Analyte	Conc.	MDL	RL	Q
7440-38-2	Arsenic	0 0044	0 0044	0.50	U
7440-39-3	Barium	**2.0**	0 0010	10	B J
7440-43-9	Cadmium	**0.0020**	0 00045	0 10	B
7440-47-3	Chromium	0.0026	0.0026	0.50	U
7439-92-1	Lead	**0.037**	0.0026	0.50	B
7782-49-2	Selenium	0 0049	0.0049	0.10	U
7440-22-4	Silver	0.0028	0.0028	0.50	U

Form 1 Analysis Data Sheet Equivalent

STL

e2M Engineering-Environmental Mngmt Inc
TCLP Analysis Data Sheet

Lab Name:	TESTAMERICA DENVER	**Client Sample ID:**	DF-DRUMS-2
Lot/SDG Number:	D7G120198	**Lab Sample ID:**	D7G120198-001
Matrix:	WATER	**Lab WorkOrder:**	J2P95
% Moisture:	N/A	**Date/Time Collected:**	07/11/07 10.27
Basis:	Wet	**Date/Time Received:**	07/12/07 08:30
Analysis Method:	7470A	**Date Leached:**	07/13/07 00:00
Unit:	mg/L	**Date/Time Extracted:**	07/17/07 13 00
QC Batch ID:	7197197	**Date/Time Analyzed:**	07/17/07 20.50
Sample Aliquot:	10 mL	**Instrument ID:**	019
Dilution Factor:	1		

CAS No.	Analyte	Conc.	MDL	RL	Q
7439-97-6	Mercury	0.000027	0.000027	0.0020	U

Form 1 Analysis Data Sheet Equivalent

e2M Engineering-Environmental Mngmt Inc

Client Sample ID: DF-DRUMS-2

General Chemistry

Lot-Sample #...: D7G120198-001 **Work Order #...:** J2P95 **Matrix.........:** SO
Date Sampled...: 07/11/07 10:27 **Date Received..:** 07/12/07
% Moisture.....: 15

PARAMETER	RESULT	RL	UNITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
pH	**9.7**	**0.10**	**No Units**	**SW846 9045C**	**07/18/07**	**7200106**
		Dilution Factor: 1		Analysis Time..: 15:59	MDL............:	
Ignitability	ND	--	--	SW846 SECTION 7.1	07/19/07	7200701
		Dilution Factor: 1		Analysis Time..: 16:00	MDL............:	
Paint Filter Test	ND	--	No Units	SW846 9095A	07/19/07	7200700
		Dilution Factor: 1		Analysis Time..: 14:15	MDL............:	
Percent Moisture	**15**	**0.10**	**%**	**ASTM D 2216-90**	**07/17/07**	**7198510**
		Dilution Factor: 1		Analysis Time..: 20:00	MDL............: 0.0	
Reactive Cyanide	ND	1.2	mg/kg	SW846 7.3.3	07/17-07/19/07	7200066
		Dilution Factor: 1		Analysis Time..: 14:00	MDL............:	
Reactive Sulfide	**27 F,B**	**59**	**mg/kg**	**SW846 7.3.4**	**07/17/07**	**7198650**
		Dilution Factor: 1		Analysis Time..: 20:00	MDL............:	

NOTE(S):

RL Reporting Limit

ND or U (Undetected) The analyte was analyzed for, but not detected

Results and reporting limits have been adjusted for dry weight.

F Found. Analyte positively identified, concentration is an estimate >MDL and <RL

B Blank contamination The analyte was found in an associated blank

SWMU/AOC Assessment Report

UNIT NUMBER: 23

UNIT NAME: Construction Debris and Foods Burial Site

TYPE OF UNIT: Burial Ground

UNIT LOCATION: The unit is approximately 175 feet from the west boundary and 1,000 feet from the south boundary of Dunn Field The unit is located in the Disposal Area of CERCLA Operable Unit 1, Dunn Field.

GENERAL DIMENSIONS AND PHYSICAL DESCRIPTION: Burial site of unknown dimensions. The maximum burial depth was 10 feet in the Dunn Field area.

FUNCTION OF UNIT: This unit of unknown dimensions was used for the disposal of discarded foods and burned construction debris. Later, the unit was filled in with soil and used for the storage of bauxite.

DATE(S) OF OPERATION: 1948

DESCRIPTION OF WASTES (include hazardous constituents if known): Discarded foods and construction debris.

