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DUNN FIELD
OFF DEPOT GROUNDWATER
REMEDIAL ACTION WORK PLAN

Defense Depot Memphis, Tennessee

Prepared for:

Defense Logistics Agency

Solutions Today for a Sustainable Tomorrow

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

April 2009

Revision 2

DUNN FIELD
OFF DEPOT GROUNDWATER
REMEDIAL ACTION WORK PLAN
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Defense Depot Memphis, Tennessee

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Air Force Center for Engineering and the Environment
Contract No. FA8903-04-D-8722
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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
AOC	Area of Concern
AQC	Air Quality Control
ARAR	Applicable or Relevant and Appropriate Requirement
AS	Air Sparging
AS/SVE	Air Sparging with Soil Vapor Extraction
AWS	air/water separator
bgs	below ground surface
BRAC	Base Realignment and Closure
BCP	BRAC Cleanup Plan
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
CY	Cubic Yards
cDCE	cis-1,2-dichloroethene
tDCE	trans-1,2-dichloroethene
DCA	1,2-dichloroethane
DCE	1,1-dichloroethene
DDMT	Defense Depot Memphis, Tennessee
DLA	Defense Logistics Agency
DO	dissolved oxygen
DoD	Department of Defense
DPT	Direct-Push Drilling Technology
EE/CA	engineering evaluation and cost analysis

LIST OF ACRONYMS AND ABBREVIATIONS
(CONTINUED)

e^2M	engineering-environmental Management, Inc.
EISR	Early Implementation of Selected Remedy
ESD	Explanation of Significant Difference
ET&D	excavation, transportation and disposal
FFA	Federal Facilities Agreement
FSP	Field Sampling Plan
GAC	granular activated carbon
gpm	gallon per minute
HDPE	high density polyethylene
HSP	Health and Safety Plan
IAQ	Indoor Air Quality
IDW	Investigation Derived Waste
IRA	Interim Remedial Action
IRACR	Interim Remedial Action Completion Report
ISTD	in-situ thermal desorption
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
MNA	monitoring natural attenuation
MLGW	Memphis Light Gas & Water
MSCHD	Memphis-Shelby County Health Department
msl	mean sea level
mV	millivolts
MW	monitoring well
NCP	National Contingency Plan
NPL	National Priorities List
NTU	nephelometric turbidity units

LIST OF ACRONYMS AND ABBREVIATIONS
(CONTINUED)

O&M	Operation and Maintenance
OPS	Operating Properly and Successfully
ORP	oxidation-reduction potential
OU	Operable Unit
OSWER	Office of Solid Waste and Emergency Response
PCA	1,1,2,2 tetrachloroethane
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
PDB	Passive Diffusion Bag
PLC	Programmable Logic Controller
PMP	Project Management Plan
POL	petroleum/oil/lubricants
POTW	publicly owned treatment works
PPE	personal protective equipment
ppb	parts per billion
PRB	permeable reactive barrier
psi	pounds per square inch
PVC	polyvinyl chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Remedial Action
RAO	Remedial Action Objectives
RASAP	Remedial Action Sampling and Analysis Plan
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDI	Remedial Design Investigation
RG	Remediation Goal
RGOs	remedial goal objectives
RI	Remedial Investigation

LIST OF ACRONYMS AND ABBREVIATIONS
(CONTINUED)

ROD	Record of Decision
ROW	right-of-way
scfm	standard cubic feet per minute
SDR	Standard Dimension Ratio
SOP	standard operating procedure
SU	standard units
SVE	Soil Vapor Extraction
SVOCs	semivolatile organic compounds
SWMU	Solid Waste Management Unit
TA	treatment area
TA	Target Analyte List
TCA	1,1,2-Trichloroethane
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation
TM	Technical Memorandum
TTZ	Target Treatment Zone
USACE	United States Army Corps of Engineers
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
VC	Vinyl Chloride
VEW	Vapor Extraction Well
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 Off Depot 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), the *Dunn Field Record of Decision Amendment* (ROD Amendment) (e^2M, 2009) and the *Memphis Depot Dunn Field Final Off Depot Groundwater Remedial Design* (Off Depot RD) (CH2M HILL, 2008). 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. This RAWP describes the work to be performed to implement the Off Depot Groundwater remedial action and includes a schedule for implementation of the RA. Specifically, the RAWP addresses:

- Description of Site Conditions (Section 1.0)
- RA Planning (Section 2.0)
- RA Construction (Section 3.0)
- RA Operation (Section 4.0)
- Contingencies (Section 5.0)

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 Off Depot 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) (e^2M, 2006) and the *Fluvial SVE RA Health and Safety Plan* (e^2M, 2007b) will provide the basis for protection of site workers. To ensure consistency with the design, much of the text within this RAWP has been taken from the Off Depot RD and construction drawings 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 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.

The Off Depot area is based on the extent of the groundwater plumes originating from former disposal sites on Dunn Field with contaminant concentrations exceeding maximum contaminant levels. The Off Depot Area shown on Figure 2 encompasses all of the groundwater plumes from Dunn Field.

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 MLGW, is located approximately two miles west of Dunn Field.

Numerous groundwater monitoring wells have been installed in the Off Depot Area. Elevation contours for the top of the uppermost clay in the Jackson Formation/Upper Claiborne Group (base of the fluvial aquifer) are shown on Figure 3. Recent water level measurements from Dunn Field and the Off Depot area were used to create the groundwater elevation contour map on Figure 4.

1.4 NATURE AND EXTENT OF GROUNDWATER 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.

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), volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs). Groundwater samples were also analyzed for CWM breakdown products, including thiodiglycol, 1,4-oxathiane, 1,4-dithiane, and various geochemical and geotechnical parameters. Chlorinated VOCs (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 were detected in the central plume. The individual CVOCs 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; October 2003).

Groundwater samples were collected from Dunn Field and the Off Depot area in October 2008. The overall plume based on total CVOC concentrations is shown on Figure 5. Isopleth maps for PCA and TCE results from the October 2008 samples are shown on Figures 6 and 7, respectively. The highest concentrations reported for these two CVOCs were in well MW-162 at 7,140 µg/L for PCA and 1,610 µg/L for TCE.

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 2008, the extraction system pumped nearly 312 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 918 pounds of CVOCs were removed, including approximately 369 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 (CY) 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 (OSWER Directive No. 9355.7-04), *Land Use in the CERCLA Remedy Selection Process* (USEPA, 1995c). 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 remediation goals (RGs) for the contaminants of concern in subsurface soils and groundwater at Dunn Field are listed in Table 1.

The following RAOs are from the ROD:

Surface Soil

- 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

Disposal Sites

- 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

Subsurface Soil Impacted with VOCs

- 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

Groundwater

- 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 from the Dunn Field ROD 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 status of the three Dunn Field RAs and changes to the remedy since completion of the ROD are discussed in the following section.

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* (MACTEC, 2004a), and *Dunn Field Disposal Sites Remedial Action Work Plan Addendum 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 CY) 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 CY) 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). The report included recommendations for decreased spacing between injection locations to achieve increased reduction in CVOCs.

1.7.3 ROD Amendment

Information gathered since completion of the Dunn Field ROD in 2004 resulted in a reassessment of components of the selected remedy.

Three studies were performed on Dunn Field as part of the Source Areas RD (CH2M HILL, 2007) and are included in that RD report. A field treatability study was conducted to evaluate the effectiveness of zero-valent iron (ZVI) injection for subsurface remediation of chlorinated volatile organic compounds (CVOCs); a soil vapor extraction (SVE) pilot study was performed to collect site-specific data for both the loess and the unsaturated fluvial deposits; and a remedial design investigation (RDI) was performed to delineate CVOC concentrations in the loess and to collect additional groundwater samples.

Additional studies were performed in the groundwater plume west of Dunn Field to aid the Off Depot RD (CH2M HILL, 2008) and are included in that RD report. A Zero-valent Iron (ZVI) PRB Implementation Study was performed west of Dunn Field. A pilot-scale ZVI PRB was installed using the jet grouting technique to evaluate its implementability and cost-effectiveness for a full-scale PRB. Groundwater flow modeling was performed to provide a quantitative description of hydrogeologic conceptual site model and allow evaluation of the effects of different treatment scenarios. The model simulated the entire potential flow path between the Off-Depot plume and the Allen well field with assumptions on the connectivity of the fluvial, intermediate, and Memphis aquifers and was useful for estimating potential contaminant migration from the fluvial aquifer to the underlying aquifers. A microcosm study was performed to evaluate 1,1,2,2-PCA and TCE degradation rates using three carbon substrates, site sediments, and groundwater, and a commercially-available microbial consortia. The study was conducted to evaluate whether target compounds could be biodegraded efficiently under existing conditions, and to assess whether site amendments might increase degradation rates.

Operation of the Fluvial SVE system began in July 2007as part of the Source Areas remedial action (RA). Monitoring of system operations has demonstrated significant CVOC mass removal from the fluvial sands (e2M, 2008b) and semiannual groundwater monitoring for the Interim Remedial Action (IRA) groundwater removal system has demonstrated reduction in groundwater CVOC concentrations (e2M, 2008e).

These studies and monitoring results have led to seven recommended changes to components of the selected remedy.

One change is considered fundamental and has resulted in this ROD Amendment:

- use of air sparging with soil vapor extraction (AS-SVE) for the Off Depot groundwater plume instead of a permeable reactive barrier.

Five changes are considered significant:

- revision to criteria for extent of the AS-SVE system and clarification of the treatment objective for AS-SVE;
- reduction in the areal extent of SVE treatment in subsurface soils on Dunn Field;
- use of thermal-enhanced SVE in the shallow subsurface soils (loess) on Dunn Field instead of conventional SVE.
- reduction in the areal extent of ZVI injections in groundwater on Dunn Field based on potential source areas with groundwater total CVOC concentrations above 1,000 µg/L; and
- use of excavation, transportation and off-site disposal (ET&D) in two areas with shallow impacts (a small area of VOC-impacted subsurface soils and an area of buried crushed drums not previously identified).

The final change is considered minor:

- re-order sequence of remedial action components so that ZVI injections in groundwater on Dunn Field will occur after implementation of the subsurface soil remedies.

Since a fundamental change in the remedy selected in the Dunn Field ROD was proposed, a ROD Amendment was prepared to comply with National Oil and Hazardous Substances Pollution Contingency Plan (NCP) Section 300.435(c)(2)(ii) and CERCLA Section 117. The *Dunn Field Revised Proposed Plan, Rev. 3* was approved by the BCT and the public comment period was held 27 October to 25 November 2008. No public comments were received. The ROD Amendment was approved by the BCT in January 2009 and is in the process of being signed by the designated representatives of DLA, EPA and TDEC.

1.7.4 Source Areas Remedial Action

The Source Areas RA includes the following components to be implemented at Dunn Field:

- Use of conventional SVE in the fluvial deposits and thermal-enhanced SVE in the loess to reduce CVOCs to levels that are protective of the intended land use and groundwater
- ET&D of soil and debris from shallow areas within the Disposal Area that have been identified since the Disposal Sites RA
- Injection of ZVI to remediate groundwater in source areas with total CVOC concentrations above 1000 µg/L
- Implementation and enforcement of land and groundwater use controls in accordance with the Dunn Field Land Use Controls Implementation Plan (LUCIP)

1.7.4.1 Fluvial SVE

The BCT concurred at the November 2006 meeting that the Fluvial SVE component of the Source Areas remedial action should be implemented on an expedited basis to limit further impacts to groundwater from CVOCs in the subsurface soil. The Fluvial SVE RAWP, Rev.1 (e^2M, 2007a) was approved by USEPA on 3 July 2007.

Construction of the Fluvial SVE system was completed in July 2007. The system includes seven SVE wells with screen lengths of 25 to 35 feet and extending from approximately 5 feet above the water table to approximately 5 feet below the loess/fluvial contact (at a depth of approximately 35 feet bgs). Individual conveyance piping was routed to each extraction well from the treatment compound to allow operational flexibility. Vacuum is created by two 13.1 horsepower regenerative blowers:

Vapor monitoring points (VMPs) were installed at ten locations, up to 80 feet from the SVE wells, to assess the vacuum ROI and vapor extraction effectiveness. System monitoring includes field measurements of vacuum, velocity and volume flow rates; VOC concentrations are determined from field measurements and laboratory analyses.

The vapor treatment system, located outside the building, consists of GAC in two epoxy-coated steel vessels. Vapor treatment is implemented as necessary to meet permit discharge limits, but has not been required since the first 6 months of operation. Condensate recovery is generally less than 2 gallons per day and has not required treatment prior to discharge to the City of Memphis sewer system. Samples are collected and analyzed as necessary for discharge in accordance with the discharge permit.

Individual SVE well flow rates vary from 20 to 190 actual cubic feet per minute (acfm) and combined flow from all SVE wells is approximately 785 standard cubic feet per minute (scfm) at 5.25 inches of mercury (in. Hg.) with both blowers operating. Field measurements indicate the ROI exceeds 80 feet.

The Fluvial SVE system extracted approximately 3,515 pounds of VOCs from startup on 25 July 2007 through 31 October 2008. CVOC concentrations in groundwater on Dunn Field have been significantly reduced since startup of the Fluvial SVE system, as shown by the changes in the Off Depot plume over time on Figure 8. CVOC concentrations in most of the wells on Dunn Field are below the Source Areas goal of 50 µg/L for each constituent; IRA wells RW-5 through RW-9 were shutdown on 9 June 2008 and wells RW-1 through RW-4 were shutdown on 23 January 2009.

1.7.4.2 Loess/Groundwater

The Loess/Groundwater RAWP was prepared to guide implementation of the remaining Source Areas remedy components: thermal-enhanced SVE and ET&D in the loess and ZVI injection in groundwater. Based on delays in completion of the LUCIP, land and groundwater use controls will be implemented as part of the Off Depot RA.

The Loess/Groundwater RAWP, Rev.1 received partial approval from USEPA on 2 October 2007 with regard to construction and operation. The Loess/Groundwater RAWP, Rev.2 was prepared to document 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 would be documented. The RAWP, Rev. 2 was approved by TDEC on 2 April 2008. The 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. Final approval was received from USEPA on 5 June 2008 and from TDEC on 7 July 2008.

ET&D

ET&D activities were performed in two areas (TA-1F and TA-3) from 6 November 2007 to 28 January 2008. Approximately 150 cubic yards was removed from TA-1F and 3,611 cubic yards from TA-3; all soil and debris was disposed as non-hazardous waste at the Waste Management landfill in Tunica, Mississippi. Confirmations samples indicated that additional excavation will be required to achieve RGs for chloroform in TA-1F and for polycyclic aromatic hydrocarbons in TA-3. Additional excavation at TA-1F and sampling to determine the extent of impacted soil at TA-3 were performed in February 2009 following demobilization for the thermal-enhanced SVE soil treatment.

Thermal-enhanced SVE

The thermal-enhanced SVE system utilized in situ thermal desorption (ISTD) to treat impacts in the loess and underlying sandy clay. Construction of the Loess SVE System was completed in May 2008. The system included 367 ISTD heater-only wells, 68 vapor extraction wells (VEWs), 63 temperature monitoring points and 26 pressure monitoring points. The system utilized an Air Quality Control (AQC) system to remove CVOCs from the vapor stream and condensate. The vapor stream and condensate were treated with separate GAC vessels. Chain link fencing and security lighting was constructed around each of the treatment areas for enhanced site security. A separate security fence encloses all of Dunn Field.

The target treatment zone (TTZ) for the Loess SVE system extended from approximately 5 feet bgs to 30 feet bgs. Each of the heater-only (HO) wells was installed from approximately 2 feet bgs to approximately 5 feet below the bottom of the TTZ to offset potential heat loss through the top and bottom of the TTZ. The HO well spacing was maintained at approximately 15 to 20 feet. After startup, the heater-only wells were ramped up to an operating temperature of 1,000 to 1,400°F.

The VEWs were completed with a 10 to 15 foot long, 2-inch diameter vacuum screen that extended from approximately 5 feet to 20 feet bgs. The spacing between VEWs was approximately 25 to 30 feet. Vacuum at the VEWs vary from approximately 6 to 20 inches of water with individual well flow rates varying around 15 standard cubic feet per minute (scfm). The temperature monitoring points were constructed of 1.5 inch diameter capped carbon steel pipe that extend to the bottom of the TTZs (20 to 30 feet bgs). Individual temperature sensors were installed in each temperature monitoring point at five-foot intervals that start at approximately 5 feet bgs. The pressure monitoring points were constructed of 1 inch diameter carbon steel pipe with a 1-foot long well screen from 5 to 6 feet bgs.

The AQC system treat extracted vapors from the treatment areas. The AQC system consisted of vacuum blowers, heat exchangers, moisture knockout tanks, a cooling tower, transfer pumps, and liquid and vapor-phase granular activated carbon (GAC) vessels. The AQC was designed to handle a combined flow of 1,500 scfm from the well field (800 scfm of steam and 700 scfm of vapor) at approximately 8 inches of mercury. This vacuum was generated by two rotary lobe positive displacement blower, with one blower operated and the other in reserve. Condensate was separated on the upstream end of the AQC system and is treated using two 250-pound liquid phase GAC vessels. The condensate treatment portion of the AQC system was designed to handle a flow rate of approximately 7 gallons per minute (gpm). Treated condensate was approved by the City of Memphis for discharge under the existing IRA discharge agreement.

The thermal-enhanced SVE system began operation on 27 May 2008. Daily field measurements included system operating parameters and photo-ionization detector readings for vapor effluent. Additional PID readings from individual treatment areas and samples of vapor and condensate for laboratory analysis were collected periodically during operations to evaluate system performance. Confirmation soil samples were collected in a phased approach based on system performance. The heater wells in individual treatment areas were shutdown as confirmation samples demonstrated that RAOs had been met. The final heater wells were shutdown on 20 November and the vacuum extraction wells and AQC system was shutdown in the final areas on 4 December 2008. Approximately 12,300 pounds of CVOCs were removed during treatment.

<u>ZVI</u>

ZVI injections were to be performed after completion of the thermal-enhanced SVE treatment. Recent groundwater samples indicated total CVOC concentrations are well below 1000 μg/L throughout Dunn Field (see Figure 5), and ZVI injection will not be required.

1.8 OFF DEPOT GROUNDWATER REMEDIAL DESIGN

The Off Depot Groundwater RA is the final RA planned for Dunn Field and has the following components:

- Installation of an air sparging with soil vapor extraction (AS/SVE) system across the core of the plume near the downgradient end.
- Monitored natural attenuation (MNA) 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

As noted in Section 1.7.3 and described below, the active component for Off Depot Groundwater was changed from a ZVI PRB to AS/SVE and the extent and treatment objectives were changed or clarified. The MNA/long-term monitoring and institutional controls components were not changed. The institutional controls will be implemented as described in the Land Use Controls Implementation Plan in Appendix A of the Off Depot RD. The change from a ZVI PRB to AS/SVE was based on information from the EISR (MACTEC, 2005b), the PRB Implementation Study in Appendix B of the *Dunn Field Off Depot Groundwater Pre-final Remedial Design* (CH2M HILL, 2007b), the Laboratory Microcosm Study Results in Appendix E of the Off Depot RD, and the results of the Fluvial SVE implementation (e^2M, 2008b).

Monitoring wells installed for the EISR provided new information on groundwater flow gradient, saturated thickness, and contaminant concentrations around the ROD-proposed location of the ZVI PRB. The relatively low groundwater gradient in that area would make it difficult to ensure consistent flow through a ZVI PRB, while the thicker saturated zone would increase the construction cost. In addition, concentrations of CVOCs downgradient of the ROD-proposed location exceed 5,000 parts per billion (ppb), which is an order-of-magnitude higher than those presented in the ROD. These concentrations are higher than considered appropriate for MNA and would require active treatment downgradient of the ZVI PRB.

To comply with the ROD and account for the new hydrogeologic information, a new ZVI PRB alignment near the midpoint of the off-Depot plume was considered. This location was selected because of a thinner saturated zone and a narrowing of the CVOC plume. The Field PRB Implementation Study was performed in this area. The results of the PRB study indicated that formation of a uniform PRB was not achieved and that several technical issues would need to be solved for installation of an effective full-scale PRB.

Based on the challenges to successful installation of a full-scale ZVI PRB, enhanced bioremediation through injection of a carbon substrate and a consortium of bacteria was considered as an alternative for the Off-Depot groundwater plume. The initial results of microcosm testing suggested enhanced bioremediation could be effectively used to address site CVOCs, and enhanced bioremediation was proposed for the off-Depot plume in the Off-Depot Groundwater Pre-final RD (CH2M HILL, 2007b). However, the uncertainty of enhanced bioremediation effectiveness and an updated cost estimate for implementation led to additional review.

AS-SVE was evaluated as an alternative to enhanced bioremediation for the Off Depot remedy. AS-SVE had been considered in the Dunn Field ROD for remediation of groundwater beneath the source areas. Although it was not selected because ZVI injection offered rapid reduction of CVOC concentrations without continuing operations and maintenance and was slightly less expensive, AS-SVE was considered a viable treatment technology.

The use of AS-SVE to treat the Off-Depot plume is similar to the use of the ZVI PRB in the Dunn Field ROD. The following similarities are noted:

- Both technologies rely on physical and/or chemical, rather than biological, processes.
- Both would treat a large portion of the Off Depot Plume, with only a small portion to be treated by MNA.
- Operations and maintenance activities are limited relative to the injection activities required for enhanced bioremediation.

The other elements that resulted in selection of AS-SVE are summarized below.

- **Proven technology.** AS-SVE has been implemented to remove CVOCs from groundwater at numerous sites, completed or in-process. The Fluvial SVE system is operating successfully on Dunn Field.
- **Straight-forward implementation**. Construction of AS and SVE wells is relatively rapid using conventional drilling methods. Air compressor and blower equipment are easily procured.
- **Rapid evaluation**. AS-SVE effectiveness can be assessed in a relatively short period, unlike

enhanced bioremediation, which requires many months to implement and reliably assess.

Therefore, based on the hydrogeologic and CVOC data collected since the ROD was signed and the challenges associated with the installation of a cost-effective, full-scale ZVI PRB, AS-SVE is considered a more appropriate remedy for the Off-Depot CVOC plume.

As the active portion of the Off Depot remedy, AS/SVE will be implemented to volatilize TCE, 1,1,2,2-PCA and other CVOCs near the leading edge of the groundwater plume west of Dunn Field. The AS/SVE system will operate to remove CVOCs from groundwater and prevent further plume migration while the Source Areas remedy is implemented. The Source Areas remedy is expected to meet fluvial soil RGs within 5 years; the loess RGs were met in November 2008 after six months of thermal-enhanced SVE treatment. The goal for Source Areas groundwater remediation is to reduce CVOC concentrations on Dunn Field to below 50 μg/L for each constituent, with the combination of the Source Areas and Off Depot remedies expected to meet the RAO of remediation to drinking water quality over time. The goal for Source Areas groundwater has been met at most locations based on groundwater samples collected in October 2008.

The *Air Sparging Design Paradigm* (Battelle, 2002) and professional experience were used to develop the AS basis of design presented in the RD. The *Design Paradigm* suggests that long-term air sparging performance cannot be predicted reliably from data collected during short-term pilot tests, and that a "standard" design approach can be used for AS systems. This standard design, used as a basis for the Off-Depot AS system, relies on a relatively dense network of closely spaced AS wells.

The vertical AS wells in each row are conservatively spaced on 15-foot centers and the rows are spaced 15 feet apart. The AS wells are offset to be centered between wells on the adjacent row(s). The extent of the AS barrier in the Off Depot RD is based on the October/November 2007 groundwater sampling results and is intended to treat groundwater with CVOCs, primarily TCE and 1,1,2,2-PCA, across the core of the plume near the downgradient end. The number of AS barriers in the direction of groundwater flow required to treat the expected maximum concentration of TCE and 1,1,2,2-PCA was based on mass transfer calculations. Only one AS row with wells on 15-foot centers is required to reduce the TCE concentration from 5,000 to 50 μg/L. However, because 1,1,2,2-PCA is less volatile than TCE, four rows are required to sequentially reduce it from 5,000 to 50 μg/L. The mass transfer analysis assumes a groundwater flow rate of 0.1 foot per day, 50% transfer efficiency, and a constant injection flow rate of 5 scfm. Henry's constants for TCE and 1,1,2,2-PCA were taken from the literature.

The AS barrier, shown on Figure 9, is positioned along Menager Avenue and the old railroad corridor on the western side of the MLGW substation property. The multiple rows of AS wells required to treat the core of the 1,1,2,2-PCA plume are positioned in the open area south of the MLGW substation entrance and north of the transmission towers.

The amount of air required for the 90 AS wells (450 scfm) was calculated based on a maximum injection rate of 15 scfm and pulsed operation such that 1/3 of the wells are operating at any one time. For this relatively slow-moving plume, the injection of up to 15 scfm for 1/3 of the day is essentially equivalent to a constant rate of 5 scfm, which was used to predict system effectiveness. Pulse operation (1) decreases the required system injection flow capacity, (2) optimizes air distribution by limiting the formation of permanent air channels, (3) maximizes system performance based on empirical evidence (Battelle, 2002), and (4) minimizes the likelihood that groundwater will bypass the AS barrier due to permeability reductions caused by the air injection. In addition, at least 15 pounds per square inch (psi) will be required to inject air along the western end of the proposed AS barrier, which has a maximum saturated thickness of 35 feet.

2.0 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.

2.1 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, RA SAP, and HSA.

2.1.1 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.

2.1.2 Waste Management Plan

The WMP is Appendix B to this RAWP and describes waste management and waste minimization activities during the installation of AS and SVE wells, VMPs and groundwater monitoring wells, and AS/SVE operations. 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.

2.1.3 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 of the AS/SVE system components (AS and SVE wells, conveyance piping, control building and treatment compound). The CQAP includes information on project meetings, construction activities, and document submittals.

2.1.4 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 field activities, field measurements, sample handling and documentation, and nonconformance/corrective actions for situations (if any) when requirements of the RA SAP are not met. Work and Test Procedures (WTPs) in Appendix B of Volume I provide specific procedures for field activities. The following WTPs from the RA SAP will be utilized in the Off Depot RA:

Number	Name
1	General Procedures for Field Personnel
2	Drilling Operations
3	Well Installation, Development, and Abandonment
4	Groundwater Sampling
6	Investigation Derived Waste Disposal
7	Sample Control and Documentation
8	Sample Containers and Preservation
9	Sample Packing and Shipping
10	Sampling Equipment Decontamination
11	Soil Sampling
12	Personnel Protective Equipment Decontamination
13	Health and Safety Monitoring

The Off Depot RA includes some activities that are not addressed in the existing WTPs. The following WTPs have been prepared and are included in Appendix E of this RAWP:

Number	Name
14	Soil Vapor Extraction Wells
15	Air Sparge Wells
16	Vapor Monitoring Points
17	Vapor Sample Probes
18	Vapor Sample Collection

Volume II of the RA SAP 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. Analytical procedures for vapor samples were not included in the QAPP. Vapor sample analyses for the Off Depot RA will be performed in accordance with *Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)* (EPA, 1999).

2.1.5 Health and Safety Plan

The *Remedial Action Health and Safety Plan* (e^2M, 2006) and the *Fluvial SVE RA Health and Safety Plan* (e^2M, 2007b) will provide the basis for protection of site workers. These documents will be updated and incorporated for the Off Depot Groundwater Health and Safety Plan (HSP). The HSP will include 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.

2.1.6 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.

2.2 SUBCONTRACTOR AND VENDOR PROCUREMENT

e²M will solicit, evaluate, select, and award the necessary subcontracts to implement the RA. Subcontracts will be awarded for:

- Site clearing and grading
- Initial and as-built surveys of drilling locations and the control building
- Installation and abandonment of groundwater monitoring wells
- Location of utilities at drilling locations and control building compound
- Installation of the AS and SVE wells and VMPs
- Installation of AS and SVE conveyance piping
- Installation of electric power
- Construction of the control buildings and interior piping
- Laboratory analyses of vapor and groundwater samples

2.3 PERMITTING

As this site is under CERCLA authority, permits are not required from local or state entities for actions that occur entirely onsite; however, 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.

Well installation 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.

Installation and operation of the SVE system is not expected to require a construction/operating permit from the Memphis Shelby County Health Department (MSCHD). MSCHD will require written notification of the intention to construct the SVE system with a request for a construction/operating permit exemption based the anticipated low level of emissions. The letter will contain approximate construction and start-up dates. Field measurements and laboratory analyses of the SVE discharge will be periodically conducted to ensure compliance with the emission limit of 0.1 lb/hour. MSCHD will be notified if emission limits are above the 0.1 lb/hour and an Operating Permit application will be submitted. Copies of SVE operations records will be kept onsite and will be subject to review by MSCHD personnel to ensure compliance with emission limits. If a MSCHD Operations Permit is issued, it can be rescinded once pre-treatment emission drop below 0.1 lb/hour.

Construction of the AS/SVE system will require building and electrical permits from the Memphis and Shelby County Department of Construction Code Enforcement. Construction drawings will be submitted for plan review before the permit is issued. On-site inspections by County officials may be required following completion of construction.

3.0 REMEDIAL ACTION CONSTRUCTION

3.1 SUMMARY OF AS-SVE SYSTEM

The AS-SVE system will be installed to intercept the majority of the Off-Depot CVOC plume and reduce individual CVOC concentrations to below 50 µg/L. The system layout, including AS and SVE wells and VMPs, is shown on Figure 9. The extent of the AS barrier in the Off Depot RD was based on the October/November 2007 groundwater sampling results. The locations of the individual AS and SVE wells were reviewed using the October 2008 groundwater sampling results, which are shown for PCA and TCE on Figure 9. The AS-SVE locations established in the Off Depot RD are consistent with the current plume extent; no changes in AS-SVE well locations are planned.

The AS barrier will include 78 vertical sparge points spaced at 15-foot intervals in two offset rows at the distal end of the plume along Menager Avenue. Twelve additional sparge points will be installed in the central portion of the AS barrier to address the core of the plume. Each sparge point will be installed at the base of the fluvial aquifer (90 to 100 feet bgs) and is designed to inject air at up to 15 scfm. Twelve SVE wells will be installed on approximately 50-foot centers to capture the vapors from the AS wells. Each SVE well will include a 30-ft screened interval, generally extending from 35 to 65 feet bgs.

The SVE system will be operated in concert with the AS system. The AS and SVE wells will be connected via buried piping to two equipment buildings; one housing the 500 scfm (at 125 psi) compressor for the sparge points and the other housing the two 450-scfm rotary lobe blowers for the SVE wells. System controls will be located in a control room in one of the buildings. The AS legs will be fitted with solenoid or motorized valves to allow maximum operational flexibility. The AS/SVE system is intended to operate 1/3 of the AS points (at 15 scfm per well) and all of the SVE wells concurrently (at 55 scfm per well).

Nine new fluvial aquifer and two new intermediate aquifer groundwater monitoring wells, shown on Figure 10, will be installed to expand the groundwater monitoring network in the vicinity of the AS barrier. The location for a new fluvial aquifer well (New 1) was shown in the Off Depot RD adjacent to existing well MW-148. Based on discussion with RD contractor CH2M HILL, the well should have been located 90 feet to the west and downgradient from the eastern end of the air sparge line. The corrected well location is shown on Figure 10.

Additionally, 10 sets of nested vapor monitoring points (VMPs) screened at 50 and 70 feet bgs will be installed to monitor the ROI of the SVE wells and the CVOC concentrations in the vadose zone; the VMP locations are shown on Figure 9.

3.2 NOTICE TO PROCEED

A Task Order for the Off Depot RA from AFCEE was awarded to e²M on 26 September 2008. Approval of both the Dunn Field ROD Amendment and this RAWP will mark the formal beginning of the Off Depot RA and progress within the project schedule will be measured from the final approval date.

3.3 PRE-CONSTRUCTION ACTIVITIES

3.3.1 Pre-Construction Conference

A pre-construction conference will be held at the DDMT facility approximately four weeks after RAWP approval and before construction work begins. The conference will be attended by DLA, USEPA, TDEC, e²M 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; and
- 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 drilling locations, treatment areas and material and equipment storage areas; site access issues will also be reviewed. e²M will document the names of conference attendees, issues discussed, clarifications made, special instructions issued, and other pertinent information and discussions.

e^2M will provide oversight and coordinate the activities of subcontractors and vendors. Construction kick-off meetings will be held with subcontractors prior to the onset of construction activities (site clearing/grading, well installation/abandonment and AS/SVE system construction). The meeting will occur at the Memphis Depot, Building 265 (e^2M Field Office) or at Dunn Field. 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.

3.3.2 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 adjacent to the MLGW substation west of Dunn Field. Dunn Field will be used for staging materials. 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). MLGW access to the substation will be maintained during AS/SVE construction activities.

3.3.3 Initial Site Survey and Utility Clearance

An initial site survey will be performed to mark locations for new monitoring wells. The survey will be performed by a Registered Professional Land Surveyor licensed in the State of Tennessee. The well locations will be cleared for underground utilities, general access and overhead obstructions. The Tennessee One-Call System, Inc. will be utilized. 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 personnel. No intrusive activities will be conducted until utilities have been located.

Since monitoring wells will be installed outside the DDMT boundaries, well construction permits will be obtained from the MSCHD. Traffic control plans will be prepared for wells located within roadways.

3.3.4 Site Clearing/Grading

The area selected for installation of the AS/SVE installation is generally open and regularly mowed. However, the abandoned railway line on the west side of the area (near MW-166/166A) is elevated, has poor drainage and is covered with dense brush. This area will be cleared and graded for drainage and for access during monitoring well installation and AS/SVE system construction and operation.

Erosion and sediment control measures will be taken to minimize erosion during grading. 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.

3.3.5 Baseline Groundwater Sampling

Baseline groundwater conditions in the Off Depot area will be established prior to construction of the AS/SVE system. The baseline groundwater sampling event will include the performance monitoring wells (25 existing wells and 11 new monitoring wells) in the vicinity of the AS/SVE system and the 58 LTM wells listed on Table 10-1 of the *Long-Term Groundwater Monitoring Plan* (LTM Plan) in Appendix C of the Off Depot RD. Since this will be the initial sampling event for the Off Depot LTM, all LTM wells will be sampled. The Off Depot LTM will replace the current IRA sampling program upon implementation. Wells abandonment and installation of new performance monitoring wells will be performed prior to the baseline groundwater sampling event. Some of the wells designated for abandonment in Table 5-3 of the LTM plan will be maintained indefinitely, as described in Section 3.3.5.2.

All wells on Dunn Field and the Off Depot area are listed on Table 2 with the current or planned monitoring programs (IRA, Source Areas performance monitoring, Off Depot performance monitoring, Off Depot LTM or MI LTM). The wells to be maintained for groundwater level measurements and those to be abandoned are also identified. The wells to be included in the Off Depot performance monitoring are shown on Figure 10. Two of the performance monitoring wells identified in the Off Depot RD, MW-

161 and MW-189, are fluvial aquifer wells in close proximity. Based on discussion with RD contractor CH2M HILL, MW-189 is now listed for abandonment and MW-163 has been added to the performance monitoring wells. The wells to be included in the Off Depot LTM for groundwater sampling or water levels measurements and the wells to be abandoned are shown on Figure 11.

3.3.5.1 Well Installation and Development

Eleven wells are planned to be installed for Off Depot performance monitoring; nine wells will be installed in the fluvial aquifer and two wells will be installed in the intermediate aquifer. The planned locations from the RD are shown on Figure 10; the final well locations will be determined with the final AS/SVE system layout.

The fluvial aquifer wells will be installed with the well screen placed to screen the fluvial aquifer from the underlying clay to the water table. The intermediate aquifer wells will be completed to the first significant (>15-ft foot thickness) sand layer within the Jackson Formation/Upper Claiborne Group. If clay is not encountered at the base of the fluvial deposits or within the Jackson Formation/Upper Claiborne Group, the well will be drilled to a depth of 200 ft bgs where the well screen will be installed. The two new intermediate aquifer wells will be constructed in the same manner as the fluvial aquifer wells except that a 6-inch diameter surface casing will be in the gray clay at the base of the fluvial aquifer to prevent the well acting as a conduit for vertical contaminant migration.

The fluvial aquifer monitoring wells will be installed in 6-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 five feet into the gray clay of the Jackson Formation/Upper Claiborne Group to confirm that the base of the fluvial aquifer is reached. The top of clay is well established at the proposed locations based on previous well borings (see Figures 3 and 10). 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 elevation of the top of clay marking the base of the fluvial aquifer and the fluvial aquifer thickness at each planned location is listed on Table 3.

Wells will be constructed with new 2-inch diameter Schedule 40 PVC casing and 0.010-inch screens using flush-fitting, internally-threaded joints. The well screens will be up to 20 feet long; the fluvial aquifer thickness ranges from 5 to 26 feet at the planned well locations (Table 3). While some variation in CVOC concentrations has been observed with depth in the aquifer, additional monitoring well clusters spanning the aquifer are not considered necessary. 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 6-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. Wells 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.

The intermediate aquifer wells will be constructed in the same manner as the fluvial aquifer wells except that a 6-inch diameter surface casing will be seated 5 feet into the gray clay. When the gray clay at the base of the fluvial aquifer is encountered, the 10-inch boring will be advanced an additional 5 feet and temporarily halted to install surface casing consisting of Schedule 80 PVC with the bottom section containing a seal and check valve. The driller will pump grout through an injection pipe connected to the check valve until the grout returns to the ground surface. Following grouting, potable water will be pumped into the inner annulus of the casing. The grout will cure for 24 hours before continuing to advance the borehole. Water present in the inner annulus of the casing will be pumped to a holding tank before the borehole is advanced to the first significant sand unit within the Jackson Formation/Upper Claiborne Group.

Monitoring wells will be developed at least 24 hours after grouting is completed 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 units (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^2M field geologist will prepare boring logs, construction diagrams, and development records for the newly constructed wells. The soil core from the capillary fringe and screened interval of the aquifer will be archived in labeled cardboard core boxes.

3.3.5.2 Well Abandonment

Thirty-nine monitoring wells at Dunn Field and the Off Depot area not needed for Off Depot performance monitoring or LTM were identified on Table 5-3 of the LTM Plan in the RD to be abandoned. Based on review for this RAWP, twelve of these wells will be maintained for further evaluation and an additional well will be abandoned. Two wells (MW-34 and MW-229) on the southern end of Dunn Field are used for the Main Installation LTM and will be maintained for that program. Four wells (MW-08, MW-129, MW-130 and MW-230) are useful in monitoring the plume migrating on to Dunn Field from the northeast and will be maintained until that issue is resolved. Six wells (MW-03, MW-07, MW-10, MW-68, MW-134 and MW-220) are part of the Source Areas RA monitoring and will be maintained until required monitoring is completed. Well PZ-02, located northeast of Dunn Field and adjacent to MW-128, is not needed and will be abandoned. The wells are listed on Table 4 and the locations are shown on Figure 11. While the wells are being maintained, all except MW-34 and MW-229 will be used for water level measurements during the Off Depot LTM events.

The total depth of each well will be measured to confirm that no obstructions are present that might interfere with placement of the tremie pipe and grout. One-half gallon of bleach will be poured into each well in accordance with Memphis Shelby County Health Department regulations. The wells will be filled with grout from the bottom up until undiluted grout is visible at the surface. The grout will be tremied into the casing, keeping the side-discharge tremie pipe approximately 1 foot below the grout surface. The water displaced by the grout will be contained for analysis and disposal. After allowing at least two days for grout settlement, the grout will be topped off with concrete. The well pad, manhole and bollards, if present, will be removed and disposed as solid waste. The wellhead location will be restored to match the surrounding area.

3.3.5.3 Groundwater Sampling

The performance monitoring and LTM wells will be sampled using either passive diffusion bags (PDBs) or low-flow sampling methods. PDBs will be used in existing wells with at least 10 feet of saturated thickness and with a quarterly to annual sample frequency. The new wells and other existing wells will be sampled using low-flow sampling methods. Samples from new wells will be collected at least 24 hours after development. Groundwater samples will be analyzed for VOCs only.

Approximately one month prior to the sample event, water levels will be measured in the existing wells selected for PDB sampling. PDBs will be placed in wells as necessary and the depth of all PDBs relative to the water level will be checked. PDBs will be positioned near the mid-point of the saturated portion of the well screen. If the saturated thickness is determined to be less than 10 feet, the wells will be identified for low-flow sampling

Prior to the baseline sampling event, groundwater level measurements will be made in all Off Depot performance monitoring and LTM wells. Measurements will be taken using Solinist Model 101 water-level meters with electronic sensors and tapes graduated in 0.01-foot increments.

Wells selected for low-flow sampling 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 5-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); ±10 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.

In the wells selected for PDB sampling, the PDB will be removed from the wells and a water sample from the PDB will be transferred to 40-milliliter vials preserved with hydrochloric acid. Following sample collection, a single, new PDB filled with deionized water will be placed near the mid-point of the saturated portion of the well screen.

3.3.6 Soil Vapor Sampling

A soil vapor survey will be performed to determine whether AS/SVE operations result in vapor intrusion issues. The survey will conform to the *Sampling and Analysis Plan and Quality Assurance Plan for Indoor Air Quality Monitoring* (IAQ SAP) in Appendix F of the Off Depot RD. The survey will also incorporate guidelines from *Tri-Services Handbook for the Assessment of the Vapor Intrusion Pathway* (Noblis, 2008) and *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (USEPA 2002). The primary CVOCs in the Off Depot plume warrant further study based on the USEPA guidance. Since the past disposal activities which resulted in the groundwater plumes did not occur in the Off Depot area, groundwater concentrations are the only source for the vapor intrusion pathway relevant to the Off Depot RA. The silty clay in the loess deposits which are present throughout the Off Depot area from the ground surface to a depth of approximately 30 feet are expected to provide a barrier for vapor intrusion. The soil vapor survey will include:

- Identification of target areas
- Structure survey
- Soil sampling
- Soil vapor sampling
- Sub-slab pressure measurements (if warranted)

Two target areas were identified in the IAQ SAP as being over or near the periphery of the known Off Depot groundwater plume. These areas were revised based on the results of the October 2008 IRA sampling event. The target area for the survey will include inhabited structures within 100 feet of the extent of the plume boundary based on the screening level concentrations for groundwater in the USEPA guidance. The screening level concentrations are:

	Screening Level (µg/L)
Carbon tetrachloride	5
Chloroform	80
cis-1,2-Dichloroethene	210
1,1-Dichloroethene	190
trans-1,2-Dichloroethene	180
1,1,2,2-Tetrachloroethane	30
Tetrachloroethene	11
Trichloroethene	5

Based on review of the October 2008 analytical results, all Off Depot monitoring wells with CVOC concentrations above one of the listed screening levels also contained TCE and at a higher multiple of the screening level. The target areas are shown on Figure 12, which includes the 5 µg/L isopleths for TCE and a 100-foot buffer.

All structures within the target area will be surveyed from the street, and if access is granted, by an interior survey. Observations for each structure will be noted and logged separately by completing the form in the IAQ SAP. Following review of the structure survey results, owners of structures with basements or sitting on slabs will be requested to allow installation of both soil vapor sampling probes and, if warranted, indoor pressure monitoring points. Indoor air pressure probes would be installed only in structures that show soil vapor concentration levels above screening levels. Site Access Agreements will be obtained from landowners prior to soil/soil vapor sampling activities.

Soil samples will be collected to determine physical properties in case vapor intrusion modeling is performed. Soil borings will be advanced using direct push drilling technology (DPT) at four locations (SP-1, SP- 2, SP-3, and SP-4) within the target areas; the locations will be determined following the target area review and structure survey. At each location, three soil samples will be collected over two foot intervals at 5-7, 10-12, and 15-17 feet bgs. These samples will be collected by capping the individual 6-inch sections of the acetate liners (or brass sleeves) from the sample interval. At each depth, the 6-inch section with the coarsest grain size will be selected for analysis. Coarse-grained sediment is expected to be a preferential pathway for migration of soil vapors, thus these zones will be tested for physical properties to estimate conservative vapor intrusion conditions. Samples will be analyzed for soil bulk density, grain density, soil moisture content, grain size, and Atterberg Limits as described in the IAQ SAP.

Soil vapor samples will be collected to assess the concentrations of VOCs near selected buildings within the target areas that are identified by the pre-sampling survey as potentially of concern for vapor intrusion and access is granted by the homeowner. Typical structures will have three outside locations for soil vapor probes as described in the IAQ SAP, but locations may be adjusted due to access constraints. A summary of the soil vapor sampling to be performed including the location (street address), number of probes, sample depths, and analytical method(s) will be prepared prior to the sample event. At each location, a soil vapor probe with two sample screens will be installed using DPT. Soil lithology will first be determined by continuously coring from ground surface to 18 feet bgs. The soil core will be reviewed to identify potential zones of distinctly coarser material (greater permeability) in which soil vapor may preferentially flow or accumulate. If such a zone is observed, the soil vapor sample screens will be placed at the coarsest soil between 4 and 8 feet bgs and between 14 and 18 feet bgs. If no such zone is observed, the vapor sample screens will be constructed at the default depths of 5 feet and 15 feet bgs.

The vapor sample screens contain a 6-inch stainless steel wire mesh screen with a pore diameter of approximately 0.0006-inches, a threaded fitting on the bottom for anchoring and a fitting at the top to connect Teflon tubing. Once the deeper sample depth is reached, a vapor sample screen will be lowered in the open borehole with tubing attached. Filter sand or glass beads will placed in the annulus to six inches above the probe. Fine bentonite chips will then be gravity poured to create an annular seal as the rods are slowly retracted. A funnel and tubing will be used to hydrate the bentonite. This process will be repeated for the installation of the shallow vapor probe. Bentonite-cement grout will be placed above the shallow vapor sample screen to the ground surface. The ends of the tubing ends be capped and clearly marked to identify vapor implant depth. The sample probe will be completed with a valve box for protection.

The vapor monitoring probes will be allowed to cure for a minimum of 48 hours prior to vapor sampling. Samples will be collected in 1-liter Summa canisters using 200 milliliters per minute regulators and submitted for analysis using EPA Method TO-15. A minimum of three well volumes (filter media volume and tubing) will be purged prior to sample collection.

An initial round of soil vapor sampling will be performed before start up of the AS/SVE system. The results of the initial sampling will be compared to soil screening levels provided in the IAQ SAP to determine whether differential air pressure testing inside buildings is needed. The sample probes will remain in place for periodic sampling during operation of the AS/SVE system. At minimum, a second round of soil vapor sampling will occur within three months of startup of the AS/SVE system. The results from the second sampling event will also be compared to soil screening levels to determine whether differential air pressure testing inside buildings is needed, and to determine additional vapor sampling and frequency.

Further testing will be conducted only within structures with associated soil vapor results that exceed the soil screening criteria. The selected structures will be tested for air pressure differentials between the sub-slab soil and the building interior. Contaminant vapors should not migrate into buildings that have higher indoor pressure than the sub-slab soil zone. Based on results of the pressure measurements, additional study may be performed to include sampling of sub-slab vapor and indoor air, and development of indoor air mitigation actions.

3.4 AS/SVE SYSTEM CONSTRUCTION

The Off Depot AS/SVE system construction will include the following major components:

- AS and SVE wells and VMPs;
- Conveyance Piping for AS and SVE wells; and
- System Compound with Control Buildings and Perimeter Fencing

3.4.1 Site Survey and Utility Clearance

A site survey will be performed to mark locations for AS and SVE wells, VMPs and the control buildings. The survey will be performed by a Registered Professional Land Surveyor licensed in the State of Tennessee. The drilling locations will be cleared for underground utilities, general access and overhead obstructions. The Tennessee One-Call System, Inc. will be utilized. 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. All location adjustments will be reviewed by the Certifying Construction Engineer (CCE) and the BCT will be informed of adjustments.

Since monitoring wells will be installed outside the DDMT boundaries, well construction permits will be obtained from the MSCHD. Traffic control plans will be prepared for wells and trenching located within roadways.

3.4.2 Well Construction

Ninety AS wells, twelve SVE wells and ten VMPs will be constructed at the distal end of the Off Depot groundwater plume. The AS and SVE wells and the VMPs are shown on Figure 9. The location coordinates, estimated boring depths and screen locations are listed on Table 5 for AS wells and on Table 6 for SVE wells and VMPs.

3.4.2.1 AS Well Construction

AS wells will be installed in 6-inch diameter soil borings advanced using rotasonic drilling to 6 to 12 inches below the top of clay at the base of the fluvial aquifer. The wells will be constructed of new, unused, decontaminated, 2-inch inside-diameter Schedule 40 PVC with internal flush-jointed threaded joints and a 30-inch long, 2.5-inch diameter microbubble sparger (Mott Corporation model # 2240-A32-30-A00-02-a). The borehole will be allowed to collapse around the microbubble sparger so that the annular space will be filled with natural formation materials to 6 to 12 inches above the top of the sparger. Once the AS well is set in the boring with the bottom of the sparger suspended at the base of the fluvial aquifer (top of clay), the drill casing will be raised above the microbubble sparger. The field geologist will measure the borehole depth using a tag line measuring tape to ensure proper collapse has occurred. If the formation materials do not collapse around and above the sparger to the desired height, then conventional filter pack will be used to augment the formation materials.

A seal of hydrated bentonite three to five feet thick will be installed above the formation materials/filter pack and a bentonite-cement grout installed with a tremie pipe will extend to approximately 3 feet bgs. A long seal will minimize the potential for pressurized air to short-circuit along the borehole and will force air into the saturated treatment zone. Soil samples will be collected continuously in 10-foot intervals to confirm site conditions are as expected and to confirm the spargers are placed at the base of the fluvial aquifer. Boring logs and construction diagrams will not be prepared; boring depths and sparger depths will be recorded.

The AS well casings will be completed with a 2-inch x 2-inch x ¾-inch PVC reducing slip "tee" and a 3/4-inch PVC to high density polyethylene (HDPE) transition fitting located approximately 2 feet bgs to facilitate connection to the HDPE conveyance pipes. A 2-inch diameter Schedule 40 PVC casing will extend from the slip "tee" to just below the natural ground surface and will then be capped with a Schedule 40 PVC slip cap with threaded plug. The well will be completed with a flush-mount wellhead vault to allow future access to the AS well. Construction drawings from the RD for the AS wells are shown on Sheet 10 in Appendix D. The control building locations have been shifted so that none of the AS wells will be installed below the building foundation.

3.4.2.2 SVE Well Construction

The SVE wells are to be constructed in 6-inch diameter soil borings advanced using rotasonic drilling methods. Lithologic core samples will be collected continuously in 10-foot intervals beginning at the ground surface. All soil borings will be advanced to approximately 5 feet above the base of the vadose zone (approximately 60 to 70 feet below ground surface depending on location). The borehole will be drilled approximately 0.5- to 1-foot below the target depth and backfilled with filter sand before installing the well. A 30-foot section of 0.006-inch continuous-slot Schedule 40 PVC screen will be installed to span the fluvial sands formation from 5 feet above the water table. Schedule 40 PVC riser will extend to approximately two feet below ground surface. Centralizers will be used at the top and bottom of the screened section. Well screen and riser will be new, unused, decontaminated, 2-inch inside-diameter Schedule 40 PVC with internal flush-jointed threaded joints.

Water level elevations from the baseline monitoring event and ground surface elevations at the SVE well locations will be used to determine the final depth prior to drilling. The bottom of the loess will be determined during drilling based on the transition from the silty and clayey loess to afine-medium grained, orange-red, loose silty sand with or without gravel. The filter pack, bentonite seal and grout seal in the SVE wells will be constructed with the same materials and installed in the same manner as in the groundwater monitoring wells, except that the filter pack will be appropriately sized for the smaller slot size of the SVE wells.

The SVE wells will be completed with a 2-inch PVC slip "tee" located approximately 2 feet bgs to facilitate the connection to the HDPE conveyance piping. Connected at 90 degrees to the "tee" will be a 2-inch PVC to high density polyethylene (HDPE) transition fitting and 2-inch x 4-inch HDPE reducing coupling. A 2-inch diameter Schedule 40 PVC casing will extend from the slip "tee" to just below the natural ground surface and will then be capped with a Schedule 40 PVC slip cap with threaded plug. The well will be completed with a 18-inch diameter concrete flush mount pad with vault to allow future access to the SVE well. Construction drawings from the RD for the SVE wells are shown on Sheet 10 in Appendix D. The control building locations have been shifted so that none of the SVE wells will be installed below the building foundation.

The e2M field geologist will prepare boring logs and construction diagrams for the SVE wells. The soil core from the vadose zone will be archived for one year in labeled cardboard core boxes.

3.4.2.3 VMP Construction

The VMPs are intended to document vapor pressure and concentrations throughout the subsurface within the AS/SVE system. Two VMPs will be installed at each of ten locations with 5-foot screens centered approximately 10 feet and 25 feet above the water table, respectively. VMPs will be constructed in 6-inch diameter soil borings advanced using rotasonic drilling methods. Each VMP borehole will be drilled approximately 0.5 foot below the target depth and backfilled with filter sand before installing the VMP. A 5-foot section of 0.010-inch slot Schedule 40 PVC will be installed with Schedule 40 PVC riser extending to the surface. A centralizer will be used at the top of the screened section. Well screen and riser will be new, unused, decontaminated, 1-inch inside-diameter Schedule 40 PVC with internal flush-jointed threaded joints and topped with a self sealing vapor sampling cap. The sampling cap will allow for vapor sampling via a brass, quick disconnect couple. Teflon tubing will extend from the sampling cap to the middle of the screen.

The filter pack, bentonite seal and grout seal in the VMPs will be constructed with the same materials and installed in the same manner as in the groundwater monitoring wells. The VMPs will be completed with a flush-mount wellhead vault to allow future access for monitoring. The e2M field geologist will prepare boring logs and construction diagrams for the VMPs. The soil core from the VMP borings will not be archived.

3.4.3 Conveyance Piping and Trenching

Individual conveyance piping will be routed to each AS and SVE well to ensure maximum system operations flexibility and to allow flow to be balanced between each well from a central location.

AS Wells. Piping will consist of 3/4-inch diameter HDPE. Wellhead connection details are provided on Sheet 10 in Appendix D. The pipe will be installed in 40-foot sections, and the joints will be butt fusion-welded by trained personnel. The AS well controls will be installed at the equipment compound; however, traffic-rated manhole covers will be installed for access and to protect the wellheads from MLGW traffic in the area.

SVE Wells. Piping will consist of 4-inch diameter standard dimension ratio (SDR) 11 or 13.5 HDPE. Wellhead connection details are provided on Sheet 10 in Appendix D. A 4-inch female threaded PVC adapter will be installed by the drilling contractor. HDPE connections will be made using 4-inch transition fittings. Coiled pipe will be used to minimize the number of joints, and the joints will be butt fusion-welded by trained personnel. The SVE well controls will be installed at the equipment compound; however, traffic-rated manhole covers will be installed for access and to protect the wellheads from MLGW traffic in the area.

Conveyance piping will be trenched from the AS and SVE wells to the equipment compound. Pipes will be grouped to minimize the number of trenches (see typical trench cross section in Sheet 3 in Appendix D). All conveyance piping will be tagged and labeled, since it will be critical to match each conveyance line with the proper manifold leg penetrating the side of the treatment system building. The spacing and orientation of each manifold leg (wall penetration) will be supplied by the equipment vendor in advance of piping installation. Concrete will be poured to support the building after all of the AS and SVE trenching under the building footprint is complete.

The pipes will be covered with at least 24 inches of compacted soil. Trench backfill (excavated soil will be reused as possible) will be compacted in 1-ft lifts using a vibratory tamping device. Trenches will not be back-filled until system start-up testing is begun and the piping can be checked for leaks.

3.4.4 Treatment Compound, Control Building, and Interior Piping

The individual AS and SVE manifold legs, compressor, blowers, after-coolers, moisture separator, and system controls will be located inside the treatment system building. Treatment system building details are provided on Sheets 7 and 8 in Appendix D. The compound will be underlain by a concrete slab and enclosed with a chain-link fence with 3-strand barbed-wire (see Sheet 9 in Appendix D). Security lighting will be installed in the compound.

Each individual SVE manifold leg will contain the following elements (mounted in the order listed, from bottom up):

- Three-inch diameter HDPE transition fitting
- Three-inch differential pressure air flow meter (ERDCO or equivalent, 0 to150 cfm)
- Pressure indicator (0-15 inches Hg)
- Three-inch manually actuated diaphragm valves (G.I.E. or equivalent, Teflon diaphragm)
- Sample port

Each individual AS manifold leg will contain the following elements (mounted in the order listed, from bottom up):

- 5/16-inch diameter red polyurethane tubing (SMC part #TU0805R-33)
- 5/16-inch diameter tube to 3/8-inch diameter National Pipe Thread (NPT) adaptor (McMaster Carr part #5111K672)
- 3/8-inch outside diameter 304 stainless steel tubing (0.01-inch thickness) (McMaster Carr part #89895K136)
- 3/8-inch speed control valve (throttling valve) (SMC part #NAS3000-N03)
- 3/8-inch pressure regulator, modular, backflow (with integrated check valve) (SMC part #AR30K-N03G-Z)
- 3/8" nickel platted bushing
- 1/2-inch rotameter (2 to 20 cfm) (McMaster Carr part #8051K22)
- Glycerin-filled stainless steel pressure gauge (0-30 psi, 0.25-inch center back mount, 2.5-inch face) (McMaster Carr part #4053K18) mounted on 1/2-inch NPT nickel plated "tee"
- 1/2-inch diameter NPT to 1/2-inch tubing adaptor (McMaster Carr #5111K677)

- 1/2-inch diameter red polyurethane tubing (SMC Part #TIUB13R-33)

For operational flexibility, the AS system will include individual solenoid valves for each well/manifold leg. To conserve space, reduce costs, and improve ease of maintenance, the system controls will consist of DIN rail-mounted solenoids inside a dedicated NEMA 4 panel, estimated to be 48-inch (tall) x 36-inch (wide) x 10-inch (deep). Operation of the pneumatic control for each solenoid valve will be checked by the construction vendor prior to shipment to the site to ensure the AS well controls are operating properly. Each cassette style solenoid will be powered (24 V DC) using #18 wire (3/4-inch conduit inlet, 1.5-meter lead supplied by the preferred vendor: SMC Corporation). The SMC part number for the DIN rail-mounted solenoid is VV5Q2-4-08C-DN-00T (5/16-inch), 2000 Series, Body Ported Manifold, Plug-In Type, Lead Wire Kit. The panel-mounted solenoid valves (SMC Model #VQ2141H-5LC-N9) for each of the AS wells will be actuated by the programmable logic controller (PLC). Unless otherwise noted above, all manifold piping will consist of hot-dip galvanized or epoxy-coated steel (coatings applied to pipe exterior only).

System data will be made accessible via a personal computer located within the treatment compound office. The computer will allow the operator to monitor system parameters including flow rates, pressures and vacuums, temperatures, and run time. Telephone service will be provided to the treatment compound to allow notification of system alarms to the operator.

3.4.5 AS Compressor

A Kaeser CSD 100 rotary screw air compressor capable of delivering at least 500 scfm at 125 psi will be used to provide air to the AS wells (cut sheet provided in RD). The compressor will be equipped with a refrigerated dryer, receiving tank, pressure relief valve, pressure regulator, particulate filter, coalescing filter, and carbon filter. The filters will minimize oil particles from the compressor in the air stream that is delivered to the subsurface. A process flow diagram is presented in Sheet 5 in Appendix D.

3.4.6 SVE Blowers

Two Kaeser Com-paK™ PD rotary blower packages (or similar) will be installed in a parallel configuration for the SVE system (cut sheet provided in RD). Each 40-horsepower (hp) blower is capable of producing 395 scfm at approximately 8 inches Hg and 2,800 revolutions per minute (rpm). The blower vacuum requirements account for the pressure loss across the HDPE conveyance piping. Each blower motor includes a variable frequency drive (VFD) which will automatically deactivate the blower in the event of a low voltage condition and protect the motor and wiring. The total flow of these blowers will be nearly 800 scfm. The dual blower configuration also permits uninterrupted SVE system operation (at lower flow rates) if one of the units is being serviced. Although significant groundwater and/or condensate recovery is not expected, a 400-gallon moisture separator tank, level controls, and transfer pump will be installed.

3.4.7 Condensate Collection

Condensate from Off Depot SVE operations will be collected in a 400-gallon air/water moisture separator tank (AWS) with level controls and transfer pump. The AWS will be located after merging of individual conveyance lines and before the two blowers. Condensate will be discharged to the City of Memphis POTW through the existing IRA groundwater recovery system. A trailer-mounted storage tank will be used to transfer the condensate from the AS/SVE treatment compound to the discharge location on Dunn Field.

Condensate samples will be collected prior to discharge and analyzed for pH, VOCs, SVOCs, and Target Analyte List (TAL) metals in accordance with the discharge permit. Discharge volumes will be reported with the analytical results to the City of Memphis on a monthly basis. All field measurements will be recorded in field logbooks, with the date, time, and location.

If the City will not accept the current condensate management approach, then a vacuum truck will be used to remove the condensate generated from the SVE system and transport the waste to a City of Memphis POTW waste portal. The condensate will be sampled and analyzed for required analytes and the data will be supplied to the City for their approval before it is transported offsite.

3.4.8 Vapor Treatment

Vapor treatment is not necessary based on expected CVOC mass removal rates.

3.4.9 IDW Management

The IDW generated during this RA-C will be managed in accordance with the procedures outlined in the WMP (Appendix B of this RAWP). IDW will include, but not be limited to:

- Drill cuttings generated during installation of the AS and SVE wells, VMPs and monitoring wells.
- 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.

3.4.10 As-Built Survey

Upon completion of construction, a Registered Professional Land Surveyor licensed in the State of Tennessee will determine as-built locations for each newly constructed MW, AS and SVE wells, and VMPs; conveyance piping trenches and the treatment compound. The survey will establish the ground surface and top of casing elevations for each well and VMP relative to mean sea level (msl) using standard surveying methods. Horizontal control will be within 0.1 foot and vertical control will be within 0.01 foot.

3.4.11 Final Construction Inspection

Upon preliminary completion of RA-C and prior to AS/SVE operations, DLA will notify the BCT for the purpose of conducting a final construction inspection. The schedule for the final construction inspection will be tentatively established in the pre-construction meeting and updated as the RA-C progresses. Participants of this inspection will include the Field Superintendent, CCE, and the BCT. The Final Inspection will consist of a walk-through of the entire project site. The objective of the inspection will be to determine whether the RA-C is complete and consistent with the plans. Outstanding items or deficiencies discovered during the inspection will be noted and an itemized list will be prepared for follow-up.

3.4.12 Site Restoration and Demobilization

All disturbed areas will be graded smooth and uniform with the surrounding areas. Large stones, debris, and materials will be removed and, if necessary, disposed of offsite. The areas will be seeded, fertilized, and mulched to minimize erosion.

During demobilization, temporary facilities such as decontamination pads and equipment storage areas, temporary utility connections, and equipment used for construction of the treatment compound will be removed from the site. Debris and solid waste materials generated during the construction activities will be removed and disposed of properly.

3.5 RA CONSTRUCTION REPORTING

3.5.1 RA-C Report

An RA-C report will be prepared to document construction of the AS-SVE system. The report will be submitted after deficiencies identified during the final construction inspection have been corrected and will contain the following information:

- Introduction including brief summaries of site conditions and the Off Depot remedy
- Descriptions of construction activities and a chronology of construction events
- Construction diagrams of AS and SVE wells, VMPs and groundwater monitoring wells
- Record drawings of the control building and treatment compound
- Construction performance standards and descriptions of construction QA/QC procedures
- Final inspection documentation and certification that the AS/SVE system is operational
- Descriptions of required operation and maintenance (O&M) activities

The report will also include design changes and deviations, photographs, waste characterization and disposal documentation, and construction testing results. The CCE will certify that the project has been constructed in compliance with the project specifications and drawings.

3.5.2 Operation and Maintenance Manual

An O&M manual will be prepared to guide system maintenance requirements and operating procedures for the AS/SVE system. The O&M package will include record drawings of system components, and specifications and manufacturer equipment manuals provided to the CCE by subcontractors. The O&M manual will address access needed to implement O&M. Standard O&M procedures presented in the manual will include, but will not be limited to, equipment inspections and preventive and corrective maintenance.

The O&M manual will contain the following information:

- System Operation and Emergency Information - descriptions of the equipment, system operational overview, normal and emergency operating conditions, safety instructions, emergency contact information, and required sample collection and laboratory analyses

- Preventive and Corrective Maintenance - preventive maintenance practices and protocols including scheduled equipment inspections, and corrective maintenance procedures to be implemented as a result of system malfunctions

- Product and Manufacturers' Data - equipment data, recommended operation conditions, recommended maintenance procedures, and warranties

- As-Built Drawings - drawings that detail the initial system configuration and any modifications made to the system

During start-up in the first two weeks of system operations, daily inspections of the system will be made. Each piece of equipment will be inspected to note that it is operating properly and that each associated gauge or meter is within the normal operating conditions specified in the O&M manual. Equipment and material will be visually inspected for damage and leaks.

4.0 REMEDIAL ACTION OPERATION

The AS-SVE system is expected to operate for 5 years in order to meet RAOs. Off-gas monitoring, SVE performance air monitoring, and system O&M will be performed regularly throughout the RA. Performance monitoring will include the collection of groundwater samples for laboratory analyses, water level measurements, periodic SVE well and effluent vapor monitoring, VMP monitoring, and indoor air quality monitoring as needed.

Groundwater monitoring will consist of performance monitoring near the AS barrier and LTM throughout the groundwater plume. Performance monitoring will include 36 monitoring wells (11 new and 25 existing). Baseline groundwater samples will be collected prior to operation of the AS-SVE system to establish a basis for evaluating remedy effectiveness. Groundwater samples will then be collected quarterly during the first year of AS-SVE operation and semiannually during the second year. After the second year, the 36 performance monitoring wells will be incorporated into LTM, which will include 94 monitoring wells, including those used for performance monitoring. The LTM wells will be monitored at semiannual to biennial intervals based on location and past results. Groundwater samples will be analyzed for CVOC parameters. Long-term monitoring will continue until the groundwater RAOs are achieved.

Upon completion of the remedy, the system will be decommissioned and the wells will be closed or plugged and abandoned in accordance with TDEC and Shelby County regulations. The site will be restored to conditions suitable for reuse in accordance with the access agreement to be developed with MLGW. Once the AS/SVE system is terminated, the only RA activity will be long-term groundwater monitoring.

4.1 AS/SVE OPERATIONS

After construction, the system will be commissioned and performance tested, which includes pressure testing of subsurface conveyance piping, review of control system logic, testing of system alarms, and evaluation of compressor capacity. Minor field changes and repairs will be completed as necessary.

Startup will be conducted over a period of 1 to 2 weeks. Startup procedure will consist of bringing individual AS and SVE headers online, assessing flow rates and extraction and injection pressures for individual wells, and balancing flow rates at the wells, as necessary.

The system design was based on pulsed operation such that 1/3 of the 90 AS wells will operate at any one time. The maximum planned air injection rate of 15 scfm will result in a total air injection rate up to 450 scfm. Initial operations will utilize every third AS well for a 4-hour cycle, such that all AS wells will be online for 8 hours each day, or 1/3 of the day. The injection of 15 scfm for 8 hours every day is equivalent to a constant rate of 5 scfm at each AS well. All 12 of the SVE wells will be online when the system is operating, and the total flow of the two SVE blowers is approximately 800 scfm.

O&M will be conducted on the AS/SVE system during the operating period. This will include routine (oil changes, filter change-out, system flow/pressure adjustments) and non-routine maintenance (responding to alarms, equipment repairs, etc.). Field notes will be recorded on maintenance and inspection forms developed for this system. Long-term O&M will also consist of flow-balancing and flow, pressure, and vacuum measurements.

4.2 AS/SVE SYSTEM MONITORING

System monitoring will include periodic SVE well and off-gas quality monitoring, VMP monitoring, equipment maintenance, and indoor air quality monitoring.

4.2.1 SVE Wells and System Effluent Monitoring

Field screening at the manifolds for the 12 fluvial SVE wells and at the system effluent will be performed with an OVA-FID or PID to gather semi-quantitative VOC data following system startup, then daily during system shake down, weekly during the first quarter and monthly thereafter. After the first two years the measurements may be decreased to quarterly. Field screening vapor samples will be collected using a portable, high vacuum oil-less vacuum pump (such as a rotary vane pump) with a vacuum capability exceeding that of the SVE blower. Vapor samples will not be collected at the discharge of the pump, because hydrocarbon vapors may be entrained in the exhaust. Prior to analysis with the calibrated OVA-FID or PID, each sample will be collected in a Tedlar® bag. All measurements will be recorded in field logbooks, with the date, time, and location.

Vapor samples for laboratory analysis will be limited to the system effluent. If vapor treatment is added due to CVOC concentration above expected levels, laboratory analysis of treatment system influent will also be performed. Vapor samples will be collected using SUMMA canisters and analyzed via EPA TO-

15 for VOCs. Samples will be collected at start-up, monthly for the first quarter and then quarterly for the remainder of the first year of operations. Sample frequency will be evaluated at the end of the first year. The sample collection protocol used in the field will follow the EPA guidance document Standard Operating Procedure (SOP) 1704: SUMMA Canister Sampling (EPA, 1995d). SUMMA canisters will be packed properly in coolers to prevent any potential puncture of the canister or exposure to excess heat that may cause the canister to rupture during shipment.

The PID readings at SVE wells and system effluent and the effluent sampling results will be used to assess VOC capture effectiveness, and the effluent sampling results will be used to verify compliance with Memphis Shelby County Health Department air regulations.

4.2.2 VMPs

Field screening at the 10 vapor monitoring points will be performed with an OVA-FID or PID to gather semi-quantitative VOC data before the AS/SVE system is started and then weekly during the first quarter and monthly thereafter. After the first two years the measurements may be decreased to quarterly. The field screening vapor samples will be collected and analyzed in the same manner as the individual SVE well samples.

In addition, a portable magnehelic differential pressure gauge will be used to collect vacuum and pressure measurements at each monitoring point. The magnehelic gauge will be connected to each VMP using flexible Tygon (or equivalent) tubing, equipped with a small isolation (ball) valve. If pressure transducers are used, a magnehelic gauge can be used for verification purposes. The gauge should be attached to the probe/transducer using a three-way joint with isolation valves, so that pressure transducer readings are not disturbed during gauge changes or during the collection of gas samples. Non-oil-based grease will be used to improve the vacuum seal. The latter step is especially critical for low permeability soils where limited vacuum response is expected.

These data will be used to assess the vacuum ROI and vapor extraction effectiveness. All field measurements will be recorded in field logbooks, with the date, time, and location.

4.2.3 Flow and Pressure Measurements

Flow and pressure will be measured through the AS/SVE system using gauges and flow meters at the same frequency as the vapor sampling events. The gauges should be connected directly to the specific manifold. All field measurements will be recorded in field logbooks, with the date, time, and location.

4.2.4 Indoor Air Quality Monitoring

The indoor air quality sampling approach is presented in the *Sampling and Analysis Plan and Quality Assurance Plan for Indoor Air Quality Monitoring*, in Appendix F of the Off Depot RD. The intent of the plan is to assess soil vapor quality near residential structures that are within or surround the Off-Depot CVOC plume. Soil vapor quality will be assessed before and then during AS/SVE system operation to evaluate its potential impact on indoor air quality. Depending on the soil vapor sampling results, a risk analysis and additional testing of indoor air will be considered.

4.3 GROUNDWATER MONITORING

Groundwater monitoring for the Of Depot RA will include performance monitoring in the area of the AS/SVE system and LTM throughout Dunn Field and the Off Depot Area. The performance monitoring wells are shown on Figure 10 and the LTM wells are shown on Figure 11. Performance monitoring and LTM sample events will be conducted at the same time and a single water level sweep of all the wells will be made prior to sample collection. Groundwater sampling procedures will be in accordance with the RA SAP and as described for baseline monitoring (Section 3.3.5.3). Samples will be analyzed for VOCs only.

Following start-up of the AS/SVE system installation, the 11 new and 25 existing performance MWs will be sampled on a quarterly basis for 1 year followed by 1 year of semiannual sampling. Performance monitoring results will be used to assess the effectiveness of the AS/SVE system in cutting off the CVOC plume. After two years, the performance monitoring wells will be assigned a sampling frequency and incorporated in LTM.

LTM will begin with the baseline sampling described in Section 3.3.5 and will replace the current IRA sampling program. LTM will utilize the 114 wells listed on Table 7. The LTM wells include 20 wells to be used for water level measurements only, 20 wells currently being used for Source Areas performance monitoring and 36 wells to be used for Off Depot performance monitoring. These wells will be incorporated in LTM once the respective performance monitoring programs are completed. The remaining 38 Off Depot LTM wells will be sampled in accordance with the frequency listed on Table 7 beginning with the baseline sampling event. LTM will continue until groundwater RAOs established in the Dunn Field ROD are met.

4.4 AS/SVE SYSTEM SHUTDOWN

Shutdown of the AS/SVE system will be considered when groundwater samples collected upgradient and downgradient of the AS barrier show individual CVOC concentrations at or below 50 µg/L for 12 months. Isolated upgradient outliers may be excluded from consideration if surrounding wells show statistically significant decreasing trends based the nonparametric Mann-Kendall test (Kendall, 1938).

If the sampling results meet these criteria, then DLA will recommend termination of the AS/SVE system to EPA and TDEC. If the criteria are not met by the next 5-year review, overall groundwater concentrations trends may be used to assess the need for continued operation. Once the AS/SVE system has been shutdown, DLA will continue to monitor Off-Depot groundwater in accordance with the LTM Plan until CVOC concentrations meet RGs specified within the Dunn Field ROD.

4.5 INTERIM REMEDIAL ACTION COMPLETION REPORT

An Interim Remedial Action Completion Report (IRACR) will be prepared following construction completion and initial monitoring for the Off Depot RA, including the AS/SVE system and MNA. The IRACR will contain the elements described in Exhibit 2-3 of EPA's guidance *Closeout Procedures for NPL Sites* (EPA, 2000), document the activities performed to implement the selected remedy, and include a narrative of work activities, as-built construction drawings, design changes and deviations, photographs, waste characterization and disposal documentation, laboratory analyses, construction testing results, construction costs with estimates of O&M costs of the RA, and QC documentation. The purpose of the IRACR will be to document that the Off Depot RA components were constructed as designed and that the remedy is operating as intended to meet RAOs established in the ROD. An Operating Properly and Successfully (OPS) determination will be incorporated in the IRACR.

The RA is operating "properly" if it is operating as designed and operating "successfully" if its operation will achieve the clean-up levels or performance goals delineated in the decision document. The USEPA interprets the term OPS to mean that the RA is functioning in such a manner that is expected to ultimately attain clean-up levels that adequately protect human health and the environment. The OPS determination will consider each of the Off Depot RA components.

Metrics for the AS/SVE component have been developed to determine whether it is operating both properly and successfully. The metrics for determining that the AS/SVE is operating properly will be as follows:

- AS and SVE wells and VMPs are installed at locations and to depths and specifications as indicated in this RAWP.
- Air compressor for AS and blowers for SVE, AWS, AS/SVE controls, and other components of the treatment compound are installed and operating as specified in the RD and this RAWP.
- AS wells achieve target flow rate of 15 scfm on average
- Blowers achieve minimum vapor extraction rate of 55 scfm from each SVE well and total vapor extraction rate for the system exceeds the total air injection rate for the AS wells.
- System effluent is below MSCHD permit requirements.

The metrics for determining that AS/SVE is operating successfully will be as follows:

- Vacuum influence as indicated by negative pressure measurements from VMPs extends throughout the AS/SVE barrier;
- Groundwater concentrations downgradient of AS/SVE barrier are below 50 µg/L for individual CVOC concentrations.

Operating properly is not considered applicable to MNA, but metrics to determine whether MNA is operating successfully will be as follows:

- CVOC concentrations decrease downgradient of AS/SVE barrier
- Overall plume boundary based on 5 and 50 µg/L isopleths is stable or retreating

Implementation of land use controls will also be documented in the IRACR. The report will describe compliance with the Dunn Field LUC protocol, recording of the Notice of Land Use Restrictions, maintenance of site fencing and results of annual site inspections.

4.6 REPORTING DURING REMEDIAL ACTION OPERATION

Quarterly summaries will be submitted to the BCT during RA-O. DLA is required to submit quarterly written summaries as specified in the Federal Facilities Agreement (USEPA, 1995b) to identify and describe completed and scheduled activities. The summaries will include the following information with respect to operation of the SVE system:

- Summary of overall system operations during the quarter, including total flow and estimated mass removal for each well and the system
- Summary of system down-time, if any, and maintenance performed on system components
- Tables of field measurements may include
  - flow rate and pressure measurements at AS wells
  - flow rate, pressure and screening level vapor concentration at manifolds for SVE wells
  - pressure and screening level vapor concentration at VMPs
  - screening level vapor concentration of effluent
- Estimated vacuum influence throughout AS/SVE treatment area based on VMP measurements
- Results of vapor sample analyses
- Condensate flow rate and results of condensate sample analyses
- Trends in vapor concentrations at individual SVE wells.
- Recommendations for modifications to system operations based on analytical results and system measurements.

Quarterly summaries are to be submitted to the BCT within eight weeks of the end of the quarter.

Additional reporting may be required \ for wastewater discharges and for air permit requirements.

4.7 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: deed and/or lease restrictions Notice of Land Use Restrictions, City of Memphis/Shelby

County zoning restrictions, the Memphis and Shelby County Health Department groundwater well restrictions, fencing and Dunn Field LUC protocol. The LUCs are described in the Land Use Control Implementation Plan (LUCIP) in Appendix A of the Off Depot RD.

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. Attachment C of the LUCIP presents 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.

4.8 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.

5.0 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 and reasonable, potential contingencies to the planned RA were described in the RD as repeated below:

The principal uncertainties of this Off Depot RA include:

1. the effective ROI of the AS array
2. the volatilization rate of the VOCs through sparging;
3. the NA rate of the VOCs; and
4. the potential movement of the plume and the length of time required for cleanup.

Contingency measures will be implemented in the event that groundwater that passes through the Off-Depot groundwater remedy treatment zone has individual CVOC concentrations greater than 50 µg/L during the system operations period. Potential contingencies could include:

1. Installation of additional AS/SVE wells
2. Continued operation of the AS/SVE system
3. Any other remedial method more cost-effective than the current approach
4. Addressing impacts to indoor air quality at nearby residences due to the operation of the AS/SVE system

Implementation of supplemental RAs will be evaluated based on the location and magnitude of residual groundwater impacts and fluvial RA effectiveness, overall groundwater data trends with respect to the objective of achieving RGs, Off-Depot groundwater remedy effectiveness, and other factors.

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TABLES

TABLE 1
REMEDIAL GOALS FROM DUNN FIELD RECORD OF DECISION
OFF DEPOT 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.

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TABLE 2
DUNN FIELD MONITORING WELLS
OFF DEPOT GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well	Installed	Northing	Easting	Location	Aquifer Screened	IRA	Source Areas RA	Off Depot RA	Off Depot LTM	MI LTM	Abandon
MW-02	Jun-82	281693.78	802244.75	DF	Fluvial						X
MW-03	Jun-82	281596.25	802100.69	DF	Fluvial	X	X				SA
MW-04	Jun-82	281278.87	802369.19	DF	Fluvial				X		
MW-05	Jun-82	281254.49	802084.68	DF	Fluvial				X		
MW-06	Jun-82	280604.17	802069.13	DF	Fluvial	X	X		SA		
MW-07	Jun-82	281839.88	802481.70	DF	Fluvial	X	X				SA
MW-08	Feb-89	282001.04	802727.91	DF	Fluvial						NE
MW-10	Mar-89	281662.55	802201.26	DF	Fluvial	X					SA
MW-12	Mar-89	281067.19	802071.22	DF	Fluvial						X
MW-13	Mar-89	281033.56	802369.21	DF	Fluvial				X		
MW-14	Mar-89	280003.37	802288.95	DF	Fluvial				X		
MW-15	Mar-89	280348.88	801985.36	DF	Fluvial	X	X		SA		
MW-28	Nov-89	281568.58	803154.48	DF	Fluvial						
MW-29	Nov-89	282104.92	802863.96	DF	Fluvial						NE
MW-30	Nov-89	282229.19	802013.96	Offsite DF	Fluvial						X
MW-31	Dec-89	281651.53	801783.90	Offsite DF	Fluvial	X			X		
MW-32	Nov-89	280834.37	801615.51	Offsite DF	Fluvial	X			X		
MW-33	Dec-89	280398.10	801561.30	Offsite DF	Fluvial	X			X		
MW-34	Nov-89	279411.21	801917.96	DF	Intermediate					X	MI
MW-35	Nov-89	281072.31	802070.44	DF	Fluvial						X
MW-37	Dec-89	280831.22	801616.58	Offsite DF	Intermediate	X			X		
MW-40	Jan-96	282460.42	800948.23	Offsite DF	Intermediate	X					X
MW-42	Jan-96	281883.92	800182.40	Offsite DF	Fluvial				H		
MW-43	Oct-98	280284.33	800111.73	Offsite DF	Intermediate	X			H		
MW-44	Jan-96	281073.71	800601.09	Offsite DF	Fluvial	X			X		
MW-45	Jan-96	280728.08	804125.99	Offsite DF	Fluvial				X		
MW-51	Jan-96	282345.86	802828.62	Offsite DF	Fluvial				X		
MW-54	Feb-96	281160.10	801183.32	Offsite DF	Fluvial	X		X	OD		
MW-56	Aug-98	279708.26	801971.55	DF	Fluvial				X		
MW-57	Aug-98	280184.05	802006.19	DF	Fluvial		X		SA		
MW-58	Aug-98	279845.07	802066.44	DF	Fluvial						X
MW-59	Aug-98	281333.67	802252.00	DF	Fluvial						X
MW-60	Aug-98	281424.39	802282.05	DF	Fluvial						X
MW-61	Aug-98	281585.68	802347.35	DF	Fluvial						X

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TABLE 2
DUNN FIELD MONITORING WELLS
OFF DEPOT GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well	Installed	Northing	Easting	Location	Aquifer Screened	IRA	Source Areas RA	Off Depot RA	Off Depot LTM	MI LTM	Abandon
MW-65	Nov-98	283529.72	803887.68	Offsite DF	Fluvial				X		
MW-67	Jul-99	280473.05	800933.94	Offsite DF	Memphis	X			H		
MW-68	Feb-00	281500.76	802040.04	DF	Fluvial	X	X				SA
MW-69	Nov-99	281202.55	802011.49	Offsite DF	Fluvial	X			X		
MW-70	Nov-99	281029.60	801988.49	Offsite DF	Fluvial	X		X	OD		
MW-71	Nov-99	280584.68	801804.71	Offsite DF	Fluvial	X			X		
MW-74	Nov-00	280991.20	802044.29	DF	Fluvial	X	X		SA		
MW-75	Nov-00	281080.10	802051.10	DF	Fluvial				X		
MW-76	Nov-00	281311.98	801642.76	Offsite DF	Fluvial	X		X	OD		
MW-77	Nov-00	281142.96	801815.29	Offsite DF	Fluvial	X		X	OD		
MW-78	Dec-00	282051.71	802065.28	Offsite DF	Fluvial				X		
MW-79	Dec-00	281794.22	800899.03	Offsite DF	Fluvial	X		X	OD		
MW-80	Dec-00	281417.56	800199.07	Offsite DF	Fluvial				H		
MW-87	Oct-00	280696.36	802038.55	DF	Fluvial				X		
MW-91	Oct-00	280474.97	802014.43	DF	Fluvial				X		
MW-95	Dec-00	282715.48	801850.80	Offsite DF	Fluvial						X
MW-126	Jul-02	282390.01	800491.67	Offsite DF	Fluvial				H		
MW-127	Jul-02	280738.40	799810.30	Offsite DF	Fluvial				H		
MW-128	Jun-03	282712.19	803376.38	Offsite DF	Fluvial				X		
MW-129	Jun-03	282271.08	803128.53	Offsite DF	Fluvial						X
MW-130	Jun-03	282116.23	803242.02	Offsite DF	Fluvial	X					NE
MW-132	Oct-03	281006.28	802129.10	DF	Fluvial	X	X		SA		
MW-134	Oct-03	281012.74	802102.58	DF	Fluvial	X	X				SA
MW-144	Jun-04	281138.63	801528.84	Offsite DF	Fluvial	X			X		
MW-145	Jun-04	280967.63	800823.18	Offsite DF	Fluvial	X			X		
MW-147	Jun-04	281501.06	801674.04	Offsite DF	Fluvial	X			X		
MW-148	Jun-04	281377.94	801461.63	Offsite DF	Fluvial	X		X	OD		
MW-149	Jun-04	281130.04	800982.76	Offsite DF	Fluvial	X		X	OD		
MW-150	Jun-04	281238.66	801283.61	Offsite DF	Fluvial	X		X	OD		
MW-151	Aug-04	281290.42	800874.85	Offsite DF	Fluvial	X		X	OD		
MW-152	Aug-04	281515.56	800892.84	Offsite DF	Fluvial	X		X	OD		
MW-153	Aug-04	282119.38	800952.34	Offsite DF	Fluvial	X			X		
MW-154	Aug-04	280501.53	800919.48	Offsite DF	Fluvial	X			H		
MW-155	Aug-04	281325.31	801168.93	Offsite DF	Fluvial	X		X	OD		