HAS A RELEASE OCCURRED? ( ) Yes ( ) No ( ) Suspected (X) Unknown

RELEASE DATA: N/A

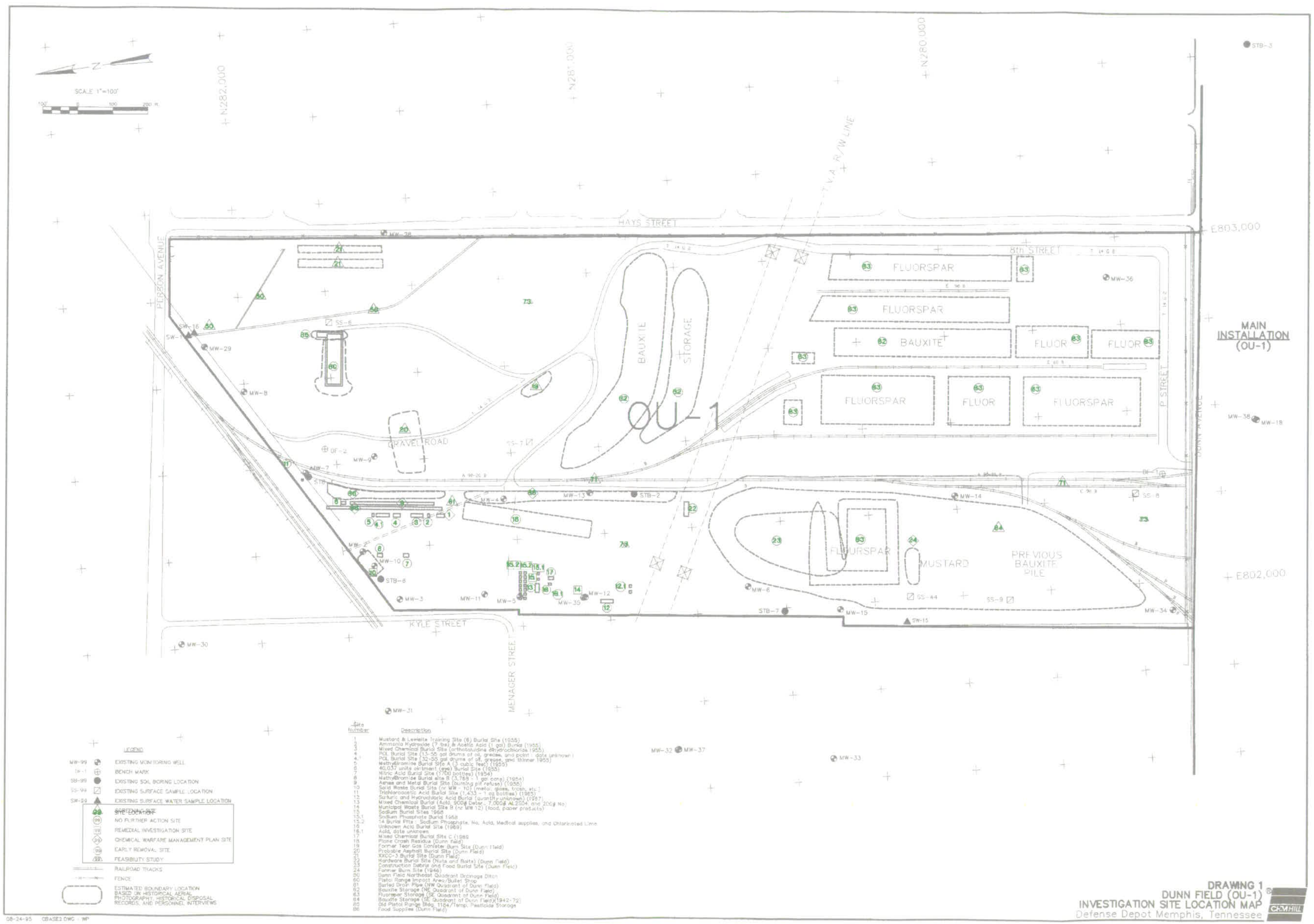
MEDIA AFFECTED: N/A

STATUS OF REMEDIAL INVESTIGATION OR REMEDIAL ACTION: Site was investigated during CERCLA Remedial Investigation and was assigned a low priority (no RA likely) per the Dunn Field Record of Decision. No further action is required for this site, however, it is located in the Dunn Field disposal area where land use controls will apply.

COMMENTS: Designated as "No Further Action" in the RFA

REFERENCES:
RFA Report, January 1990; page 22 of 60
Dunn Field RI Report, Rev. 2, July 2002; Section 8, Table 8-1
Dunn Field RI Report, Rev. 2, July 2002; Section 10 6, page 10-20
BRAC Clean-up Plan, Rev. 2, Version 7, December 2003, Section 3.4.4, page 3-87
Dunn Field Record of Decision, February 2004, Rev. 2; Table 2-2, page 1 of 3

DATE PREPARED: March 09, 2004


MAIN INSTALLATION (OU-1)
DUNN AVENUE
HAYS STREET
PERSON AVENUE
KYLE STREET
MENAGER STREET
8th STREET
P STREET
T.V.A. R/W LINE
GRAVEL ROAD
OU-1
BAUXITE
STORAGE
FLUORSPAR
FLUOR
PREVIOUS BAUXITE PILE
MUSTARD
N282,000
N281,000
N280,000
E803,000
E802,000
SCALE 1"=100'
LEGEND
MW-99 EXISTING MONITORING WELL
DF-1 BENCH MARK
SB-99 EXISTING SOIL BORING LOCATION
SS-99 EXISTING SURFACE SAMPLE LOCATION
SW-99 EXISTING SURFACE WATER SAMPLE LOCATION
SITE LOCATION
NO FURTHER ACTION SITE
REMEDIAL INVESTIGATION SITE
CHEMICAL WARFARE MANAGEMENT PLAN SITE
EARLY REMOVAL SITE
FEASIBILITY STUDY
RAILROAD TRACKS
FENCE
ESTIMATED BOUNDARY LOCATION BASED ON HISTORICAL AERIAL PHOTOGRAPHY, HISTORICAL DISPOSAL RECORDS, AND PERSONNEL INTERVIEWS
Site Number Description
1 Mustard & Lewisite Training Site (6) Burial Site (1955)
2 Ammonia Hydroxide (7 lbs) & Acetic Acid (1 gal) Burial (1955)
3 Mixed Chemical Burial Site (orthotoluidine dihydrochloride 1955)
4 POL Burial Site (13-55 gal drums of oil, grease, and paint : date unknown)
4.1 POL Burial Site (32-55 gal drums of oil, grease, and thinner 1955)
5 MethylBromide Burial Site A (3 cubic feet) (1955)
6 40,037 units ointment (eye) Burial Site (1955)
7 Nitric Acid Burial Site (1700 bottles) (1954)
8 MethylBromide Burial site B (3,768 - 1 gal cans) (1954)
9 Ashes and Metal Burial Site (burning pit refuse) (1955)
10 Solid Waste Burial Site (nr MW - 10) (metal, glass, trash, etc.)
11 Trichloroacetic Acid Burial Site (1,433 - 1 oz bottles) (1965)
12 Surfuric and Hydrochloric Acid Burial (quantity unknown) (1967)
13 Mixed Chemical Burial (Acid, 900# Deter., 7,000# AL2SO4, and 200# Na)
14 Municipal Waste Burial Site B (nr MW 12) (food, paper products)
15 Sodium Burial Sites 1968
15.1 Sodium Phosphate Burial 1968
15.2 14 Burial Pits : Sodium Phosphate, Na, Acid, Medical supplies, and Chlorinated Lime
16 Unknown Acid Burial Site (1969)
16.1 Acid, date unknown
17 Mixed Chemical Burial Site C (1969
18 Plane Crash Residue (Dunn field)
19 Former Tear Gas Canister Burn Site (Dunn Field)
20 Probable Asphalt Burial Site (Dunn Field)
21 XXCC-3 Burial Site (Dunn Field)
22 Hardware Burial Site (Nuts and Bolts) (Dunn Field)
23 Construction Debris and Food Burial Site (Dunn Field)
24 Former Burn Site (1946)
50 Dunn Field Northeast Quadrant Drainage Ditch
60 Pistol Range Impact Area/Bullet Stop
61 Buried Drain Pipe (NW Quadrant of Dunn Field)
62 Bauxite Storage (NE Quadrant of Dunn Field)
63 Fluorspar Storage (SE Quadrant of Dunn Field)
64 Bauxite Storage (SE Quadrant of Dunn Field)(1942-72)
65 Old Pistol Range Bldg. 1184/Temp. Pesticide Storage
66 Food Supplies (Dunn Field)
DRAWING 1
DUNN FIELD (OU-1)
INVESTIGATION SITE LOCATION MAP
Defense Depot Memphis, Tennessee
CH2M HILL
08-24-95 OBASE2.DWG WP

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FPM

Geophysical & UXO Services
Division of FPM Group, Ltd.

October 12, 2007

Project No.: 884-07-02

Mr. Kevin Sedlak, MS, PG
engineering-environmental Management, Inc. (e2M)
184 Creekside Park
Spring Branch, TX 78070

**Re: Geophysical Survey Report – Dunn Field Source Area
Memphis Defense Depot, Tennessee**

Dear Mr. Sedlak:

In this letter report, we discuss the results of the surface geophysical survey conducted by FPM Geophysical & UXO Services (FPM) at the Dunn Field Source Area (DFSA), Memphis Defense Depot, Tennessee on October 9, 2007. The scope of the project and area of interest that required a geophysical survey were specified by e2M.