TABLE 2
DUNN FIELD MONITORING WELLS
OFF DEPOT GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well	Installed	Northing	Easting	Location	Aquifer Screened	IRA	Source Areas RA	Off Depot RA	Off Depot LTM	MI LTM	Abandon
MW-156	Aug-04	281143.44	800408.84	Offsite DF	Fluvial	X					X
MW-157	Aug-04	281050.91	801348.32	Offsite DF	Fluvial	X		X	OD		
MW-158	10/4/2004	281434.42	801005.34	Offsite DF	Fluvial	X		X	OD		
MW-158A	10/5/2004	281443.51	801005.67	Offsite DF	Fluvial	X		X	OD		
MW-159	10/6/2004	281304.29	801006.52	Offsite DF	Fluvial	X		X	OD		
MW-160	10/11/2004	281366.52	801304.26	Offsite DF	Fluvial	X		X	OD		
MW-161	10/7/2004	281120.29	801596.82	Offsite DF	Fluvial	X		X	OD		
MW-162	10/8/2004	281244.22	801596.06	Offsite DF	Fluvial	X		X	OD		
MW-163	10/7/2004	281152.59	801487.27	Offsite DF	Fluvial	X		X	OD		
MW-164	10/9/2004	280997.55	801497.47	Offsite DF	Fluvial	X		X	OD		
MW-165	11/4/2004	281384.63	800855.49	Offsite DF	Fluvial	X		X	OD		
MW-165A	11/4/2004	281383.55	800865.69	Offsite DF	Fluvial	X		X	OD		
MW-166	11/4/2004	281224.99	800928.09	Offsite DF	Fluvial	X		X	OD		
MW-166A	11/4/2004	281213.35	800927.36	Offsite DF	Fluvial	X		X	OD		
MW-167	11/4/2004	281394.03	800618.54	Offsite DF	Fluvial	X			H		
MW-168	11/4/2004	281903.51	801003.88	Offsite DF	Fluvial	X					X
MW-168A	11/4/2004	281896.50	800934.51	Offsite DF	Fluvial	X					X
MW-169	12/4/2004	282491.23	800956.58	Offsite DF	Intermediate	X			X		
MW-170	12/4/2004	282443.17	801260.46	Offsite DF	Fluvial	X			X		
MW-171	12/4/2004	282315.35	801057.83	Offsite DF	Fluvial	X			X		
MW-172	3/13/2006	280213.31	802221.98	DF	Fluvial	X	X		SA		
MW-174	10/11/2005	280352.00	802092.07	DF	Fluvial	X	X		SA		
MW-175	10/12/2005	280618.49	802175.36	DF	Fluvial	X	X		SA		
MW-176	10/25/2005	280823.77	802032.08	DF	Fluvial				X		
MW-178	10/20/2005	280982.81	802227.34	DF	Fluvial	X	X		SA		
MW-179	10/14/2005	281075.70	802158.65	DF	Fluvial	X	X		SA		
MW-180	10/20/2005	281476.43	802131.85	DF	Fluvial	X	X		SA		
MW-182	10/19/2005	280524.22	800623.13	Offsite DF	Fluvial				X		
MW-183	10/17/2005	280526.52	800613.05	Offsite DF	Intermediate						X
MW-184	10/24/2005	280903.16	801442.29	Offsite DF	Fluvial				X		
MW-185	10/26/2005	282673.47	800985.92	Offsite DF	Fluvial				X		
MW-186	10/31/2005	282691.30	800988.07	Offsite DF	Fluvial				X		
MW-187	3/14/2006	280563.18	802348.09	DF	Fluvial	X	X		SA		
MW-189	Mar-06	281115.99	801587.43	Offsite DF	Fluvial						X

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TABLE 2
DUNN FIELD MONITORING WELLS
OFF DEPOT GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well	Installed	Northing	Easting	Location	Aquifer Screened	IRA	Source Areas RA	Off Depot RA	Off Depot LTM	MI LTM	Abandon
MW-190	3/24/2006	281138.88	801595.73	Offsite DF	Fluvial				X		
MW-191	3/22/2006	281133.68	801546.91	Offsite DF	Fluvial						X
MW-192	3/21/2006	281156.67	801555.48	Offsite DF	Fluvial						X
MW-193	3/20/2006	281167.35	801531.90	Offsite DF	Fluvial						X
MW-194	6/7/2006	281115.71	801567.74	Offsite DF	Fluvial						X
MW-195	6/6/2006	281139.31	801566.63	Offsite DF	Fluvial						X
MW-196	6/6/2006	281145.94	801576 20	Offsite DF	Fluvial						X
MW-196B	8/30/2006	281152.42	801579.89	Offsite DF	Fluvial						X
MW-196C	8/31/2006	281146.15	801552.09	Offsite DF	Fluvial						X
MW-220	May-07	281617.49	802166.87	DF	Fluvial	X	X				SA
MW-221	May-07	281399.71	802100.05	DF	Fluvial	X	X		SA		
MW-222	May-07	280986.04	802145.54	DF	Fluvial	X	X		SA		
MW-223	May-07	280913.53	802104.29	DF	Fluvial	X	X		SA		
MW-224	Apr-07	281017.74	802181.62	DF	Fluvial	X	X		SA		
MW-225	Apr-07	280947.12	802070.50	DF	Fluvial	X	X		SA		
MW-226	May-07	280931.94	802147.21	DF	Fluvial	X	X		SA		
MW-227	Apr-07	280257.91	802081.00	DF	Fluvial	X	X		SA		
MW-228	Apr-07	280251.88	802157.40	DF	Fluvial	X	X		SA		
MW-229	8/1/2007	279293.98	802836.28	DF	Intermediate					X	MI
MW-230	7/30/2007	281842.54	802800.22	DF	Fluvial	X					NE
MW-231	8/31/2007	280944.20	801628.65	Offsite DF	Intermediate	X			X		
MW-232	9/17/2007	281294.53	801006.27	Offsite DF	Intermediate	X		X	OD		
MW-233	9/1/2007	280953.30	801628.62	Offsite DF	Fluvial	X					X
MW-234	9/16/2007	281005.44	801630.89	Offsite DF	Intermediate	X			X		
MW-235	9/5/2007	280727.57	800447.83	Offsite DF	Fluvial	X			X		
MW-236	9/6/2007	.283535.07	800762.86	Offsite DF	Fluvial	X					X
MW-237	9/20/2007	281356.02	800963.99	Offsite DF	Intermediate	X			X		
MW-238	9/18/2007	280918.68	802082.45	DF	Intermediate	X					X
MW-239	9/20/2007	281334.02	801009.58	Offsite DF	Intermediate	X			X		
MW-240	10/3/2007	282897.03	800869.30	Offsite DF	Intermediate	X			X		
PZ-02	Oct-98	282748.00	803373.00	Offsite DF	Fluvial						X
RW-01	Oct-99	280267.14	801973.88	DF	Fluvial	X					
RW-01A	Oct-99	280386.26	801990.08	DF	Fluvial	X					
RW-01B	Oct-99	280504.87	802009.37	DF	Fluvial	X					

TABLE 2
DUNN FIELD MONITORING WELLS
OFF DEPOT GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well	Installed	Northing	Easting	Location	Aquifer Screened	IRA	Source Areas RA	Off Depot RA	Off Depot LTM	MI LTM	Abandon
RW-02	Oct-99	280624.56	802003.32	DF	Fluvial	X					
RW-03	Feb-98	280743.76	802012.69	DF	Fluvial	X					
RW-04	Feb-98	280918.07	802027.11	DF	Fluvial	X					
RW-05	Mar-98	281113.38	802041.97	DF	Fluvial	X					
RW-06	Jan-98	281264.22	802067.17	DF	Fluvial	X					
RW-07	Jan-98	281442.21	802079.19	DF	Fluvial	X					
RW-08	Jan-98	281574.72	802088.53	DF	Fluvial	X					
RW-09	Jan-98	281688.06	802232.41	DF	Fluvial	X					
NEW 1	-	-	-	Offsite DF	Fluvial			X			
NEW 2	-	-	-	Offsite DF	Fluvial			X			
NEW 3	-	-	-	Offsite DF	Fluvial			X			
NEW 4	-	-	-	Offsite DF	Fluvial			X			
NEW 5	-	-	-	Offsite DF	Fluvial			X			
NEW 6	-	-	-	Offsite DF	Fluvial			X			
NEW 7	-	-	-	Offsite DF	Fluvial			X			
NEW 8	-	-	-	Offsite DF	Fluvial			X			
NEW 9	-	-	-	Offsite DF	Fluvial			X			
NEW 10	-	-	-	Offsite DF	Intermediate			X			
NEW 11	-	-	-	Offsite DF	Intermediate			X			

Legend

X: Sample collected in monitoring program
H: Well used for water level measurements only
SA: Well used for Source Areas RA performance monitoring.
OD: Well used for Off Depot RA performance monitoring.
MI: Well used for Main Installation LTM. Will not be abandoned per Off Depot RD.
NE: Well used for monitoring plume migrating on to Dunn Field from northeast.

Notes

1) Wells labeled SA and OD will not be abandoned or added to the Off Depot LTM until the RA monitoring is completed.

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TABLE 3
NEW PERFORMANCE MONITORING WELLS
OFF DEPOT GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well	Northing	Easting	Location	Aquifer Screened	Estimated Ground Elevation (ft, msl)	Estimated Top of Clay Elevation (ft, msl)	Planned Boring Depth (ft, bgs)	Planned Surface Casing Depth (ft, bgs)	Estimated Groundwater Elevation (ft, msl)	Estimated Fluvial Aquifer Thickness (ft)	Planned Riser Length (ft)	Planned Screen Length (ft)
NEW 1	801394.8	281399.9	Offsite DF	Fluvial	295	208	91	na	215	7	71.3	15
NEW 2	801233.1	281302.8	Offsite DF	Fluvial	296	202	99	na	213	11	78.6	15
NEW 3	801117.1	281374.1	Offsite DF	Fluvial	293	194	104	na	213	19	78.9	20
NEW 4	801101.0	281333.6	Offsite DF	Fluvial	290	193	102	na	213	20	77.3	20
NEW 5	801034.7	281381.5	Offsite DF	Fluvial	291	190	106	na	213	23	81.3	20
NEW 6	800951.6	281388.8	Offsite DF	Fluvial	289	186	108	na	213	27	82.7	20
NEW 7	800900.3	281340.2	Offsite DF	Fluvial	287	186	106	na	213	26	80.8	20
NEW 8	800718.2	281188.3	Offsite DF	Fluvial	274	191	88	na	213	22	63.3	20
NEW 9	800810.7	281070.7	Offsite DF	Fluvial	286	188	103	na	213	25	77.7	20
NEW 10	800913.5	281011.8	Offsite DF	Intermediate	291	189	<200	106	tbd	-	tbd	15
NEW 11	801021.8	281211.8	Offsite DF	Intermediate	286	187	<200	104	tbd	-	tbd	15

Notes

1) Ground, top of clay and groundwater elevations based on observations in nearby wells.
2) Borings for fluvial aquifer wells to be drilled 5 feet into the uppermost clay
3) Screens for fluvial aquifer wells to be no longer than 20 feet and to span the aquifer if possible.
4) Surface casing for intermediate aquifer wells to be drilled 5 feet into the uppermost clay

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TABLE 4
MONITORING WELLS TO BE ABANDONED
OFF DEPOT GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well	Installed	Northing	Easting	Location	Well Depth (ft, bgs)	Aquifer Screened	Abandon
MW-02	Jun-82	281693.78	802244.75	DF	30.0	Fluvial	X
MW-12	Mar-89	281067.19	802071.22	DF	84.4	Fluvial	X
MW-29	Nov-89	282104.92	802863.96	DF	54.2	Fluvial	X
MW-30	Nov-89	282229.19	802013.96	Offsite DF	59.0	Fluvial	X
MW-35	Nov-89	281072.31	802070.44	DF	89.6	Fluvial	X
MW-40	Jan-96	282460.42	800948 23	Offsite DF	95.0	Intermediate	X
MW-58	Aug-98	279845 07	802066.44	DF	67.0	Fluvial	X
MW-59	Aug-98	281333.67	802252.00	DF	82.5	Fluvial	X
MW-60	Aug-98	281424.39	802282.05	DF	82.5	Fluvial	X
MW-61	Aug-98	281585.68	802347.35	DF	78.5	Fluvial	X
MW-95	Dec-00	282715.48	801850.80	Offsite DF	60.0	Fluvial	X
MW-156	Aug-04	281143.44	800408.84	Offsite DF	68.9	Fluvial	X
MW-168	11/4/2004	281903.51	801003.88	Offsite DF	121.2	Fluvial	X
MW-168A	11/4/2004	281896.50	800934.51	Offsite DF	88.8	Fluvial	X
MW-183	10/17/2005	280526.52	800613.05	Offsite DF	168.3	Intermediate	X
MW-189	Mar-06	281115.99	801587.43	Offsite DF	87.3	Fluvial	X
MW-191	3/22/2006	281133.68	801546.91	Offsite DF	77.6	Fluvial	X
MW-192	3/21/2006	281156.67	801555.48	Offsite DF	78.7	Fluvial	X
MW-193	3/20/2006	281167.35	801531.90	Offsite DF	81.6	Fluvial	X
MW-194	6/7/2006	281115.71	801567.74	Offsite DF	84.6	Fluvial	X
MW-195	6/6/2006	281139.31	801566.63	Offsite DF	80.6	Fluvial	X
MW-196	6/6/2006	281145.94	801576.20	Offsite DF	74.9	Fluvial	X
MW-196B	8/30/2006	281152.42	801579.89	Offsite DF	77.5	Fluvial	X
MW-196C	8/31/2006	281146.15	801552.09	Offsite DF	80.4	Fluvial	X
MW-233	9/1/2007	280953.30	801628.62	Offsite DF	67.9	Fluvial	X
MW-236	9/6/2007	283535.07	800762 86	Offsite DF	34.9	Fluvial	X
MW-238	9/18/2007	280918.68	802082.45	DF	190.8	Intermediate	X
PZ-02	Oct-98	282748.00	803373.00	Offsite DF	54.0	Fluvial	X
RD Listed Wells to be Maintained							
MW-34	Nov-89	279411.21	801917.96	DF	156.6	Intermediate	MI
MW-229	8/1/2007	279293.98	802836.28	DF	208.4	Intermediate	MI
MW-08	Feb-89	282001.04	802727.91	DF	66.5	Fluvial	NE
MW-129	Jun-03	282271.08	803128.53	Offsite DF	80.0	Fluvial	NE
MW-130	Jun-03	282116.23	803242.02	Offsite DF	79.5	Fluvial	NE
MW-230	7/30/2007	281842.54	802800.22	DF	74.3	Fluvial	NE
MW-03	Jun-82	281596.25	802100.69	DF	75.5	Fluvial	SA
MW-07	Jun-82	281839.88	802481.70	DF	77.0	Fluvial	SA
MW-10	Mar-89	281662.55	802201.26	DF	68.6	Fluvial	SA
MW-68	Feb-00	281500.76	802040.04	DF	82.5	Fluvial	SA
MW-134	Oct-03	281012.74	802102.58	DF	90.0	Fluvial	SA
MW-220	May-07	281617.49	802166.87	DF	79.9	Fluvial	SA

Legend

X: Well to abandoned prior to Off Depot baseline sampling.
NE: Will not be abandoned until remedial action for Northeast off-site plume determined.
MI: Well used for Main Installation LTM. Will not be abandoned.
SA: Will not be abandoned until Source Areas RA performance monitoring completed.

TABLE 5
AIR SPARGE WELLS
OFF DEPOT GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well	Northing	Easting	Estimated Ground Elevation (ft, msl)	Estimated Top of Clay Elevation (ft, msl)	Estimated Groundwater Elevation (ft, msl)	Planned Boring Depth (ft, bgs)	Planned Riser Length (ft)	Planned Screen Length (ft)	Estimated Saturated Thickness (ft)
AS 1	281243.7	800914.3	285	184	213	101	97.7	2.5	28
AS 2	281250.0	800928.0	284	184	213	100	97.0	2.5	29
AS 3	281258.7	800915.7	285	185	213	101	97.7	2.5	28
AS 4	281265.0	800929.1	284	185	213	100	96.9	2.5	28
AS 5	281273.6	800917.0	285	185	213	101	97.4	2.5	28
AS 6	281279.9	800930 5	284	185	213	100	96.5	2.5	27
AS 7	281288.6	800918.3	285	186	213	100	96.8	2.5	27
AS 8	281294.9	800931.8	285	186	213	100	96.5	2.5	27
AS 9	281303.5	800919.5	285	186	213	100	96.9	2.5	27
AS 10	281309.8	800933.3	285	186	213	100	96.7	2.5	27
AS 11	281318.4	800921.0	286	186	213	101	97.4	2.5	27
AS 12	281324.7	800934.6	286	186	213	101	97.4	2.5	27
AS 13	281333.4	800922.3	286	186	213	101	97.5	2.5	27
AS 14	281339.7	800935.9	287	186	213	102	98.4	2.5	27
AS 15	281348.3	800923.8	287	186	213	102	98.3	2.5	27
AS 16	281362.8	800924.4	288	186	213	103	99.5	2.5	27
AS 17	281372.2	800936.3	288	186	213	104	100.2	2.5	27
AS 18	281358.6	800942.4	289	186	213	104	100.4	2.5	27
AS 19	281370.8	800951.0	289	186	213	104	100.6	2.5	27
AS 20	281357.0	800957.4	289	186	213	104	100.4	2.5	26
AS 21	281369.4	800966.0	289	186	213	104	100.5	2.5	27
AS 22	281355.9	800972.4	290	187	213	104	100.6	2.5	26
AS 23	281368.1	800981.1	289	187	213	103	99.8	2.5	26
AS 24	281354.3	800987.3	290	188	213	103	100.0	2.5	25
AS 25	281366.7	800995.8	290	187	213	104	100.2	2.5	25
AS 26	281352.8	801002.0	290	188	213	103	99.6	2.5	25
AS 27	281365.2	801010.9	290	189	213	103	99.4	2.5	24
AS 28	281351.7	801017.2	291	189	213	103	99.2	2.5	24
AS 29	281364.2	801025.9	291	189	213	103	99.3	2.5	24
AS 30	281350.3	801032.1	291	190	213	102	98.5	2 5	23
AS 31	281362.6	801040.8	291	190	213	102	98.5	2.5	23
AS 32	281348.8	801047.0	291	191	213	101	97.9	2.5	22
AS 33	281361.4	801055.7	291	191	213	102	98.1	2.5	22
AS 34	281347.6	801062.0	291	191	213	101	97.2	2.5	22
AS 35	281360.0	801070.7	292	191	213	101	97.5	2.5	21
AS 36	281346.2	801076.9	291	192	213	100	96.4	2.5	21
AS 37	281358.6	801085.6	292	192	213	101	97.5	2.5	21
AS 38	281344.8	801091.9	291	193	213	100	96.4	2.5	20
AS 39	281357.2	801100.5	292	193	213	100	96.4	2.5	20
AS 40	281343.2	801106.7	291	194	213	99	95.3	2.5	19
AS 41	281355.8	801115.4	292	193	213	100	96.1	2.5	19
AS 42	281342.3	801121.6	292	194	213	99	95.2	2.5	19
AS 43	281354.4	801130.5	293	194	213	99	95.7	2.5	18
AS 44	281340.9	801136.5	292	195	213	98	94.6	2.5	18
AS 45	281353.0	801145.4	293	195	213	99	95.4	2.5	18
AS 46	281339.3	801151.6	292	196	213	98	94.1	2.5	17
AS 47	281351.7	801160.1	293	196	213	98	94.2	2.5	17
AS 48	281338.0	801166.4	292	197	213	96	92.8	2.5	16
AS 49	281350.5	801175.1	293	197	213	97	93.6	2.5	16

TABLE 5
AIR SPARGE WELLS
OFF DEPOT GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well	Northing	Easting	Estimated Ground Elevation (ft, msl)	Estimated Top of Clay Elevation (ft, msl)	Estimated Groundwater Elevation (ft, msl)	Planned Boring Depth (ft, bgs)	Planned Riser Length (ft)	Planned Screen Length (ft)	Estimated Saturated Thickness (ft)
AS 50	281336.6	801181.4	293	198	213	96	92.3	2.5	15
AS 51	281349.6	801189.7	293	198	213	96	92.2	2.5	15
AS 52	281335.2	801196.4	293	199	213	95	92.0	2.5	15
AS 53	281347.6	801205.2	293	199	213	95	91.6	2.5	14
AS 54	281333.8	801211.1	294	200	213	95	91.6	2.5	13
AS 55	281346.3	801220.0	294	201	213	94	90.6	2.5	12
AS 56	281332.6	801226.5	295	202	213	94	90.6	2.5	12
AS 57	281344.8	801234.8	294	202	213	94	90.2	2.5	12
AS 58	281331.2	801241.1	295	202	213	94	90.0	2.5	11
AS 59	281343.6	801249 8	295	203	213	92	89.0	2.5	10
AS 60	281329.8	801256.0	295	203	213	93	89.5	2.5	10
AS 61	281318.9	801232.6	295	202	213	94	91.0	2.5	11
AS 62	281320.2	801217.7	295	201	213	95	91.5	2.5	12
AS 63	281321.6	801202.7	294	199	213	96	92.0	2.5	14
AS 64	281323.0	801187.6	292	199	213	95	91.1	2.5	14
AS 65	281311.1	801179.3	292	198	213	95	91.0	2.5	15
AS 66	281309.6	801194.1	293	199	213	95	91.5	2.5	14
AS 67	281308.0	801209.1	295	200	213	95	91.9	2.5	13
AS 68	281307.2	801223.9	295	201	213	95	91.6	2.5	12
AS 69	281296.0	801200.5	294	200	213	95	91.4	2.5	13
AS 70	281297.0	801185.5	292	198	213	94	90.8	2.5	15
AS 71	281298.7	801170.5	291	198	213	95	91.1	2.5	16
AS 72	281284.9	801176.9	291	199	213	93	90.0	2.5	14
AS 73	281355.7	801258.7	294	204	213	91	87 7	2.5	10
AS 74	281342.1	801264.8	295	204	213	92	88.5	2.5	9
AS 75	281354.1	801272.8	294	205	213	90	86.9	2.5	9
AS 76	281340.7	801279.8	295	205	213	91	87.0	2.5	8
AS 77	281352.5	801288 2	295	206	214	90	86.0	2.5	7
AS 78	281339.3	801294.6	295	206	214	90	86.5	2.5	7
AS 79	281351.7	801303.5	295	207	214	89	85.7	2.5	7
AS 80	281365.2	801297.0	294	207	214	88	84.9	2.5	7
AS 81	281363.8	801312.0	294	207	214	88	84.4	2.5	7
AS 82	281377.6	801305.8	294	206	214	89	85.2	2.5	7
AS 83	281376.1	801320.8	294	207	214	88	84.4	2.5	7
AS 84	281374.3	801335.7	294	207	214	88	84.0	2.5	7
AS 85	281373.4	801350.5	294	207	214	87	84.0	2.5	6
AS 86	281372.2	801365.6	294	207	214	87	83.6	2.5	7
AS 87	281370.6	801381.6	294	208	214	88	84.0	2.5	7
AS 88	281374.7	801396.1	294	208	214	87	83.9	2.5	7
AS 89	281379.1	801410.6	294	207	214	88	84.2	2.5	7
AS 90	281383.4	801425.1	294	207	214	88	84.0	2.5	7

Notes

1) Ground, top of clay and groundwater elevations based on observations in nearby wells.
2) Borings for AS wells to be drilled 1 foot into the uppermost clay
3) AS wells will have 30-inch micro-sparger rather than well screen.

TABLE 6
SVE WELLS AND VMPS
OFF DEPOT GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well	Northing	Easting	Estimated Ground Elevation (ft, msl)	Estimated Groundwater Elevation (ft, msl)	Planned Boring Depth (ft, bgs)	Planned Riser Length (ft)	Planned Screen Length (ft)
SVE 1	281279.7	800921.1	285	213	68	37	30
SVE 2	281318.9	800926.2	286	213	69	38	30
SVE 3	281361.7	800950.4	289	213	73	42	30
SVE 4	281363.8	801002.2	290	213	74	43	30
SVE 5	281358.1	801061.8	291	213	74	43	30
SVE 6	281354.7	801106.7	292	213	75	44	30
SVE 7	281349.5	801166.8	293	213	76	45	30
SVE 8	281306.5	801190.4	292	213	75	44	30
SVE 9	281316.6	801213.7	295	213	78	47	30
SVE 10	281341.1	801244.0	295	213	77	46	30
SVE 11	281351.2	801294.9	295	214	77	46	30
SVE 12	281368.7	801371.5	294	214	76	45	30
VMP 1A	281359.1	801422.3	297	214	75	70	5
VMP 1B	281359.1	801422.3	297	214	-	55	5
VMP 2A	281375.9	801274.3	294	213	74	68	5
VMP 2B	281375.9	801274.3	294	213	-	53	5
VMP 3A	281275.1	801166.0	291	213	71	65	5
VMP 3B	281275.1	801166.0	291	213	-	50	5
VMP 4A	281327.6	801098.6	289	213	70	64	5
VMP 4B	281327.6	801098.6	289	213	-	49	5
VMP 5A	281370.2	801162.5	293	213	73	68	5
VMP 5B	281370.2	801162.5	293	213	-	53	5
VMP 6A	281427.8	800979.9	294	213	74	68	5
VMP 6B	281427.8	800979.9	294	213	-	53	5
VMP 7A	281366.1	800896.6	287	213	67	62	5
VMP 7B	281366.1	800896.6	287	213	-	47	5
VMP 8A	281254.8	800988.3	284	213	65	59	5
VMP 8B	281254.8	800988.3	284	213	-	44	5
VMP 9A	281320.0	801010.1	287	213	68	62	5
VMP 9B	281320.0	801010.1	287	213	-	47	5
VMP 10A	281260.6	800867.9	282	213	62	57	5
VMP 10B	281260.6	800867.9	282	213	-	42	5

Notes

1) Ground and groundwater elevations based on observations in nearby wells.
2) Borings for SVE wells to be drilled to 4 feet above the water table
3) Bottom of screens for SVE wells to be 5 feet above the water table.
4) Screens for VMP xA wells to be centered 10 feet above the water table.
5) Screens for VMP xB wells to be centered 25 feet above the water table.
6) VMPs xA and xB to be installed in a single borehole.

TABLE 7
LTM WELL CLASSIFICATION AND SAMPLE FREQUENCY
OFF DEPOT GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well	Off Depot LTM	Off Depot Classification	Off Depot Sample Frequency
MW-04	X	Background	Biennial
MW-05	X	Sentinel	Biennial
MW-13	X	Background	Biennial
MW-14	X	Background	Biennial
MW-31	X	Performance	Annual
MW-32	X	Performance	Annual
MW-33	X	Sentinel	Biennial
MW-37	X	Sentinel	Biennial
MW-44	X	Performance	Annual
MW-51	X	Background	Biennial
MW-56	X	Sentinel	Biennial
MW-65	X	Background	Biennial
MW-69	X	Sentinel	Annual
MW-71	X	Performance	Annual
MW-75	X	Performance	Annual
MW-78	X	Sentinel	Biennial
MW-87	X	Sentinel	Annual
MW-91	X	Sentinel	Biennial
MW-128	X	Background	Biennial
MW-144	X	Performance	Annual
MW-145	X	Sentinel	Annual
MW-147	X	Performance	Semiannual
MW-153	X	Sentinel	Biennial
MW-169	X	Sentinel	Biennial
MW-170	X	Sentinel	Biennial
MW-171	X	Sentinel	Biennial
MW-176	X	Sentinel	Annual
MW-182	X	Sentinel	Biennial
MW-184	X	Performance	Biennial
MW-185	X	Sentinel	Biennial
MW-186	X	Sentinel	Biennial
MW-190	X	Performance	Annual
MW-231	X	Sentinel	Biennial
MW-234	X	Sentinel	Biennial
MW-235	X	Sentinel	Biennial
MW-237	X	Sentinel	Biennial
MW-239	X	Sentinel	Biennial
MW-240	X	Sentinel	Biennial
MW-06	SA	Performance	Annual
MW-15	SA	Performance	Annual
MW-57	SA	Performance	Annual
MW-74	SA	Performance	Annual
MW-132	SA	Performance	Annual
MW-172	SA	Background	Annual
MW-174	SA	Sentinel	Annual

Well	Off Depot LTM	Off Depot Classification	Off Depot Sample Frequency
MW-54	OD	Performance	Semiannual
MW-70	OD	Performance	Semiannual
MW-76	OD	Performance	Annual
MW-77	OD	Performance	Annual
MW-79	OD	Sentinel	Biennial
MW-148	OD	Performance	Semiannual
MW-149	OD	Performance	Semiannual
MW-150	OD	Performance	Semiannual
MW-151	OD	Performance	Semiannual
MW-152	OD	Performance	Semiannual
MW-155	OD	Performance	Semiannual
MW-157	OD	Performance	Annual
MW-158	OD	Performance	Semiannual
MW-158A	OD	Performance	Semiannual
MW-159	OD	Performance	Semiannual
MW-160	OD	Performance	Semiannual
MW-161	OD	Performance	Annual
MW-162	OD	Performance	Annual
MW-163	OD	Performance	Annual
MW-164	OD	Performance	Annual
MW-165	OD	Performance	Semiannual
MW-165A	OD	Performance	Semiannual
MW-166	OD	Performance	Semiannual
MW-166A	OD	Performance	Semiannual
MW-232	OD	Sentinel	Semiannual
NEW 1	OD	Performance	Semiannual
NEW 2	OD	Performance	Semiannual
NEW 3	OD	Performance	Semiannual
NEW 4	OD	Performance	Semiannual
NEW 5	OD	Performance	Semiannual
NEW 6	OD	Performance	Semiannual
NEW 7	OD	Performance	Semiannual
NEW 8	OD	Performance	Semiannual
NEW 9	OD	Performance	Semiannual
NEW 10	OD	Sentinel	Semiannual
NEW 11	OD	Sentinel	Semiannual
MW-03	H	Performance	Hydro
MW-07	H	Performance	Hydro
MW-08	H	Background	Hydro
MW-10	H	Performance	Hydro
MW-28	H	Background	Hydro
MW-42	H	Background	Hydro
MW-43	H	Sentinel	Hydro
MW-45	H	Background	Hydro
MW-67	H	Sentinel	Hydro

TABLE 7
LTM WELL CLASSIFICATION AND SAMPLE FREQUENCY
OFF DEPOT GROUNDWATER RA WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well	Off Depot LTM	Off Depot Classification	Off Depot Sample Frequency
MW-175	SA	Performance	Annual
MW-178	SA	Background	Annual
MW-179	SA	Performance	Annual
MW-180	SA	Performance	Annual
MW-187	SA	Background	Annual
MW-221	SA	Performance	Annual
MW-222	SA	Performance	Annual
MW-223	SA	Performance	Annual
MW-224	SA	Performance	Annual
MW-225	SA	Performance	Annual
MW-226	SA	Performance	Annual
MW-227	SA	Performance	Annual
MW-228	SA	Performance	Annual
MW-68	H	Performance	Hydro
MW-80	H	Background	Hydro
MW-126	H	Background	Hydro
MW-127	H	Background	Hydro
MW-129	H	Background	Hydro
MW-130	H	Background	Hydro
MW-134	H	Performance	Hydro
MW-154	H	Background	Hydro
MW-167	H	Background	Hydro
MW-220	H	Performance	Hydro
MW-230	H	Background	Hydro

Legend

X: Sample to be collected in LTM program
H: Well to be used for water level measurements only
SA: Well also sampled for Source Areas RA performance monitoring.
OD: Well also sampled for Off Depot RA performance monitoring.

Notes

1) Wells labeled SA and OD will not be added to Off Depot LTM sample events until the RA monitoring is completed; water levels will be measured.

FIGURES

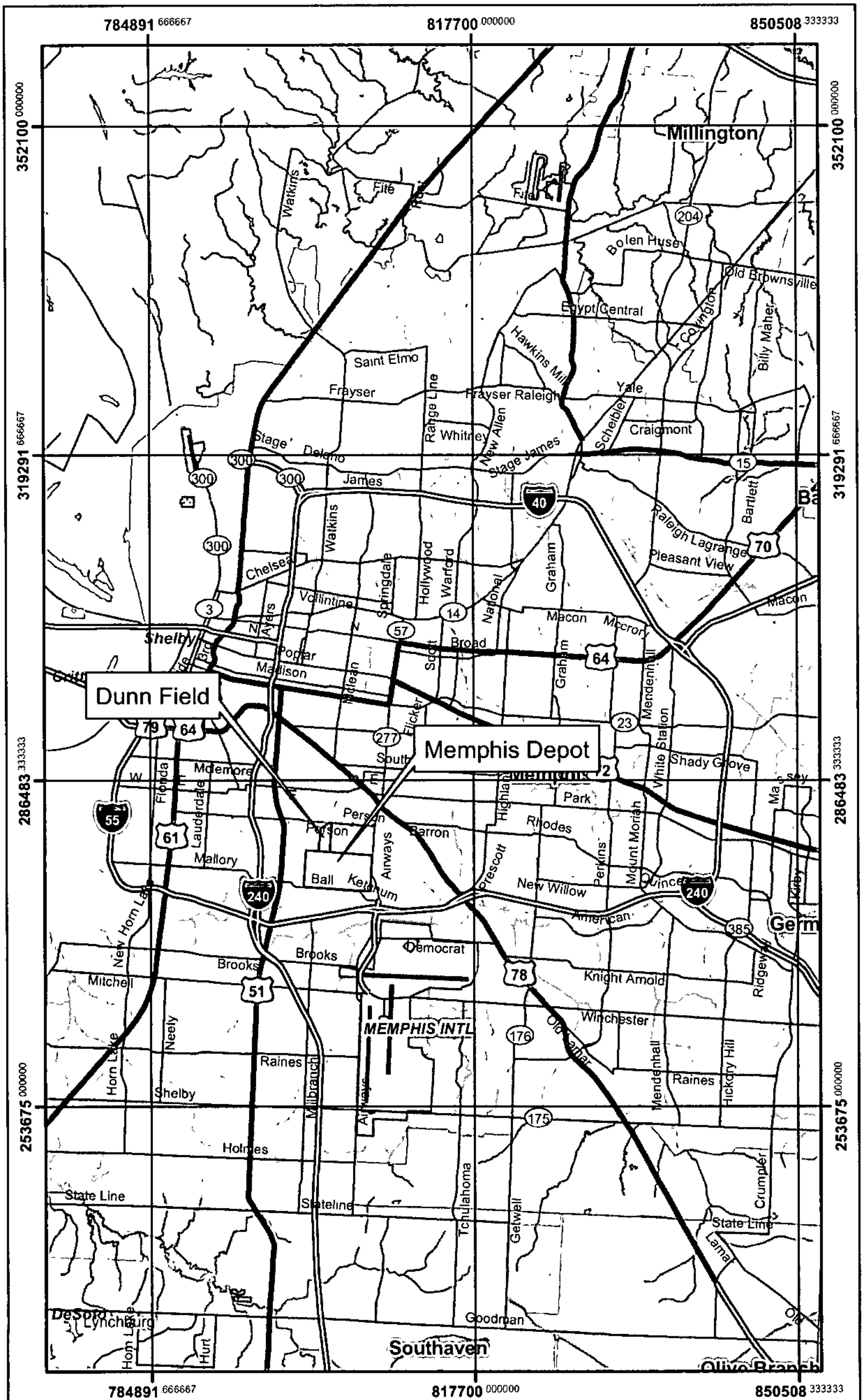
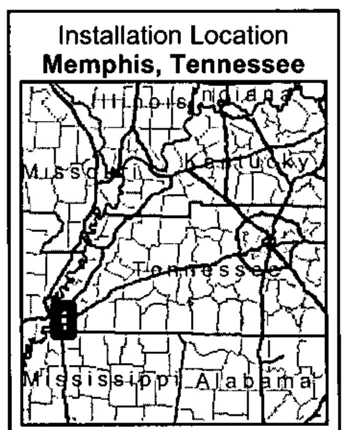


Figure 1

SITE LOCATION MAP

OFF DEPOT GROUNDWATER
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE



Date: January 2009
Edition: Rev 1

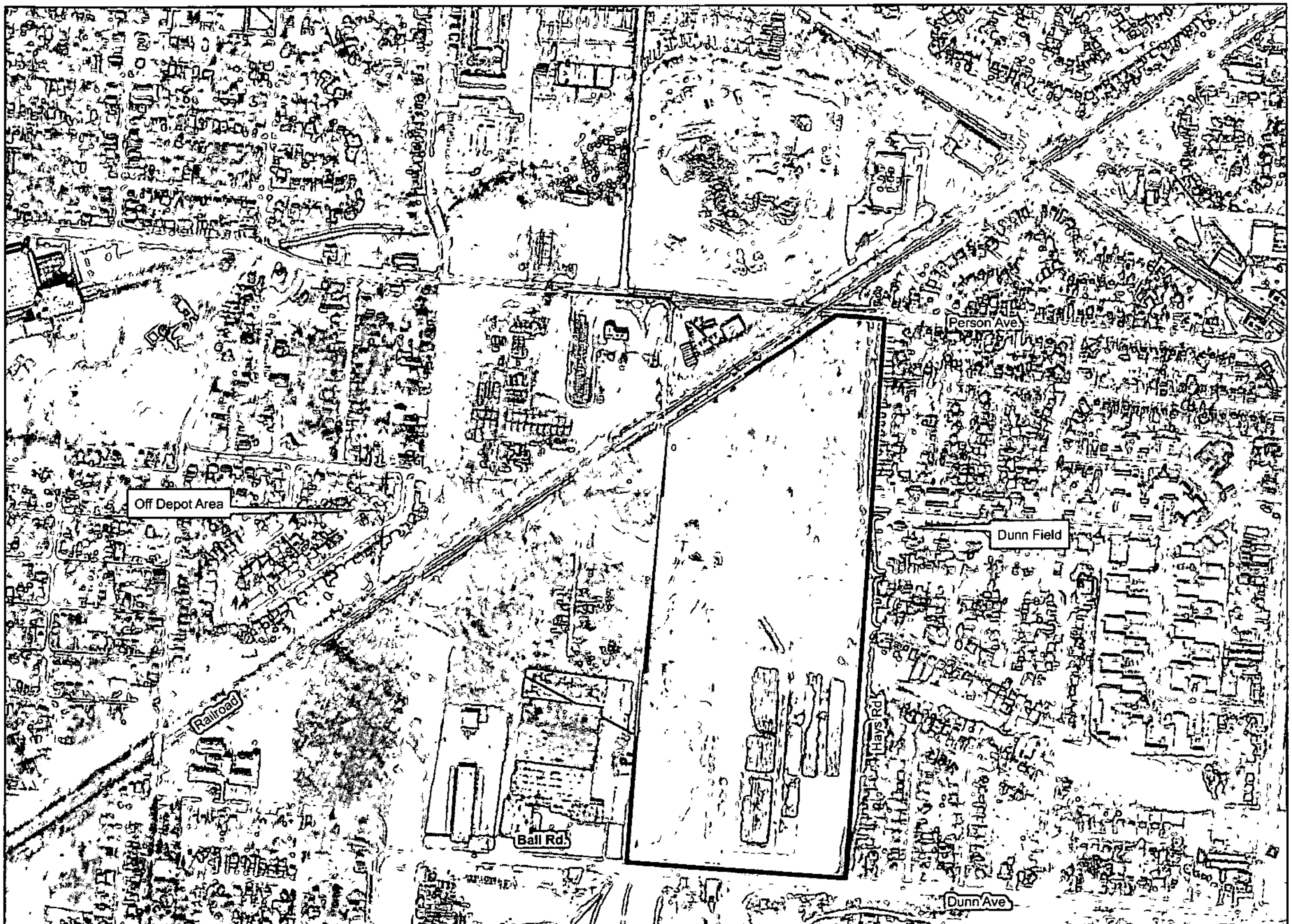


Figure 2

OFF DEPOT AREA

OFF DEPOT GROUNDWATER
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

984 86

Projection: NAD 1927 StatePlane Tennes:
Units Feet

Aerial Photo Date 2006

0 250 500 750
Feet

Installation Location
Memphis, Tennessee

Date: January 2009
Edition: Rev 1

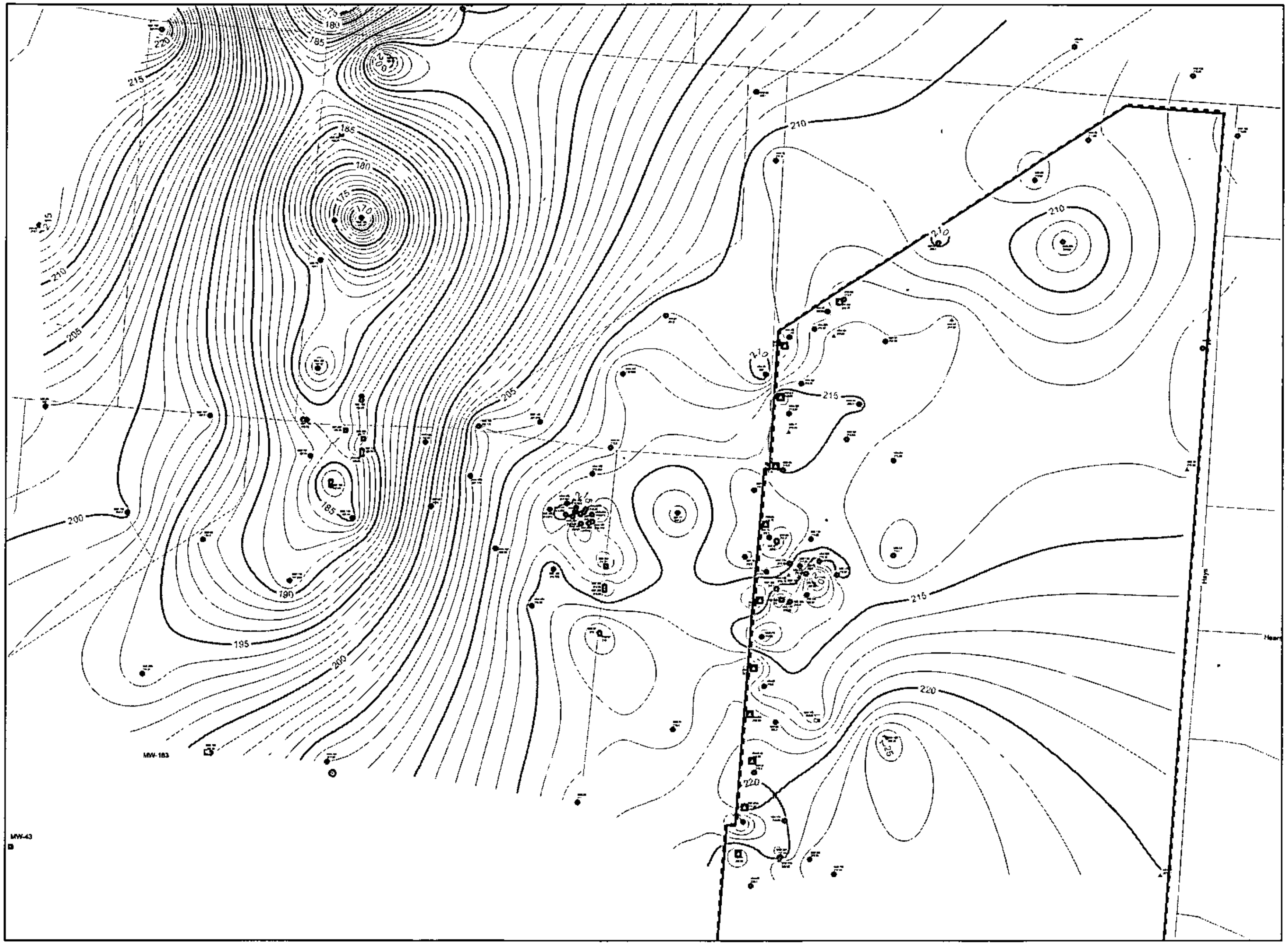


Figure 3

TOP OF CLAY MAP

OFF DEPOT GROUNDWATEF
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Legend

- Monitoring Well Screened in the Fluvial Aquifer
- Recovery Well Screened in the Fluvial Aquifer
- Monitoring Well Screened in the Intermediate Aquifer
- Monitoring Well Screened in the Transition Zone
- Monitoring Well Screened in the Memphis Aquifer

Dunn Field Boundary

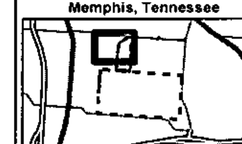
MW-03 100.12 Top of Clay Elevation above Mean Sea Level

Top of Clay Contours
- 1-ft.
- 5-ft.