1.0 Introduction

The purpose of the surface geophysical survey was to locate buried metal items thought to represent drums. FPM investigated an approximately 1-acre area of the DFSA site using a Geonics EM61-MK2 high-resolution time-domain electromagnetic metal detector (EM61) coupled to a Trimble Pathfinder Pro-XRS differential global positioning system (DGPS).

Site conditions consisted of an open, grassy area that generally sloped from the site access road on the east, toward a tree-lined drainage ditch located immediately to the west of survey area. Total relief was approximately 15 feet.

2.0 Survey Equipment, Quality Control and Field Procedures

2.1 Field Equipment

The Geonics EM61-MK2 time-domain electromagnetic system generates a pulsed primary magnetic field that induces "secondary" eddy currents in the ground and in nearby metal objects. The receiver is timed to measure the induced secondary magnetic field in four time gates after the primary field generated within the ground has dissipated (i.e., measured response is caused only by currents induced in metal objects).

The EM61 consists of a pair of 1.0- x 0.5-meter coils that were configured in the wheel or "cart" mode (the EM61 can also be carried using a shoulder harness for rough terrain). The lower coil, which is both a transmitter and receiver, is located 17.5 inches above the ground surface. The upper coil, which is strictly a receiver coil, is 12.5 inches above the lower coil. The nominal sampling width of the EM61-MK2 is 1.0 meter. EM data were recorded on a Juniper Systems Allegro field computer.

The Trimble Pathfinder Pro-XRS DGPS provides sub-meter accuracy and operates on a single frequency that utilizes a carrier phase measurement technique and is equipped with multi-path rejection technology. This technology is favorable in open, as well as lightly wooded and congested areas where GPS signals are affected by multi-path reflection.

EM61 survey data were linked coupled to the GPS to provide real-time positional control. The data were acquired by linking the GPS rover to the EM61 Allegro field computer. An RS232 data cable serves as the communication bridge between the GPS rover and the respective data logger. Positional data were sampled and recorded at a rate of 1 sample per second or 1 Hz. The GPS rover was configured to output a National Marine Electronics Association (NMEA) data string utilizing the Global Positioning System Fixed Data (GGA) format to the geophysical data logger. Positional information was logged in the World Geodetic System, 1984 (WGS84), UTM 15N coordinate system. The positional data were later projected in the Tennessee State Planar coordinate system, North American Datum, 1927 (NAD27), FIPS 4100. Final survey data are presented in U.S. Feet.

2.2 Quality Control

Prior to conducting the geophysical survey, FPM occupied a land survey control point provided by e2M to verify the DGPS data positioning was accurate. The projection used at the DFSA is NAD27, and the survey data collected at the control point was with 2 feet of the published coordinates for that point and determined to be acceptable for this type of investigation.

As a geophysical quality control (QC) measure, FPM conducted a "walkaway" noise test with the EM61 to determine the potential effect of high-voltage power lines that traverse the DFSA approximately 200 feet north of the site. Collecting data roughly perpendicular to the trend of the power lines, the magnitude of the response was determined to be less than 5 milliVolts (mV), which is negligible.

Pre-survey QC steps included the following:

- Electronics Warm-Up: Equipment/electronics warm-up is conducted to minimize sensor drift due to thermal stabilization. The manufacturer's instructions for equipment startup will be followed. If instrument readings fail to stabilize within the recommended warm-up period, an additional 5 minutes will be added to the warm-up period. If instrument readings fail to stabilize after the additional 5 minutes, troubleshooting procedures will be

- initiated. Equipment that fails to stabilize will be replaced. The EM61 functioned properly following the required warm-up period.

- Personnel Test: Personnel tests will be conducted on all survey personnel to ensure that potential interference sources (e.g., pocketknives, pens, and buckles) have been removed from their bodies. All personnel performing the surveys or who come into close proximity to the survey equipment will approach the sensor and have the instrument operator monitor and record the results. Acceptance criteria will be established on-site based on the survey equipment used and the target item geophysical signature. All equipment operators passed the personnel test for this type of investigation.

- Vibration Test: The vibration test, also known as a cable shake test, will be used to identify shorting cables and problematic connectors. All cables will be shaken for a minimum of 5 seconds with the instrument held in a static position. If shorts are found, the associated cables and/or connectors will be replaced immediately. The vibration test will be repeated once repairs are complete. Acceptance criteria include an absence of data spikes in the data profile during the test. If data spikes persist, troubleshooting procedures will be initiated. If the data spike issue cannot be resolved, the equipment will be replaced. The EM61 functioned properly during the vibration test.