984 87

0 125 250 375 5(

Feet



Date: January 2009
Edition: Rev 1

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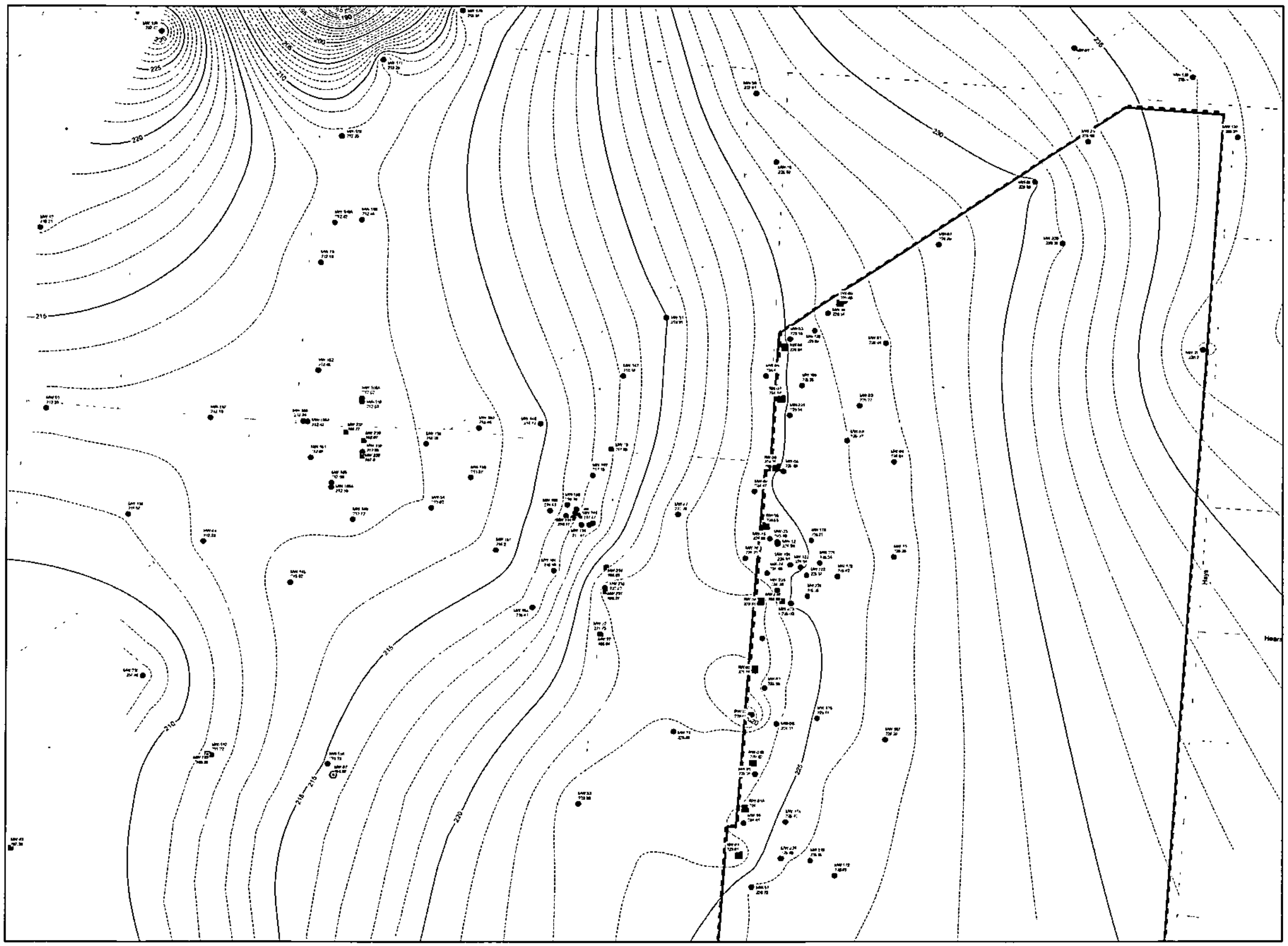

Figure 4

GROUNDWATER ELEVATION CONTOUR MAP 14 OCTOBER 2008

OFF DEPOT GROUNDWATER REMEDIAL ACTION WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

984 88

Legend

- Monitoring Well Screened in the Fluvial Aquifer
- Recovery Well Screened in the Fluvial Aquifer
- Monitoring Well Screened in the Intermediate Aquifer
- Monitoring Well Screened in the Transition Zone
- Monitoring Well Screened in the Memphis Aquifer
- Dunn Field Boundary

MW-03 100.12 Blue non-italics: value used for groundwater contours

MW-237 100.15 Black Italics: value not used for groundwater contours (non-fluvial well or anomalous reading)

Groundwater Contours
-- 1-ft Contour
— 5-ft Contour

0 125 250 375 50
Feet

Installation Location
Memphis, Tennessee

Date: March 2009
Edition: Rev 1

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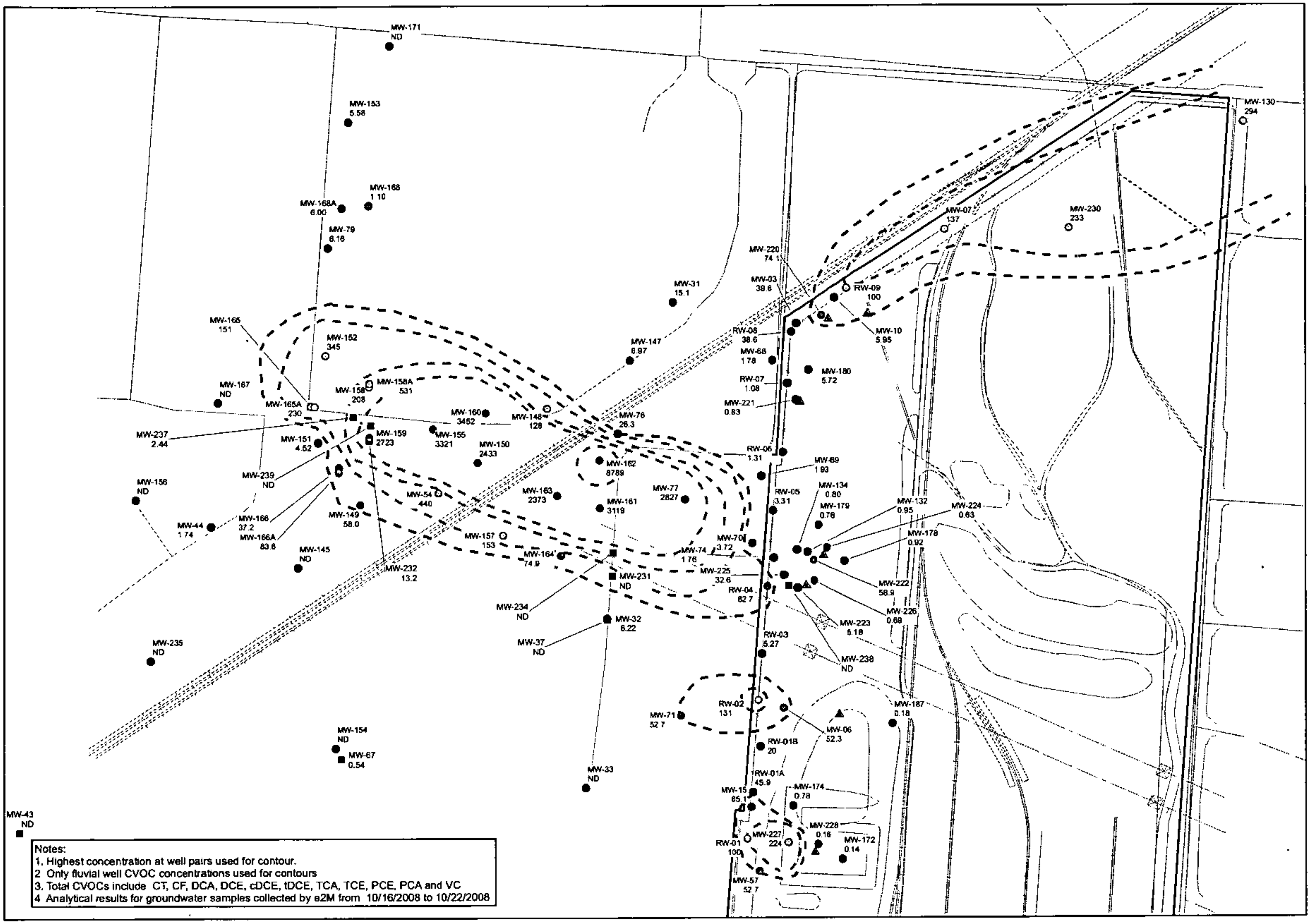
984 89



Notes:
1. Highest concentration at well pairs used for contour.
2. Only fluvial well CVOC concentrations used for contours
3. Total CVOCs include CT, CF, DCA, DCE, cDCE, tDCE, TCA, TCE, PCE, PCA and VC
4. Analytical results for groundwater samples collected by e2M from 10/16/2008 to 10/22/2008

Figure 5

TOTAL CVOC CONCENTRATIONS, OCTOBER 2008

OFF DEPOT GROUNDWATER REMEDIAL ACTION WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Legend

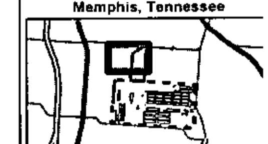
CVOCs Fluvial Wells
ug/L
- 0 - 50
- 51 - 100
- 101 - 500
- 501 - 1000
- 1001 - 5000
- 5001 - 10000

CVOCs Non-Fluvial Wells
ug/L
- 0 - 50

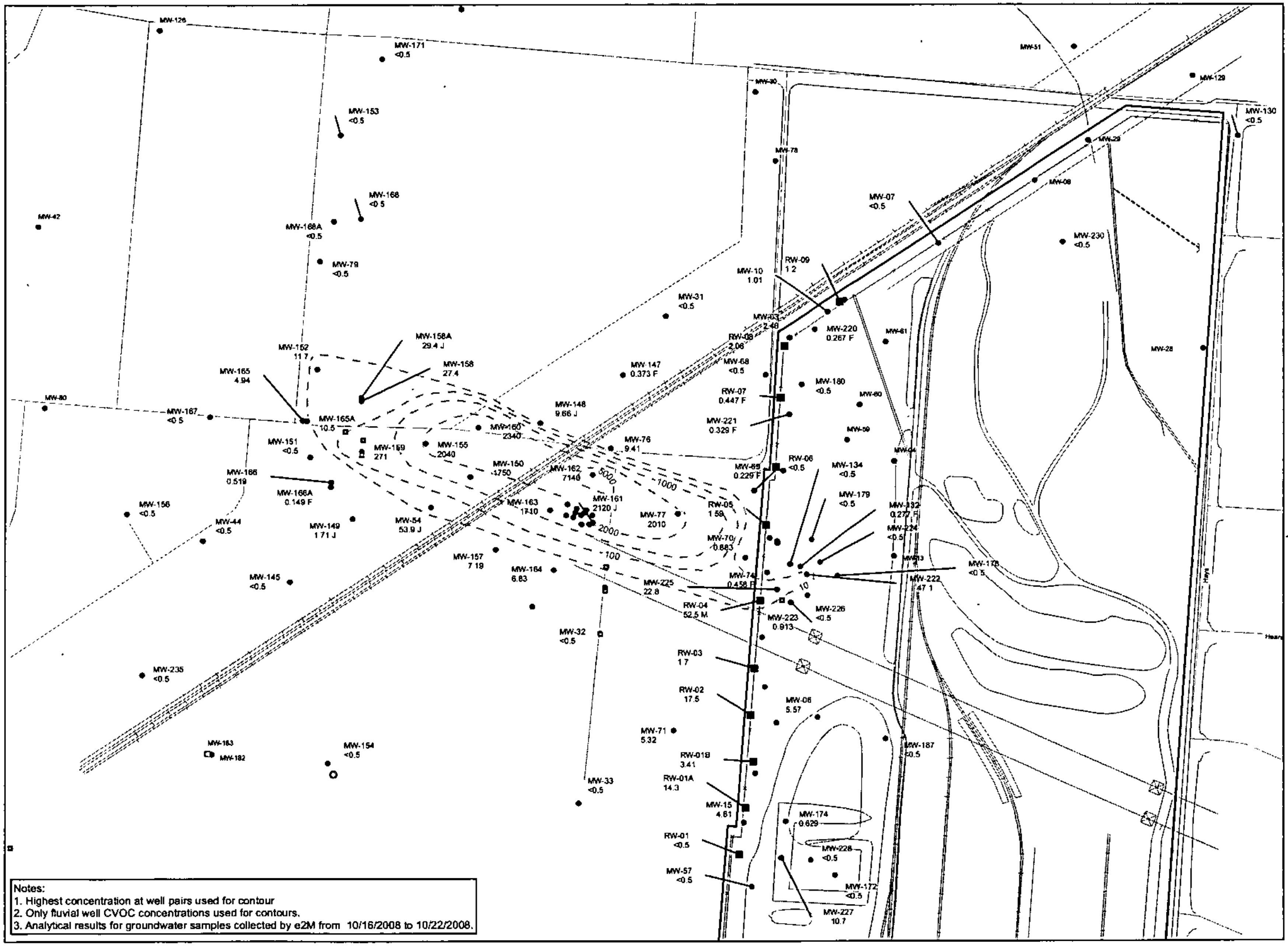
Total CVOC Isopleth (ug/L)
- 50
- 100
- 500
- 1000
- 5000

SVE -Soil Vapor Extraction Point

0 50100 200 300 400
Feet



Date: January 2009
Edition: Rev 1



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N W E S

Figure 6

PCA ISOPLETH MAP
OCTOBER 2008

OFF DEPOT GROUNDWATER
REMEDIAL ACTION
WORK PLAN

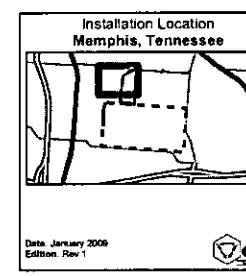
DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Legend

- Monitoring Well Screened in the Fluvial Aquifer
- Recovery Well Screened in the Fluvial Aquifer
- Monitoring Well Screened in the Intermediate Aquifer
- Monitoring Well Screened in the Transition Zone
- Monitoring Well Screened in the Memphis Aquifer
- Dunn Field Boundary
- Isoconcentration contours of 1,1,2,2-Tetrachloroethane (P

0 125 250 375 50

Feet



Date: January 2009
Edition: Rev 1

984 90

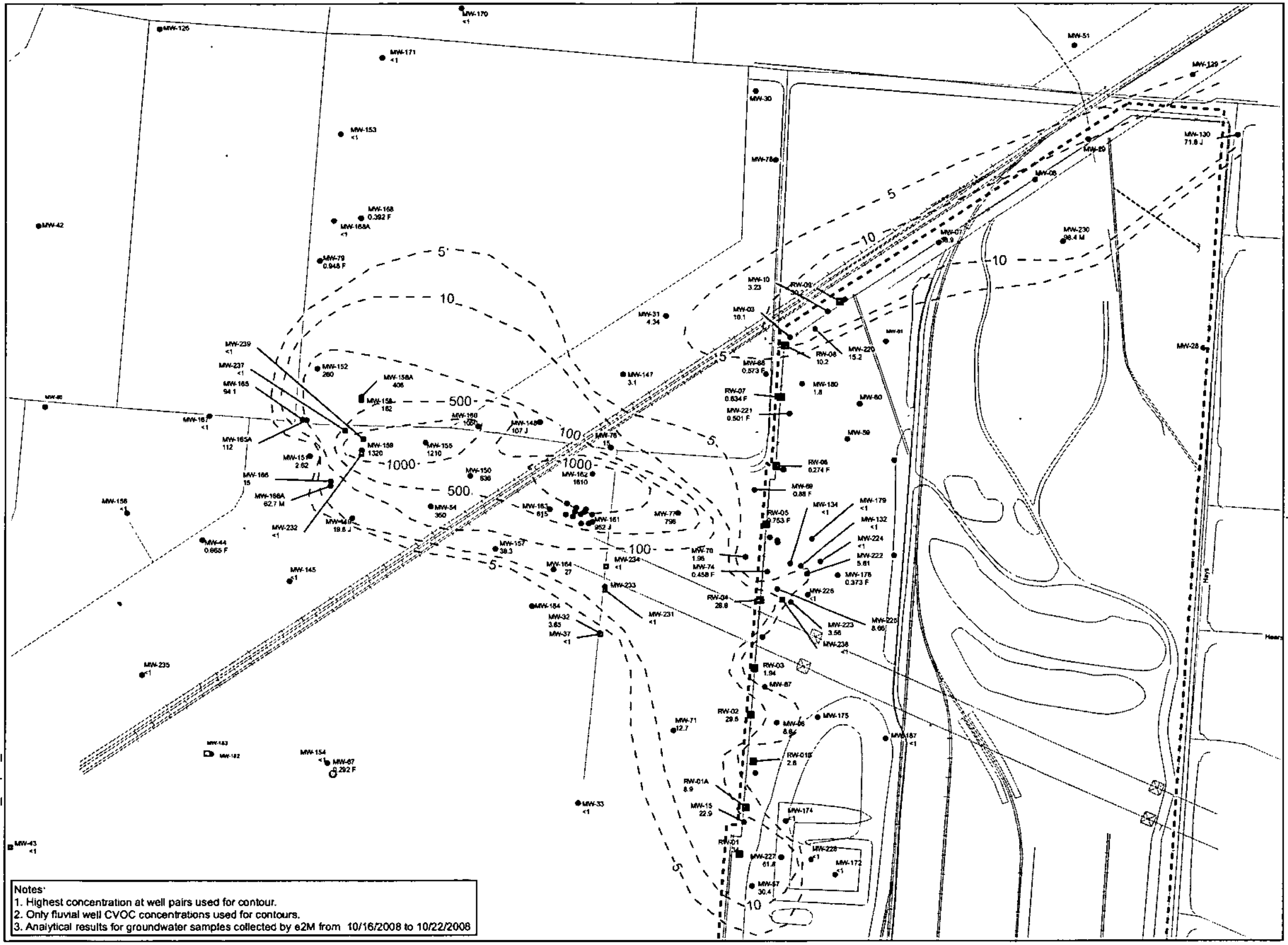


Figure 7

TCE ISOPLETH MAP
OCTOBER 2008

OFF DEPOT GROUNDWATER
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Legend
- Monitoring Well Screened in the Fluvial Aquifer
- Recovery Well Screened in the Fluvial Aquifer
- Monitoring Well Screened in the Intermediate Aquifer
- Monitoring Well Screened in the Transition Zone
- Monitoring Well Screened in the Memphis Aquifer
- Dunn Field Boundary
- Isoconcentration contours of Trichloroethene (TCE)

0 125 250 375 50
Feet

Installation Location
Memphis, Tennessee

Date: March 2009
Edition: Rev 1

984 91

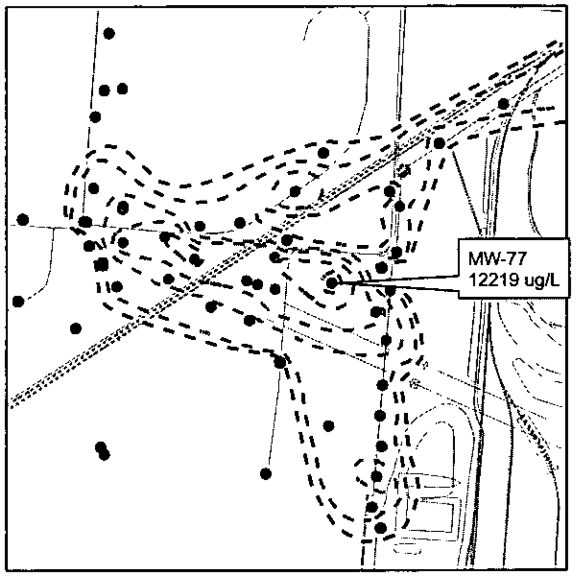
N
W E
S

Figure 8

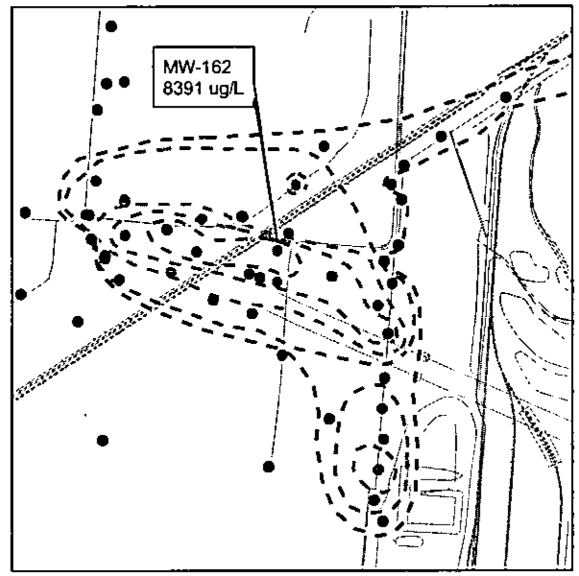
TOTAL CVOC CONCENTRATIONS, TIME TREND

OFF DEPOT GROUNDWATER
REMEDIAL ACTION
WORK PLAN

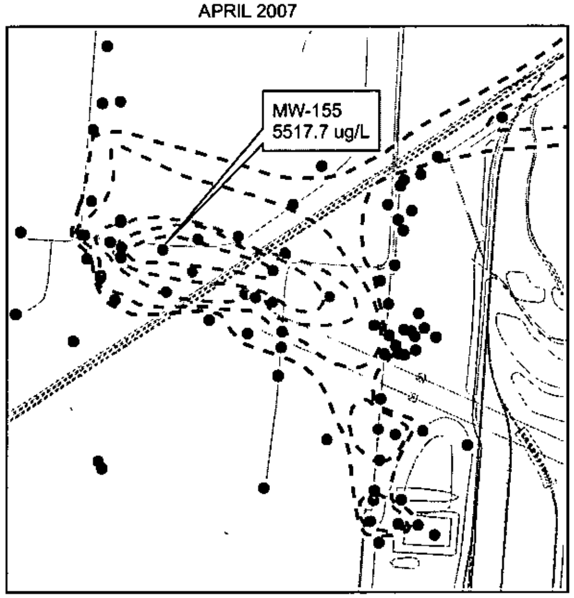
DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE



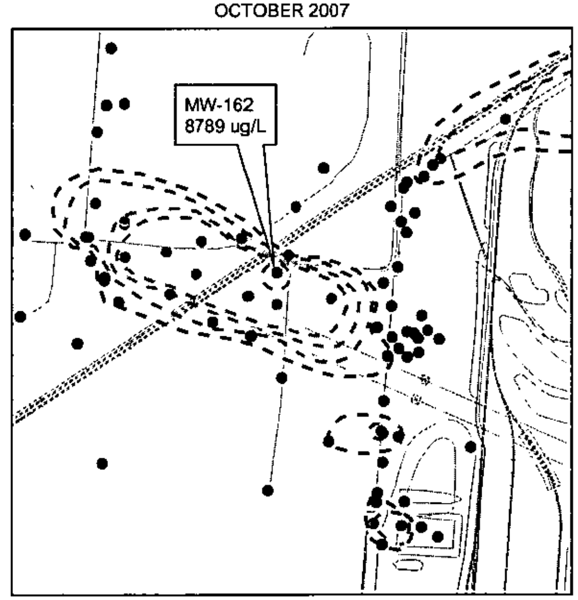
APRIL 2007



OCTOBER 2007



APRIL 2008



OCTOBER 2008

Legend

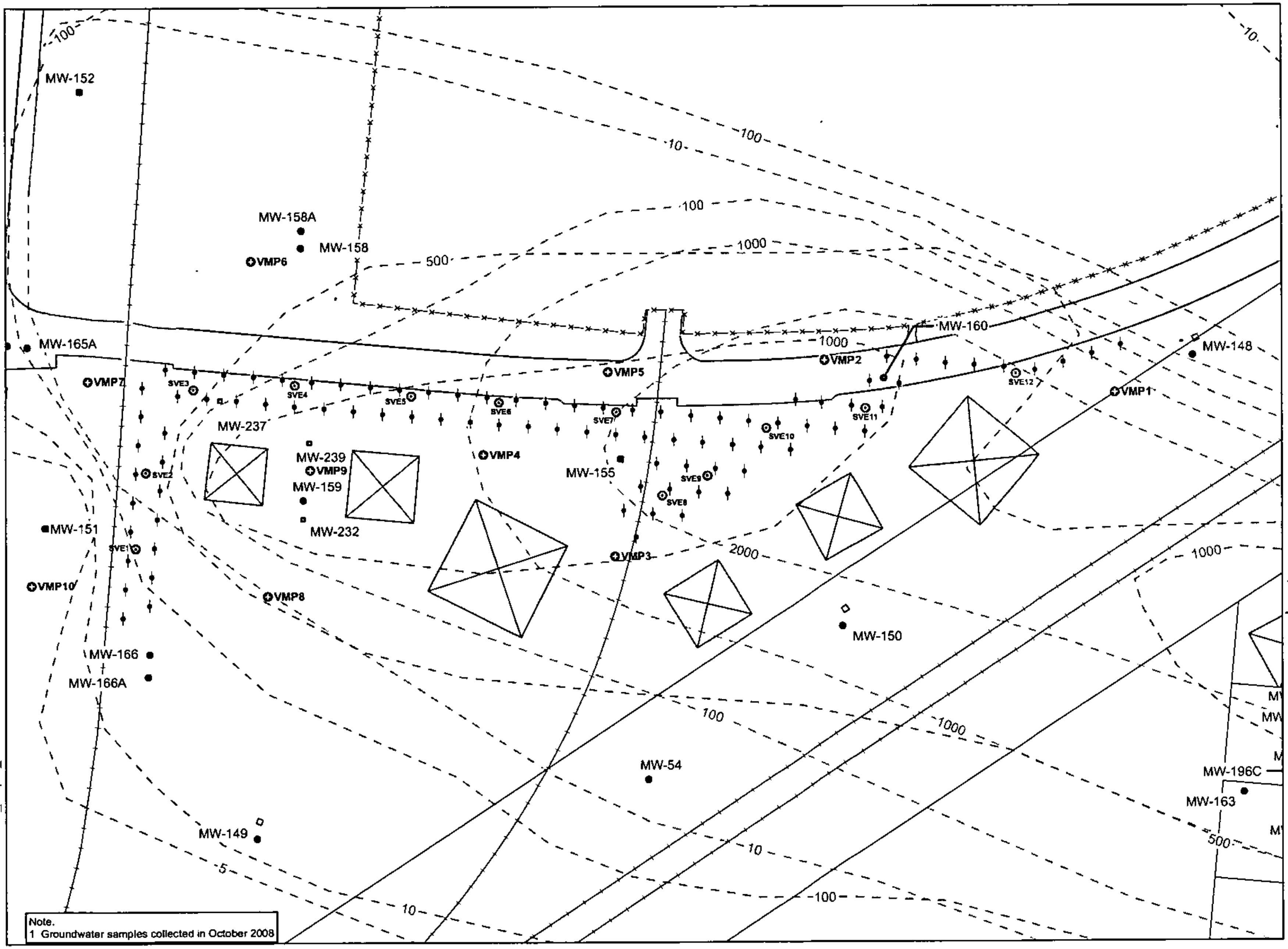
Total CVOC Isopleth (ug/L)
- 50
- 100
- 500
- 1000
- 5000
- 10000

Total CVOC Ranges (ug/L)
- 0 - 100
- 101 - 500
- 501 - 1000
- 1001 - 5000
- 5001 - 10000
- 10001 - 50000

Notes:
1. Highest concentration at well pairs used for contour.
2. Total CVOCs include, CT, CF, DCA, DCE, cDCE, tDCE, TCA, TCE, PCE, PCA and VC
3. Highest Total CVOC labeled for each event.

0 200 400 600 800 1,000
Feet

984 92



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S

Figure 9

AS/SVE WELL LOCATIONS

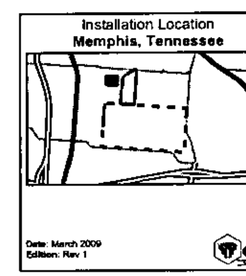
OFF DEPOT GROUNDWATEF
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Legend

- Monitoring Well Screened in the Fluvial Aquifer
- Monitoring Well Screened in the Intermediate Aqui
- Vapor Monitoring Point (VMP)
- Soil Vapor Extration (SVE)
- Air Sparge Point
- Isoconcentration contours of 1,1,2,2-Tetrachloroethane (PCA)
- Isoconcentration contours of Trichloroethene (TCE)

0 25 50 75 10
Feet



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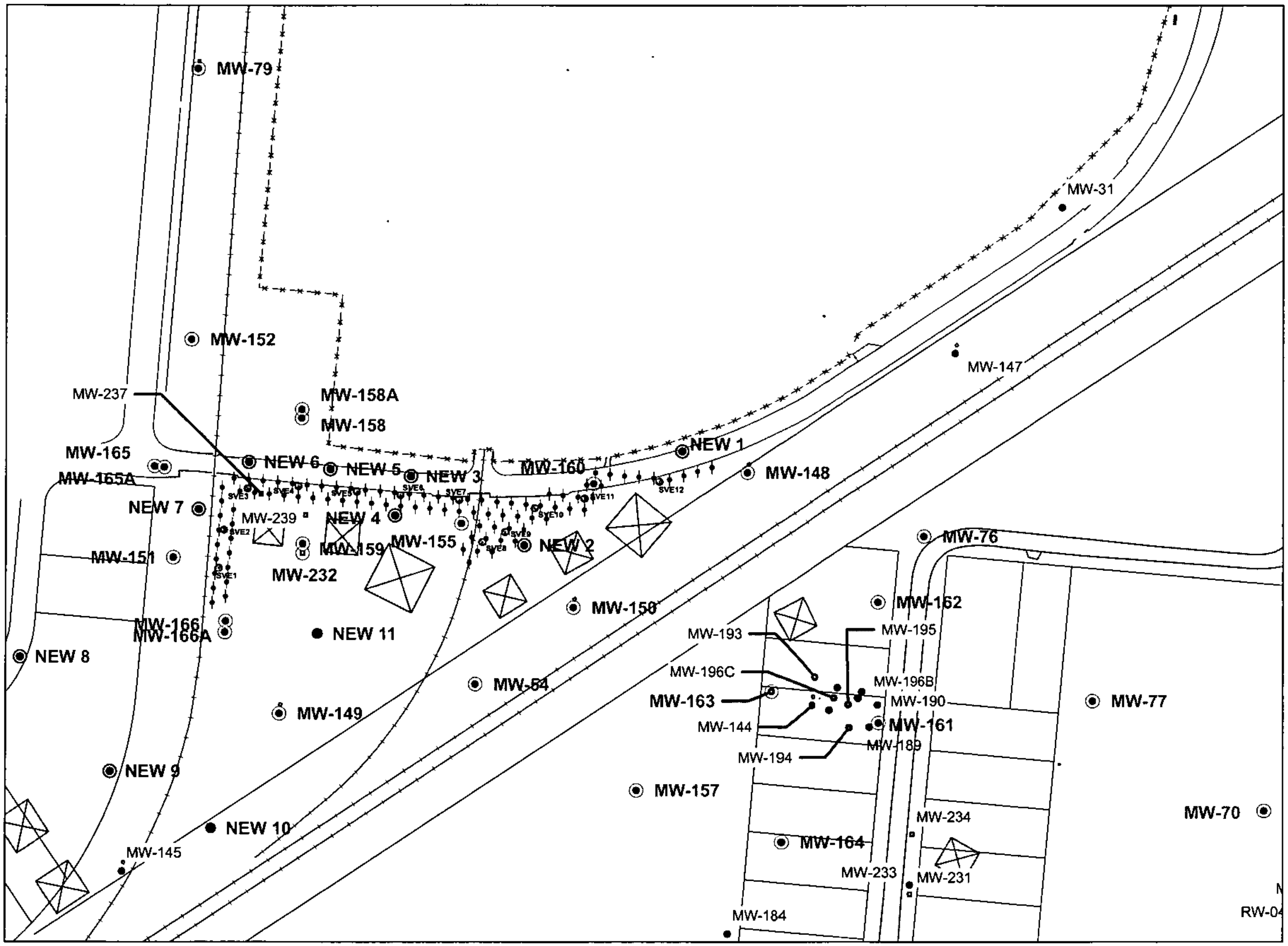

Figure 10

PERFORMANCE WELL LOCATIONS

OFF DEPOT GROUNDWATER REMEDIAL ACTION WORK PLAN

DUNN FIELD DEFENSE DEPOT MEMPHIS, TENNESSEE

Legend

- Monitoring Well Screened in the Fluvial Aquifer
- Monitoring Well Screened in the Intermediate Aquifer
- MW-166 Existing Performance Well
- New Fluvial Monitoring Well
- New Intermediate Monitoring Well
- Soil Vapor Extraction (SVE)
- Air Sparge Point

0 50 100 150

Feet

Installation Location
Memphis, Tennessee

Date: March 2009
Edition: Rev 1

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984 94

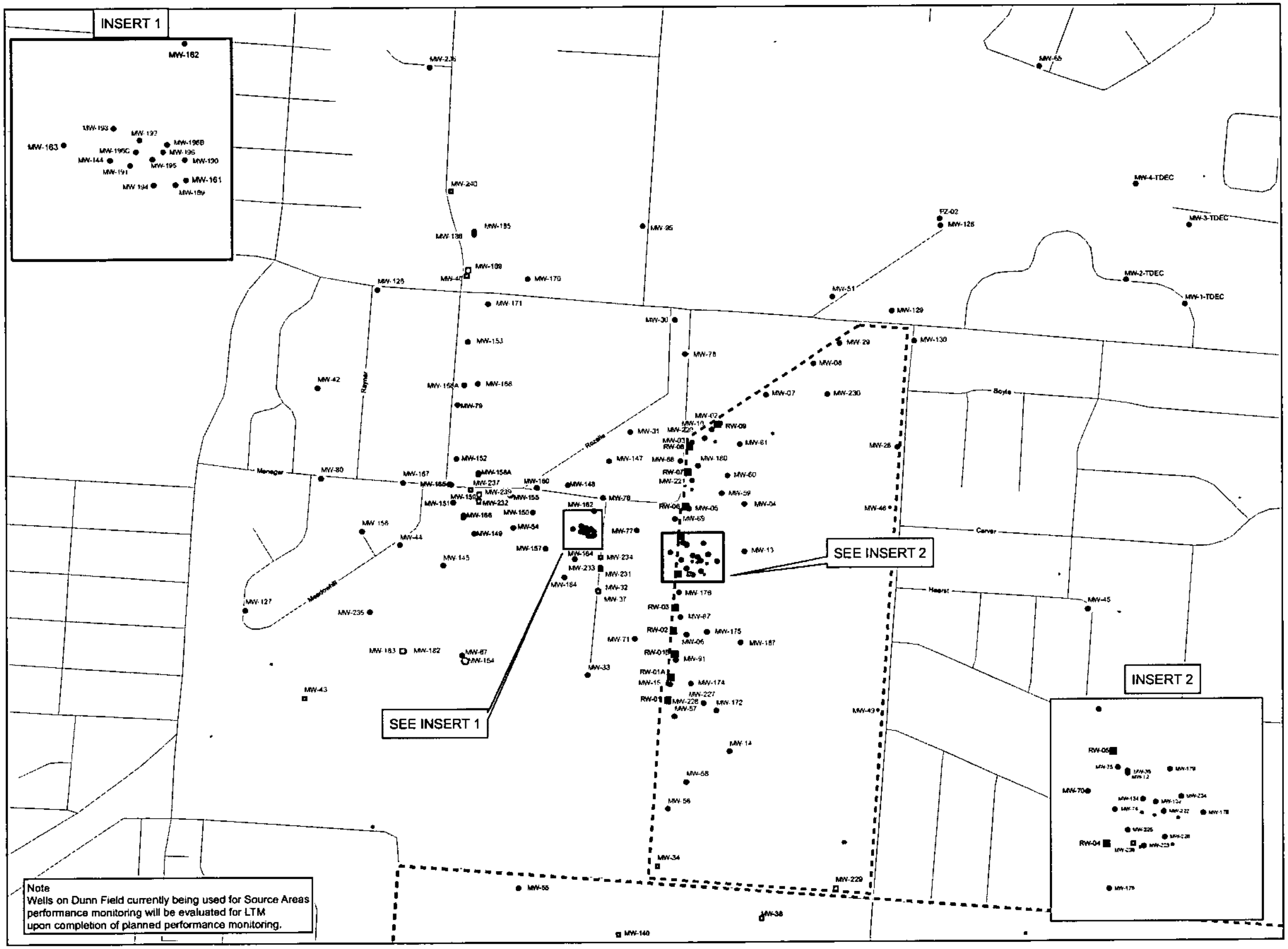


Figure 11

LTM WELL LOCATIONS

OFF DEPOT GROUNDWATER REMEDIAL ACTION WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Legend
- Monitoring Well Screened in the Fluvial Aquifer
- Recovery Well Screened in the Fluvial Aquifer
- Monitoring Well Screened in the Intermediate Aquifer
- Monitoring Well Screened in the Transition Zone
- Monitoring Well Screened in the Memphis Aquifer

- MW-04 Sample
- MW-42 Water Level Only
- MW-03 Abandon

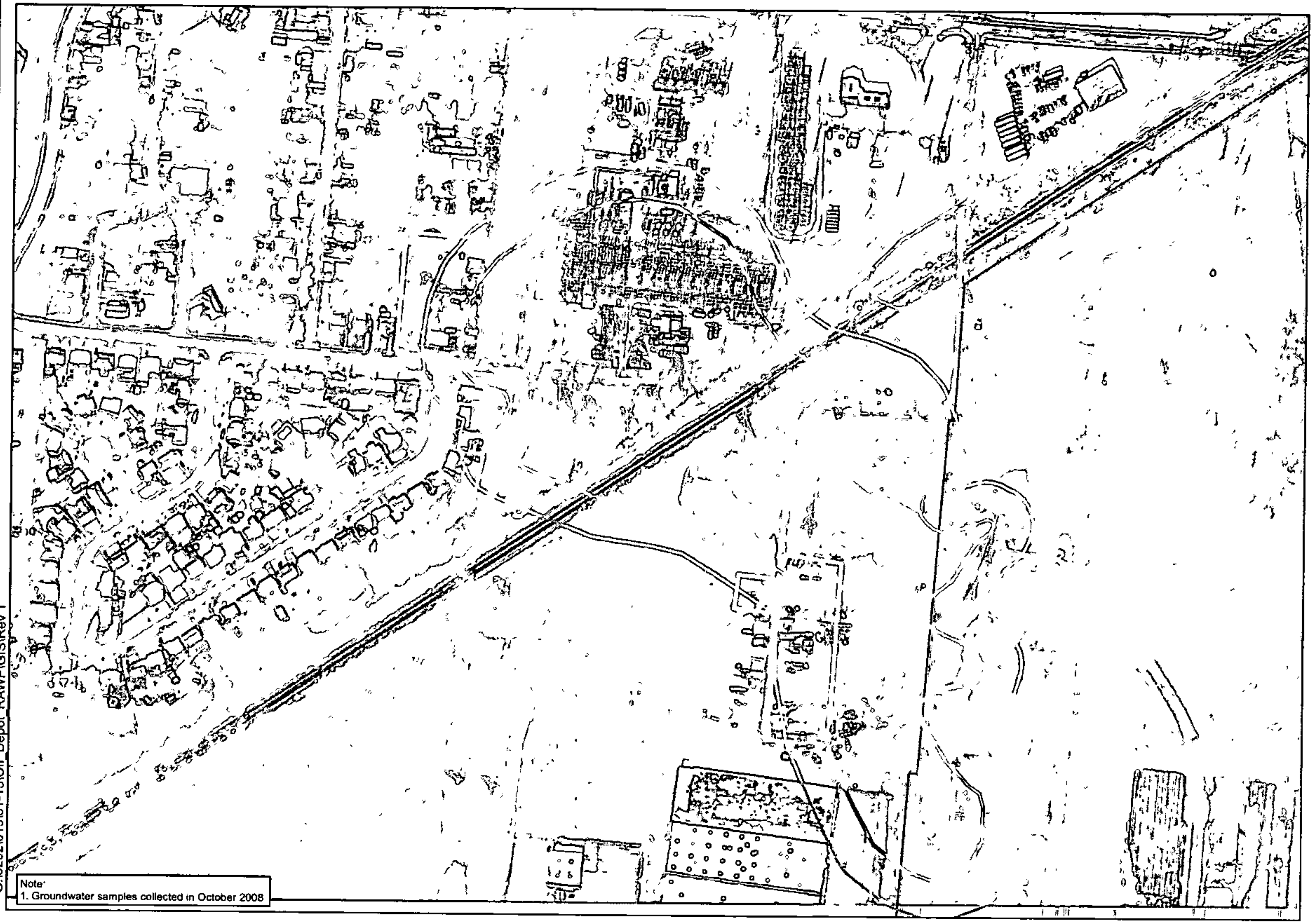
— Dunn Field Boundary

0 200 400 600 800
Feet

Installation Location
Memphis, Tennessee

Date: March 2009
Edition: Rev 1

984 95



N
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S

Figure 12

TARGET AREAS FOR VAPOR INTRUSION MONITORING

OFF DEPOT GROUNDWATER
REMEDIAL ACTION
WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Legend

TCE 5 ug/L

Extent of 100-ft Buffer

Target Areas

0 50100 200 300 400
Feet

Installation Location
Memphis, Tennessee

Date: March 2009
Edition: Rev 1

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APPENDIX A

PROJECT MANAGEMENT PLAN

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LIST OF ACRONYMS AND ABBREVIATIONS

AFCEE	Air Force Center for Engineering and the Environment
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 Off Depot 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 Off Depot 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 *Off Depot Groundwater Remedial Design* (Off Depot RD) (CH2M HILL, 2008) 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 e^2M's Project Manager and designated POC for the project. Mr. Holmes will have the primary responsibility for managing the Off Depot 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. Kevin Sedlak is e^2M's RA Task Manager as well as the Field Team Leader for RA activities at DDMT. He will coordinate activities of the field teams and subcontractors and will work with the CCE to address technical issues that arise. RA-C activities will include oversight of surveying activities, installation of monitoring wells, and installation of the AS/SVE system including air sparge points, SVE wells and VMPs and associated piping, control building and equipment compound. Mr. Sedlak will direct 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. Steven Herrera, P.E. is e^2M's Project Engineer and will assist in resolving technical issues regarding construction and operation of the AS/SVE system. He will coordinate activities of the AS/SVE system subcontractor. Mr. Herrera is a registered Professional Engineer with over 8 years of experience in environmental engineering.

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.

1.4 FIELD TEAMS

Construction activities during RA will include:

- Installation and abandonment of groundwater monitoring wells;
- Installation of AS points, SVE wells and VMPs; and

- Installation of conveyance piping, control building and equipment compound.

A field geologist will oversee the drilling, installation and developing of monitoring wells, monitoring activities and soil excavation. Construction of the AS/SVE system will be overseen by e[2]M-site personnel and the project engineer who will verify that AS and SVE well locations and system construction conform 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, and AS/SVE system locations;
- Drilling activities for installation and abandonment of monitoring wells;
- Construction of the concrete pad and fencing for the AS/SVE equipment compound; and
- Construction and installation of AS/SVE equipment and control buildings.

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 Of Depot Groundwater RA implementation is presented in Figure A-2. The schedule presents timelines and milestones for the RA. The schedule for Off Depot Groundwater RA implementation is based on the DDMT master schedule presented in the *BRAC Cleanup Plan, V.12* (e2M, 2008) and the Remedial Design/Remedial Action Schedule, Figure 6-4 in the Off Depot RD. The schedule will be updated as needed and 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. Renaghan 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 this RAWP and the *Remedial Action Sampling and Analysis Plan* (RA SAP) (MACTEC Engineering and Consulting, Inc, 2005). 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 Off Depot 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 Off Depot RA components and at least 1 year of operation of the Fluvial SVE system.