- Static / Standard Test: A background static and standard test is a 3-minute test performed at the start and end of each survey session. The static test is conducted to quantify instrument background readings and drift, locate potential interference spikes, and provide repeatability of the instrument to a standard test item. After instrument warm-up, a minimum of 1-minute of static background data will be collected. Following the 1-minute static test, a standard (e.g., metal item such as a trailer ball or wrench) will be placed on the ground centered under the EM61 coils. The final 1-minute static test is conducted after the standard is removed. The EM61 passed the opening and closing static tests and showed a repeatable value of 16-18 mV for the standard used.

- Latency / Moving Repeatability Tests: A latency and data repeatability test will be performed at the beginning and end of the day. Latency refers to the amount of time required for the sensor to "see" the target and the GPS to record the position of the associated anomaly, usually 200 to 400 milliseconds. The EM61 will be passed over a standard metal item (e.g., trailer ball or wrench) with known real world coordinates and sensor response two times; once in the S-N direction and once in the N-S direction. The latency will be applied to the geophysical data. The corrected geophysical data will be interpreted and the results will be compared to the known position and response of the metal object. Errors in position repeatability outside acceptable tolerances indicate a problem in navigation or navigation equipment. Errors in amplitude repeatability outside acceptable tolerances indicate detector problems or operator error. Acceptance criteria for data repeatability include ±20% for response amplitude and ±20 cm for positional accuracy. The EM61 passed the latency and moving repeatability tests.

2.3 Field Procedures

Following QC testing, the proposed survey area was walked with the EM61 in the reconnaissance mode to identify the broad outline of site anomalies and aid with selecting the actual area to be investigated. Once the survey area was selected, the east baseline was established with a metric fiberglass tape approximately 8 meters from the western edge of the site access road, and the west baseline was established 60 meters to the west. Using these baselines as references, alternating color pinflags were placed 3 meters apart to provide good line of sight for the EM61 equipment operator to minimize data gaps during data collection.

The EM61 survey was conducted along lines nominally spaced 1.5 meters apart and data were collected at 10 Hz, resulting in an approximately 0.25-ft downline station interval. Data were collected and analyzed from the first three time-gates of the lower coil and from the single time-gate of the upper coil. The upper coil time gate matches the third time-gate of the lower coil.

Surface features that could potentially affect data interpretation were surveyed with the DGPS. At the DFSA site, this included five monitoring wells.

To verify the positional data collected in WGS84 would successfully re-project into NAD27 during data processing, the four corners of the survey area were shot with the DGPS in both WGS84 and NAD27.

3.0 Geophysical Survey Results and Recommendations

EM61 data from Channels 1, 2 and 3 were evaluated and it was determined that the signal to noise ratio (SNR) was superior in the Channel 3 data. **Figure 1** presents the Grid Map of EM61 Channel 3 data with the interpreted results. The data were analyzed using the OASIS Montaj® geophysical mapping system from Geosoft, Inc. The data were processed in the WGS84 coordinate system and projected in NAD27 utilizing the DGPS data at the monitoring wells and the four corners of the survey area. An additional minor re-projection (~1 meter) was made to align the data with the e2M coordinate data for the wells.

The typical EM61 response to a buried drum or a cluster of buried drums can vary from a few 10's to well over 1,000 mV, largely dependent on the number of drums present, their age and degree of decomposition, and their depth. From the data shown in **Figure 1**, much of the western and southern portion of the site shows high-amplitude anomalies caused by significant buried metal thought to represent drums based on site history. The western and southern anomalies are seen to trend off site. Significant amounts of buried metal also occur in the northern and eastern portions of the site, some of which are identified.

Table 1 presents the coordinates of pinflags used to mark out three anomalous areas of the site. The area identified by the white boundary on **Figure 1** shows a broad area interpreted to contain a high concentration of buried metal. EM61 Channel 3 amplitudes exceed 500 mV in much of this area. The two areas identified by yellow boundaries on **Figure 1** are interpreted to have the highest volume of buried metal in the area investigated. EM61 Channel 3 amplitudes exceed 3,000 mV in these areas.

Other than the possible need to further define the boundaries of those anomalies trending off-site, no additional surface geophysical surveys are recommended for this site.