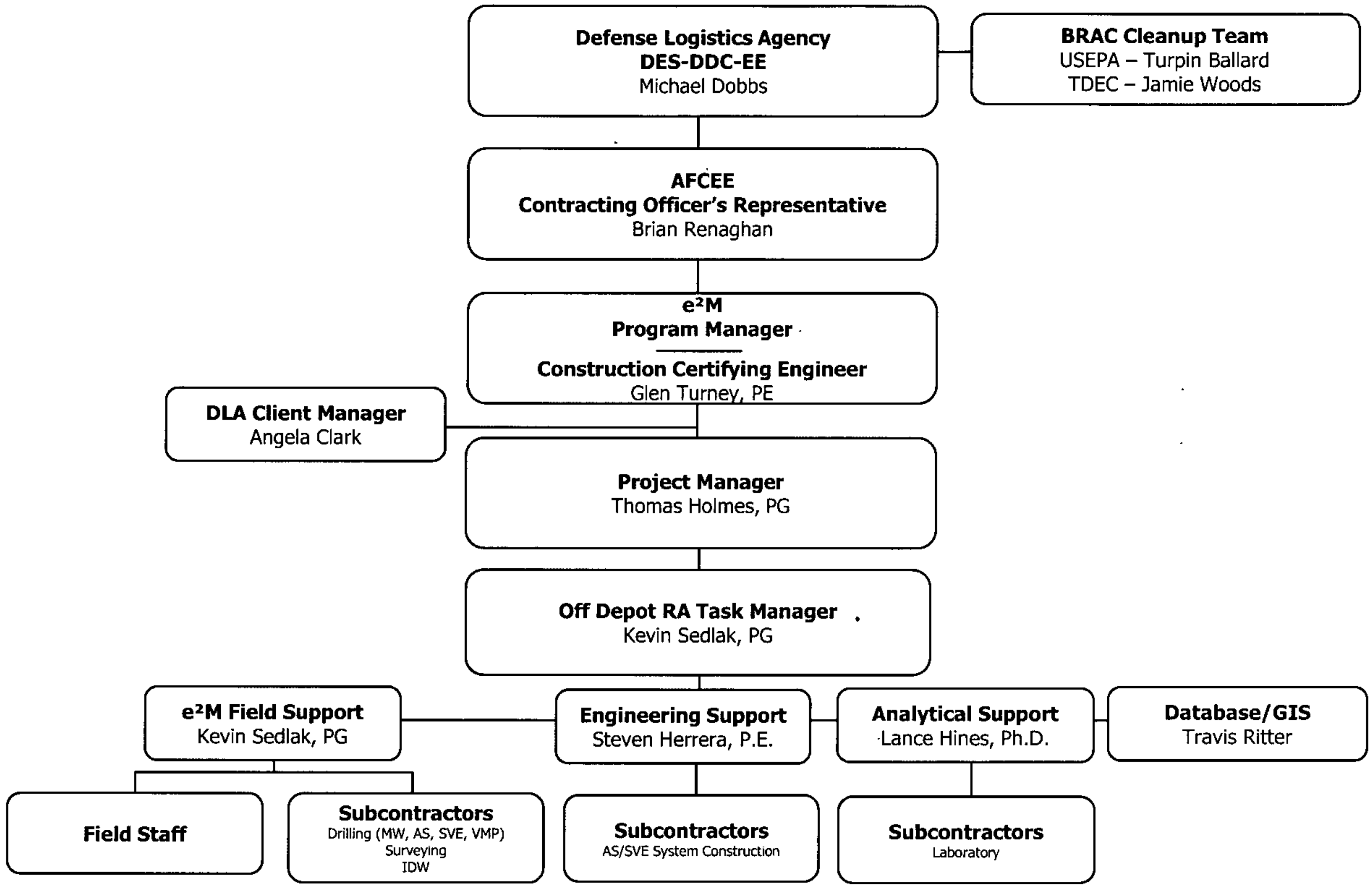
4.0 REFERENCES

CH2M Hill, 2008. Rev. 0 Memphis Depot, Dunn Field Off Depot Groundwater Final Remedial Design. Prepared for the U.S. Army Engineering and Support Center, Huntsville, Alabama. May 2008.

engineering-environmental Management, Inc., 2007. BRAC Cleanup Plan, Version 12, Rev. 1 Defense Distribution Depot, Memphis, Tennessee. November 2008.

MACTEC Engineering and Consulting, Inc, 2005. Remedial Action Sampling and Analysis Plan, Volume I: Field Sampling Plan and Volume II: Quality Assurance Project Plan. Prepared for the Air Force Center for Environmental Excellence. November 2005.

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

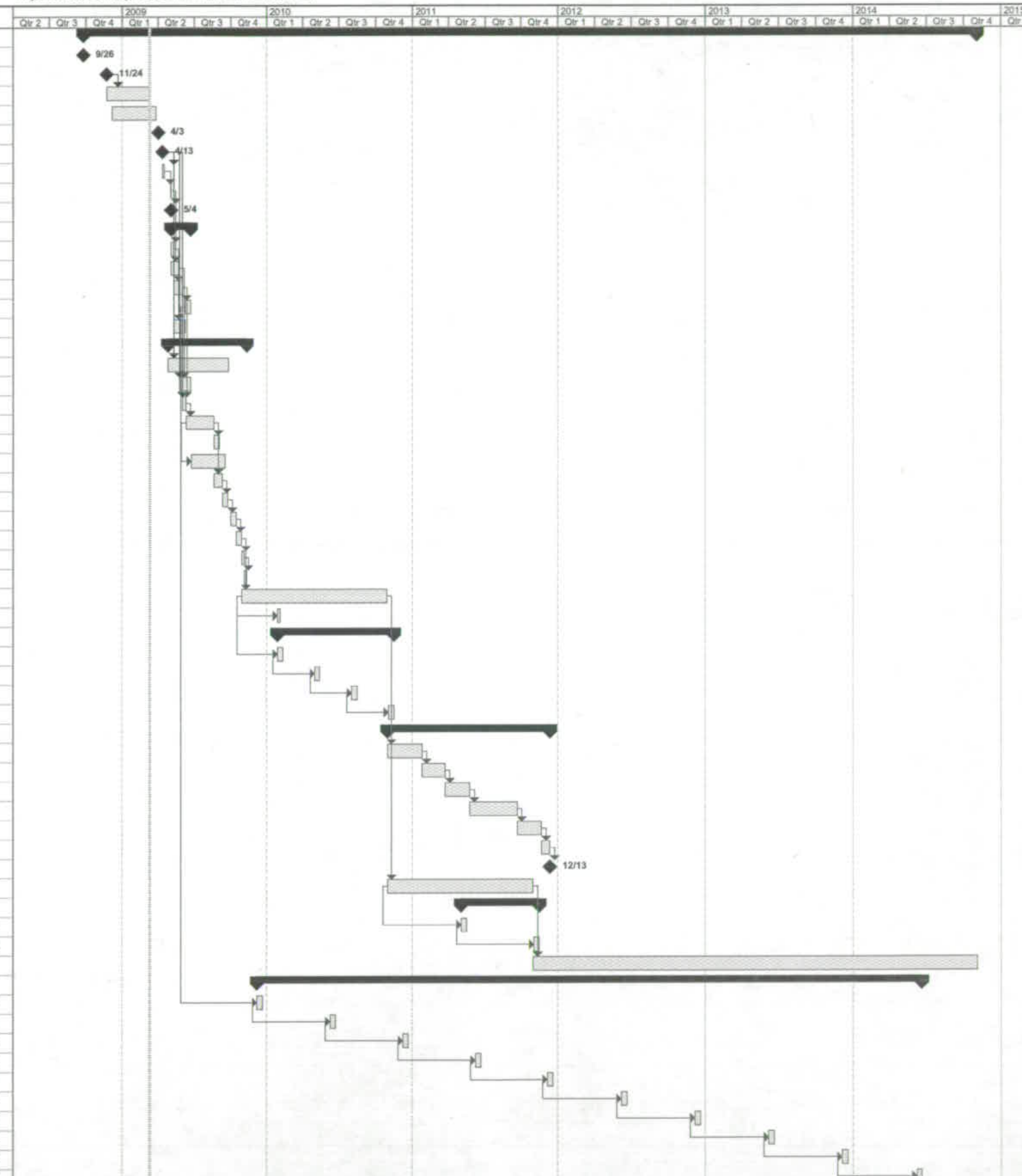
Figure A-1
Off Depot Groundwater Remedial Action Project Organization Chart

984 106

984 107

Figure A-2
Project Schedule - Off Depot Groundwater Remedial Action Work Plan

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Off Depot Groundwater Remedial Action**	**1592 days**	**Fri 9/26/08**	**Mon 11/3/14**	
2	Task Order Award	0 days	Fri 9/26/08	Fri 9/26/08	
3	Notice to Proceed	0 days	Mon 11/24/08	Mon 11/24/08	
4	Award Subcontracts	80 days	Mon 11/24/08	Fri 3/13/09	3
5	MLGW Site Access Agreement	80 days	Mon 12/8/08	Fri 3/27/09	
6	Approval of ROD Amendment	0 days	Fri 4/3/09	Fri 4/3/09	
7	Approval of RAWP	0 days	Mon 4/13/09	Mon 4/13/09	
8	Preconstruction Conference	5 days	Mon 4/13/09	Fri 4/17/09	7
9	Mobilization	1 day	Mon 5/4/09	Mon 5/4/09	8FS+10 days
10	**Notice of Off Depot RA Implementation**	0 days	Mon 5/4/09	Mon 5/4/09	9
11	**Pre-Construction Activities**	**35 days**	**Tue 5/5/09**	**Mon 6/22/09**	
12	Utility Clearance	5 days	Tue 5/5/09	Mon 5/11/09	9
13	Site Clearing and Grading	15 days	Tue 5/5/09	Mon 5/25/09	9
14	New MW Installation and Well Abandonment	15 days	Tue 5/12/09	Mon 6/1/09	12
15	Baseline Groundwater Sampling	10 days	Tue 6/9/09	Mon 6/22/09	14FS+5 days
16	Baseline Vapor Intrusion Sampling	20 days	Tue 5/12/09	Mon 6/8/09	12
17	**AS/SVE System Construction**	**143 days**	**Mon 4/27/09**	**Wed 11/11/09**	
18	Construct Control Buildings Off-Site	110 days	Mon 4/27/09	Fri 9/25/09	7FS+10 days
19	Power Drop from MLGW	20 days	Tue 5/26/09	Mon 6/22/09	13,7
20	Drill and Install VMPs	7 days	Tue 6/2/09	Wed 6/10/09	14,7
21	Drill and Install AS Wells	50 days	Thu 6/11/09	Wed 8/19/09	20
22	Drill and Install SVE Wells	10 days	Thu 8/20/09	Wed 9/2/09	21
23	AS and SVE Trenching, Piping and Wellheads	60 days	Thu 6/25/09	Wed 9/16/09	21SS+10 days
24	Construct Pad and Fencing for Control Buildings	15 days	Thu 8/20/09	Wed 9/9/09	21
25	Install Power Supply for Control Buildings	10 days	Thu 9/10/09	Wed 9/23/09	24
26	Install Control Buildings and Connect Piping and Power	10 days	Thu 10/1/09	Wed 10/14/09	25FS+5 days
27	System Start-Up and Testing	10 days	Thu 10/15/09	Wed 10/28/09	26
28	BCT Construction Inspection	5 days	Thu 10/29/09	Wed 11/4/09	27
29	Demobilization and Site Restoration	5 days	Thu 11/5/09	Wed 11/11/09	28
30	**AS-SVE Year 1 Operations**	262 days	Thu 10/29/09	Fri 10/29/10	27
31	Vapor Intrusion Sampling Round 2	5 days	Fri 1/29/10	Thu 2/4/10	30SS+66 days
32	**Year 1 Groundwater Sampling**	**208 days**	**Fri 1/29/10**	**Tue 11/16/10**	
33	1st Quarter Samples	10 days	Fri 1/29/10	Thu 2/11/10	30SS+66 days
34	2nd Quarter Samples	10 days	Mon 5/3/10	Fri 5/14/10	33SS+66 days
35	3rd Quarter Samples	10 days	Tue 8/3/10	Mon 8/16/10	34SS+66 days
36	4th Quarter Samples	10 days	Wed 11/3/10	Tue 11/16/10	35SS+66 days
37	**Off Depot Groundwater Interim RA Completion Report**	**292 days**	**Mon 11/1/10**	**Tue 12/13/11**	
38	Prepare & Submit Rev. 0 Off Depot RACR to BCT	62 days	Mon 11/1/10	Tue 1/25/11	30
39	BCT Review & Submit Comments on Rev. 0 Off Depot RACR	42 days	Wed 1/26/11	Thu 3/24/11	38
40	Respond to BCT Comments on Rev. 0 Off Depot RACR	44 days	Fri 3/25/11	Wed 5/25/11	39
41	Prepare & Submit Rev. 1 Off Depot RACR	86 days	Thu 5/26/11	Thu 9/22/11	40
42	BCT Review of Rev. 1 Off Depot RACR w/ Concurrence	43 days	Fri 9/23/11	Tue 11/22/11	41
43	EPA Approval of Off Depot Final RACR and OPS Determination	15 days	Wed 11/23/11	Tue 12/13/11	42
44	**Off Depot RA Complete / Remedy in Place**	0 days	Tue 12/13/11	Tue 12/13/11	43
45	**AS-SVE Year 2 Operations**	262 days	Mon 11/1/10	Tue 11/1/11	30
46	**Year 2 Groundwater Sampling**	**142 days**	**Wed 5/4/11**	**Thu 11/17/11**	
47	1st Semiannual Samples	10 days	Wed 5/4/11	Tue 5/17/11	45SS+132 days
48	2nd Semiannual Samples	10 days	Fri 11/4/11	Thu 11/17/11	47SS+132 days
49	**AS-SVE Year 3-5 Operations**	784 days	Wed 11/2/11	Mon 11/3/14	45
50	**Long-Term Groundwater Monitoring Year 1-5**	**1183 days**	**Wed 12/9/09**	**Fri 6/20/14**	
51	Year 1 1st Semiannual Samples	10 days	Wed 12/9/09	Tue 12/22/09	15SS+131 days
52	Year 1 2nd Semiannual Samples	10 days	Thu 6/10/10	Wed 6/23/10	51SS+131 days
53	Year 2 1st Semiannual Samples	10 days	Thu 12/9/10	Wed 12/22/10	52SS+130 days
54	Year 2 2nd Semiannual Samples	10 days	Thu 6/9/11	Wed 6/22/11	53SS+130 days
55	Year 3 1st Semiannual Samples	10 days	Thu 12/8/11	Wed 12/21/11	54SS+130 days
56	Year 3 2nd Semiannual Samples	10 days	Fri 6/8/12	Thu 6/21/12	55SS+131 days
57	Year 4 1st Semiannual Samples	10 days	Fri 12/7/12	Thu 12/20/12	56SS+130 days
58	Year 4 2nd Semiannual Samples	10 days	Fri 6/7/13	Thu 6/20/13	57SS+130 days
59	Year 5 1st Semiannual Samples	10 days	Fri 12/6/13	Thu 12/19/13	58SS+130 days
60	Year 5 2nd Semiannual Samples	10 days	Mon 6/9/14	Fri 6/20/14	59SS+131 days



Project: Off Depot RA Schedule Rev 1
Date: Mon 3/9/09

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
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 Off Depot Groundwater Remedial Action (RA) at Defense Depot Memphis, Tennessee (DDMT). The RA consists of air sparging with soil vapor extraction at the distal end of the Off Depot Groundwater plume to remove CVOCs from groundwater and to limit plume migration.

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, air sparge points, SVE wells and vapor monitoring points;
- 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.

Based on previous investigations conducted at DDMT and the Off Depot area 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. 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.

All soil borings will be drilled west of Dunn Field and away from disposal areas. Only groundwater contamination has been identified in this area. Soil cuttings will be placed into roll-off boxes and spread on the surface at Dunn Field. Alternatively, the soil cuttings could be disposal at a landfill permitted to receive Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) off-site waste.

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 in accordance with the analytical requirements of the existing IRA discharge permits. Development and purge water generated during previous investigations has met permit limits and been discharged directly to the publicly owned treatment works (POTW) without treatment.

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).

3.0 GENERAL REQUIREMENTS

3.1 WASTE CHARACTERIZATION

Drill cuttings and excavated soil/debris will be placed into roll-off boxes prior to disposal on Dunn Field. Characterization samples will not be collected unless warranted by field observations. If off-site disposal is required, the soil cuttings will be 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.

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

Wastes generated during RA-C and RA-O are not expected to be hazardous.

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

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Attachments

LIST OF ACRONYMS AND ABBREVIATIONS

AS	Air sparging
CCE	Construction Certifying Engineer
CQAP	Construction Quality Assurance Plan
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
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
SVE	Soil vapor extraction
TDEC	Tennessee Department of Environment and Conservation
VMP	Vapor monitoring point
WMP	Waste Management Plan

1.0 INTRODUCTION

This Construction Quality Assurance Plan (CQAP) describes quality assurance/quality control (QA/QC) activities during construction associated with Off Depot Groundwater Remedial Action (RA) west of Dunn Field at Defense Depot, Memphis, Tennessee (DDMT). This CQAP addresses Remedial Action Construction (RA-C) activities related to installation/construction of the air sparging with soil vapor extraction (AS/SVE) system. The QA/QC activities will aid in completing the RA-C in accordance with specifications and procedures presented in the *Memphis Depot Off Depot Groundwater Final Remedial Design* (RD) (CH2M HILL, 2008) and achieving the following objectives:

- Installation of AS points, SVE wells and VMPs at the proper locations and depths
- Installation of groundwater monitoring wells and abandonment of existing monitoring wells
- Construction of conveyance piping and compressors capable of achieving the flow rates specified at AS points
- Construction of conveyance piping and blowers capable of achieving the flow rates and vacuum pressure specified at SVE wells
- Construction of condensate storage/discharge system
- Construction of the control buildings in accordance with specifications
- Disposal of RA-C wastes in accordance with the Waste Management Plan (WMP) in Appendix C of the RAWP
- 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 Off Depot 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 engineering support will communicate with Mr. Turney, the Project Manager and RA Task Manager through telephone and e-mail communications 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 3.3 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 (see Attachment C-1) 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 AS POINTS, SVE AND MONITORING WELLS

The locations, numbers, and depths of AS points, SVE wells, VMPs and groundwater monitoring wells are presented in Sections 3.3 and 3.4 of the RAWP. Specifications for the AS points, wells and VMPs 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 and air sparge points 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 (see Attachment C-2), the TDEC Water Well Licensing Regulations and Well Construction Standards (Chapter 1200-4-9) and the Shelby County Rules and Regulations of Wells.
- Ensuring that all drilling permits required to conduct this work are obtained
- 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 construction of monitoring wells, AS points, SVE wells and VMPs
- Obtaining lot numbers and manufacturers specification sheets for the micro-spargers, well casing and screen materials.
- Obtaining sieve analyses of the well filter pack material to document that the grain-size distributions meet the gradation specification
- Certifying that the well filter pack material is contaminant-free
- Confirming that cement grout mixtures conform to specifications in the RD and the RAWP
- Confirming boring and well installation depths provided by the drilling subcontractor.

The e^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.

3.2 CONVEYANCE PIPING AND TRENCHING

Conveyance piping sizes for AS and SVE piping are presented in Section 3.4 of the RAWP. Trenching locations are provided in the RD and Sheet 10 of the Construction Drawings (Appendix D of RAWP). QA/QC activities will include:

- Utility clearance to be conducted prior to excavation activities to locate all existing utilities.
- Approval of all trenching locations by the CCE or his designee prior to construction activities.
- Subcontractor to provide submittal with piping material and fittings to be used.
- Subcontractor to provide documentation that personnel are trained to perform butt-fusion welding activities of HDPE piping.
- Subcontractor to permanently label all piping with AS point or SVE well designation during installation.
- Subcontractor to install individual piping runs from the well to the compound one at a time to prevent mis-labeling.
- e^2M field staff to be onsite during pipeline installation to verify labeling of all pipelines.
- The piping trenches will remain open until system start-up testing is conducted and will be visually inspected for leaks prior to backfilling trenches.

3.3 SVE/AS CONTROL BUILDING AND TREATMENT COMPOUND

The AS/SVE control building compound to be constructed on MLGW property west of Dunn Field is described in Section 3.4 of the RAWP. The compound will have a concrete base and will be enclosed with a chain link fence. The compound will contain two control buildings; Building 1 will house the SVE system and the control room, and Building 2 will house the AS system. The SVE building will contain the individual SVE manifold legs, blowers and moisture separator in the equipment room and the system control panel in a second room (office). The AS building will contain the individual AS manifold legs, compressor and moisture separator. Individual conveyance piping will be routed from each AS and SVE well to provide operational flexibility. A two blower system will permit uninterrupted SVE system operation at lower extraction rates if one of the units is offline for maintenance. The extracted vapor will be discharged without treatment as the mass removal rates will be below permit requirements. A condensate recovery system will be installed. Construction drawings are provided in Appendix D of the RAWP. SVE/AS QA/QC construction activities will include the following:

- 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
- The Subcontractor will submit the layout, manufacturer's data, and dimensional information for all equipment and supplies provided or constructed for the facility, which will subsequently be verified and approved by the CCE or his designated representative prior to installation activities. Submittals from the Subcontractor will include a piping and instrumentation diagram, summary of system controls, electrical wiring diagram, diagram/sketch of the main control panel, and drawings of exterior fencing with locations of gates, and of concrete pad with locations of manholes and utility stub-outs and expansion joints.
- The Subcontractor will submit bi-weekly progress reports summarizing system construction status including summarizing completed tasks during the previous week, planned tasks to be completed the following week, and any technical or schedule issues.
- The CCE or his designated representative will inspect the SVE/AS system at the manufacturer's facility prior to delivery. The purpose of the inspection is to verify that all components have been properly installed per the design drawings and project specifications. Limited testing of system components and controls will also be conducted. Deficiencies noted during the inspection will be brought to the attention of the Subcontractor. All deficiencies will be corrected, at discretion of the CCE, to meet the contractual or technical requirements prior to shipment to the site. The CCE will use the Pre-Shipment Inspection form (Table C-1) as a guide during the inspection process. All deficiencies will be noted on the form.
- The CCE or his designated representative will perform a Pre Start-up Inspection prior to system startup. The inspection will occur following system delivery and once all electrical, conveyance piping, and other connections have been completed. The purpose of the inspection is to ensure the system sustained no damage during transport and delivery, electrical and piping hookups were completed properly, and all inspections or notifications by or to local authorities have been completed. Additionally, the CCE or his designee will inspect other construction details associated with this RA to ensure all construction requirements were met (i.e., system compound

and fencing, trenching, piping, well construction, etc.). The SVE/AS Pre Startup Inspection Checklist (Table C-2) will be completed. All construction deficiencies will be noted on the form and rectified by the appropriate Subcontractor.

3.4 SVE/AS SYSTEM TESTING PROCEDURE AND SYSTEM START-UP

Following the Pre Start-up inspection, the SVE/AS system will be performance tested. The objectives of the testing are to:

- Confirm that the system has been constructed as designed;
- Check that the equipment operates as specified;
- Facilitate any necessary modifications in the system based on observations of site conditions that are different than expected during system construction; and
- Gather and evaluate initial operational data.

Testing will consist of powering up system components in preparation of testing equipment and control systems. The inspection will be performed by the CCE or his designee. Analog controls will be tested to verify operating ranges. When controls provide ON/OFF signals, switches will be manually tripped to test control loops. All control systems will be completed to verify operability. Safety shutdown sequences (i.e., high compressor pressure) will be tested to be sure they are functioning properly. Motors that can be started with hand switches will be turned on to test rotation of rotating equipment. A Start-up and Function Performance Inspection List (Table C-3) will be used by the CCE or his designee to document the inspection process.

Start-up and testing of the SVE/AS system will be conducted over a period one to two weeks and proceed slowly with a planned sequence of events as noted in this section. Prior to system startup, Baseline PID measurements will be collected at all VMPs. PID data, as with all field data, will be recorded on field forms and observations noted in system field log book.

The SVE system will be brought online first. All SVE wells and the bleed valve will be in the 100% open position to minimize the vacuum impact. All SVE piping will be inspected to ensure connections are secure (no leaks detected). System vacuum will gradually be increased by closing the bleed valve. The variable frequency drive can also be adjusted to increase system vacuum. Manifold valves can also be adjusted. Operating the SVE system prior to the AS system will help establish subsurface capture zone.

Initial monitoring will include vacuum measurements at VMPs and SVE wells. Pressures, temperatures, air flow rates, and other system data will be recorded. Baseline PID readings will be collected from all SVE wells and system influent. The startup of the AS system will not occur until PID measurements have stabilized or as directed by the CCE or his designee. Following startup of the AS system, air flow rates, pressures and other system data will be recorded.

During the start-up period, all valves, gauges, solenoid valve sequencing, system controls, alarms, and PLC logic will be tested to ensure functionality and to determine effects of system operation at different scenarios (e.g., different variations of AS and SVE wells online/offline). SVE manifold valves will be adjusted to balance air flows from all wells. Field measurements and monitoring (PID readings) will be conducted daily during the start-up period. System operational data will be compared to design assumptions. Condensate collection rates at the SVE and AS systems will also be observed and noted. The AS/SVE subcontractor will be onsite during the start-up period to assist with system operation and troubleshooting activities.

4.0 REFERENCES

CH2M Hill, 2008. Rev. 1, Memphis Depot Dunn Field Off Depot Groundwater Final Remedial Design. Prepared for the U.S. Army Engineering and Support Center, Huntsville, Alabama. September 2008.

TABLES

TABLE C-1
SVE/AS SYSTEM PRE-SHIPMENT INSPECTION
CONSTRUCTION QUALITY ASSURANCE PLAN
OFF DEPOT GROUNDWATER RAWP
Dunn Field - Defense Depot Memphis, Tennessee

No.	Checklist Item	MR	AR	Recommended Action/Comments
	SVE Header/Manifold			
1	Manifold piping size/material installed per specification (15 legs)			
2	Pressure gauge installed per specification (15 total)			
3	Flow indicator installed as required (15 total)			
4	Diaphragm valve installed per specification (15 total)			
5	Sample port installed per specification (15 total)			
	Air/Water Separator			
6	Correct size vessel installed (with mist eliminator) per specification			
7	Vacuum relief valve installed per specification			
8	Bleed valve and manual drain valve installed per specification			
9	Site glass installed with level switch per specification			
10	Float system installed per specification			
	Condensate Transfer			
11	Transfer pump installed per specification			
12	Transfer piping size/material installed per specification			
13	Check valve installed per specification			
14	Pressure gauge installed per specification			
15	Flow meter installed per specification			
16	535 gallon stand tank installed per specification			
	SVE Blowers and Other Major Equipment			
17	Blowers installed with VFD per specification (two blowers total)			
18	Piping size/material installed per specification			
19	Pressure transmitter installed per specification			
20	Vacuum gauge installed per specification (3 total)			
21	Temperature gauge installed per specification (2 total)			
22	Check valve installed downstream of blowers per specification			
23	Pressure gauge installed downstream of blowers per specification			
24	Temperature gauge installed downstream of blowers per specification			
	Discharge Piping			
25	Piping size/material installed per specification			
26	Thermal mass flow sensor transmitter installed per specification			
27	Pressure transmitter installed per specification			
28	Pressure gauge installed per specification			
29	Temperature gauge installed per specification			
30	Sample port installed per specification			
31	Ensure stack is adequate height per specification			

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TABLE C-1
SVE/AS SYSTEM PRE-SHIPMENT INSPECTION
CONSTRUCTION QUALITY ASSURANCE PLAN
OFF DEPOT GROUNDWATER RAWP
Dunn Field - Defense Depot Memphis, Tennessee

No.	Checklist Item	MR	AR	Recommended Action/Comments
	SVE Building/Office			
32	SVE building proper size per specification			
33	SVE building framing material as specified			
34	Door separating office and equipment room provided per specification			
35	Floor covering as specified			
36	Interior wall/ceiling covering as specified			
37	Building doors installed in correct places per specification			
38	Aluminum wall louvers w/ air filter installed per specification			
39	Rain guard hood installed per specification			
40	HVAC/lighting installed per specification			
41	Desk installed per specification			
42	Desktop computer provided per specification			
43	Electrical outlets installed per specification			
44	Phone jacks installed per specification			
45	Fire extinguisher installed per specification			
46	Exterior electrical outlet installed per specification			
	System Control Panel/Controls			
47	Control panel installed per specification			
48	Control panel equipped for telemetric monitoring and control via modem and internet connection			
49	Panel controls installed per specification and subcontractor submittal			
50	Preliminary testing of system controls (Note: a complete test of PLC and system alarms will be completed during system startup)			
	AS Header/Manifold			
51	Manifold piping size/material installed per specification (100 legs)			
52	Tubing from compressor correct size (5/16") per specification			
53	Speed control valve installed per specification (100 total)			
54	Pressure regulator installed as required (100 total)			
55	Rotameter installed per specification (100 total)			
56	Pressure gauge installed per specification (100 total)			
57	Name plate installed per specification (100 total)			
58	Tubing to solenoids valves correct size (1/2") per specification			
59	Piping in steel painted raceway			

TABLE C-1
SVE/AS SYSTEM PRE-SHIPMENT INSPECTION
CONSTRUCTION QUALITY ASSURANCE PLAN
OFF DEPOT GROUNDWATER RAWP
Dunn Field - Defense Depot Memphis, Tennessee

No.	Checklist Item	MR	AR	Recommended Action/Comments
	Air Sparge Compressor and Other Major Equipment			
60	AS Compressor provided and installed per specification (with particulate filter and inlet silencer)			
61	Receiving tank provided and installed per specification			
62	Receiving tank provided with vacuum relief valve, pressure gauge, and manual drain valves per specification			
63	Refrigerated air dryer provided and installed per specification			
64	Filtered separator provided and installed per specification			
65	Oil removal filter provided and installed per specification			
66	Vapor adsorber provided and installed per specification			
67	Automatic magnetic drain provided and installed per specification			
68	Condensate management system provided and installed per specification			
69	Interior piping provided installed per specification			
	Solenoid Master Panel			
70	Solenoid valves provided and installed per specification (100 total)			
71	Solenoid manifold provided and installed per specification (100 total)			
	AS Equipment Enclosure			
72	All piping installed per specification (100 total)			
73	Cabinet doors installed per specification			
	Air Sparge Building			
74	AS building proper size per specification			
75	Building doors installed in correct places per specification			
76	Aluminum wall louvers installed per specification			
77	Rain guard hood installed per specification			
78	HVAC/lighting installed per specification			
79	Electrical outlets installed per specification			
80	Phone jacks installed per specification			
81	Fire extinguisher installed per specification			
82	Exterior electrical outlet installed per specification			

MR = meets requirement
AR = action required
Inspection Completed by: ____________________
Inspector Project Role: ____________________
Date of Inspection: ____________________ Place of Inspection: ____________________
Additional notes/deficiencies on attached sheets.

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TABLE C-1
SVE/AS SYSTEM PRE-SHIPMENT INSPECTION
CONSTRUCTION QUALITY ASSURANCE PLAN
OFF DEPOT GROUNDWATER RAWP
Dunn Field - Defense Depot Memphis, Tennessee

Other notes/deficiencies noted by inspector (attach additional sheets as required):

TABLE C-2
SVE/AS SYSTEM PRE-STARTUP INSPECTION
CONSTRUCTION QUALITY ASSURANCE PLAN
OFF DEPOT GROUNDWATER RAWP
Dunn Field - Defense Depot Memphis, Tennessee

No.	Checklist Item	MR	AN	Date Inspected	Recommended Action/Comments
	AS/SVE Wells				
1	AS wells installed per specification				
2	SVE well installed per specification				
3	VMPs installed per specification				
4	AS/SVE/VMP construction information noted in field log books				
4	All wells labeled at well head				
5	All wells have traffic rated cover and concrete apron per specification				
6	Wells/VMPs surveyed				
	Trenching/Piping				
7	Piping/trenching completed per design/specification				
8	Pressure test complete (except for joints that require testing while system is in operation)				
	Equipment Compound				
9	Concrete pad constructed per specification				
10	Chain Link fencing (w/ barbed wire) installed per specification				
11	Fence gates installed per specification				
12	Exterior lighting installed per specification.				
	SVE/AS System Delivery				
13	SVE system delivered to site with all components and w/o damage				
14	AS system delivered to site with all components and w/o damage				
15	Condensate holding tank				
16	Building placed on equipment pad per design				
17	Buildings anchored per specification				
	Permits/Notifications				
18	Operational permits obtained (if applicable)				
19	MSCHD notified of planned startup (if applicable)				
20	Trailer tank registered with local DMV				
	Electrical and Communication Hookup (Pre Start-up)				
21	Transformers installed by contractor per specifications				
22	Electrical service brought to AS/SVE unit disconnect				
23	Communication lines between AS and SVE buildings installed and functional				
24	Protective covers on terminal boxes and panels in place				
25	Grounding installed/checked				
26	Wiring integrity between components and supply (no damage or deterioration)				
27	Major equipment functional				
28	Lighting/HVAC functional				
29	AC outlets functional				
30	MLGW/City of Memphis inspection completed				
31	Phone line/internet connection established				

TABLE C-2
SVE/AS SYSTEM PRE-STARTUP INSPECTION
CONSTRUCTION QUALITY ASSURANCE PLAN
OFF DEPOT GROUNDWATER RAWP
Dunn Field - Defense Depot Memphis, Tennessee

No.	Checklist Item	MR	AN	Date Inspected	Recommended Action/Comments
	SVE Equipment Major Equipment Check				
32	Blower pump rotation verified				
33	Valves/piping/hardware installed per specification and subcontractor submittals				
34	SVE stack installed				
	Piping Connections				
35	SVE well conveyance piping connected to system				
36	SVE header/sample ports clearly labeled/identified				
37	AS conveyance piping connection to system.				
38	AS header clearly labeled/identified				
39	Exterior piping connections intact (visual inspection only)				
40	Interior piping connections intact (visual inspection only)				
41	Connect transfer piping to 595-gallon holding tank				
	Ancillary Equipment				
41	Field monitoring instruments available (PID, vacuum gauges, etc.)				
42	Field monitoring forms available				

MR = meets requirement
AR = action required
Inspection Completed by: ______________________
Inspector Project Role: ______________________

Additional notes/deficiencies on attached sheets.

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TABLE C-2
SVE/AS SYSTEM PRE-STARTUP INSPECTION
CONSTRUCTION QUALITY ASSURANCE PLAN
OFF DEPOT GROUNDWATER RAWP
Dunn Field - Defense Depot Memphis, Tennessee

Other notes/deficiencies noted by inspection (attach additional sheets as required):

TABLE C-3
SVE/AS SYSTEM STARTUP AND FUNCTION PERFORMANCE INSPECTION
CONSTRUCTION QUALITY ASSURANCE PLAN
OFF DEPOT GROUNDWATER RAWP
Dunn Field - Defense Depot Memphis, Tennessee

No.	Checklist Item	MR	AN	Date Inspected	Recommended Action/Comments
	SVE Air/Water Separator (Post Start-up)				
1	Ensure AWS vessel is not leaking				
2	Ensure all valves are functional				
3	Condensate drainage is unobstructed				
4	Condensate transfer pump functional				
5	Condensate flow meter functional				
6	Pressure gauge functional				
7	Valves/piping/ labeled as necessary				
8	535-gallon holding tank free of leaks				
	SVE System Major Components				
9	Blowers functioning as designed (including VFDs)				
10	Interior pipe connections inspected/tested (no leaks)				
11	Exterior pipe connections inspected/tested (no leaks)				
12	Manifold piping gauges/valves functioning				
13	All other flow meters/gauges functioning				
	Air Sparge System Major Components				
14	AS Compressor functioning as designed				
15	Receiving tank functioning as designed				
16	Receiving tank vacuum relief valve, pressure gauge, and manual drain functioning as designed				
17	Refrigerated air dryer functioning as designed				
18	Filtered separator functioning as designed				
19	Oil removal filter functioning as designed				
20	Vapor adsorber functioning as designed				
21	Automatic magnetic drain functioning as designed				
22	Condensate management system functioning as designed				
23	Manifold piping inspected (free of leaks)				
24	Manifold speed control valves functioning as designed (100 total)				
25	Manifold pressure regulator functioning as designed (100 total)				
26	Manifold rotameter functioning as designed (100 total)				
27	Solenoid valves functioning as designed (100 total)				
28	Solenoid manifold functioning as designed (100 total)				
29	Other gauges/valves functioning as designed				
	Control Panel and System Controls				
30	Main control panel installed and functioning per specification				
31	Main control panel disconnect switch functioning				
32	Control panel emergency STOP button functioning				

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TABLE C-3
SVE/AS SYSTEM STARTUP AND FUNCTION PERFORMANCE INSPECTION
CONSTRUCTION QUALITY ASSURANCE PLAN
OFF DEPOT GROUNDWATER RAWP
Dunn Field - Defense Depot Memphis, Tennessee

No.	Checklist Item	MR	AN	Date Inspected	Recommended Action/Comments
	Control Panel and System Controls (continued)				
33	HOA switches functioning				
34	Vacuum transmitter functioning/relaying data (at blower influent)				
35	Pressure transmitter functioning/relaying data (at blower effluent)				
36	Air/Mass Meter transmitter functioning/relaying data				
37	All system alarms functioning per specification/contractor submittal:				
38	AWS high/high alarm				
39	SVE low vacuum alarm				
40	SVE system high vacuum alarm				
41	SVE/AS manifold high vacuum alarm				
42	SVE/AS Manifold Low vacuum alarm				
43	UPS low battery alarm				
44	AS/SVE high discharge pressure alarm				
45	Blower/compressor equipment start failure alarm				
46	Other alarms				
47	Ability to adjust pulsing frequencies of solenoid valves				
	Building Piping Connections				
48	AS polyurethane tubing connection to HDPE piping inspected (free of leaks)				
49	SVE piping connections to HDPE conveyance piping inspected (fee of leaks)				
50	HDPE piping connections at SVE well heads inspected (free of leaks)				
51	HDPE piping connections at AS well heads inspected (free of leaks)				
	SVE/AS Buildings				
50	AS Building free of weather related leaks				
51	SVE building free of weather related leaks				
52	Door locks functioning				
53	AS Building meets noise requirements per specification				
54	SVE Building meets noise requirements per specification				

MR = meets requirement
AR = action required
Inspection Completed by: ______________________
Inspector Project Role: ______________________

Additional notes/deficiencies on attached sheets.

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TABLE C-3
SVE/AS SYSTEM STARTUP AND FUNCTION PERFORMANCE INSPECTION
CONSTRUCTION QUALITY ASSURANCE PLAN
OFF DEPOT GROUNDWATER RAWP
Dunn Field - Defense Depot Memphis, Tennessee

Other notes/deficiencies noted by inspection (attach additional sheets as required):

ATTACHMENT C-1

NON-CONFORMANCE REPORT

ATTACHMENT C-1
SVE/AS SYSTEM CONSTRUCTION
DEFICIENCY/NON-CONFORMANCE SUMMARY REPORT
CONSTRUCTION QUALITY ASSURANCE PLAN
OFF DEPOT GROUNDWATER RAWP
Dunn Field - Defense Depot Memphis, Tennessee

Purpose:

The purpose of this Deficiency/Non-Conformance Summary Report is to document and address deficiencies noted during construction inspections. Examples may include: incomplete or improperly completed work, material defects, builder oversights, etc. The project CCE or representative will formally notify the contractor in writing and attach this Summary Report. The Contractor will submit a suggested solution to address the noted deficiency for approval by the CCE. The final resolution will be documented in writing, and will reference this report.

Date of Inspection: ________________
Place of Inspection: ________________
Inspection Completed by: ________________
Inspector Project Role: ________________
Contractor: ________________
Contractor POC: ________________

Summary of Deficiency (Inspector to provide detailed summary of deficiency including photos, sketches, actual measurements, etc. Also cite appropriate reference document (i.e., sheet number, specification, RFP, etc.)):

ATTACHMENT C-1 (CONTINUED)
SVE/AS SYSTEM CONSTRUCTION
DEFICIENCY/NON-CONFORMANCE SUMMARY REPORT
CONSTRUCTION QUALITY ASSURANCE PLAN
OFF DEPOT GROUNDWATER RAWP
Dunn Field - Defense Depot Memphis, Tennessee

Contractor's Suggested Solution:

Expected Completion Date: ______________________

Contractor Signature: ________________________________ Date: ________________

CCE Response to Contractor's Suggested Solution:

☐ AGREE WITH CONTRACTOR SOLUTION ☐ REPAIR ☐ REWORK ☐ REJECT/SCRAP ☐ OTHER

Comments:

CCE (or Representaive) Signiture : ___________________________ Date: ________________

ATTACHMENT C-2

SUBSTANTIVE RQUIREMENTS 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

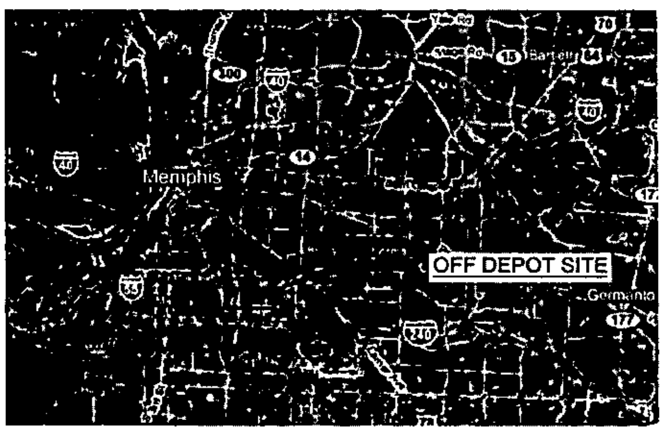
- Any well that is to be permanently plugged and abandoned shall be completely filled and sealed in such a manner that vertical movement of fluid either into or between formation(s) containing USDWs through the bore hole is not allowed.

APPENDIX D

REMEDIAL DESIGN CONSTRUCTION DRAWINGS

OFF-DEPOT DUNN FIELD
GROUNDWATER REMEDIAL DESIGN
MEMPHIS, TENNESSEE

SITE MAP
NTS



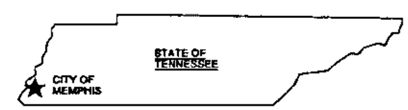
LOCATION MAP
NTS

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	GENERAL SITE MAP
3	F-1	AIR SPARGE AND SOIL VAPOR EXTRACTION LAYOUT
4	F-2	FLUVIAL AS/SVE EXISTING GROUND PROFILES
5	F-3	FLUVIAL SAND AS/SVE PROCESS FLOW DIAGRAMS
6	F-4	FLUVIAL SANDS AS/SVE EQUIPMENT COMPOUND ELEVATION DETAILS
7	F-5	FLUVIAL SANDS AS/SVE EQUIPMENT COMPOUND PLAN VIEW
8	F-6	BUILDING DETAILS
9	F-7	CHAIN LINK FENCE DETAILS
10	F-8	FLUVIAL SANDS AS/SVE DETAILS
11	F-9	FLUVIAL SANDS AS/SVE COMPOUNDS ELECTRIC RISER DIAGRAM

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



VICINITY MAP
NTS

NO.	DATE	REVISION	BY	APVD

DSGN M. PERLMUTTER | DR E. GROGGS | CHK M. STRONG | APVD M. PERLMUTTER

OFF-DEPOT DUNN FIELD
GROUNDWATER
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

GENERAL
TITLE SHEET, LOCATION
MAP,
AND INDEX TO DRAWINGS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.

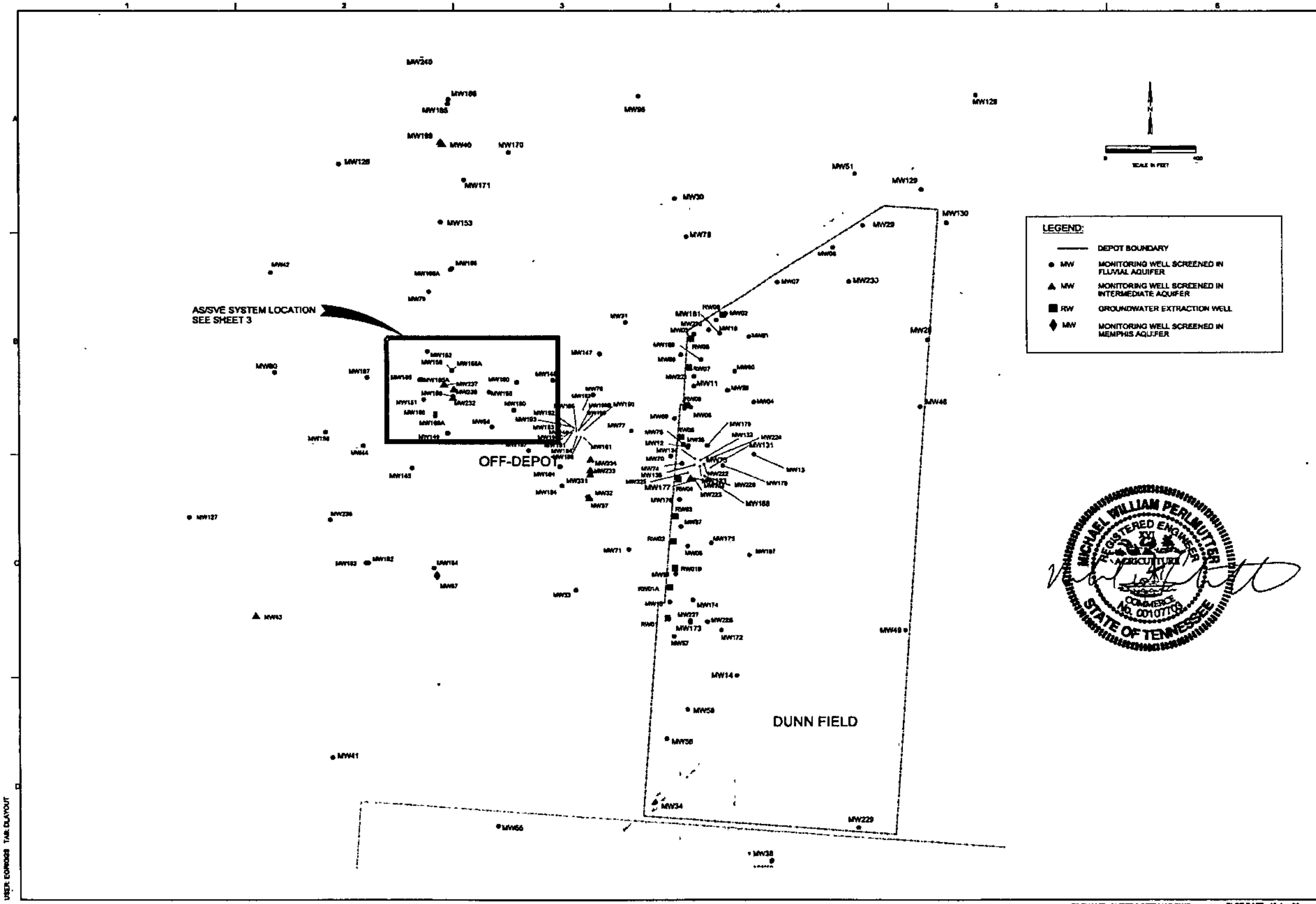
DATE SEPTEMBER, 2006
PROJ 334408
DWG G-1
SHEET 1

USER: EGRIGGS TAB: LAYOUT1

ATL/PROJ/148071 DDMT/ODRD2007/DRAWINGS

FILENAME: SHEET 1 (COVER).DWG PLOT DATE: 17-Apr-08 PLOT TIME: 11:24:23 AM

984 144



CH2MHILL

OFF-DEPOT DUNN FIELD
GROUNDWATER
REMEDIAL DESIGN
MEMPHIS, TN

GENERAL
SITE MAP

NO.	DATE	REVISION	BY	APVD

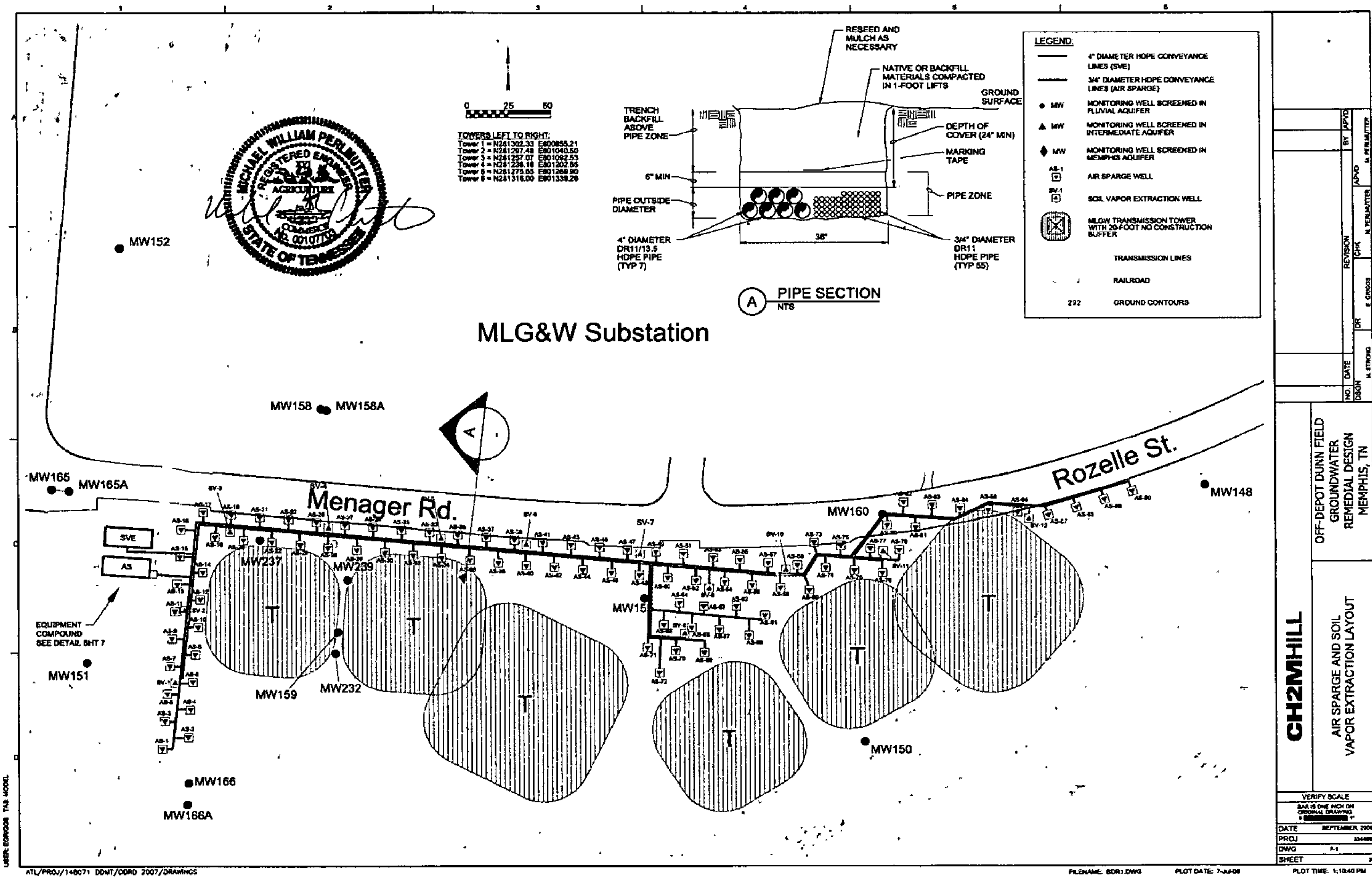
DSGN N. STRONG | DR E. GRIGGS | CHK N. PERLMUTTER | APVD N. PERLMUTTER

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.

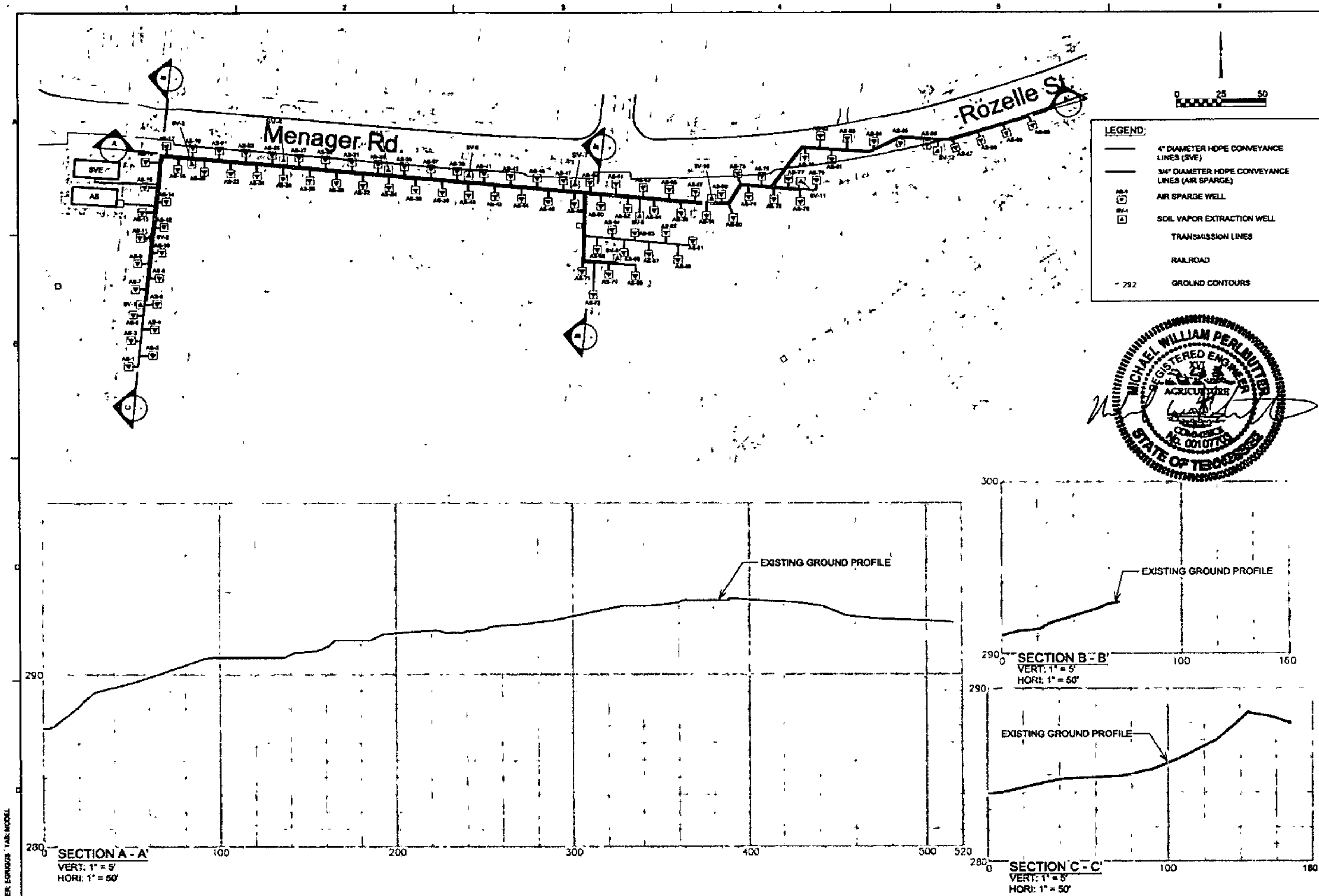
DATE	SEPTEMBER, 2008
PROJ	334469
DWG	G-2
SHEET	2

984 145

USER: EGRIGGS TAB: DLAYOUT
ATL/PROJ/148071 DDMT/ODDRD2007/DRAWINGS
FILENAME: SHEET 2 SITE MAP.DWG PLOT DATE: 15-Apr-08 PLOT TIME: 3:15:32 PM


MLG&W Substation
Menager Rd.
Rozelle St.
MW152
MW158
MW158A
MW165
MW165A
MW151
MW166
MW166A
MW237
MW239
MW159
MW232
MW15
MW160
MW150
MW148
SVE
AS
EQUIPMENT COMPOUND SEE DETAIL SHT 7
SV-3
SV-4
SV-7
SV-10
SV-11
SV-12
T
0 25 50
TOWERS LEFT TO RIGHT:
Tower 1 = N281302.33 E800855.21
Tower 2 = N281297.48 E801040.50
Tower 3 = N281257.07 E801092.53
Tower 4 = N281236.16 E801202.65
Tower 5 = N281275.65 E801268.90
Tower 6 = N281316.00 E801338.26
RESEED AND MULCH AS NECESSARY
NATIVE OR BACKFILL MATERIALS COMPACTED IN 1-FOOT LIFTS
GROUND SURFACE
TRENCH BACKFILL ABOVE PIPE ZONE
DEPTH OF COVER (24" MIN)
MARKING TAPE
6" MIN
PIPE ZONE
PIPE OUTSIDE DIAMETER
36"
4" DIAMETER DR11/13.5 HDPE PIPE (TYP 7)
3/4" DIAMETER DR11 HDPE PIPE (TYP 55)
A PIPE SECTION
NTS
LEGEND:
4" DIAMETER HDPE CONVEYANCE LINES (SVE)
3/4" DIAMETER HDPE CONVEYANCE LINES (AIR SPARGE)
MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
MW MONITORING WELL SCREENED IN INTERMEDIATE AQUIFER
MW MONITORING WELL SCREENED IN MEMPHIS AQUIFER
AS-1 AIR SPARGE WELL
SV-1 SOIL VAPOR EXTRACTION WELL
MLGW TRANSMISSION TOWER WITH 20-FOOT NO CONSTRUCTION BUFFER
TRANSMISSION LINES
RAILROAD
292 GROUND CONTOURS
MICHAEL WILLIAM PERLMUTTER
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
STATE OF TENNESSEE
NO. DATE REVISION BY APVD
DSGN M. STRONG
DR E. GRIGGS
CHK M. PERLMUTTER
APVD M. PERLMUTTER
OFF-DEPOT DUNN FIELD
GROUNDWATER
REMEDIAL DESIGN
MEMPHIS, TN
CH2MHILL
AIR SPARGE AND SOIL
VAPOR EXTRACTION LAYOUT
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
DATE SEPTEMBER 2006
PROJ
DWG F-1
SHEET
ATL/PROJ/148071 DDMT/ODRD 2007/DRAWINGS
FILENAME: BDR1.DWG
PLOT DATE: 7-Jul-08
PLOT TIME: 1:10:40 PM
USER: EGRIGGS TAB: MODEL

984 147



CH2MHILL

OFF-DEPOT DUNN FIELD
GROUNDWATER
REMEDIAL DESIGN
MEMPHIS, TN

FLUVIAL AS/SVE
EXISTING GROUND PROFILE

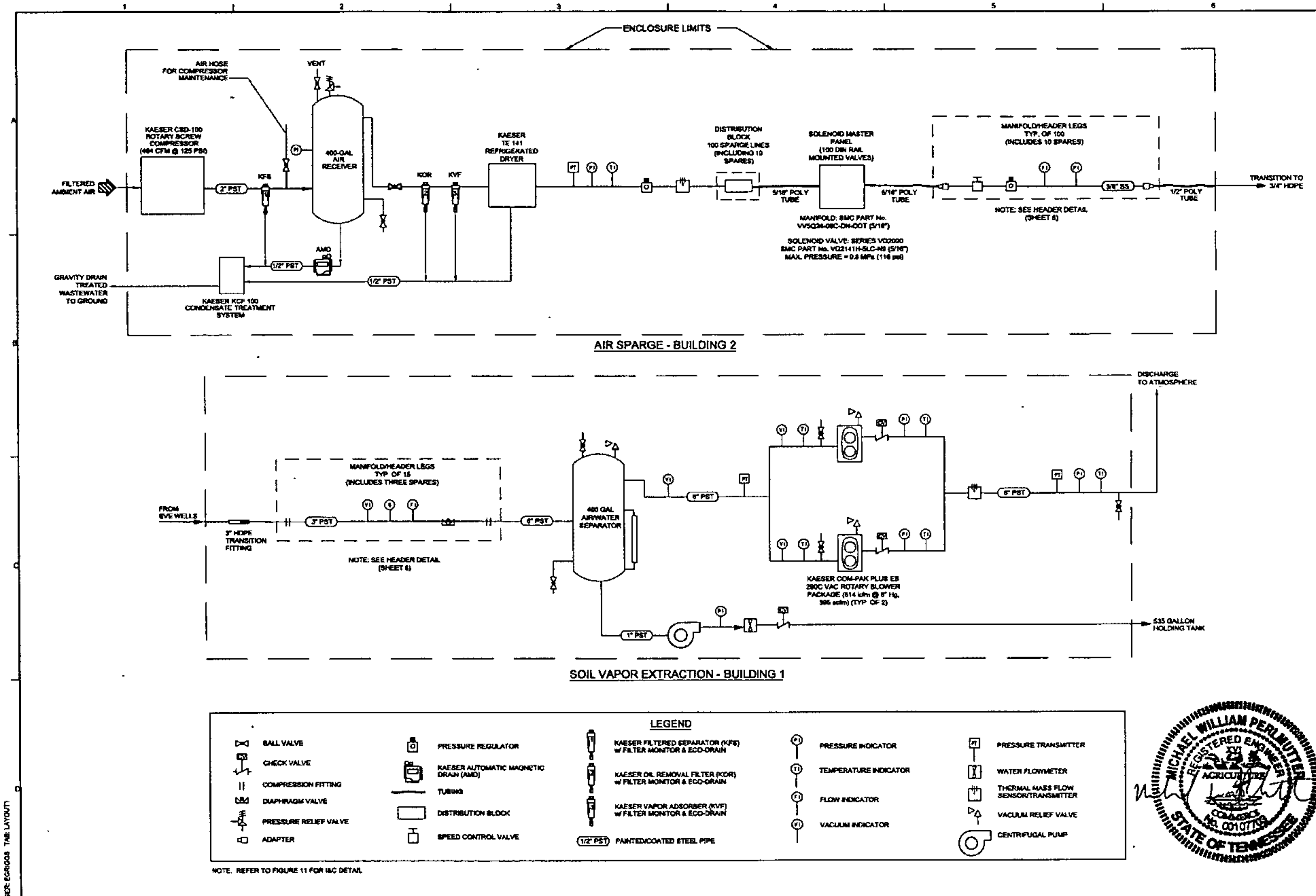
NO.	DATE	REVISION	BY	APVD

DSGN M. STRONG
DR E. GRIGGS
CHK M. PERLMUTTER
APVD M. PERLMUTTER

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

DATE	SEPTEMBER, 2008
PROJ	334468
DWG	F-2
SHEET	4

USER: EGRIGGS TAB: MODEL
ATL/PROJ/146071 DOMT/OORD 2007/DRAWINGS
FILENAME: BDR1.DWG PLOT DATE: 7-Jul-08 PLOT TIME: 1:10:40 PM



CH2MHILL

FLUVIAL SANDS AS/SVE
PROCESS FLOW DIAGRAMS

OFF-DEPOT DUNN FIELD
GROUNDWATER AREAS
REMEDIAL DESIGN
MEMPHIS, TN

NO	DATE	REVISION	BY	APVD

DSGN H. STRONG | DR E. GRIGGS | CHK H. PERLMUTTER | APVD H. PERLMUTTER

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.

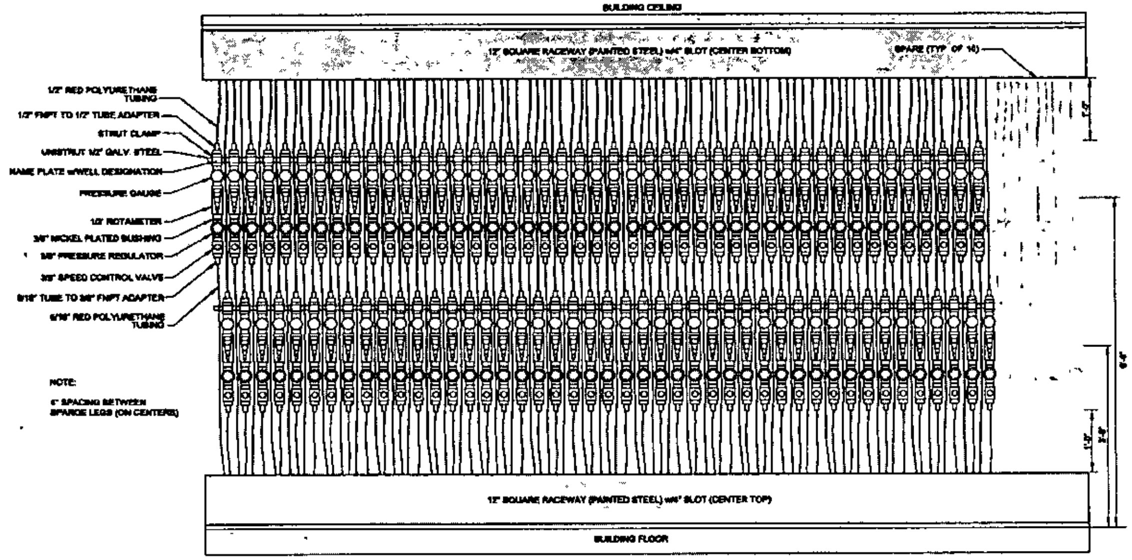
DATE	SEPTEMBER, 2008
PROJ	334469
DWG	F-3
SHEET	5

ATL/PROJ/148071 DDMT/ODRD2007/DRAWINGS

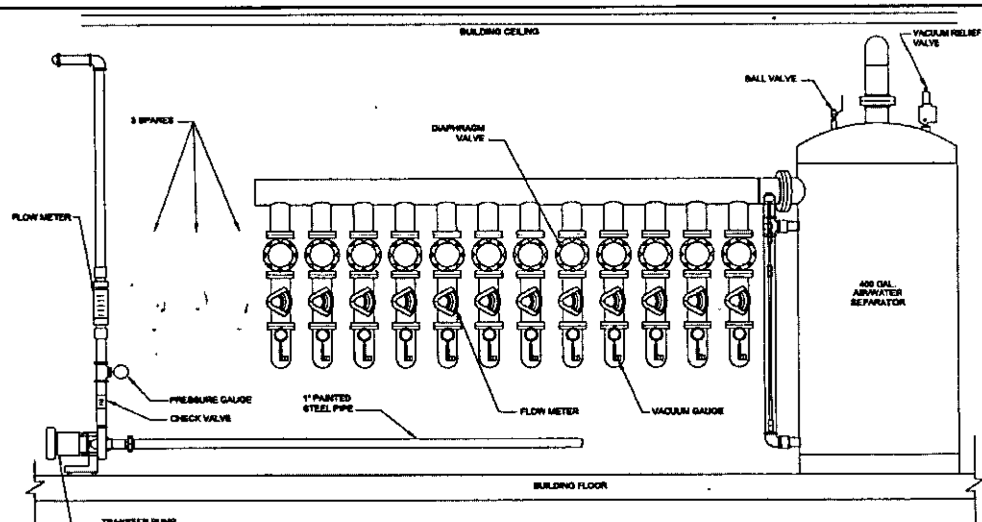
FILENAME: SHEET 5 (PROCESS FLOW DIA).DWG PLOT DATE: 10-Sep-08 PLOT TIME: 12:10:42 PM

USER: EGRIGGS TAB: LAYOUT1

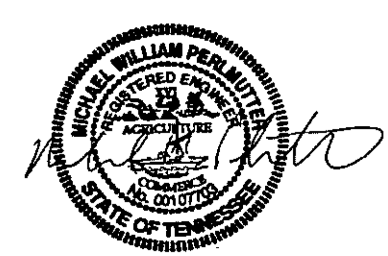
984 148

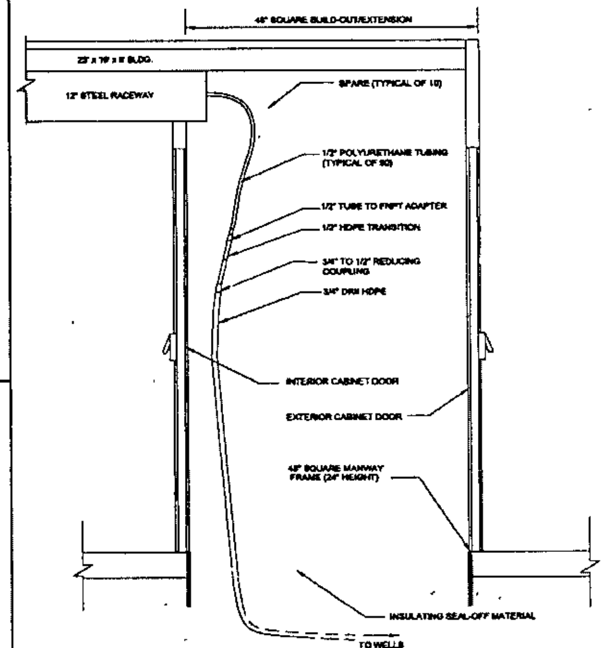


AIR SPARGE HEADER
ELEVATION DETAIL
N.T.S.



SVE HEADER
ELEVATION DETAIL
N.T.S.





EQUIPMENT ENCLOSURE
BUILD-OUT DETAIL
N.T.S.

NO.	DATE	REVISION	BY	APVD

DSGN H. STRONG | DR G. HARTLEY | CHK H. PERLMUTTER | APVD H. PERLMUTTER

OFF-DEPOT DUNN FIELD
GROUNDWATER
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

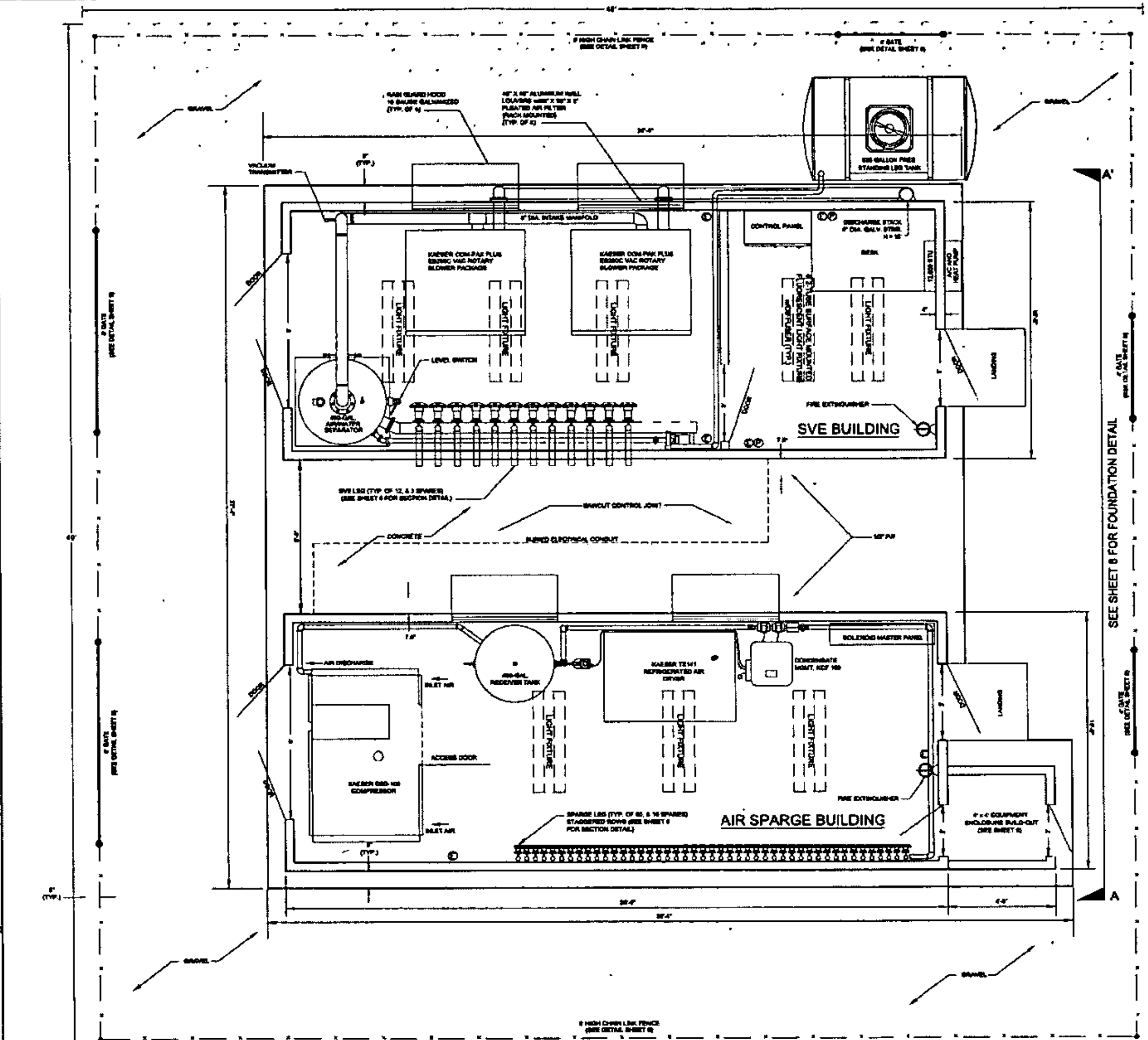
FLUVIAL SANDS AS/SVE
EQUIPMENT COMPOUND
ELEVATION DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.

DATE	SEPTEMBER, 2008
PROJ	334469
DWG	P-4
SHEET	6

984 149

USER: GHARTLEY TAB: LAYOUT1
ATL/PROJ/148071 DDMT/OORD2007/DRAWINGS
FILENAME: SHEET 6 (EQUIPMNT_COMPO_ELEV).DWG PLOT DATE: 10-Sep-08 PLOT TIME: 3:43:48 PM



BUILDING SPECIFICATIONS

1. PERIMETER FRAME: [illegible]
2. METAL WEATHER SHIELD: [illegible]
3. FLOOR JOISTS: [illegible]
4. FLOOR INSULATION: [illegible]
5. FLOOR COVERING: [illegible]
6. WALL STUDS: [illegible]
7. WALL INSULATION: [illegible]
8. INTERIOR WALL COVERING: [illegible]
9. EXTERIOR WALL SHEATHING: [illegible]
10. ROOF FRAMING: [illegible]
11. INTERIOR CEILING: [illegible]
12. ROOF INSULATION: [illegible]
13. EXTERIOR ROOF SHEATHING: [illegible]
14. ROOF COVERING: [illegible]
15. EXTERIOR SIDING: [illegible]
16. EXTERIOR DOORS: [illegible]
17. FULL DEPTH FORK POCKETS: [illegible]
18. INTERIOR LIGHT FIXTURES: [illegible]
19. INTERIOR CEILING HEIGHT: [illegible]
20. ELECTRIC SERVICE PANEL: [illegible]
21. HVAC: [illegible]

LEGEND

ELECTRICAL OUTLET

PHONE JACK

MICHAEL WILLIAM PERLMUTTER
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No. 00107770
STATE OF TENNESSEE

CH2MHILL

FLUVIAL SANDS AS/SVE
EQUIPMENT COMPOUND
PLAN VIEW

OFF- DEPOT DUNN FIELD
GROUNDWATER
REMEDIAL DESIGN
MEMPHIS, TN

NO.	DATE	REVISION	BY	APVD

DSGN R. STRONG · DR G. HARTLEY · CHK M. PERLMUTTER · APVD M. PERLMUTTER

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.

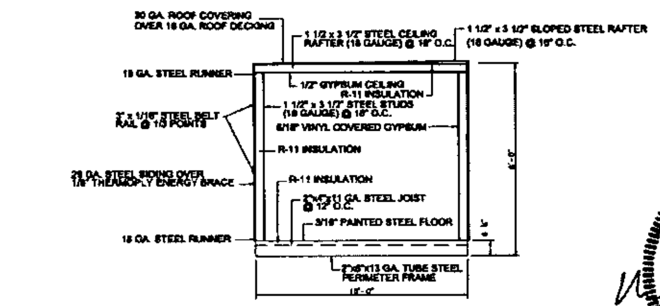
DATE	SEPTEMBER, 2008
PROJ	334469
DWG	F-5
SHEET	7

USER: EGRIGGS TAB: LAYOUT2

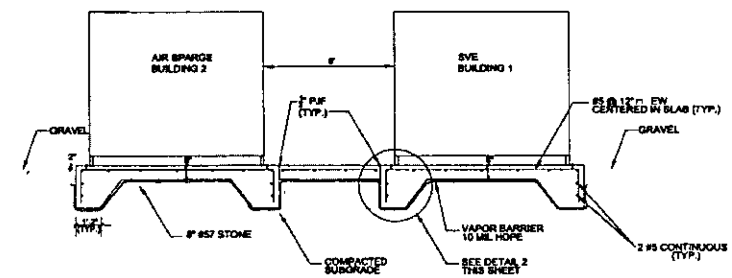
ATL/PROJ/148071 DDMT/SARD 2008/memphisDepotBldgLayout.dwg

FILENAME: SHEET 7 (EQUIPMENT COMP PLAN).DWG PLOT DATE: 15-Aug-08 PLOT TIME: 3:04:50 PM

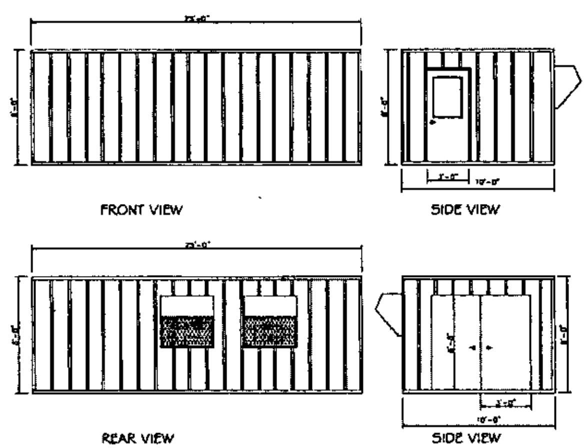
984 150



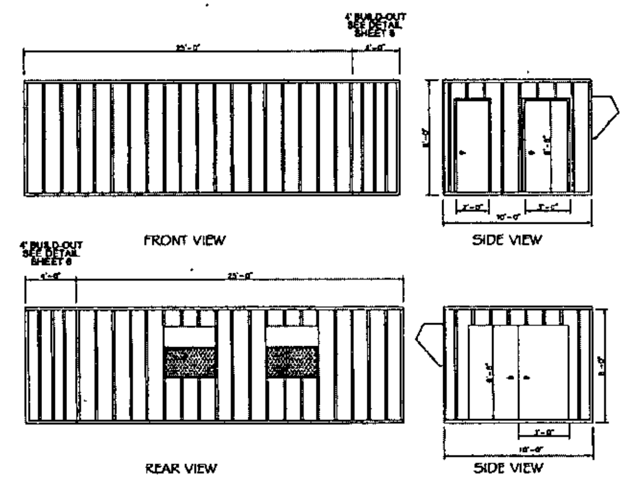
CROSS SECTION



1 BUILDING FOUNDATION DETAIL A - A'
NTS

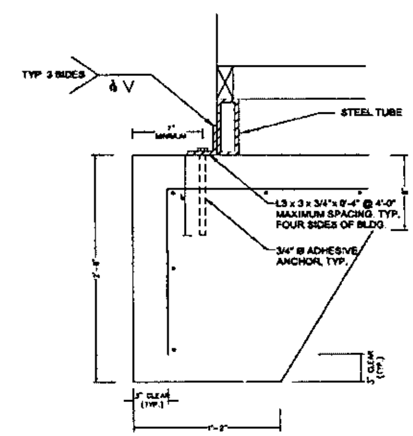


SVE EQUIPMENT COMPOUND FRAME DETAIL
NTS



AIR SPARGE EQUIPMENT COMPOUND FRAME DETAIL
NTS

NOTES:
1. DOORS MAY REQUIRE ADJUSTMENT DUE TO SHIFTING DURING TRANSPORT
2. ALL STEEL CONSTRUCTION, ALL DOORS KEYED ALIKE, 3/16 PAINTED STEEL FLOOR
3. OVERALL DIMENSIONS ARE OUTSIDE OF FRAME TO OUTSIDE OF FRAME. DIMENSIONS DO NOT INCLUDE SHEATHING, SIDING, OR ANY OTHER PROTRUSION SUCH AS DOOR KNOBS, A/C SLEEVES, SPRINKLERS, ETC.



2 ATTACHMENT DETAIL
NTS

CH2MHILL

OFF-DEPOT DUNN FIELD GROUNDWATER REMEDIAL DESIGN MEMPHIS, TN

BUILDING DETAILS

NO.	DATE	REVISION	BY	APVD

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

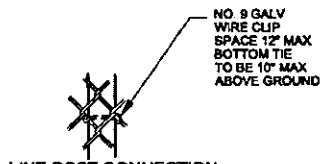
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

DATE	SEPTEMBER, 2008
PROJ	339469
DWG	F-6
SHEET	6

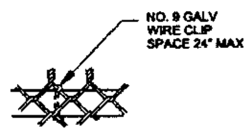
FILENAME: SHEET 6 (BLDG DETAILS).DWG PLOT DATE: 5-Sep-08 PLOT TIME: 3:13:33 PM

ATL/PROJ/148071 DDMT/SARD 2008

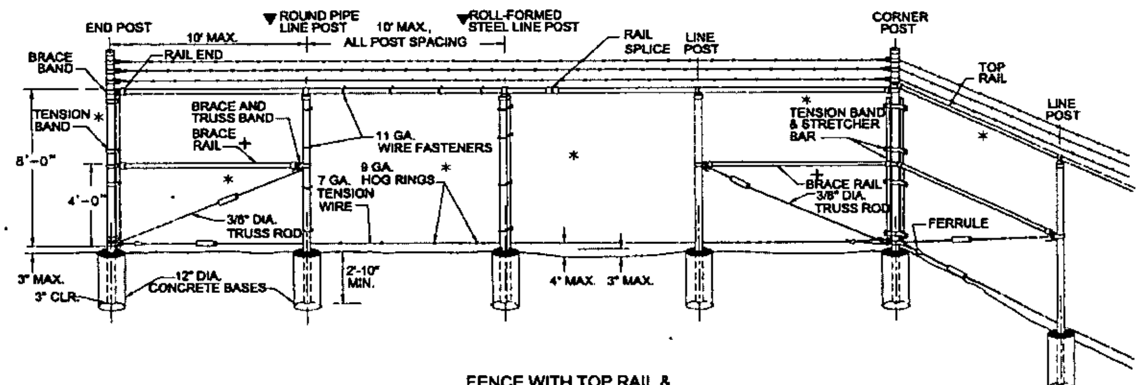
USER: EGRIGGS TAB: LAYOUT1



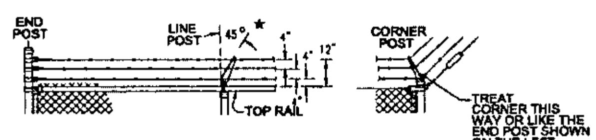
LINE POST CONNECTION



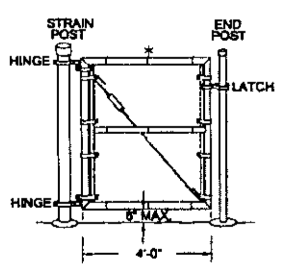
TOP RAIL CONNECTION



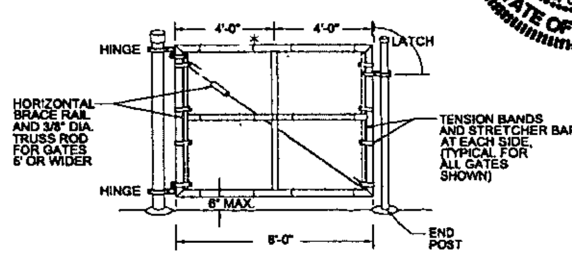
FENCE WITH TOP RAIL & THREE STRAND BARBED WIRE



BARBED WIRE TOP



WALK GATE



SINGLE GATE

GENERAL NOTES

1. AT EACH LOCATION WHERE AN ELECTRIC TRANSMISSION, DISTRIBUTION, OR SECONDARY LINE CROSSES A FENCE, THE CONTRACTOR SHALL FURNISH AND INSTALL A GROUND CONFORMING TO ARTICLE 250 OF THE NATIONAL ELECTRIC CODE. A GROUND SHALL ALSO BE INSTALLED A MAXIMUM OF EVERY 500 FT. ALONG THE FENCE. THE GROUND ROD SHALL BE A MINIMUM DIAMETER OF 1/2 IN. AND 8 FT. IN LENGTH, AND DRIVEN AT LEAST 7 1/2 FT. INTO THE GROUND. THE ROD SHALL BE CONNECTED TO EACH WIRE WITH A MINIMUM AWG NO. 8 STRANDED COPPER WIRE. GROUNDING WILL NOT BE PAID FOR SEPARATELY BUT SHALL BE INCLUDED IN THE COST OF THE FENCE.
2. H (HEIGHT OF FABRIC) SHALL BE AS SHOWN ON THE PLANS. FABRIC IS AVAILABLE IN THE FOLLOWING HEIGHTS: 36 IN., 42 IN., 48 IN., 60 IN., 72 IN., 84 IN., 96 IN., 108 IN., 120 IN., AND 144 IN
3. CHAIN LINK FENCE SHALL CONFORM TO AASHTO M 181.
4. CHAIN LINK FABRIC SHALL BE 2 IN MESH NO. 9 GAGE GALVANIZED OR ALUMINUM COATED WIRE SECURELY FASTENED TO TENSION WIRE, LINE POSTS, RAILS, BRACES AND STRETCHER BARS SPACED AS SHOWN HEREON WIRE FASTENERS AND TIE CLIPS SHALL BE NO. 11 GAGE (W&M) GALVANIZED STEEL WIRE OR NO. 7 GAGE (B&S) ALUMINUM WIRE, AND HOG RINGS SHALL BE NO 9 GAGE, ALL IN CONFORMANCE WITH ASTM F 626.
5. STEEL POSTS, RAILS AND GATE FRAMES SHALL CONFORM TO AASHTO M 181 TYPE 1, GRADE 1 OR GRADE 2.
6. AT THE CONTRACTOR'S OPTION, PIPE USED FOR FENCE CONSTRUCTION SHALL CONFORM TO THE DIMENSIONS AND WEIGHTS FOR EITHER "ORDINARY PIPE" OR "ALTERNATIVE PIPE" AS SHOWN ON SHEET 2. "ALTERNATIVE PIPE" SHALL BE HIGH STRENGTH STEEL PIPE CONFORMING TO FEDERAL SPECIFICATION RR-F-191/3C.
7. TENSION WIRE SHALL BE CONTINUOUS BETWEEN END OR CORNER POST AND LINE BRACE POST. A TURNBUCKLE OR OTHER APPROVED TIGHTENING DEVICE SHALL BE USED FOR EACH CONTINUOUS SPAN OF TENSION WIRE.
8. TENSION WIRE SHALL CONFORM TO AASHTO M 181.
9. CONCRETE FOOTINGS SHALL HAVE TOPS CROWNED AT GROUND LEVEL AND SHALL BE CLASS B. CONCRETE WITH LIGHTWEIGHT AGGREGATE CONFORMING TO AASHTO M 195, MAY BE SUBSTITUTED.
10. TERMINATION OF FENCE AT BRIDGES OR OTHER STRUCTURES SHALL BE AS SHOWN ON THE PLANS.
11 CHAIN LINK FABRIC UP TO 5 FT. HIGH SHALL BE KNUCKLED AT THE TOP AND BOTTOM SELVAGES. FABRIC OVER 5 FT. HIGH SHALL BE TWISTED AND BARBED ON THE TOP SELVAGE AND KNUCKLED ON THE BOTTOM SELVAGE.
12. FENCE MAY BE CONSTRUCTED WITH EITHER ROUND PIPE OR ROLL-FORMED STEEL COMPONENTS. THE CONTRACTOR SHALL STATE AT THE PRECONSTRUCTION CONFERENCE, THE TYPE OF CONSTRUCTION AND TYPE OF LINE POST TO BE USED THROUGHOUT THE PROJECT
13. THE CONTRACTOR SHALL BE RESPONSIBLE FOR RE-ESTABLISHING DISTURBED OR DESTROYED SURVEY MONUMENTS TO THE APPROPRIATE ACCURACY IN ACCORDANCE WITH SUBSECTION 625.08 OF THE STANDARD SPECIFICATIONS.