Table 1
Coordinates of Anomalous Areas Marked Out

Id	X	Y
Broad Outline of High Metal Concentration Area		
1	802110.5	280569.7
2	802218.8	280513.5
3	802217.8	280592.4
4	802164.8	280648.8
5	802141.1	280654.9
6	802109.2	280639.1
Highest Metal Concentration (Southern Area)		
Id	X	Y
7	802128.4	280576.3
8	802206.0	280559.6
9	802207.8	280589.1
10	802134.7	280602.4
Highest Metal Concentration (Northern Area)		
Id	X	Y
11	802125.9	280634.9
12	802169.3	280606.4
13	802169.6	280629.4
14	802147.2	280648.2

Note: Coordinates in US Feet, North American Datum (NAD) 27, TN State Plane, FIPS 4100

4.0 Certification

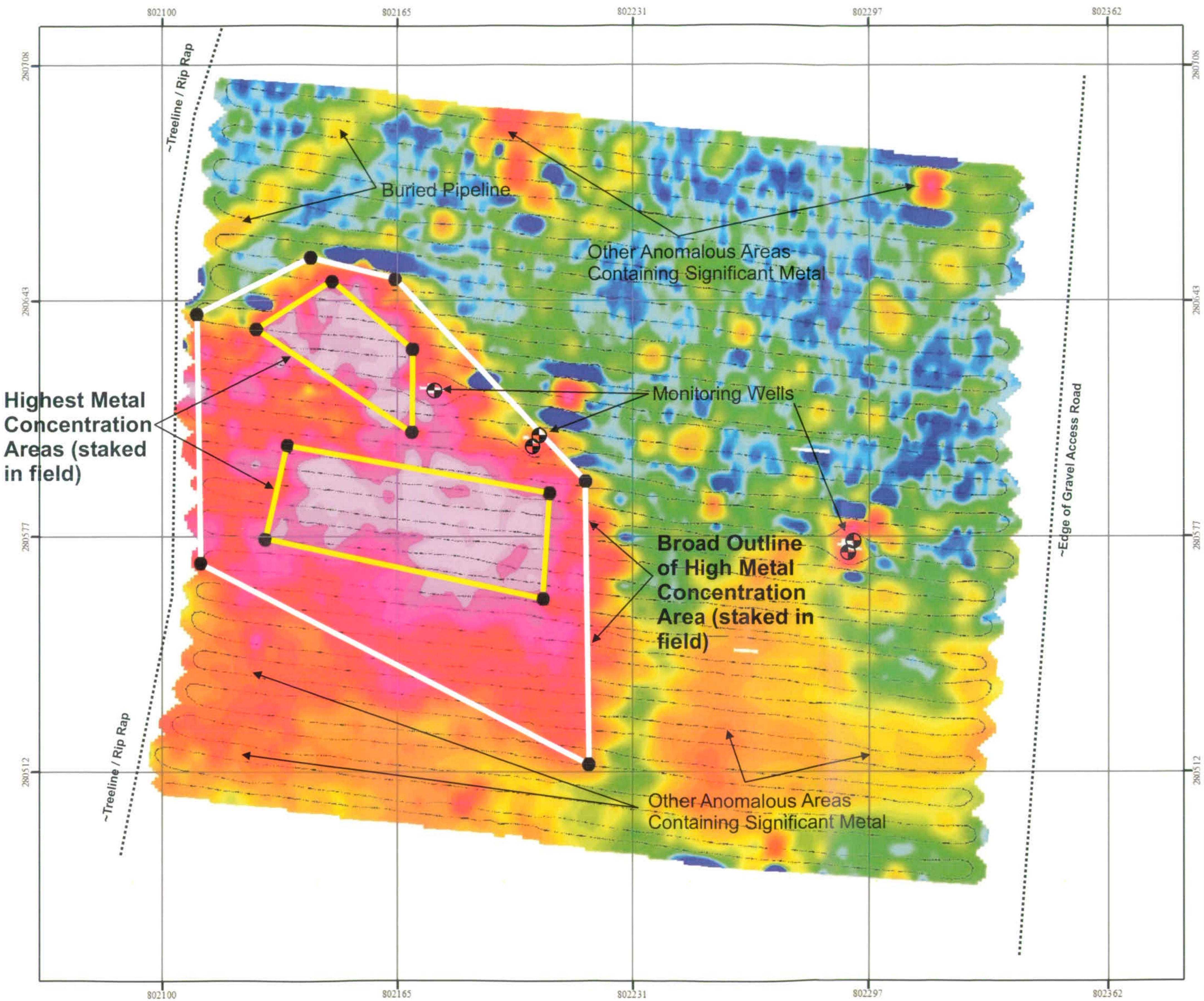
All geophysical data analysis, interpretations, conclusions, and recommendations in this document have been prepared under the supervision of and reviewed by FPM Geophysical & UXO Services senior geophysicists.