LEGEND

* ATTACH FABRIC TO ALL FENCE & GATE STRUCTURES AT 12 IN. INTERVALS VERTICALLY AND AT 20 IN HORIZONTALLY.

TIGHTENER OR TURNBUCKLE SYMBOL

▼ TYPE OF LINE POST (ROUND PIPE OR ROLL-FORMED STEEL) SHALL BE AT THE OPTION OF THE CONTRACTOR UNLESS OTHERWISE SHOWN ON THE PLANS.

+ BRACE RAIL IS NOT REQUIRED FOR 36 IN., 42 IN., OR 48 IN. FABRIC HEIGHTS. BRACE RAIL FOR FENCE WITH ROLL-FORMED STEEL ELEMENTS IS 12 IN. BELOW THE TOP RAIL.

NO.	DATE	REVISION	BY	APVD

DSGN M. STRONG | DR G. HARTLEY | CHK M. PERLMUTTER | APVD M. PERLMUTTER

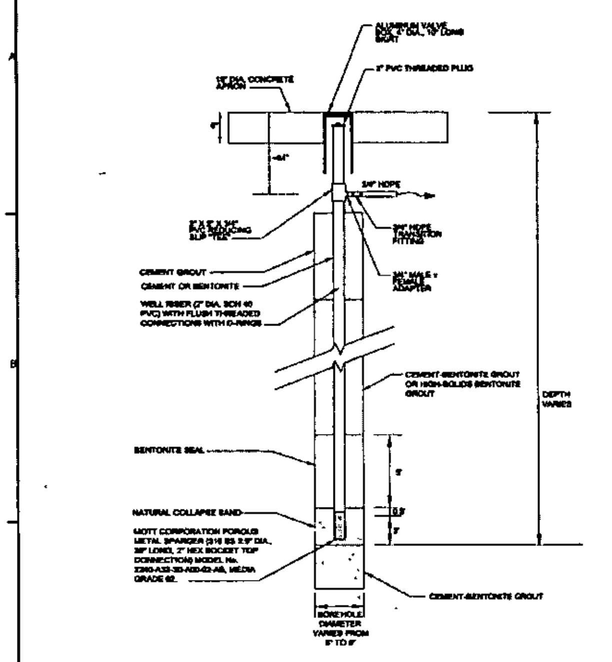
OFF-DEPOT DUNN FIELD
GROUNDWATER
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

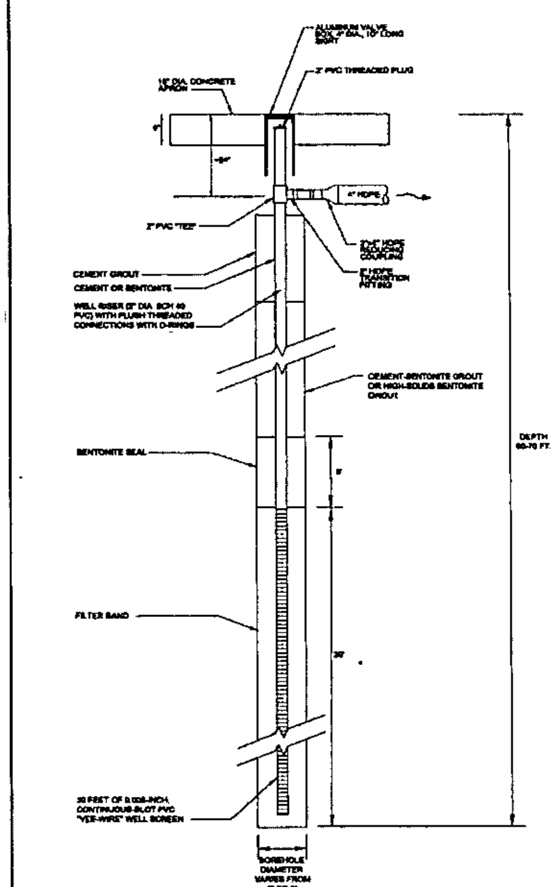
CHAIN LINK
FENCE DETAILS

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

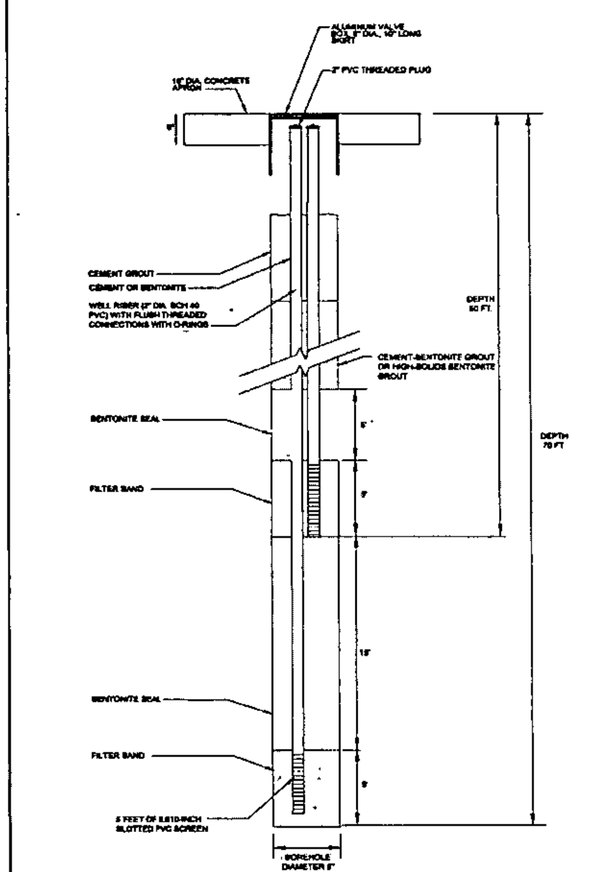
DATE	MAY, 2008
PROJ	334466
DWG	F-7
SHEET	9



4 AIR SPARGE WELLHEAD DETAIL DIRECT BURIAL
NTS



5 SVE WELLHEAD DETAIL DIRECT BURIAL
NTS



6 VAPOR MONITORING POINT
NTS

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

CH2MHILL

FLUVIAL SANDS AS/SVE DETAILS

OFF-DEPOT DUNN FIELD GROUNDWATER REMEDIAL DESIGN MEMPHIS, TN

NO	DATE	REVISION	BY	APVD

DSGN H. STRONG | DR E. GRIGGS | CHK M. PERLMUTTER | APVD M. PERLMUTTER

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.

DATE	SEPTEMBER, 2008
PROJ	334469
DWG	F-8
SHEET	10

USER: EGRIGGS TAB: LAYOUT1
ATL/PROJ/148071 DDMT/DDRD2007/DRAWINGS
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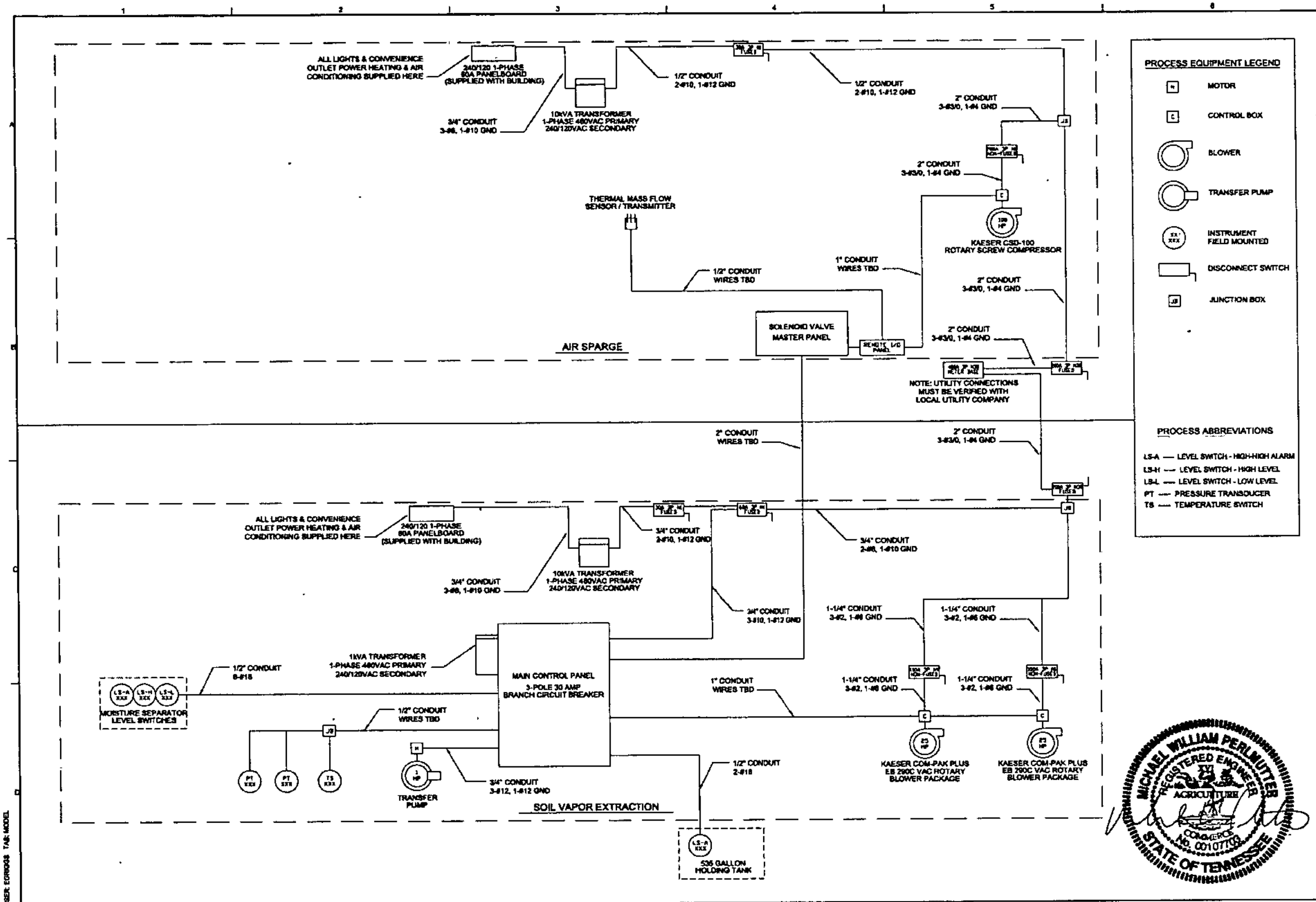


CH2MHILL

OFF-DEPOT DUNN FIELD
GROUNDWATER
REMEDIAL DESIGN
MEMPHIS, TN

FLUVIAL SANDS AS/SVE
COMPOUNDS
ELECTRICAL RISER DIAGRAM

NO	DATE	REVISION	BY	APVD

DSGN M. STRONG | DR G. HARTLEY | CHK M. PERLMUTTER | APVD M. PERLMUTTER

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.

DATE APRIL, 2006
PROJ 334469
DWG F-9
SHEET 11

FILENAME: SHEET 11 FLUVIALSANDSAS_SVEELECTRICALRISERDIAGRAM.DWG PLOT DATE: 22-May-06 PLOT TIME: 1:51:24 PM

USER: EGRIGGS TAB: MODEL

984 154

APPENDIX E
NEW WORK AND TEST PROCEDURES

WORK AND TEST PROCEDURE 14
SOIL VAPOR EXTRACTION WELLS

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for the installation of soil vapor extraction (SVE) wells suitable for removal of volatile organic compounds from the vadose zone. Procedures for abandonment upon completion of remedial action are also included. This WTP was prepared for use in the Off Depot Remedial Action at Defense Depot Memphis, Tennessee (DDMT) and as an addendum to the *Remedial Action Sampling and Analysis Plan* (RASAP) (MACTEC, 2005).

2.0 DISCUSSION

This WTP specifies details and procedures for the construction and installation of SVE wells at DDMT. SVE wells allow for the removal of subsurface vapor from pore spaces in the vadose zone by applying a vacuum. The extracted vapor is transported to the surface via conveyance piping and, if necessary, treated at the surface prior to discharge to the atmosphere. SVE well design is provided in the *Memphis Depot Dunn Field Final Off-Depot Groundwater Remedial Design, Rev.1* (Off Depot RD) (CH2M HILL, 2008). SVE well installation will be supervised by qualified environmental professionals according to project specifications. Well installation will be performed by the drilling subcontractor under the direction of a registered geologist/engineer. General requirements for the drilling subcontractor and oversight are provided in WTP 2, Drilling Operations.

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs should be reviewed in conjunction with this WTP;

NUMBER	NAME
1	General Instructions for Field Personnel
2	Drilling Operations
12	Personnel Protective Equipment Decontamination

3.2 PREPARATION

SVE well installation will occur immediately after drilling. Therefore, preparations should be made prior to beginning drilling operations. These preparations are given in WTPs 1 and 2.

3.3 WELL CONSTRUCTION

Well design and construction was set forth in the Off Depot RD.

3.3.1 Well Construction Materials

A 30-foot section of 0.006-inch continuous-slot "Vee-Wire" Schedule 40 PVC screen will be used. Centralizers will be used at the top and bottom of the screened section. Well screen and riser will be new, unused, decontaminated, 2-inch inside-diameter Schedule 40 PVC with internal flush-jointed threaded joints. Use of solvent or glue will not be permitted.

3.3.2 Well Design

SVE wells will be designed and installed in a manner to remove vapors from the vadose zone in excess of the inflow from the air sparge wells. This section describes well installation and construction including the placement of the screen, installation of the filter pack, bentonite seal, and grout seal. The Field Team Leader (FTL) and the Project/Task Manager will collectively decide on adjustment to well depths, locations, screened intervals, etc. Planned locations and depths are provided in Table 6 of this RAWP. Water level elevations from the October 2008 monitoring event and ground surface elevations at the SVE well locations will be used to determine the final depth prior to drilling.

3.3.2.1 Screen Location

The SVE well screens will be installed with the bottom of the screen approximately 5 feet above the water table. The boring will be drilled approximately 1 foot below the planned screen depth in order to install filter sand at the base of the screen.

3.3.2.2 Plumbness and Alignment

The well pipe assembly will be hung in the borehole, prior to placement of the filter pack, and not allowed to rest on the bottom of the hole to keep the well assembly straight and plumb. Centralizers will be installed at the bottom and top of the well screen.

3.3.2.3 Filter Pack

A filter pack will be installed in the annular space between the boring and the well screen. The filter pack of silica sand will be clean, inert, well rounded and contain less than 2 percent flat particles. The filter pack will be certified as free of contaminants by the supplier and have a grain size distribution compatible with the formation materials and the screen. A filter pack size of 10-20 will be used based on SVE wells previously installed on Dunn Field. The filter pack will be placed from the bottom of the hole to a minimum of 4 feet above the top of the well screen. When sonic drilling methods are used, the filter pack will be emplaced through the nominal 6-inch diameter steel casing using the gravity method. The procedure for gravity installation of the filter pack will be as follows: Prior to installation of the well casing, the inside of the 6-inch steel casing will be thoroughly cleared of sediment and cuttings by reaming with the 4-inch sampling barrel and flushing with potable water. The sand filter pack will be gravity-placed through the 6-inch steel casing in lifts of no more than approximately 1 foot. Care will be taken to prevent bridging by frequently measuring the thickness of the filter pack as it is placed. As the steel casing is slowly withdrawn between lifts, it will be vibrated with the sonic drilling head to compact the sand filter pack.

3.3.2.4 Bentonite Seal

A minimum 5-foot thick bentonite seal will be installed above the filter pack in the annular space of the well. Only 100 percent sodium bentonite (pellets or chips) will be used and care will be taken to prevent bridging by frequently measuring the thickness of the bentonite as it is gravity placed. Since the seal will be installed above the water table, the bentonite will be hydrated with water from an approved water source. At least 5 gallons of water will be added after each 24 to 30 inches of bentonite is placed. The bentonite seal will be allowed to hydrate for a minimum of 4 hours prior to placement of the grout collar around the well.

3.3.2.5 Grout Seal

A non-shrinking cement-bentonite grout mixture will be placed in the annular space from the top of the bentonite seal to approximately 3 feet below the ground surface. The cement-bentonite mixture will consist of the following compounds in proportion to each other: 94 pounds of neat Type I Portland or American Petroleum Institute (API) Class A Cement, not more than four pounds of 100 percent sodium bentonite powder, and not more than 8 gallons potable water. A side discharge tremie pipe will be used to place the grout mixture into the annular space.

3.3.2.6 Well Completion Details

The SVE wells will be completed with a 2-inch PVC slip "tee" located approximately 2 feet bgs to facilitate the connection to the HDPE conveyance piping. Connected at 90 degrees to the "tee" will be a 2-inch PVC to high density polyethylene (HDPE) transition fitting and 2-inch x 4-inch reducing coupling. A 2-inch diameter Schedule 40 PVC casing will extend from the slip "tee" to just below the natural ground surface and will then be capped with a Schedule 40 PVC slip cap with threaded plug. The well will be completed with a 18-inch diameter concrete flush mount pad with vault to allow future access to the SVE well.

3.3.3 Well Installation

The SVE wells will be constructed in 6-inch diameter soil borings advanced using rotasonic drilling methods. Lithologic core samples will be collected continuously in 10-foot intervals beginning at the ground surface. All soil borings will be advanced to approximately 5 feet above the water table (approximately 70 to 80 feet below ground surface depending on location). The borehole will be drilled approximately 0.5- to 1-foot below the target depth and backfilled with filter sand before installing the well. Well installation will be supervised by a qualified geologist/engineer.

3.3.3.1 Procedures

The following protocols will be used to install the well casing and screen:

1. Remove the PVC screen and riser from packaging and steam clean to remove manufacturing residues.

2. Install a 30-foot section of 2-inch (I.D.), threaded, flush jointed, pre-manufactured PVC screen with PVC centralizers at top and bottom inside the steel drill casing. Screen will be 6 to 12 inches above boring termination.
3. Install 2-inch (I.D.), threaded, flush jointed, PVC riser to 2 feet bgs.
4. Install the filter pack using the gravity method through the annular opening between drill casing and well screen, as the drill casing is removed, to distribute the filter pack around the screen in a uniform height and density. Take care to prevent bridging by measuring the thickness of the filter pack as it is placed.
5. Continue removing drill casing and installing filter pack until at least 4 feet above the top of the well screen. Use the sonic drilling head to vibrate the steel casing as it is slowly withdrawn in order to compact the filter pack and prevent bridging.
6. Install a minimum 5-foot bentonite seal. The bentonite seal will be hydrated with potable water. Allow the bentonite seal a minimum of 4 hours of hydration time before grouting the annulus.
7. Remove remaining drill casing and grout boring annulus to 6-inches below the top of the riser with a grout/bentonite mixture.
8. Install "tee", PVC riser, and surface completion as described in Section 3.3.2.6 of this WTP.

3.3.3.2 Well Installation Diagrams

The e^{2}M field geologist will prepare boring logs and construction diagrams for the SVE wells. The soil core from the vadose zone will be archived in labeled cardboard core boxes. The field supervisor will maintain suitable logs detailing drilling and well construction practices. Well dimensions, amount, type and manufacture of materials used to construct each well will be recorded on the SVE Well Installation Diagrams (Attachment 14.1). Details will include:

- Well identification
- Drilling method
- Installation date(s)
- Total boring depth
- Lengths and descriptions of the screen and riser
- Thickness and descriptions of filter pack, bentonite seal, casing grout, and any

backfilled material

- Quantities of all materials
- Summary of material penetrated by the boring

Each installation diagram will be completed and reviewed in the field. A final version will be submitted in an appendix of the Technical Report.

3.3.4 Well Abandonment

Upon completion of remedial action operations or if an SVE well is damaged or otherwise not fit for continued use, it will be abandoned in accordance with Memphis Shelby County Health Department regulations. The total depth of each well will be measured to confirm that no obstructions are present that might interfere with placement of the tremie pipe and grout. One-half gallon of bleach will be poured into each and the well will be filled with grout from the bottom up until undiluted grout is visible at the surface. The grout will be tremied into the casing, keeping the side-discharge tremie pipe approximately 1 foot below the grout surface. After allowing at least two days for grout settlement, the grout will be topped off with concrete. The well pad and manhole will be removed and disposed as solid waste. The wellhead location will be restored to match the surrounding area.

3.3.5 Location Survey

Upon completion of the wells, a Tennessee licensed professional surveyor will locate each new SVE well by standard surveying methods. A vertical survey will be conducted to establish the elevation of each SVE well casing. Vertical control will be to the National Geodetic Vertical Datum. The horizontal grid coordinates within 0.1 foot, the ground elevation to within 0.01 foot, and the elevation of the top of casing within 0.01 foot will be recorded. The survey will be referenced to the State Plane coordinate system.

3.4 POST-OPERATION

3.4.1 Field

Before leaving the site, the following procedures will be performed by on-site personnel:

- Decontaminate all field equipment.

- Ensure that installed wells are secured.
- Complete logbook, making notations as to site conditions, anomalous readings, etc.
- Complete SVE well installation diagram.
- Ensure that related equipment and associated supplies have been shipped back to the office.
- Ensure that all IDW has been disposed in accordance with the RAWP and WTP 6.
- Ensure that the site is returned to its condition prior to well installation to the extent feasible (i.e., all trash related to well installation must be disposed of prior to departure from the site).

3.4.2 Office

Upon return to the office, field personnel will perform the following:

- Submit logbook and any original forms to Project/Task Manager for review.

4.0 REFERENCES

CH2M HILL, 2008. Memphis Depot Dunn Field Off Depot Groundwater Final Remedial Design Rev. 1. Prepared for the U.S. Army Engineering and Support Center, Huntsville, September 2008.

MACTEC Engineering and Consulting, Inc, 2005a. Remedial Action Sampling and Analysis Plan, Volume I: Field Sampling Plan and Volume II: Quality Assurance Project Plan. Prepared for the Air Force Center for Environmental Excellence. November, 2005.

USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

5.0 ATTACHMENTS

Attachment 14.1 – SVE Well Installation Diagram

ATTACHMENT 14.1

SOIL VAPOR EXTRACTION INSTALLATION DIAGRAM
WORK AND TEST PROCEDURES
OFF DEPOT GROUNDWATER RAWP
Defense Depot Memphis, Tennessee

WELL ID: ____________________

PROJECT: ____________________

E2M FIELD REP. ____________________

INSTALLATION DETAILS

DATE(S) ____________________

START TIME ____________________

END TIME ____________________

DRILLING CONTRACTOR ____________________

DRILLING TECHNIQUE ____________________

DRILL ROD SIZE AND TYPE ____________________

RISER DETAILS

MANUFACTURER: ____________________

MATERIAL: ____________________

DIAMETER: ____________________

LENGTH: ____________________

SCREEN DETAILS

MANUFACTURER: ____________________

MATERIAL: ____________________

SLOT SIZE: ____________________

DIAMETER: ____________________

LENGTH: ____________________

SCREENED INTERVAL (FT): ____________________

BOREHOLE DETAILS

TOTAL DEPTH: ____________________

DIAMETER: ____________________

FILTER SAND DETAILS

TYPE/GRADATION: ____________________

AMOUNT(UNITS): ____________________

BENTONITE SEAL DETAILS

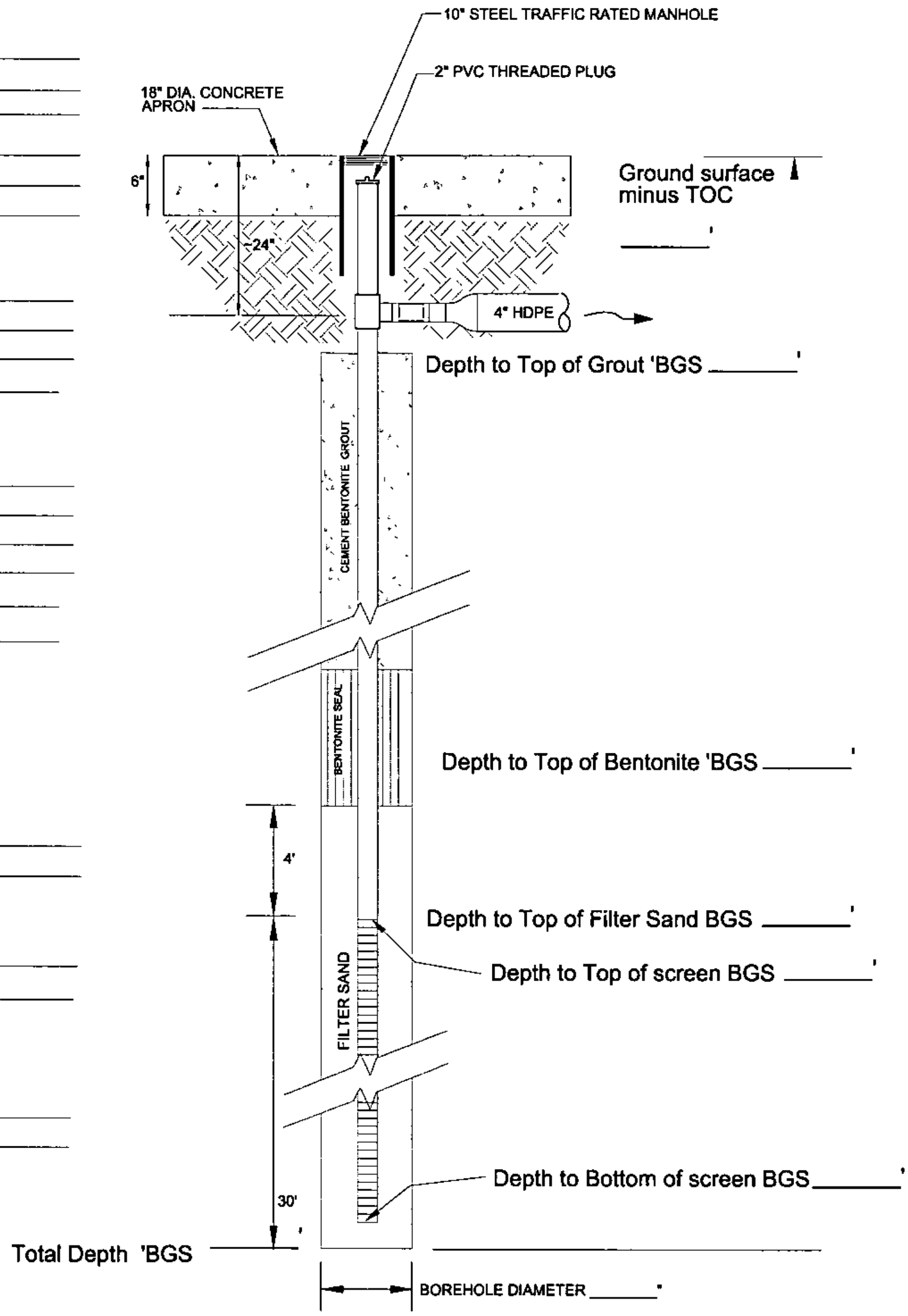
TYPE: ____________________

AMOUNT: ____________________

CEMENT BENTONITE GROUT DETAILS

TYPE: ____________________

AMOUNT: ____________________



WORK AND TEST PROCEDURE 15

AIR SPARGE WELLS

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for the installation of air sparge (AS) wells suitable to remove volatile organic compounds from groundwater. Procedures for abandonment upon completion of remedial action are also included. This WTP was prepared for use in the Off Depot Remedial Action at Defense Depot Memphis, Tennessee (DDMT) and as an addendum to the *Remedial Action Sampling and Analysis Plan* (RASAP) (MACTEC, 2005).

2.0 DISCUSSION

This WTP specifies details and procedures for the construction and installation of AS wells at DDMT. AS wells are installed in the saturated zone for injection of fine air bubbles to strip (volatilize) dissolved VOCs in groundwater and transport the VOCs to the overlying vadose zone. The VOCs in vapor phase will be captured by soil vapor extraction wells. AS well design is provided in the *Memphis Depot Dunn Field Final Off-Depot Groundwater Remedial Design, Rev.1* (Off Depot RD) (CH2M HILL, 2008). AS well installation will be supervised by qualified environmental professionals according to project specifications. Well installation will be performed by the drilling subcontractor under the direction of a registered geologist/engineer. General requirements for the drilling subcontractor and oversight are provided in WTP 2, Drilling Operations.

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs in the RA SAP should be reviewed in conjunction with this WTP;

NUMBER	NAME
1	General Instructions for Field Personnel
2	Drilling Operations
12	Personnel Protective Equipment Decontamination

13	Health and Safety Monitoring

3.2 PREPARATION

AS well installation will occur immediately after drilling. Therefore, preparations should be made prior to beginning drilling operations. These preparations are given in WTPs 1 and 2.

3.3 WELL CONSTRUCTION

Well design and construction was set forth in the Off Depot RD.

3.3.1 Well Construction Materials

The wells will be constructed of 2-inch diameter Schedule 40 PVC casing and a 30-inch long, 2.5-inch diameter microbubble sparger (Mott Corporation model #2240-A32-30-A00-02-AB, media grade 02). Well casing will be new, unused, decontaminated, 2-inch inside-diameter Schedule 40 PVC with internal flush-jointed threaded joints. Use of solvent or glue will not be permitted.

3.3.2 Well Design

AS wells will be designed and installed to inject a diffuse air supply to the base of the fluvial aquifer to volatize dissolved VOCs from the water and into the vapor phase. This section describes well installation and construction including the placement of the sparge unit (micro-bubbler), installation of the filter pack, bentonite seal, and grout seal. The Field Team Leader (FTL) and the Project/Task Manager will collectively decide on adjustment to well depths, locations, screened intervals, etc. Planned locations and depths are provided in Table 5 of this RAWP. Water level elevations from the October 2008 monitoring event and ground surface elevations at the AS well locations will be used to determine the final depth prior to drilling.

3.3.2.1 Air Sparge Unit Location

The AS microbubbler will be installed just above the clay at the base of the fluvial aquifer. The boring will be drilled approximately 6 to 12 inches below the top of the clay at the base of the fluvial aquifer (generally 85 to 105 feet bgs).

3.3.2.2 Plumbness and Alignment

The well pipe assembly will be hung in the borehole, prior to placement of the filter pack, and not allowed to rest on the bottom of the hole to keep the well assembly straight and plumb.

3.3.2.3 Filter Pack

The borehole will be allowed to collapse around the microbubble sparger so that the annular space will be filled with natural formation materials to 6 to 12 inches above the top of the sparger. If the formation materials do not collapse around the sparger, then conventional filter pack will be used to fill the annular space around the sparger. If filter pack is required to be added it will consist of clean, inert, well rounded silica sand with less than 2 percent flat particles. The filter pack will be certified as free of contaminants by the supplier and have a grain size distribution compatible with the formation materials and the screen. A filter pack size of 20-40 will be used as in monitoring wells previously installed on Dunn Field. The filter pack will be emplaced through the nominal 6-inch diameter steel casing using the gravity method. Care will be taken to prevent bridging of the filter pack as it is placed.

3.3.2.4 Bentonite Seal

A 3 to 5-foot thick bentonite seal will be installed above the formation materials/filter pack. Only 100 percent sodium bentonite (pellets or chips) will be used and care will be taken to prevent bridging by frequently measuring the thickness of the bentonite as it is gravity placed. When the seal is installed above the water table, the bentonite will be hydrated with water from an approved water source. At least 5 gallons of water will be added after each 24 to 30 inches of bentonite is placed. The bentonite seal will be allowed to hydrate for a minimum of 4 hours prior to placement of the grout collar around the wells. If the bentonite is emplaced below the water table no additional hydration will be required and the boring can be immediately grouted to prevent the bentonite swelling into the drill casing.

3.3.2.5 Grout Seal

A non-shrinking cement-bentonite grout mixture will be placed in the annular space from the top of the bentonite seal to approximately 3 feet below ground surface. The cement-bentonite mixture will consist of the following compounds in proportion to each other: 94 pounds of neat Type I Portland or American Petroleum Institute (API) Class A Cement, not more than four pounds of 100 percent sodium bentonite powder, and not more than 8 gallons potable water. A side discharge tremie pipe will be used to place the grout mixture into the annular space.

3.3.2.6 Well Completion Details

The AS well will be completed with a 2-inch x 2-inch x ¾-inch PVC reducing slip "tee" and a 3/4-inch PVC to high density polyethylene (HDPE) transition fitting located approximately 2 feet bgs to facilitate connection to the HDPE conveyance pipes. A 2-inch diameter Schedule 40 PVC casing will extend from the slip "tee" to just below the natural ground surface and will then be capped with a Schedule 40 PVC slip cap with threaded plug. The well will be completed with a flush-mount wellhead vault to allow future access to the AS well.

3.3.3 Well Installation

The AS wells will be constructed in 6-inch diameter soil borings advanced using rotasonic drilling methods. Lithologic core samples will be collected continuously in 10-foot intervals beginning at the ground surface. All soil borings will be advanced 0.5 to 1 foot into the clay layer at the base of the aquifer (approximately 85 to 105 feet bgs depending on location). Well installation will be supervised by a qualified geologist/engineer.

3.3.3.1 Procedures

The following protocols will be used to install the well casing and screen:

1. Remove the micro-bubbler and riser from packaging and steam clean to remove manufacturing residues.
2. Install a 30-inch long micro-bubbler and 2-inch (I.D.), threaded, flush jointed, PVC riser inside the steel drill casing; PVC riser will extend to 2 feet bgs. Micro-bubbler will be approximately 6 to 12 inches above boring termination.
3. Raise drill casing to approximately 9 inches above top of micro-bubbler and allow formation materials to collapse. Measure the depth of the annular space to confirm formation materials are at least 6 inches above top of micro-bubbler. If necessary top of with filter pack using the gravity method. Take care to prevent bridging by measuring the thickness of the filter pack as it is placed.
4. Install a 3 to 5-foot bentonite seal. The bentonite seal will be hydrated with potable water, if required.

5. Remove remaining drill casing and grout boring annulus to 2 feet bgs with a grout/bentonite mixture.
6. Install "tee", PVC riser, and surface completion as described in Section 3.3.2.6 of this WTP.

3.3.3.2 Well Installation Diagrams

Construction diagrams for the AS wells will be prepared; boring logs will not be prepared. The e^{2}M field geologist will record drilling and well construction details in the field log. Well dimensions, amount, type and manufacture of materials used to construct each well will be recorded on the AS Well Installation Diagram (Attachment 15.1). Details will include:

- Well identification
- Drilling method
- Installation date(s)
- Total boring depth
- Depths and descriptions of the micro-bubbler and riser
- Thickness and descriptions of natural collapse/filter pack, bentonite seal, casing grout, and any backfilled material
- Quantities of all materials
- Summary of material penetrated by the boring

Each installation diagram will be completed and reviewed in the field. A final version will be submitted in an appendix of the Technical Report.

3.3.4 Well Abandonment

Upon completion of remedial action operations or if an AS well is damaged or otherwise not fit for continued use, it will be abandoned in accordance with Memphis Shelby County Health Department regulations. The total depth of each well will be measured to confirm that no obstructions are present that might interfere with placement of the tremie pipe and grout. One-half gallon of bleach will be poured into each and the well will be filled with grout from the bottom up until undiluted grout is visible at the surface. The grout will be tremied into the casing, keeping the side-discharge tremie pipe approximately 1 foot below the grout surface. After allowing at least two days for grout settlement, the grout will be topped off with concrete.

The well pad and manhole will be removed and disposed as solid waste. The wellhead location will be restored to match the surrounding area.

3.3.5 Location Survey

Upon completion of the wells, a Tennessee licensed professional surveyor will locate each new AS well by standard surveying methods. A vertical survey will be conducted to establish the elevation of each AS well casing. Vertical control will be to the National Geodetic Vertical Datum. The horizontal grid coordinates within 0.1 foot, the ground elevation to within 0.01 foot, and the elevation of the top of casing within 0.01 foot will be recorded. The survey will be referenced to the State Plane coordinate system.

3.4 POST-OPERATION

3.4.1 Field

Before leaving the site, the following procedures will be performed by on-site personnel:

- Decontaminate all field equipment.
- Ensure that installed wells are secured.
- Complete logbook, making notations as to site conditions, anomalous readings, etc.
- Complete AS well installation diagram.
- Ensure that related equipment and associated supplies have been shipped back to the office.
- Ensure that all IDW has been disposed in accordance with the RAWP and WTP 6.
- Ensure that the site is returned to its condition prior to well installation to the extent feasible (i.e., all trash related to well installation must be disposed of prior to departure from the site).

3.4.2 Office

Upon return to the office, field personnel will perform the following:

- Submit logbook and any original forms to Project/Task Manager for review.

4.0 REFERENCES

CH2M HILL, 2008. Memphis Depot Dunn Field Off Depot Groundwater Final Remedial Design Rev. 1. Prepared for the U.S. Army Engineering and Support Center, Huntsville, September 2008.

MACTEC Engineering and Consulting, Inc, 2005a. Remedial Action Sampling and Analysis Plan, Volume I: Field Sampling Plan and Volume II: Quality Assurance Project Plan. Prepared for the Air Force Center for Environmental Excellence. November, 2005.

USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

5.0 ATTACHMENTS

Attachment 15.1 – AS Well Installation Diagram

ATTACHMENT 15.1

AIR SPARGE POINT INSTALLATION DIAGRAM
WORK AND TEST PROCEDURES
OFF DEPOT GROUNDWATER RAWP
Defense Depot Memphis, Tennessee

WELL ID: ____________________

PROJECT: ____________________

E2M FIELD REP. ____________________

INSTALLATION DETAILS

DATE(S): ____________________

START TIME: ____________________

END TIME: ____________________

DRILLING CONTRACTOR: ____________________

DRILLING TECHNIQUE: ____________________

DRILL ROD SIZE AND TYPE: ____________________

BOREHOLE DETAILS

TOTAL DEPTH: ____________________

DIAMETER: ____________________

SPARGER DETAILS

MATERIAL: ____________________

DIAMETER: ____________________

LENGTH: ____________________

DEPTH TO BOTTOM: ____________________

RISER DETAILS

MANUFACTURER: ____________________

MATERIAL: ____________________

DIAMETER: ____________________

LENGTH: ____________________

FILTER SAND DETAILS

TYPE/GRADATION: ____________________

AMOUNT(UNITS): ____________________

BENTONITE SEAL DETAILS

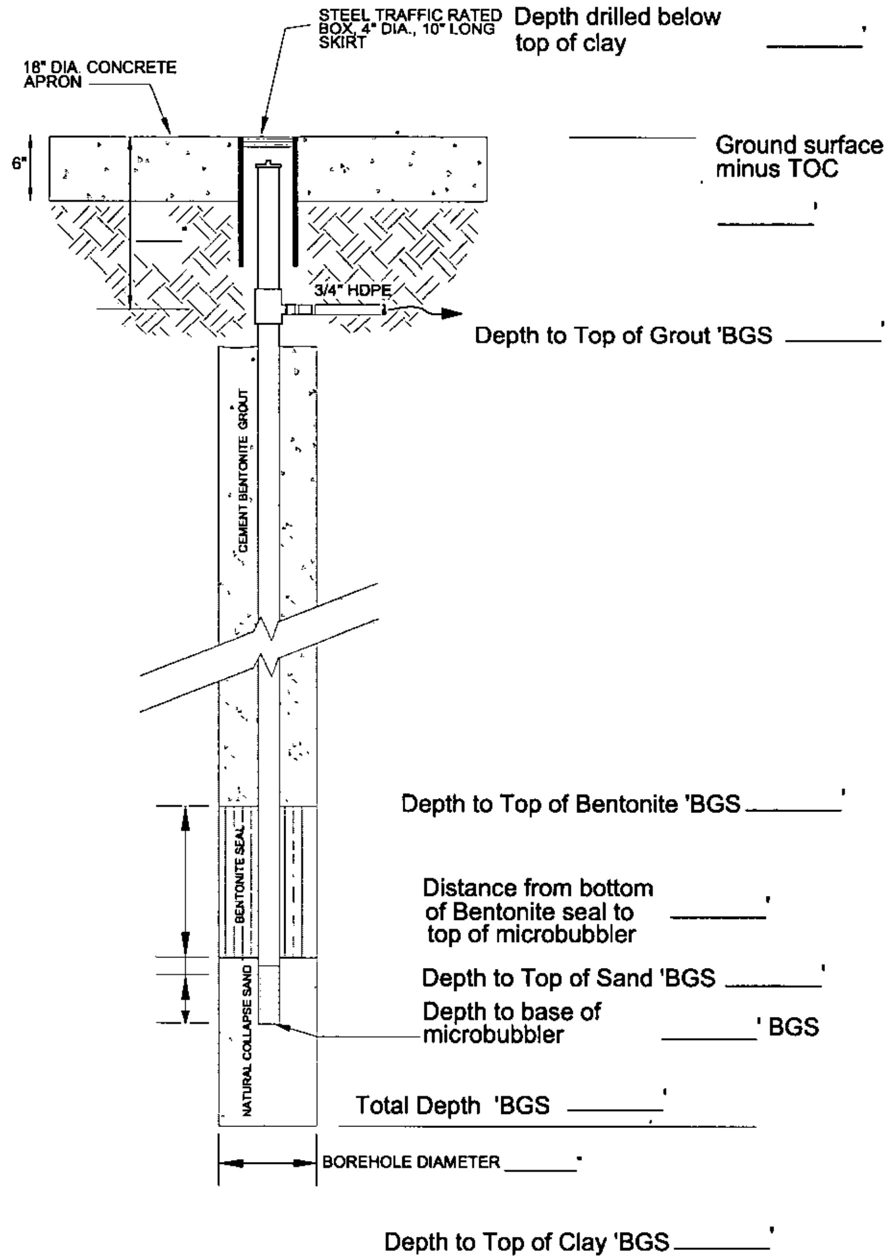
TYPE: ____________________

AMOUNT(UNITS): ____________________

CEMENT BENTONITE GROUT DETAILS

TYPE: ____________________

AMOUNT(UNITS): ____________________



WORK AND TEST PROCEDURE 16
VAPOR MONITORING POINTS

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for the installation of vapor monitoring points (VMPs) suitable to provide vacuum readings and VOC concentrations to evaluate the effectiveness of the air sparge (AS)-SVE system,. Procedures for abandonment upon completion of remedial action are also included. This WTP was prepared for use in the Off Depot Remedial Action at Defense Depot Memphis, Tennessee (DDMT) and as an addendum to the *Remedial Action Sampling and Analysis Plan* (RASAP) (MACTEC, 2005).

2.0 DISCUSSION

This WTP specifies details and procedures for the construction and installation of VMPs at DDMT. VMPs will allow pressure readings to be collected to evaluate the radius of influence of the SVE wells and measurement of VOC concentrations through field readings and sampling for laboratory analysis. VMP design is provided in the *Memphis Depot Dunn Field Final Off-Depot Groundwater Remedial Design, Rev.1* (Off Depot RD) (CH2M HILL, 2008). VMP installation will be supervised by qualified environmental professionals according to project specifications. Installation will be performed by the drilling subcontractor under the direction of a registered geologist/engineer. General requirements for the drilling subcontractor and oversight are provided in WTP 2, Drilling Operations.

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs should be reviewed in conjunction with this WTP;

NUMBER	NAME
1	General Instructions for Field Personnel
2	Drilling Operations
12	Personnel Protective Equipment Decontamination
13	Health and Safety Monitoring

3.2 PREPARATION

VMP installation will occur immediately after drilling. Therefore, preparations should be made prior to beginning drilling operations. These preparations are given in WTPs 1 and 2.

3.3 WELL CONSTRUCTION

VMP design and construction was set forth in the Off Depot RD. Two VMPs will be installed at each designated location with 5-foot screens centered approximately 10 feet and 25 feet above the water table, respectively. The VMP with the deeper screen will be designated 'A' and the shallower screen 'B'. Pressure readings and field measurements will be made through 0.25-inch Teflon® tubing extending from the well cap to the mid-point of the screened interval.

3.3.1 Construction Materials

A 5-foot section of 0.006-inch continuous-slot screen will be used. Well screen and riser will be new, unused, decontaminated, 1-inch inside-diameter Schedule 40 PVC with internal flush-jointed threaded joints. Use of solvent or glue will not be permitted.

3.3.2 Design

VMPs will be designed and installed in a manner to allow pressure measurement and vapor sampling. Two nested VMPs will be installed in one boring at each location. This section describes installation and construction including the placement of the screen, installation of the filter pack, bentonite seal, and grout seal. The Field Team Leader (FTL) and the Project/Task Manager will collectively decide on adjustment to well depths, locations, screened intervals, etc. Planned locations and depths are provided in Table 6 of this RAWP. Water level elevations from the October 2008 monitoring event and ground surface elevations at the VMP locations will be used to determine the final depth prior to drilling.

3.3.2.1 Screen Locations

The VMP screens will be installed with the middle of the lower screen approximately 10 feet above the water table and the middle of the upper screen about 25 feet above the water table. The boring will be drilled approximately 0.5 foot below the planned lower screen depth in order to install filter sand at the base of the screen.

3.3.2.2 Plumbness and Alignment

The two VMP assemblies will be hung in the borehole, prior to placement of the filter pack, and not allowed to rest on the bottom of the hole to keep the well assembly straight and plumb.

3.3.2.3 Filter Packs

A filter pack will be installed in the annular space between the boring and the VMP screens. The filter pack of silica sand will be clean, inert, well rounded and contain less than 2 percent flat particles. The filter pack will be certified as free of contaminants by the supplier and have a grain size distribution compatible with the formation materials and the screen. A filter pack size of 10-20 will be used based on SVE wells previously installed on Dunn Field. The filter pack will be placed from the bottom of the hole to approximately 2.5 feet above the top of the lower VMP screen. A 5-foot bentonite seal will be placed between the lower and upper VMP screen (see 3.3.2.4). Additional filter pack will then be placed from approximately 2.5 feet below to 3 feet above the upper VMP screen.

The filter pack will be emplaced through the nominal 8-inch diameter drill casing using the gravity method. The procedure for gravity installation of the filter pack will be as follows: Prior to installation of the well casing, the inside of the 8-inch steel casing will be thoroughly cleared of sediment and cuttings by reaming with the 4-inch sampling barrel and flushing with potable water. The sand filter pack will be gravity-placed through the 6-inch steel casing in lifts of no more than approximately 1 foot. Care will be taken to prevent bridging by frequently measuring the thickness of the filter pack as it is placed. As the steel casing is slowly withdrawn between lifts, it will be vibrated with the sonic drilling head to compact the sand filter pack.

3.3.2.4 Bentonite Seals

Two bentonite seals will be installed in the annular space of the boring, between the filter packs for the lower and upper VMP screens and above the filter pack for the upper VMP screen. Each seal will be approximately 5 feet thick. Only 100 percent sodium bentonite (pellets or chips) will be used and care will be taken to prevent bridging by frequently measuring the thickness of the bentonite as it is gravity placed. Since the seal will be installed above the water table, the bentonite will be hydrated with water from an approved water source. At least 5 gallons of water will be added after each 24 to 30 inches of bentonite is placed. The bentonite seal will be allowed to hydrate for a minimum of 4 hours prior to placement of the grout collar around the wells.

3.3.2.5 Grout Seal

A non-shrinking cement-bentonite grout mixture will be placed in the annular space from the top of the upper bentonite seal to approximately 1 foot below ground surface. The cement-bentonite mixture will consist of the following compounds in proportion to each other: 94 pounds of neat Type I Portland or American Petroleum Institute (API) Class A Cement, not more than four pounds of 100 percent sodium bentonite powder, and not more than 8 gallons potable water. A side discharge tremie pipe will be used to place the grout mixture into the annular space.

3.3.2.6 Well Completion Details

The casing for each VMP will be cut approximately 3 inches bgs and 1-inch self-sealing vapor sampling cap ("Ex-cap") will be placed on the well. The Ex-cap cap is made of reinforced chemical-resistant nylon with two Buna Nitrile O-rings and to allow pressure measurements, vapor monitoring and sampling via a brass, quick-connect coupling. Teflon® tubing, 0.25-inch diameter, will connect to the inside of the vapor sampling cap and extend down the interior of the well casing to the mid-point of the screened interval. A freely draining flush-mount 10-inch inner diameter manhole cover with a lockable lid will be placed over the casing. The top of the casing will be at least 6 inches above the bottom of the box. The manhole will be centered in a 3-foot diameter in a 6-inch thick concrete pad.

3.3.3 Well Installation

The VMPs will be constructed in 8-inch diameter soil borings advanced using rotasonic drilling methods. Lithologic core samples will be collected continuously in 10-foot intervals beginning at the ground surface. All soil borings will be advanced to approximately 7 feet above the water table (approximately 65 to 75 feet below ground surface depending on location). Well installation will be supervised by a qualified geologist/engineer.

3.3.3.1 Procedures

The following protocols will be used to install the well casing and screen:

1. Remove the PVC screen and riser from packaging and steam clean to remove manufacturing residues.
2. Install both sets of 5-foot section of 1-inch (I.D.), threaded, flush jointed, pre-manufactured PVC screen and riser inside the steel drill casing. Lower screen will be 6 inches above boring termination. PVC risers will extend to 0.25-foot bgs.
3. Install the lower filter pack using the gravity method through the annular opening between drill casing and well screen, as the drill casing is removed, to distribute the filter pack around the screen in a uniform height and density.
4. Install the lower bentonite seal. The bentonite seal will be hydrated with potable water. Allow the bentonite seal a minimum of 1 hour of hydration time.
5. Install the upper filter pack using the same method as above. In both cases, take care to prevent bridging by measuring the thickness of the filter pack as it is placed. Continue removing drill casing and installing filter pack until at least 3 feet above the top of the upper VMP screen. Use the sonic drilling head to vibrate the steel casing as it is slowly withdrawn in order to compact the filter pack and prevent bridging.
6. Install the final 5-foot bentonite seal. The bentonite seal will be hydrated with potable water. Allow the bentonite seal a minimum of 4 hours of hydration time before grouting the annulus.
7. Remove remaining drill casing and grout boring annulus to 6-inches below the top of the riser with a grout/bentonite mixture.
8. Install flush-mount surface completion as described in Section 3.3.2.6 of this WTP.

3.3.3.2 Well Installation Diagrams

The e^{2}M field geologist will prepare boring logs and construction diagrams for the VMPs. The field supervisor will maintain suitable logs detailing drilling and well construction practices. Well dimensions, amount, type and manufacture of materials used to construct each well will be recorded on the VMP Installation Diagrams (Attachment 16.1). Details will include:

- Well identification
- Drilling method
- Installation date(s)
- Total boring depth

- Lengths and descriptions of the screen and riser
- Length of Teflon® tubing
- Thickness and descriptions of filter pack, bentonite seal, casing grout, and any backfilled material
- Quantities of all materials
- Summary of material penetrated by the boring

Each installation diagram will be completed and reviewed in the field. A final version will be submitted in an appendix of the Technical Report.

3.3.4 Well Abandonment

Upon completion of remedial action operations or if a VMP well is damaged or otherwise not fit for continued use, it will be abandoned in accordance with Memphis Shelby County Health Department regulations. The total depth of each well will be measured to confirm that no obstructions are present that might interfere with placement of the tremie pipe and grout. One-half gallon of bleach will be poured into each and the well will be filled with grout from the bottom up until undiluted grout is visible at the surface. The grout will be tremied into the casing, keeping the side-discharge tremie pipe approximately 1 foot below the grout surface. After allowing at least two days for grout settlement, the grout will be topped off with concrete. The well pad and manhole will be removed and disposed as solid waste. The wellhead location will be restored to match the surrounding area.

3.3.5 Location Survey

Upon completion of the wells, a Tennessee licensed professional surveyor will locate each new VMP by standard surveying methods. A vertical survey will be conducted to establish the elevation of each VMP well pad. Vertical control will be to the National Geodetic Vertical Datum. The horizontal grid coordinates within 0.1 foot, the ground elevation to within 0.01 foot, and the elevation of the top of casing within 0.01 foot will be recorded. The survey will be referenced to the State Plane coordinate system.

3.4 POST-OPERATION

3.4.1 Field

Before leaving the site, the following procedures will be performed by on-site personnel:

- Decontaminate all field equipment.
- Ensure that installed wells are secured.
- Complete logbook, making notations as to site conditions, anomalous readings, etc.
- Complete VMP installation diagram.
- Ensure that related equipment and associated supplies have been shipped back to the office.
- Ensure that all IDW has been disposed in accordance with the RAWP and WTP 6.
- Ensure that the site is returned to its condition prior to well installation to the extent feasible (i.e., all trash related to well installation must be disposed of prior to departure from the site).

3.4.2 Office

Upon return to the office, field personnel will perform the following:

- Submit logbook and any original forms to Project/Task Manager for review.

4.0 REFERENCES

CH2M HILL, 2008. Memphis Depot Dunn Field Off Depot Groundwater Final Remedial Design Rev. 1. Prepared for the U.S. Army Engineering and Support Center, Huntsville, September 2008.

MACTEC Engineering and Consulting, Inc, 2005a. Remedial Action Sampling and Analysis Plan, Volume I: Field Sampling Plan and Volume II: Quality Assurance Project Plan. Prepared for the Air Force Center for Environmental Excellence. November, 2005.

USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

5.0 ATTACHMENTS

Attachment 16.1 – VMP Installation Diagram

ATTACHMENT 16.1
VAPOR MONITORING POINT INSTALLATION DIAGRAM
WORK AND TEST PROCEDURES
OFF DEPOT GROUNDWATER RAWP
Defense Depot Memphis, Tennessee

WELL ID: ____________________

PROJECT: ____________________

E2M FIELD REP. ____________________

INSTALLATION DETAILS

DATE(S) ____________________

START TIME ____________________

END TIME ____________________

DRILLING CONTRACTOR ____________________

DRILLING TECHNIQUE ____________________

DRILL ROD SIZE AND TYPE ____________________

BOREHOLE DETAILS

TOTAL DEPTH: ____________________

DIAMETER: ____________________

RISER DETAILS (A-DEEP, B-SHALLOW)

MANUFACTURER: ____________________

MATERIAL: ____________________

(A) DIAMETER: ____________________

(A) LENGTH: ____________________

(B) DIAMETER: ____________________

(B) LENGTH: ____________________

SCREEN DETAILS

MANUFACTURER: ____________________

MATERIAL: ____________________

SLOT SIZE: ____________________

DIAMETER: ____________________

LENGTH: ____________________

(A) SCREENED INTERVAL (FT) BGS: ________

(B) SCREENED INTERVAL (FT) BGS: ________

UPPER FILTER SAND DETAILS

TYPE/GRADATION: ____________________

AMOUNT(UNITS): ____________________

LOWER FILTER SAND DETAILS

TYPE/GRADATION: ____________________

AMOUNT(UNITS): ____________________

UPPER BENTONITE SEAL DETAILS

TYPE: ____________________

AMOUNT: ____________________

LOWER BENTONITE SEAL DETAILS

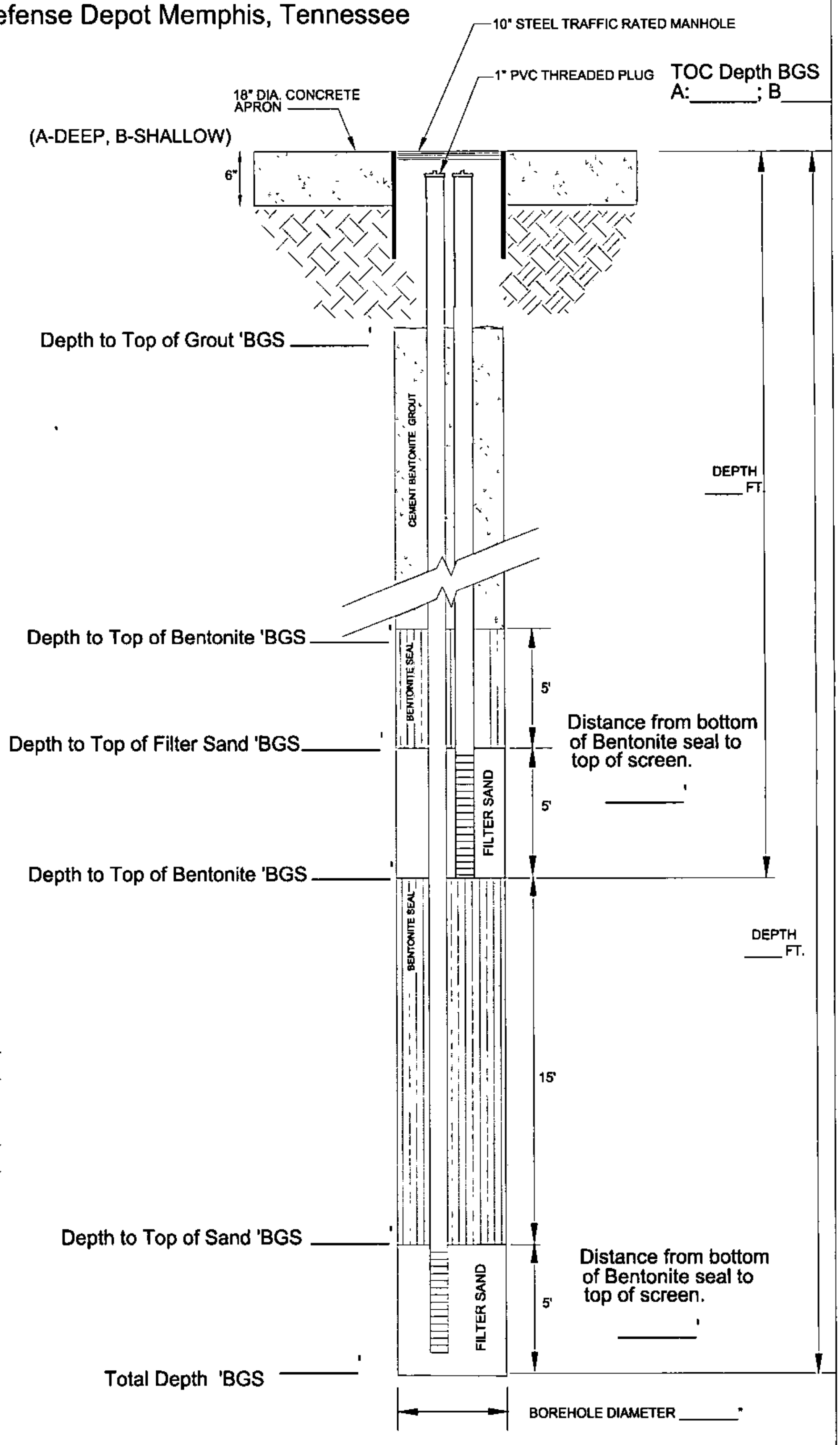
TYPE: ____________________

AMOUNT: ____________________

GROUT DETAILS

TYPE: ____________________

AMOUNT: ____________________



WORK AND TEST PROCEDURE 17

VAPOR SAMPLING PROBES

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for the installation of vapor sampling probes (VSPs) suitable to monitor vapor intrusion associated with the Off Depot groundwater and the air sparge and soil vapor extraction (AS-SVE) system. Procedures for abandonment upon completion of monitoring activities are also included. This WTP was prepared for use in the Off Depot Remedial Action at Defense Depot Memphis, Tennessee (DDMT) and as an addendum to the *Remedial Action Sampling and Analysis Plan* (RASAP) (MACTEC, 2005).

2.0 DISCUSSION

This WTP specifies details and procedures for the construction and installation of VSPs at DDMT. VSPs will allow field measurements and vapor sampling around structures within the target areas based on recent groundwater monitoring results. VSP design is described in Appendix F of the *Memphis Depot Dunn Field Final Off-Depot Groundwater Remedial Design, Rev.1* (Off Depot RD) (CH2M HILL, 2008). VSP installation will be supervised by qualified environmental professionals according to project specifications. Installation will be performed by the drilling subcontractor under the direction of a registered geologist/engineer. General requirements for the drilling subcontractor and oversight are provided in WTP 2, Drilling Operations.

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs should be reviewed in conjunction with this WTP;

NUMBER	NAME
1	General Instructions for Field Personnel
2	Drilling Operations
12	Personnel Protective Equipment Decontamination
13	Health and Safety Monitoring

3.2 PREPARATION

VSP installation will occur immediately after drilling. Therefore, preparations should be made prior to beginning drilling operations. These preparations are given in WTPs 1 and 2.

3.3 VSP CONSTRUCTION

VSP design and construction was described in the Off Depot RD. Each VSP will contain two screened sections for vapor monitoring. The borehole will be advance using direct-push technology (DPT); soil coring will be used in the two sample intervals, 4 to 8 feet below ground surface (bgs) and 14 to 18 feet bgs, to minimize compaction and loss of gas permeability

3.3.1 Construction Materials

Each screened section will be 6-inches in length, with a pore diameter of approximately 0.0006-inches constructed of double woven stainless steel wire screen, a threaded fitting on the bottom for anchoring, and a fitting on top to connect to Teflon tubing.

3.3.2 Design

VSPs will be designed and installed in a manner to allow shallow vapor sampling. This section describes installation and construction including the placement of the screen, installation of the filter pack, bentonite seal, and grout seal. The Field Team Leader (FTL) and the Project/Task Manager will collectively decide on adjustment to well depths, locations, screened intervals, etc.

3.3.2.1 Screen Locations

Two vapor probes will be installed in each borehole. The first (deeper) vapor probe ('A') will be lowered in the open borehole with ¼-inch Teflon tubing attached, positioned in the coarsest soil between 14 and 18 feet bgs (or at 15 feet bgs if no such zone is observed), and will be at least three inches above the bottom of the borehole. The second (shallow) vapor probe ('B') will be lowered in the open borehole with ¼-in Teflon tubing and be placed in the coarsest soil between 4 and 8 feet bgs (or at 5 feet bgs if no such zone is observed).

3.3.2.2 Filter Packs

A filter pack of silica sand (clean, inert, well rounded and with less than 2 percent flat particles) or glass beads will be installed in the annular space between the boring and the vapor probe screens. The filter pack will be certified as free of contaminants by the supplier and have a grain size distribution compatible with the formation materials and the screen. A filter pack size of 10-20 will be used based on SVE wells previously installed on Dunn Field. The filter pack will be placed from the bottom of the hole to approximately 2 feet above the top of the deeper vapor probe screen. A 2 to 3-foot bentonite seal will be placed between the deep and shallow vapor probes (see 3.3.2.3). An additional filter pack will then be placed from approximately 2 feet below to 2 feet above the upper vapor probe. The filter pack will be emplaced through the boring using the gravity method in lifts of no more than approximately 1 foot. Care will be taken to prevent bridging by frequently measuring the thickness of the filter pack as it is placed.

3.3.2.3 Bentonite Seals

Two bentonite seals will be installed in the annular space of the boring, between the filter packs for the deep and shallow vapor probes and above the filter pack for the upper vapor probe. Each seal will be 2 to 3 feet thick. Only 100 percent sodium bentonite (pellets or chips) will be used and care will be taken to prevent bridging by frequently measuring the thickness of the bentonite as it is gravity placed. Since the seal will be installed above the water table, the bentonite will be hydrated with water from an approved water source. At least 5 gallons of water will be added after each 24 to 30 inches of bentonite is placed. The bentonite seal will be allowed to hydrate for a minimum of 4 hours prior to placement of the grout seal.

3.3.2.4 Grout Seal

A non-shrinking cement-bentonite grout mixture will be placed in the annular space from the top of the upper bentonite seal to approximately 0.5 feet bgs. The cement-bentonite mixture will consist of the following compounds in proportion to each other: 94 pounds of neat Type I Portland or American Petroleum Institute (API) Class A Cement, not more than four pounds of 100 percent sodium bentonite powder, and not more than 8 gallons potable water.

3.3.2.5 Completion Details

The VSP will be completed with a flush-mount wellhead vault for access during sampling. Tubing for each probe ('A' and 'B') will be clearly labeled.

3.3.3 Well Installation

The VSPs are to be constructed using Geoprobe System's DT325 rod advancement tool and a direct push rig to reach the desired vapor probe depth. The DT325 will allow collecting of continuous soil cores to a depth of 18 feet to determine vapor implant depths. The soil cores will be reviewed by an e^2M geologist to identify zones of distinctly coarser material.

3.3.3.1 Procedures

Borings for VSPs will be advanced by direct push drilling methods. The following protocols will be used to install vapor probe:

1. Advance DT325 system with soil coring to desired depth. Once the cutting shoe is immediately above the desired soil gas probe interval, the sample sheath and soil sample or solid point is removed.
2. Remove the inner rod string and last soil core.
3. Attach Teflon tubing to vapor probe 'A' and lower to desired depth (at least 3 inches above boring bottom).
4. Pour filter media through the rod bore as rods are slowly retracted until the filter media extends approximately 24 inches above the vapor probe.
5. Measure depth to the top of the filter media and keep below rods and cutting shoe to prevent bridging.
6. Add fine bentonite chips through the rod bore as the rods are slowly retracted. Bentonite seal will be 2 to 3 feet. Add water through the tube to hydrate each 6-inch increment of bentonite. Avoid wetting the interior of the rods to prevent bridging of the sand and bentonite that could result in damage or loss of implants.
7. Attach Teflon tubing to vapor probe 'B' and lower to desired depth (at least 12 inches above lower bentonite seal).
8. Pour filter media through the rod bore as rods are slowly retracted until the filter media extends approximately 24 inches above the vapor probe.
9. Add fine bentonite chips through the rod bore as the rods are slowly retracted. Bentonite seal will be 2 to 3 feet. Add water through the tube to hydrate each 6-inch increment of bentonite.
10. Grout from the top of the upper bentonite seal to about 6 inches below grade.

3.3.3.2 VSP Installation Diagrams

The e^2M field geologist will prepare boring logs and construction diagrams for the VSPs. The field supervisor will maintain suitable logs detailing drilling and well construction practices. Probe dimensions, amount, type and manufacturer of materials used to construct each VSP will be recorded on the VSP Installation Diagrams (Attachment 17.1). Details will include:

- Well identification
- Drilling method
- Installation date(s)
- Total boring depth
- Lengths and descriptions of the screen and tubing
- Thickness and descriptions of filter pack, bentonite seal, casing grout, and any backfilled material
- Quantities of all materials
- Summary of material penetrated by the boring

Each installation diagram will be completed and reviewed in the field. A final version will be submitted in an appendix of the Technical Report.

3.3.4 VSP Abandonment

Upon completion of vapor intrusion monitoring or if a VSP is damaged or otherwise not fit for continued use, it will be filled with grout from the bottom up until undiluted grout is visible at the surface. The grout will be tremied into the casing. After allowing at least two days for grout settlement, the grout will be topped off with concrete. The well pad and manhole will be removed and disposed as solid waste. The wellhead location will be restored to match the surrounding area.

3.3.5 Location Survey

Upon installation, a Tennessee licensed professional surveyor will locate each new VSP by standard surveying methods. A vertical survey will be conducted to establish the elevation of each VSP well pad. Vertical control will be to the National Geodetic Vertical Datum. The horizontal grid coordinates within 0.1 foot, the ground elevation to within 0.01 foot, and the elevation of the top of casing within 0.01 foot will be recorded. The survey will be referenced to the Tennessee State Plane coordinate system.

3.4 POST-OPERATION

3.4.1 Field

Before leaving the site, the following procedures will be performed by on-site personnel:

- Decontaminate all field equipment.
- Ensure that installed wells are secured.
- Complete logbook, making notations as to site conditions, anomalous readings, etc.
- Complete VSP installation diagram.
- Ensure that related equipment and associated supplies have been shipped back to the office.
- Ensure that all IDW has been disposed in accordance with the RAWP and WTP 6.
- Ensure that the site is returned to its condition prior to well installation to the extent feasible (i.e., all trash related to well installation must be disposed of prior to departure from the site).

3.4.2 Office

Upon return to the office, field personnel will perform the following:

- Submit logbook and any original forms to Project/Task Manager for review.

4.0 REFERENCES

CH2M HILL, 2008. Memphis Depot Dunn Field Off Depot Groundwater Final Remedial Design Rev. 1. Prepared for the U.S. Army Engineering and Support Center, Huntsville, September 2008.

Geoprobe Systems, 2002. Direct Push Installation of Devices for Active Soil Gas Sampling & Monitoring.

MACTEC Engineering and Consulting, Inc, 2005a. Remedial Action Sampling and Analysis Plan, Volume I: Field Sampling Plan and Volume II: Quality Assurance Project Plan. Prepared for the Air Force Center for Environmental Excellence. November, 2005.

USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

5.0 ATTACHMENTS

Attachment 17.1 – VSP Installation Diagram

ATTACHMENT 17.1
VAPOR SAMPLING POINT INSTALLATION DIAGRAM
WORK AND TEST PROCEDURES
OFF DEPOT GROUNDWATER RAWP
Defense Depot Memphis, Tennessee

WELL ID: ____________________

PROJECT: ____________________

E2M FIELD REP. ____________________

LOCATION ADDRESS: ____________________

LOCATION DESCRIPTION: ____________________

____

INSTALLATION DETAILS

DATE(S) ____________________

START TIME ____________________

END TIME ____________________

DRILLING CONTRACTOR ____________________

DRILLING TECHNIQUE ____________________

SIZE AND TYPE ____________________

ROD ADVANCEMENT TOOL USED ____________________

BOREHOLE DETAILS

TOTAL DEPTH: ____________________

DIAMETER: ____________________

TUBING DETAILS (A-DEEP, B-SHALLOW)

TUBING MATERIAL: ____________________

(A) DIAMETER: ____________________

(A) LENGTH: ____________________

(B) DIAMETER: ____________________

(B) LENGTH: ____________________

VAPOR IMPLANT DETAILS

MANUFACTURER: ____________________

MATERIAL: ____________________

PORE DIAMETER: ____________________

LENGTH: ____________________

UPPER FILTER SAND DETAILS

TYPE/GRADATION: ____________________

AMOUNT(UNITS): ____________________

LOWER FILTER SAND DETAILS

TYPE/GRADATION: ____________________

AMOUNT(UNITS): ____________________

UPPER BENTONITE SEAL DETAILS

TYPE: ____________________

AMOUNT: ____________________

LOWER BENTONITE SEAL DETAILS

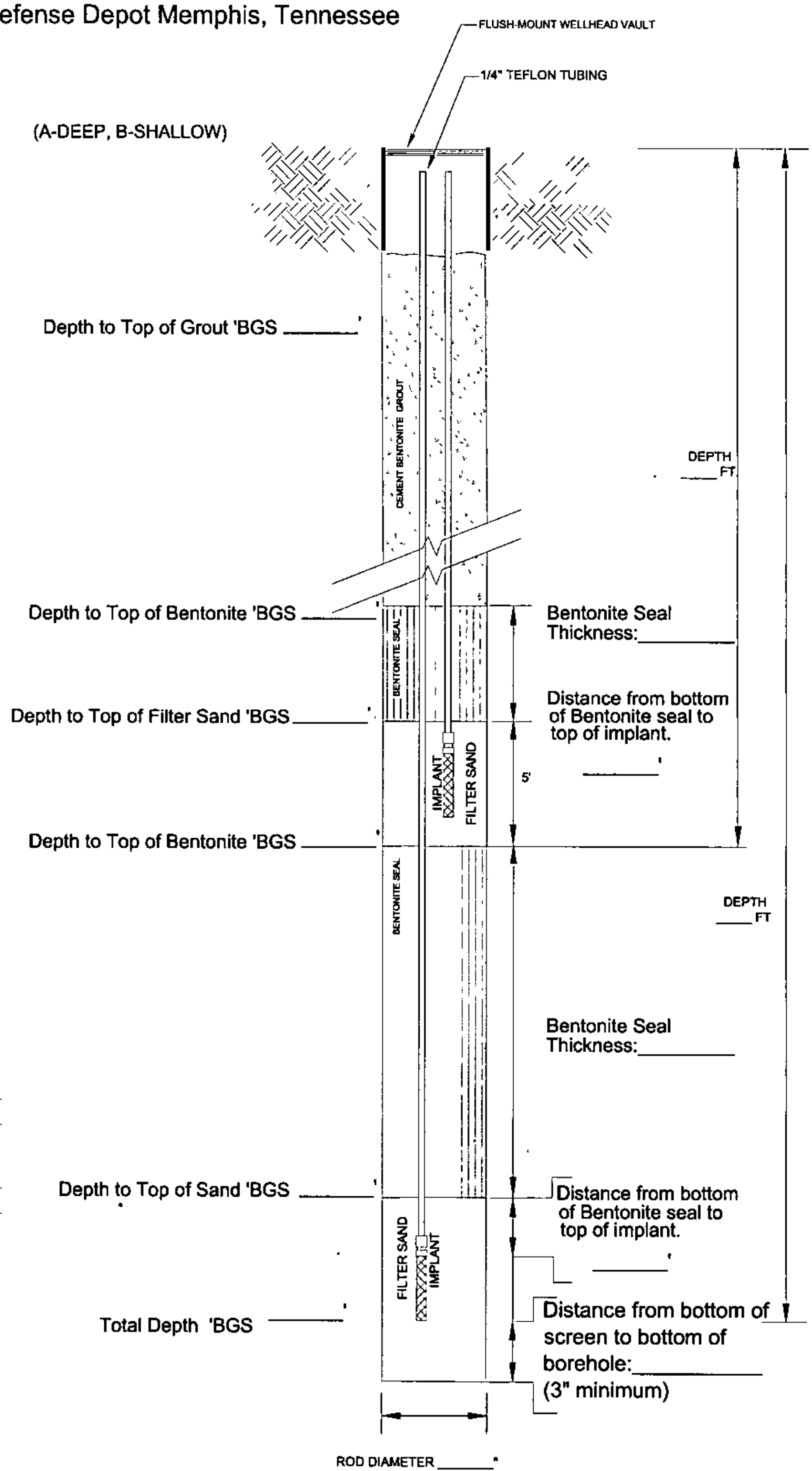
TYPE: ____________________

AMOUNT: ____________________

GROUT DETAILS

TYPE: ____________________

AMOUNT: ____________________



Note: The first (deeper) vapor implant ('A') will be positioned in the coarsest soil between 14 and 18 feet bgs (or at 15 feet bgs if no such zone is observed), and will be at least three inches above the bottom of the borehole. The second (shallow) vapor implant ('B') will be positioned in the coarsest soil between 4 and 8 feet bgs (or at 5 feet bgs if no such zone is observed).

WORK AND TEST PROCEDURE 18

VAPOR SAMPLE COLLECTION

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for collection of vapor samples from soil vapor extraction (SVE) wells, SVE treatment system effluent, vapor monitoring points (VMPs) and vapor intrusion sampling probes (VSPs). Samples will be used for field measurements with a photoionization detector (PID) and for laboratory analysis. This WTP was prepared for use in the Off Depot Remedial Action at Defense Depot Memphis, Tennessee (DDMT) and as an addendum to the *Remedial Action Sampling and Analysis Plan* (RASAP) (MACTEC, 2005).

2.0 DISCUSSION

This WTP specifies details and procedures for collection of laboratory samples from the SVE component of the air sparging and SVE (AS-SVE) system at DDMT. Field measurements, laboratory results and system measurements will be evaluated and used to make recommendations for system operations.

An SVE system uses blowers connected to extraction wells to extract subsurface vapor from pore spaces in the vadose zone. Periodically, laboratory vapor samples are collected from individual extraction wells or the system to monitor system performance and assess attainment of remedial goals. VMPs are installed in various locations at set distances from SVE wells and are used to determine the vacuum influence of SVE wells; field measurements and laboratory samples are collected to measure VOC concentrations. VSPs are installed near structures in the vicinity of groundwater plumes to monitor for vapor intrusion.

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs should be reviewed in conjunction with this WTP;

NUMBER	NAME
1	General Instructions for Field Personnel
7	Sample Control and Documentation
8	Sample Containers and Preservation
9	Sample Packing and Shipping
10	Sampling Equipment Decontamination

12	Personnel Protective Equipment Decontamination
13	Health and Safety Monitoring
14	Soil Vapor Extraction Wells
16	Vapor Monitoring Points
17	Vapor Sampling Probe

3.2 PREPARATION

Prior to leaving the office for field work, the field team leader is responsible for activities listed in WTP 1, as well as the following actions:

- Working with the project chemist to generate a sampling plan detail listing sample locations and constituents to be sampled.
- Coordinating with the analytical laboratory to ensure that the sample containers, and preservatives are shipped to the site and arrive prior to the start of sampling event.
- Generating paperwork for each event including; sample labels, request for analysis forms, field sampling reports, purge forms. Shipping appropriate paperwork and field books to the site prior to the start of sampling.
- Ordering appropriate supplies and equipment for delivery prior to the start of sampling.
- Confirm the shipping receipts and schedule with lab and equipment suppliers.

After arrival on site, but prior to commencement of operations, the following procedures will be employed:

- Check that required sampling equipment has arrived on site.
- Conduct site set up activities; posting of signage and establishment of a decontamination area, and organization and inventory of supplies in the field storage area.
- Check that monitoring equipment is functioning properly, and calibrated as needed.
- Assign tasks to field teams according to the project work plan.

3.3 SAMPLE COLLECTION

Prior to sampling, a field station will be established. The station will contain equipment, supplies, safety gear, and instrumentation necessary for the collection of samples. Environmental conditions will also be noted. Each sampling site will be characterized by the following factors:

- Location of work
- Weather conditions including precipitation, temperature and wind direction

- Ongoing activities that may influence or disrupt sampling efforts
- Accessibility to the sampling locations

All laboratory sampling will be documented in a bound field log. The field log will summarize sampling events include sampling locations and times, field conditions and other significant information related to the sampling event.

3.3.1 Sample Locations and Frequency

Field screening vapor samples will be collected from individual SVE wells, the SVE system effluent (vapor stream from all SVE wells), and vapor monitoring points (VMPs). Samples for field measurements will be collected using an oil-less vacuum pump and captured in Tedlar bags for PID readings. Field measurements from SVE wells and system effluent will be collected following startup, then daily during system shake down, weekly during the first quarter, and monthly thereafter. After the first two years, the measurements may be decreased to quarterly. Field screening measurements from VMPs will be collected prior to system startup, weekly during the first quarter, and monthly thereafter. After the first two years, the measurements may be decreased to quarterly.

Laboratory vapor samples will be collected via Summa canisters from the effluent of the SVE system after startup for a baseline reading, monthly for three months and quarterly for the remainder of the first year of operations. Sample frequency will be evaluated at the end of the first year.

Vapor intrusion samples for laboratory analysis will be collected from VSPs prior to the startup of the AS-SVE systems. At least one additional round of samples will be collected after the first quarter of AS-SVE operations.

3.3.2 Sample Containers

Laboratory samples will be collected by field personnel in accordance with the RAWP and at the direction of the Field Team Leader (FTL) or Project Engineer. The Project Engineer will provide a sample collection schedule to field personnel prior to the sampling event. Sample collection will follow U.S. Environmental Protection Agency (EPA) TO-15 (VOCs) procedures. Laboratory samples from the SVE system effluent will be collected in 6-liter Summa canisters with a 200 milliliter/minute regulator for laboratory analysis. Samples from VSPs will be collected in 1-liter Summa canisters using 200 milliliters per minute regulators. Standard turnaround time (TAT) for laboratory results is 15 days working days.

Summa canisters will be delivered from the analytical laboratory; a pressure gauge and flow regulator for each Summa canister should be included. Arrangement for delivery will be coordinated by the Project Chemist.

3.3.3 SVE Wells and System Effluent

Field measurements and samples for laboratory analysis will be collected to monitor system performance and emissions. Field measurements with a PID will be collected from individual SVE wells and from the system effluent. Samples for laboratory analysis will only be collected for the system effluent

3.3.3.1 Field Measurements

Field measurements will be collected from individual SVE wells and the system effluent. While online, the SVE system is continuously pulling vapor from the subsurface; thus, no purging of wells or the system is required prior to field (PID) sample collection. Ensure all wells to be sampled are online for a minimum of two hours prior to sample collection. Field measurement procedures are as follows:

- Connect sampling pump inlet hose to SVE well sample port located on SVE manifold.
- Open appropriate well sample port ball valve.
- Turn on sampling pump and allow it to run for five seconds to purge the pump and tubing.
- Connect tedlar bag to discharge of sampling pump by inserting nipple of bag into pump discharge tube.
- Allow tedlar bag to fill (approximately 20 seconds).
- Once filled, disconnect tedlar bag from sampling pump.
- Close SVE well sample port ball valve.
- Connect calibrated PID Meter to tedlar bag.
- Allow PID Meter to measure VOC concentration. Ensure reading on PID meter stabilizes before recording VOC concentration. This usually takes 10 to 15 seconds.
- Record peak VOC concentration and time.

3.3.3.2 Laboratory Samples

Procedures for sample collection from the SVE system effluent are as follows:

- Fill out SUMMA canister tag with sampling information using a ball point pen.
- Remove the Summa canister valve cap.
- Attach regulator to 6-liter SUMMA canister. An individual regulator should be provided by the laboratory for each SUMMA canister.

- Run dedicated tubing from SVE manifold to regulator/canister assembly by connecting swaglock.
- Open appropriate SVE well sample port ball valve.
- Record starting SUMMA canister pressure on chain of custody (COC). The starting SUMMA canister pressure should be at least -25 in. Hg or greater. If not, the canister has leaked and should not be used for sampling.
- Open Summa canister valve located at top of sampling canister.
- Record sampling start time on COC.
- Allow SUMMA canister to fill until pressure gauge on regulator reads -5 in.Hg. (approximately 30 minutes with a 6-liter canister and a 200 ml/min flow regulator).
- Close sampling port ball valve at SVE well.
- Disconnect SUMMA canister from regulator.
- Record time of sample collection, date, and SUMMA canister serial and regulator numbers on chain of custody form.

3.3.4 VMPs

Field measurements will be collected from VMPs to evaluate system performance and determine SVE well vacuum influence. It is necessary to purge VMPs prior to sample collection. Procedure will be repeated for the 'A' and 'B' screens at each VMP.

<u>Purging:</u>

- Unlock VMP well casing (secured by padlock).
- Attach regulator to "quick connect" on well cap, run line to a "T" connection.
- Run one line out from the "T" to the pump.
- Attach second line to the SUMMA canister via swaglock.
- Turn on sampling pump and allow lines to purge for approximately five minutes. Purge time is based on tubing diameter and length and is intended to remove three tubing volumes.

<u>Field (PID) Measurements:</u>

- Attach tedlar bag to discharge of sampling pump by inserting nipple of bag into pump discharge tube.
- Allow tedlar bag to fill (approximately 20 seconds).
- Once filled, disconnect tedlar bag from sampling pump.
- Connect calibrated PID Meter to tedlar bag.
- Allow PID Meter to measure VOC concentration. Ensure reading on PID meter stabilizes before recording VOC concentration. This usually takes 10 to 15 seconds

- Record peak VOC concentration and time..
- Open valve on tedlar bag to completely deflate bag.
- Collect additional PID readings following the previous steps until three consecutive readings are within 10% of each other.

3.3.5 VSP Samples

Laboratory samples will be collected at VSPs to monitor for vapor intrusion associated with AS-SVE operations. It is necessary to purge VSPs prior to sample collection. Field (PID) measurements will be collected as part of this procedure to ensure the VSP has been properly purged. Procedure will be repeated for each of the two sample probes.

<u>Purging:</u>

- Unlock VSP well casing (secured by padlock).
- Attach regulator to VSP, run line to a "T" connection.
- Run one line out from the "T" to the pump.
- Attach second line to the SUMMA canister via swaglock.
- Turn on sampling pump and allow lines to purge for approximately five minutes. Purge time is based on tubing diameter and length and is intended to remove three tubing volumes.

<u>Field (PID) Measurements:</u>

- Attach tedlar bag to discharge of sampling pump by inserting nipple of bag into pump discharge tube.
- Allow tedlar bag to fill (approximately 20 seconds).
- Once filled, disconnect tedlar bag from sampling pump.
- Connect calibrated PID Meter to tedlar bag.
- Allow PID Meter to measure VOC concentration. Ensure reading on PID meter stabilizes before recording VOC concentration. This usually takes 10 to 15 seconds.
- Record peak VOC concentration. Also record sampling time.
- Open valve on tedlar bag to completely deflate bag.
- Collect additional PID readings following the previous steps until three consecutive readings are within 10% of each other. All readings and sampling times are recorded.

<u>Laboratory Sample Collection:</u>

- Shut off ball valve on pump.
- Turn off sampling pump.

- Remove the 1-liter Summa canister valve cap, attach vacuum gauge to the canister, and open the canister valve.
- Record starting SUMMA canister pressure on chain of custody. The starting SUMMA canister pressure should be at least -25 in. Hg or greater. If not, the canister has leaked and should not be used for sampling.
- Open Summa canister valve located at top of sampling canister.
- Record sampling start time on field sampling sheet.
- Allow SUMMA canister to fill until pressure gauge on regulator reads -5 in.Hg. (approximately 5 minutes with a 1-liter canister and a 200 ml/min flow regulator).
- Close valve at SUMMA canister.
- Close VMP sampling port ball valve.
- Disconnect SUMMA canister from regulator.
- Record time of sample collection, date, and SUMMA canister serial and regulator numbers on chain of custody form.

3.4 POST-SAMPLING

3.4.1 Field

Following sample collection, the following procedures will be performed by on-site personnel:

- Decontaminate all field equipment.
- Ensure all field documentation is completely filled out. This includes the COC and SUMMA sampling tag. Unless revised by the project manager, standard turn-around time (15 days) will be used. Retain copy of COC for the project file.
- Package SUMMA canisters in sturdy cardboard boxes with packing material to prevent any potential puncture of the canister. In most cases, the boxes and packing material used by the laboratory to ship the SUMMA canisters to the site can be reused.
- Ship SUMMA canisters to laboratory for analysis via Federal Express or other overnight service. Ensure copy of COC is included in shipment.
- Complete logbook, making notations as to site conditions, anomalous readings, etc.
- Ensure that equipment and associated supplies have been shipped back to the office or supplier.
- Ensure that all IDW/trash has been disposed in accordance with the RAWP.

3.4.2 Office

Upon return to the office, field personnel will perform the following:

- Submit logbook and any original forms to Project/Task Manager for review.

4.0 REFERENCES

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