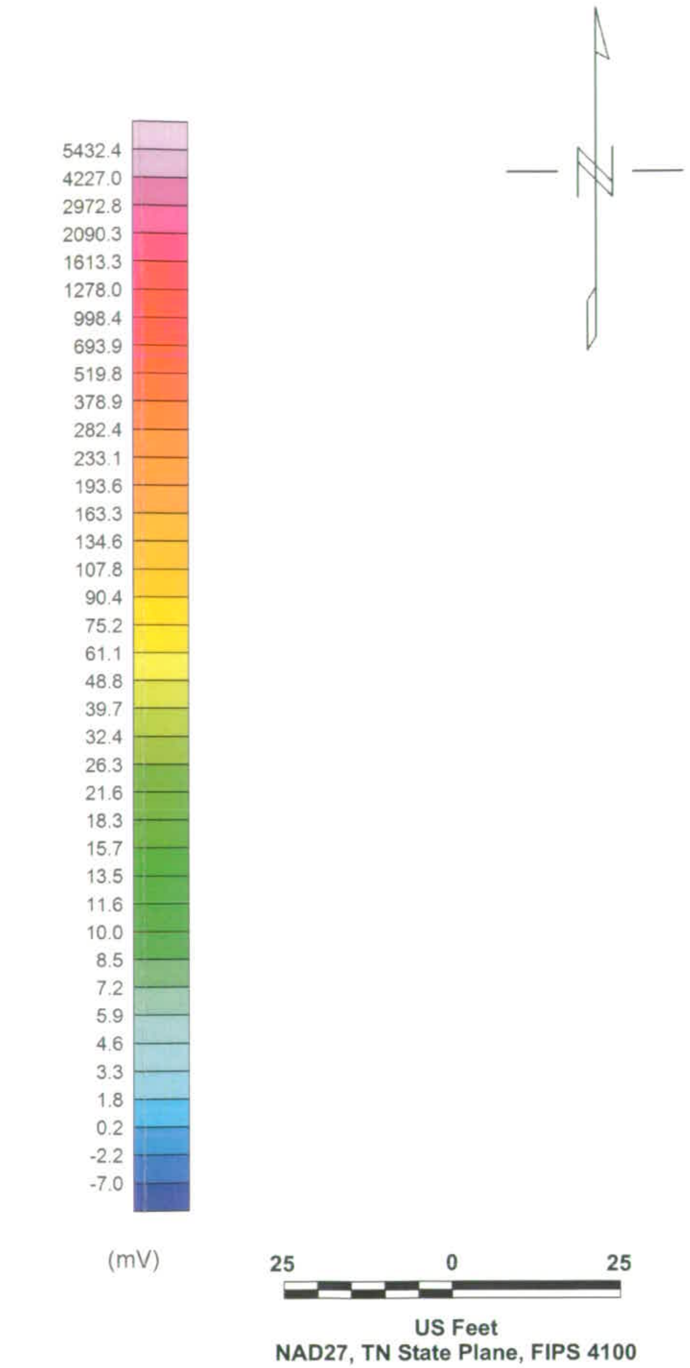
10/12/2007

Jeffrey B. Hackworth, R.Gp., P.G. **Date**
California Registered Geophysicist GP979
Division Manager, FPM Geophysical & UXO Services
Oak Ridge, Tennessee

* This geophysical investigation was conducted using sound scientific principles and state-of-the-art technology. A high degree of professionalism was maintained during all aspects of the project from the field investigation and data acquisition, through data processing, interpretation, and preparation of the deliverable. All original field data files, field notes and observations, and other pertinent information are maintained in the project files and are available for the client to review.

A geophysicist's certification of interpreted geophysical conditions comprises a declaration of his/her professional judgment. It does not constitute a warranty or guarantee, expressed or implied, nor does it relieve any other party of its responsibility to abide by contract documents, applicable codes, standards, regulations, or ordinances.





FPM Geophysical & UXO Services

e2M, Inc.
Memphis, TN

Figure No. 1

Project No. 884-07-02

Date: October, 2007

Dunn Field Source Area
Grid Map of EM61-MK2 Data with Interpretation

Memphis Defense Depot
Memphis, Tennessee

APPENDIX F

FIELD PROCEDURES

Magnetic Separation Testing Procedure

1. Weigh the empty containers that the samples will be collected in.
2. Samples (approximately 1,000 g) of the iron-sand mixture are collected from the discharge of the mixing device (e.g., shoot of a concrete mixer) and/or from the recovered soil core.
3. Weigh the sample (empty container and sample) and record the weight. Determine the net weight of the sample by subtracting the empty sample container weight. A suitable weighing device must be used.
4. Dry the sample. If cemented together during drying, lightly breakup, weigh and record the net weight.
5. Spread the sample out in a suitable container (e.g., bowl, pan, cardboard box, etc.).
6. Cover the magnet in a material (such as a plastic bag) to allow the magnetic material to be easily separated from the magnet.
7. Pass the magnet over the sample to remove the magnetic fraction. Care must be taken to minimize the trapping sand particles within the iron grains. The magnetic fraction is removed from the magnet and placed in a container.
8. Continue passing the magnet over the material until no more magnetic material is removed. Mixing of the non-magnetic fraction between passes may be required to obtain all the magnetic particles.
9. The magnetic fraction may contain some non-magnetic (sand) particles. **Steps 5 to 8** should be repeated at least three more times to completely separate the magnetic and non-magnetic fractions. After each separation, the non-magnetic fraction should be added to the non-magnetic fraction from the previous separation.
10. Weight the magnetic and non-magnetic fractions and record the results. The total net weight of the magnetic and non-magnetic fractions should be the same as the weight prior to separation.
11. The dry iron net weight percent is calculated as follows:

$$\text{Dry Iron Net Weight Percent} = \frac{\text{Net Weight of Magnetic Material}}{\text{Total Net Weight of Dry Sample}} \times 100$$

Depending on the iron/sand sample moisture content, the estimated time to complete the magnetic separation test is about 15 to 25 minutes.

Equipment Required for Magnetic Separation Testing

- Sample containers
- Balance/Scale (battery powered scale if electrical outlet is not available; approximately 500 grams required)
- Hot plate, if electrical outlet available (or propane camping stove)
- Frying pan (8- or 10 inch)
- Large spoon (metal is better than plastic)
- Disposable aluminum cookie sheet
- Magnet
- Zip top bags (e.g., Ziploc®)
- Permanent ink pen (e.g., Sharpie®)
- Worksheets/Log Book

THERMAL REMEDIATION services inc.

Sampling of Hot Soil

Mark Bowen
Project Engineer
Anderson Mulholland & Associates

Greg Beyke, PE
VP - Engineering
Thermal Remediation Services

936 177

THERMAL REMEDIATION services inc.

Hot Soil Sample Procedure

- The soil core barrel can be collected by any method, although direct push technology (DPT, GeoProbe™) is preferred.
- A temperature-resistant core barrel is required, Teflon™, stainless steel, or brass.
- standard work gloves or heavy-duty rubber gloves provide protection to handle the collected cores

THERMAL REMEDIATION services inc.

Hot Soil Sample Procedure

- The recovered core barrel is immediately capped and placed on ice for cooling
- Typical cooling time for a 2" core barrel is 5-10 minutes for a metal barrel, 10-20 minutes for a Teflon barrel.

Meat thermometer

936 179

THERMAL REMEDIATION services inc.

Hot Soil Sample Procedure

- When the core barrel is cool (<20°C), the core barrel is opened and an analysis subsample is collected from near the centerline of the core barrel.
- the sample will be screened at surface with a PID and the soil sample will be collected from the six inch interval registering the highest value on the PID in accordance with 6.2.7.1 of the NJDEP *Field Sampling Procedures Manual*

936 180

THERMAL REMEDIATION services inc.

What if the Hot Soil Sample Procedure is not followed?

- The heat capacity of moist soil is about 0.3 BTU/lb°F.
- In cooling from 212°F to 60°F, about 45 BTU/lb are available for evaporation of water and VOCs.
- 45 BTU can evaporate 0.045 lb of water or 4.5% of the mass of the sample.
- During the ERH remediation, we plan to evaporate about 18% of the total mass of the site, four times greater than the most that could be evaporated under "worst practices" soil sampling.

THERMAL REMEDIATION services inc.

Lawrence Livermore National Laboratory Study - 1993

- An innovative soil sample analysis technique called Bulk Thermal Desorption (BTD) was tested.
- To evaluate BTD, LLNL spiked hot soil samples with TCE and chlorobenzene.
- A total of 17 hot soil sample cores were spiked and the average spike recovery was 89% - this is generally considered to be good recovery.
- LLNL attributed the minor discrepancy to the spiking procedure, not hot soil sampling.

THERMAL REMEDIATION services inc.

Battelle - Interagency DNAPL Consortium Study - 2001

- Specifically designed to test the Hot Soil Sample procedure.
- Funded and reviewed by DOE, DoD, NASA, and US EPA.
- Battelle spiked hot soil samples with 1,1,1-TCA.
- Three hot soil sample cores were spiked and the average spike recovery was 94%.

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE