889 946B File: 541.460.000n
M.D.

THE MEMPHIS DEPOT
TENNESSEE

ADMINISTRATIVE RECORD
COVER SHEET

AR File Number 889

Part III of III

Defense Distribution Center (Memphis)
Dunn Field

Source Area Remedial Design

Performance Standards Verification Plan

Rev. 3

PREPARED FOR

U.S. Army Engineering and Support Center, Huntsville
4820 University Square
Huntsville, AL 35816

April 2007

PREPARED BY

CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346

Contents

Figures

Tables

Attachments

Acronyms and Abbreviations

°C	degrees Celsius
AFCEE	Air Force Center for Environmental Excellence
BCT	Base Realignment and Closure Cleanup Team
CGI/O_2	combustible gas indicator/oxygen
COC	chemical of concern
CQAP	Construction Quality Assurance Plan
CVOC	chlorinated volatile organic compound
DEQ	Department of Environmental Quality
DO	dissolved oxygen
EM	Engineer Manual
EPA	U.S. Environmental Protection Agency
ERD	enhanced reductive dechlorination
FID	flame ionization detector
GAC	granular activated carbon
gpm	gallon per minute
IDW	investigation-derived waste
IRA	interim remedial action
mg/kg	milligram per kilogram
MS/MSD	matrix spike/matrix spike duplicate
MW	monitoring well
NAPL	non-aqueous phase liquid
ORP	oxidation reduction potential
OVA	organic vapor analyzer
PID	photoionization detector
POTW	publicly owned treatment works
ppm	parts per million
PSVP	Performance Standards Verification Plan
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RA	remedial action
RAC	remedial action contractor
RD	remedial design
RDI	remedial design investigation
RG	remedial goal
ROD	record of decision
ROI	radius of influence
SA RA	source area remedial action
SOP	standard operating procedure
STOP	SVE Termination or Optimization Process
SVE	soil vapor extraction
SVOC	semivolatile organic compound

Acronyms and Abbreviations, Continued

T&D	transportation and disposal
TAL	target analyte list
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
TMP	temperature monitoring point
TTZ	target treatment zone
TWA	time-weighted average
USACE	U.S. Army Corps of Engineers
VMP	vapor or vacuum monitoring point
VOC	volatile organic compound
ZVI	zero-valent iron

1.0 Introduction

This Performance Standards Verification Plan (PSVP) is part of the Dunn Field Source Areas Remedial Design (RD) and has been prepared for the U.S. Army Corps of Engineers (USACE) - Huntsville Center as part of Task Order 6 under Contract Number DACA87-02-D-0006.

This PSVP addresses the quantitative performance standards for the soil, vapor, and water compliance sampling activities required through completion of the remedial action (RA), as well as post-RA monitoring. The Construction Quality Assurance Plan (CQAP) developed by the RA contractor (RAC) will address all qualitative performance standards.

1.1 Purpose of the Performance Standards Verification Plan

The purpose of this PSVP is to identify and describe the sampling and analysis work and quality assurance/quality control (QA/QC) elements required during and after the RA to verify that all RD performance standards have been met. The work addressed by this plan includes the following activities:

Groundwater Remedy

- Baseline sampling event as part of preliminary activities just before the soil vapor extraction (SVE) RAs are operating.
- One sampling event during operation of the thermal-enhanced SVE system (between 3 to 9 months after system startup).
- At least two more quarterly sampling events between the termination of the loess deposits thermal-enhanced SVE system and the zero-valent iron (ZVI) injections to assess the impact of the soil remedies on source area groundwater quality and finalize the ZVI injection layout.
- Quarterly monitoring for 1 year following the injection of ZVI into the fluvial aquifer beneath Dunn Field to evaluate the effectiveness of and assess the need for additional ZVI injections. An additional year of monitoring may be conducted in areas selected for strategic ZVI re-injection.
- QA/QC sampling of ZVI
- ZVI injection monitoring (that is, injection flow rate, subsurface pressure distribution and ground surface heave)
- Sampling and analysis of soil to evaluate iron distribution

Soil Remedy – Loess Deposits (Thermal-Enhanced Soil Vapor Extraction)

- Sampling and analysis of pre-treatment soil (if required by the thermal-enhanced SVE vendor) and interim and/or post-treatment soil
- Monitoring soil temperature via temperature monitoring points (TMPs)

889 954

- Using vapor or vacuum monitoring points (VMPs) (piezometers) to assess radius of influence (ROI)
- Sampling the granular activated carbon (GAC) unit
- Sampling and field and laboratory analysis of pre- and post-treated extracted soil vapor
- Sampling and analysis of thermal-enhanced SVE system condensate
- Monitoring ambient air
- Sampling to assess the impact of the loess thermal-enhanced SVE system on source area groundwater quality will be conducted as described above

Soil Remedy – Loess Deposits (Excavation, Transportation, and Offsite Disposal)

- Sampling and analysis of excavation perimeter
- Sampling and analysis of excavated material for transportation and disposal (T&D) waste characterization
- Sampling and analysis of drummed or bottled liquid waste to characterize for further action (as necessary)
- Sampling and analysis of borrow soils
- Sampling and analysis of water from the excavation and decontamination areas to characterize for further action

Soil Remedy – Fluvial Sands

- Sampling and analysis of interim and/or post-treatment soil
- Using VMPs (piezometers) to assess ROI
- Sampling and field and laboratory analysis of pre- and post-treated extracted soil vapor
- Sampling and analysis of SVE system condensate
- Sampling the GAC unit
- Monitoring ambient air
- Sampling to assess the impact of the fluvial sands SVE system on source area groundwater quality will be conducted as described above

1.2 Organization of the PSVP

The remainder of this PSVP is organized as follows:

- Sections 2 through 4: Field Sampling Plan (FSP)
- Section 5, SVE Rebound Testing Procedures
- Section 6, References

Relevant site background, geology, hydrogeology, and history are provided in the *Memphis Depot Dunn Field Source Areas Final Remedial Design* (CH2M HILL, 2007).

2.0 Sampling Overview

An overview of the sampling activities to be conducted during and after the RA is presented in this section, along with the sampling objectives for specific media associated with the groundwater and soil remedies. Analytical parameters and sampling frequency for specific media are provided in Section 3.

2.1 Groundwater Remedy

2.1.1 Baseline Sampling

Baseline groundwater samples will be collected from existing and new source area monitoring wells (MWs) to evaluate overall source area remedy effectiveness. New MWs include stainless steel MWs installed to replace existing polyvinyl chloride (PVC) MWs located in the thermal treatment areas; with appropriate rationale, the RAC may recommend additional monitoring locations. The 26 groundwater sampling locations for the source area remedy are shown on Figure 1. The baseline groundwater sampling effort would occur just before the fluvial sands SVE system is initiated.

2.1.2 Soil RA Effectiveness Sampling

Several quarterly groundwater sampling events will be conducted between the start of the loess deposits thermal-enhanced SVE system and the ZVI injections to evaluate the impact of the soil remedies on source area groundwater. The scope of the groundwater remedy will be adjusted, if necessary, based on the assessment results.

2.1.3 Zero-Valent Iron Quality Assurance/Quality Control Sampling

The ZVI will be sampled and analyzed to ensure that the material is free of contaminants and meets the manufacturer's specifications.

2.1.4 Zero-Valent Iron Injection Monitoring

In addition to the quantity of iron, nitrogen gas, and water applied at each injection location, the following system operational parameters[1] will be monitored to evaluate injection effectiveness:

- Nitrogen gas flow rate
- ZVI and water slurry composition
- ZVI and water slurry injection flow rate
- Injection interval
- Downhole injection initiation and maintenance pressures
- Injection pressure influence at surrounding monitoring points
- Ground surface heave adjacent to, and in the vicinity of, the injection point

[1] From ARS Technologies, Inc *Ferox^sm Field Injection Workplan* (November 2004) for early implementation of the selected remedy at Dunn Field

Other visual observations during each injection will also be recorded. Monitoring details are provided in Section 3.

2.1.5 Soil Confirmation Borings

The ZVI injection process will be calibrated through the use of soil confirmation borings after every eight ZVI injections are completed. As described in Section 3, the soil borings will be advanced to confirm that the ZVI is adequately distributed based on the design ROI assumptions. Soil samples will be collected from the injection zone to detect the presence of ZVI powder through both visual and laboratory analysis and to review the effect of the injections on the surrounding matrix.

2.1.6 Post-Injection Groundwater Sampling

Groundwater samples will be collected and analyzed to evaluate the effectiveness of and need for additional ZVI injections. As shown on Figure 1, 26 new and existing MWs will be sampled.

2.2 Soil Remedy – Loess Deposits (Thermal-Enhanced SVE)

Evaluation of the soil remedy will include vapor, vacuum, and soil monitoring to assess the effectiveness of the thermal-enhanced SVE system.

2.2.1 Temperature Monitoring

The selected vendor will routinely monitor the temperature of the treatment area to ensure that the desired bulk soil temperature is maintained during the constant heating phase.

2.2.2 Vacuum and Vapor Monitoring Points (Piezometers)

The selected vendor will use vacuum piezometers or pressure sensors to verify that vacuum influence is established and maintained during the operation of the thermal-enhanced SVE system. The evaluation process may be facilitated with the use of the *U.S. Army Corps of Engineers Soil Vapor Extraction Performance Checklist* (see Attachment A), *Development of Recommendations and Methods to Support Assessment of Soil Venting Performance and Closure* (U.S. Environmental Protection Agency [EPA], 2001), *Guidance on Soil Vapor Extraction Optimization* (Air Force Center for Environmental Excellence [AFCEE], 2001) (see Attachment B includes the SVE Termination or Optimization Process [STOP] Decision Tree), or other relevant SVE performance monitoring guidance.

2.2.3 Extracted Soil Vapor Sampling

Extraction well and treatment system influent and effluent vapor samples will be collected routinely to evaluate the effectiveness of the thermal-enhanced SVE system and assess the need for system modifications. In addition, the vapor treatment systems will be monitored (influent and effluent) to assess chemical of concern (COC) mass removal rates, evaluate vessel breakthrough, and comply with air permitting standards.

2.2.4 SVE System Condensate Sampling

The condensate that is generated during the operation of the thermal-enhanced SVE system will be collected, treated as necessary, and then discharged through the existing publicly owned treatment works (POTW) connection on the north side of Dunn Field. The condensate will be sampled and characterized in accordance with the provisions of the discharge agreement with the City of Memphis.

2.2.5 Soil Sampling

Confirmation soil samples will be collected at or near the pre-treatment sample locations (remedial design investigation [RDI] and, if applicable, baseline locations) to compare directly with the pre-treatment soil samples and to evaluate whether remedial goals (RGs) have been achieved. An adequate number of soil samples (nearly 30) will be collected to evaluate the effectiveness of the thermal-enhanced SVE system based on statistical analyses.

Soil samples will also be collected based on the temperature profile during treatment (that is, samples will be collected where temperature objectives were not achieved). Soil samples will be collected at the onset of the cool-down phase to determine whether the electrodes or heating elements need to be re-activated to meet the loess RGs.

2.2.6 Ambient Air Monitoring

Semi-qualitative ambient air monitoring will be performed at the periphery of the treatment system to assess the presence of fugitive emissions. In the event ambient air volatile organic compound (VOC) concentrations exceed the threshold, formal ambient air monitoring will be performed as an interim response action. The analytical results will be used to trigger an operation and maintenance response.

2.3 Soil Remedy – Loess Deposits (Excavation, Transportation, and Offsite Disposal)

2.3.1 Excavated Soil

During the RA, contaminated soil will be removed from one 20-foot by 20-foot by 15-foot deep area on the east side of Treatment Area 1. Excavated soil, which is anticipated to be non-hazardous, will be stockpiled on 20 mil liners during the final waste characterization. The excavated soils will be sampled and analyzed using the toxicity characteristic leaching procedure (TCLP) to evaluate disposal options.

As a possible cost savings alternative, excavated soil could be placed within the treatment areas targeted for thermal-enhanced SVE. The soil would be treated along with the in situ materials. The cost estimate in the RD assumes offsite disposal.

2.3.2 Waste

If encountered, waste (in bulk and drums) will be staged, segregated, and sampled to characterize for the appropriate treatment/disposal method. Empty drums will be transported offsite for disposal.

2.3.3 Excavation Perimeter

Confirmation samples will be collected from the side walls and bottoms of the proposed excavation to assess whether additional excavation is required. The perimeter of the excavation will be sampled in accordance with the State of Michigan Department of Environmental Quality (DEQ) *Verification of Soil Remediation* Guidance Document (Michigan DEQ, April 1994).

2.3.4 Borrow Soil

Soil from potential borrow areas will be sampled and analyzed to ensure that the backfill material is clean.

2.3.5 Storm Water and Decontamination Water

Samples of storm water and decontamination water will be collected and analyzed to determine the appropriate disposal methods.

2.4 Soil Remedy – Fluvial Sands

The soil remedy evaluation will include vapor and soil monitoring to assess the effectiveness of the SVE system. The evaluation process may be facilitated with the use of the *U.S. Army Corps of Engineers Soil Vapor Extraction Performance Checklist* (see Attachment A), *Development of Recommendations and Methods to Support Assessment of Soil Venting Performance and Closure* (EPA, 2001), *Guidance on Soil Vapor Extraction Optimization* (AFCEE, 2001) (see Attachment B includes the STOP Decision Tree), or other relevant SVE performance monitoring guidance.

2.4.1 Vacuum and Vapor Monitoring Points (Piezometers)

Approximately 10 VMPs will be installed to assess the vacuum ROI and vapor extraction effectiveness; each VMP will have at least two screened intervals. Over time, soil vapor analytical data collected from the monitoring points can be used to estimate remediation progress.

2.4.2 Extracted Soil Vapor Sampling

Extraction well and treatment system influent and effluent vapor samples will be collected routinely to evaluate the effectiveness of the fluvial sands SVE system and assess the need for system modifications. In addition, the vapor treatment systems will be monitored (influent and effluent) to assess COC mass removal rates, evaluate vessel breakthrough, and comply with air permitting standards.

2.4.3 SVE System Condensate Sampling

The condensate that is generated during the operation of the fluvial sands SVE system will be collected, treated as necessary, and then discharged through the existing POTW connection on the north side of Dunn Field. The condensate will be sampled and characterized in accordance with the provisions of the discharge agreement with the City of Memphis.

2.4.4 Soil Sampling

Confirmation soil sampling will be initiated after the rebound testing process described in Section 5 is complete. At that time, soil samples will be collected and analyzed for the COCs to assess remedy effectiveness. The SVE system will be shut down if the soil concentrations are at or below the RGs presented in Table 2-21G of the *Final Memphis Depot Dunn Field Record of Decision* (ROD) (CH2M HILL, 2004). Otherwise, as described in Section 5, strategic operation may continue.

2.5 General Construction and Waste Management

2.5.1 Other Soil

Other soil will be excavated during the following RA construction activities:

- Boring construction
- Pipe trenching
- Treatment equipment compound construction

A majority of the soil is expected to be reused within the targeted treatment areas as backfill. Excess soil will be stockpiled and characterized to evaluate disposal or reuse options at Dunn Field.

2.5.2 Storm Water and Decontamination Water

Samples of accumulated storm water and decontamination water will be collected and analyzed to determine the appropriate disposal methods.

3.0 Sampling Strategy and Sample Analysis

This section describes the sampling strategy to be used for each of the media presented in Section 2. To minimize analytical costs, field measurements will be used as appropriate to screen media before soil, vapor, or water samples are collected. Recommended data quality levels are summarized in Table 1.

3.1 Groundwater Remedy

3.1.1 Baseline Sampling

Prior to soil RA implementation, a single baseline groundwater sampling event will be conducted using 26 existing and new source area MWs shown below.

Treatment Area 1	Treatment Area 2	Treatment Area 3	Treatment Area 4
MW-3 MW-7 **MW-10** **MW-11** MW-68 MW-180 **MW-181**	**MW-73** MW-74 **MW-131** MW-132 **MW-133** MW-134 **MW-135** **MW-177** MW-178 MW-179 **MW-188**	MW-6 MW-175 MW-188	MW-15 MW-57 **MW-173** MW-174 MW-187
7 MWs	11 MWs	3 MWs	5 MWs

Note: Existing PVC MWs replaced with new stainless steel MWs

In addition to VOC analysis, groundwater samples will be analyzed for the parameters summarized in Table 2. Analyses for biological indicator parameters, such as nitrate, sulfate, methane, and carbon dioxide, will also be conducted to determine if biologically-mediated enhanced reductive dechlorination (ERD) is occurring.

Baseline groundwater sampling will be performed in accordance with the RAC's Sampling and Analysis Plan (MACTEC, 2004) and, as necessary, the EPA Region 4 Science and Ecosystems Services Division *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual* (EISOPQAM), dated November 2001, and the USACE's Engineer Manual (EM) 200-1-3, dated February 2001.

Sampling methods and equipment have been chosen to minimize decontamination requirements and the possibility of cross-contamination (see Table 3a). Reusable sampling equipment will be decontaminated between locations by following these steps:

- Scrub with brushes in Liqinox® solution
- Rinse twice with potable water

- Rinse with analyte-free water
- Rinse with isopropanol (pesticide-grade)
- Rinse with analyte-free water
- Air dry

Groundwater levels will be measured in MWs prior to and during each sampling event. Water levels will be measured using an electronic sensor with tape graduated in 0.01 foot. Measurements will be recorded as depth to water from the mark on top of the well casing. Well number, date and time of measurement, and depth to water will be recorded in the field logbook.

Before sampling, each well will be purged using a low-flow bladder pump to minimize both agitation of the groundwater and sample turbidity. The following methods are consistent with Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures (EPA, 1996). The intent of this procedure is to remove stagnant water from the well and introduce fresh groundwater into the well at a rate that does not produce significant drawdown of the water level in the well being sampled. This procedure reduces both the time it takes to purge the wells and the quantity of water removed (investigation-derived waste). The field team should keep the pumping rate as low as possible, being careful not to lower the water level in the well. The anticipated pumping rate is 0.15 to 0.25 gallons per minute (gpm) so that water levels do not decline more than 1.2 inches (0.1 foot). Water level measurements should be made concurrently with the water quality parameter measurements. Field measurements of dissolved oxygen, oxidation-reduction potential, turbidity, pH, temperature, and specific conductance will be made at the beginning and at 5-minute intervals during purging. The water quality parameters should be measured using an airtight flow-through cell. Measurement data will be recorded in the field logbook. Purging will continue until field measurements are stable to within +/- 10 percent over three successive measurements. The above parameters will be documented and the wells will then be sampled using the same low-flow pump rate.

Once the field parameters have stabilized, samples will be collected from the MWs using the low-flow bladder pump and Teflon®-lined tubing. Headspace in the volatiles sample container must be minimized by filling the sample jar until a positive meniscus is present.

Containers will be quickly and adequately sealed. Container rims and threads will be clean before tightening lids. Unless otherwise specified, Teflon®-lined screw lids will be used to seal the jar. Sample containers will be properly labeled and immediately cooled to 4 plus or minus 2 degrees Celsius (°C), and this temperature will be maintained through delivery to the laboratory until the samples are analyzed. New tubing will be used and the pump decontaminated for each well.

3.1.2 Soil RA Effectiveness Sampling

Effectiveness monitoring will include the collection of groundwater samples for field and laboratory analyses (same as baseline) and measurement of groundwater levels in all 26 source area MWs once during operation of the thermal-enhanced SVE system (between 3 to 9 months after system startup) and twice between the termination of the loess deposits thermal-enhanced SVE system and the ZVI injections (no less than a quarterly frequency).

A portion of the data from these events and baseline sampling will be used to conduct a trend analysis using the Mann-Kendall test. If a decreasing trend is observed in all wells specified in each area (see below), then additional sampling events will be conducted (for no more than another year) before ZVI is finally injected. Otherwise, ZVI injection will occur immediately. The MWs for each treatment area that will be used in the trend analysis are as follows:

- **TA1:** MW-10 and MW-3
- **TA2:** MW-73, MW-74, MW-132, MW-134, MW-135, and MW-177
- **TA4:** MW-173

As a result, the scope of the groundwater remedy could be re-evaluated as the loess deposits and fluvial sands chlorinated volatile organic compound (CVOC) mass is reduced and the groundwater CVOC concentrations respond accordingly. The RAC will adjust the number of ZVI injection locations if the plume geometry changes (increase or decrease in area) between the approval of the RD and implementation of the groundwater remedy.

3.1.3 Zero-Valent Iron Quality Assurance/Quality Control Sampling

Upon delivery to the site, the ZVI will be sampled and analyzed to ensure that the material is free of contaminants and meets the manufacturer's specifications. QA samples will be collected from 5 percent of the ZVI super-sacks and analyzed by an independent, third-party-certified laboratory to evaluate conformity with the specifications[2] listed in Table 4. Sample methods and equipment are summarized in Table 3b.

The QA/QC samples may be avoided if the subcontractor or supplier provides certified laboratory results that indicate the ZVI is free of contamination and meets specifications upon delivery.

3.1.4 Zero-Valent Iron Injection Monitoring

In addition to the quantity of iron, nitrogen gas, and water applied at each injection location, several system operational parameters will be monitored to evaluate injection effectiveness.

ZVI and Water Slurry

For each injection interval, the quantity of slurry injected and the duration of injection will be monitored. The slurry volume will be gauged by metering at the pump and checked by visually measuring the amount of liquid that is displaced from the slurry holding tank. Because a single batch of iron powder slurry will be mixed and injected at one time, exact quantities can be recorded during each injection. Injection pressures will be observed to ensure proper operation of the system and iron powder dispersion into the formation.

[2] From http://www hepure com/zero_valent_iron_product_information.html

889 963

Down-hole Injection Initiation and Maintenance Pressures

For each injection interval, a pressure transducer and datalogging equipment will be used to record pressure data at frequent intervals (every 0.5 second or less) within nearby MWs. The resulting pressure-time data plot, interpretation/ determination of fracture initiation pressure, and fracture maintenance pressures will be used to modify the injection process, as necessary, to ensure uniform horizontal and vertical distribution of ZVI. Nitrogen gas flow rate throughout the injection process will also be recorded.

TABLE 4
Vendor ZVI Specifications
Memphis Depot Dunn Field Performance Standards Verification Plan

Trace Elements (ppm by weight)			Chemical Analysis	
Li = 32	Cr = 25	Sn = 4	Carbon	0.25
Be = 0.28	Co = 180	Hg = <0.1	Sulfur	0.01
B = 6.5	Cu = 12	Bi = <0.01	Oxygen	1.2
Na = 45	Ga = 100	Pd = <0.1	Hydrogen Loss	1.0
Al = 1500	As = 8	Ag = 1.2	**Particle Size (weight %)**	
Ca = 500	Zr = 7.6	Cd = <0.1	>100 mesh	Trace
Ti = 1000	Mo = 5	Mg = 1800	>140	4
V = 1500	Ge = 15	Si = 400	>200	25
Mn = 800	Se = <0.05	Sc = 4.5	>230	16
Ni = 230	Nb = <0.5	Sb = 1.3	>325	25
Zn = 4	In = <0.1	Pb = <0.05	Pan	28
Physical Properties			**Laser Diffraction (µm)**	
Apparent density (g/cm^3)	2.55		D10	45
Surface area (m^2/g)	0.1		D50	85
			D90	140

Injection Pressure Influence at Surrounding Monitoring Points

During the injections, pressure gauges will be placed at wells near the injection points to monitor for pressure influence. Each pressure gauge will be equipped with a drag arm indicator that records the maximum pressure detected at the monitoring point during the injection. In addition, visual observations will be used to indicate pressure influence in surrounding wells. The MW casings will be sealed to atmosphere using removable caps. Groundwater elevations will be monitored between injection events.

Ground Surface Heave

Ground surface heave will be monitored during each injection using surveying transits, heave rods, and/or inclinometers. The heave rod will be placed at locations of varying radial distance from the fracture/injection well. During each injection event, the rod will be observed for the maximum amount of upward motion (surface heave) and the post-injection resting position (residual heave). Ground surface heave monitoring data provide additional information that can be used to assess the distances and orientation of injection fluid propagation.

3.1.5 Soil Confirmation Borings

The ZVI injection process will be intermittently calibrated through the use of soil confirmation borings after every eight ZVI injections are completed; about five sampling events will be completed. As such, two confirmation sampling events will be completed in the Treatment Areas 1 and 2 and one will be completed in Treatment Area 4. Each sampling event will include three borings at several radial distances. The soil borings will be advanced to confirm that the ZVI is adequately distributed based on the design ROI assumptions. Soil samples will be collected from the injection zone to detect the presence of ZVI powder through both visual and laboratory analyses (EPA Method SW846 6010B) to review the effect of the injections on the surrounding matrix.

For each of the estimated 3 soil sampling locations, confirmation borings will be established at radial distances of 5, 10, and 20 feet. Depending on the saturated thickness and injection interval at the selected ZVI injection location, one or two 10-foot long soil cores will be collected from each boring and examined. Boring depths will range from 70 to 90 feet below ground surface. Grab samples will be collected from each sample interval and analyzed for total iron (see Table 3c). Natural iron content of the solids in the fluvial aquifer ranges from 2,000 to 4,000 milligrams per kilogram (mg/kg) (CH2M HILL, 2002). If ZVI powder is delivered uniformly by the Ferox[SM] injections, the soil analysis should show an average increase of 5,000 mg/kg (based on a target ratio of 0.5 percent iron to soil).

Field screening techniques will also be used to verify qualitatively the emplacement of the ZVI. One method is to inspect the soil cores visually for the presence of injected ZVI. The Ferox[SM] slurry should cause a distinctive black staining that may be visually detected in soil cores. Once oxidized, the powder turns to reddish brown, which may also be detected if the natural soil color is a lighter color. A second screening method relies on the difference in magnetic property between the natural iron minerals and ZVI powder. Iron minerals within the fluvial aquifer are most likely chemically bound to the aquifer matrix and are not extractable with a magnet. To use this method, the soil core sample is allowed to dry, crushed, and then scanned with a powerful magnet. The magnet will pick up the Ferox[SM] iron powder, thereby providing empirical evidence of effective dispersion. The magnetic separation test procedures are provided in Attachment C.

3.1.6 Post-Injection Groundwater Sampling

Following the completion of the ZVI injection, the 26 new and existing source area MWs (see Figure 1) will be sampled on a quarterly basis and analyzed for the same parameters discussed in Section 3.1.1 (baseline sampling). An additional year of monitoring will be conducted in areas selected for strategic ZVI re-injection. Otherwise, groundwater monitoring beyond 1 year will be conducted as part of the long-term monitoring program that will be prepared as part of the third RD for Dunn Field (Off-Depot groundwater). The sampling schedule may change due to observed trends and variability.

3.2 Soil Remedy – Loess Deposits (Thermal-Enhanced SVE)

As described in Section 2, the specific vendor for the thermal-enhanced SVE soil remedy will be selected during the RA process. Though the final sampling and monitoring requirements for the thermal-enhanced SVE system will be defined by the vendor, preliminary approaches for each method are described below.

3.2.1 Temperature Monitoring

ERH: TRS plans to install 22 TMPs, each containing six thermocouples or thermistors to monitor the soil temperature in 5-foot intervals. The TMPs would be installed several feet from the electrode to ensure that the bulk soil temperature is monitored.

ISTD: TerraTherm plans to monitor their thermocouples frequently to ensure that the entire target treatment zone (TTZ) is heated to the target temperature. If cool zones are detected, more power would be delivered to these zones or additional heaters would be installed. The first criteria for having achieved the performance standards is to have the entire TTZ heated to the target temperature. Forty boreholes would be used for temperature monitoring.

3.2.2 Vacuum and Vapor Monitoring Points (Piezometers)

ERH: Each TMP boring would also include one or more vacuum piezometer intervals at various depths. These piezometer intervals would be used to verify that vacuum influence is established and maintained during the remediation.

ISTD: The subsurface process would be monitored using pressure sensors.

3.2.3 Extracted Soil Vapor Sampling

Extraction well and treatment system influent and effluent vapor samples will be collected routinely to evaluate mass removal rates and the effectiveness of the thermal-enhanced SVE vapor treatment systems and assess the need for system modifications.

ERH: The vapor-phase GAC units would be monitored to ensure treatment effectiveness.

ISTD: Performance of the effluent treatment system for separation and treatment of vapors and entrained liquids would be verified by detailed process sampling. The removed COC mass would be monitored as follows:

- Some of the COC mass would be condensed in the compression and chilling unit. The volume would be readily measured by the tracking the quantity of non-aqueous phase liquid (NAPL) collected in drums or other suitable storage containers.
- COC mass in the condensate would be estimated from a simple summation of volume and COC concentrations, using grab samples submitted to a laboratory for VOC analysis and simple flow meters to track the volume of condensate produced.
- The COCs that were not condensed would be trapped in the vapor-phase GAC unit and then quantified based on the observed influent and effluent vapor concentrations. Literature values for GAC trapping capacity would also be used to estimate the mass for each regeneration cycle.

3.2.4 Soil Sampling

Confirmation soil samples will be collected at or near the pre-treatment sample locations (RDI and, if applicable, baseline locations) to compare directly with the pre-treatment soil samples and to evaluate whether RGs have been achieved. Approximately 30 soil samples will be collected at the onset of the cool-down phase, capped, cooled, and then shipped to a laboratory for analysis. The hot soil sampling method that was validated during the Cape Canaveral Inter-Agency demonstration project (Gaberell, 2002) will be used (see Attachment D).

In addition to a direct comparison to baseline levels at a specific location, the number of samples will allow for a statistical analysis to evaluate whether the overall site is below RGs within a defined confidence level. Soil samples will also be collected based on the temperature profile during treatment (that is, samples will be collected where temperature objectives were not achieved). The proposed loess sample locations are shown on Figure 3. The analytical results from the RDI, which are summarized in Table 5, will be compared with the post-treatment sampling results.

Select electrodes or heater wells could be re-activated as necessary and treatment would continue until RGs are achieved. Confirmation soil sampling would be repeated following the completion of the second heating cycle.

3.2.5 Condensate Sampling

ERH: Approximately 9 gpm of condensate would be collected, treated as necessary, and then discharged to the City of Memphis POTW through the existing interim remedial action (IRA) groundwater recovery system.

ISTD: Approximately 5 to 6 gpm of condensate would be treated with liquid-phase GAC. Literature values for GAC trapping capacity would be used to estimate the mass for each regeneration cycle.

Condensate would be discharged to the City of Memphis POTW through the existing IRA groundwater recovery system. The condensate would be collected and then transferred to the existing groundwater IRA system via conveyance piping or other vendor-selected method. Condensate samples will be collected and analyzed for ph, VOCs, semivolatile organic compounds (SVOCs), target analyte list (TAL) metals, in accordance with the current agreement with the City of Memphis. 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 of the recording clearly noted.

3.2.6 Ambient Air Monitoring

Weekly to monthly field screening using an organic vapor analyzer (OVA)-FID will be performed to gather semi-quantitative VOC data from the periphery of the soil treatment system to assess the presence of fugitive emissions. In the event ambient air VOC concentrations are 1 parts per million by volume above baseline total VOCs, formal ambient air monitoring will be performed as an interim response action. Sampling methods and equipment are summarized in Table 3d.

Ambient air samples will be collected using 6-liter SUMMA canisters placed on a table approximately 3 to 5 feet above ground surface. The canisters will be equipped with metering valves calibrated in the laboratory to allow 8 hour time-weighted average (TWA) sample collection. Three to five ambient air samples will be collected during each sampling event:

- One upwind sample that represents background ambient air
- One to three samples in the treatment area (potential vapor source)
- One downwind sample will be collected near the potential receptors

A portable weather monitoring station will be installed onsite to record wind direction and speed during each sampling event. Since the treatment area is not immediately adjacent to occupied buildings, the hazard associated with fugitive air emissions is not expected to be significant. However, if ambient air sampling indicates chlorinated VOC concentrations exceed the Occupational Safety and Health Administration (OSHA) action level or EPA

Region 9 preliminary goals, the SVE system will be adjusted or deactivated until vapor mitigation can be addressed (for example, repair the soil cover, modify the loess air injection or extraction flow rates). All field measurements will be recorded in field logbooks, with the date, time, and location of the recording clearly noted.

3.3 Soil Remedy – Loess Deposits (Excavation, Transportation, and Offsite Disposal)

3.3.1 Post Remedial Soil Compliance Monitoring

Confirmation samples will be collected in accordance with the State of Michigan DEQ *Verification of Soil Remediation* Guidance Document (Michigan DEQ, April 1994). Because the proposed excavation is less than 0.25 acre, the small site soil cleanup verification guidance, which emphasizes biased sampling, will be used for this RA. The biased approach specified in this guidance recommends soil sampling from areas most likely to exceed the cleanup criteria. This approach minimizes the number of samples required to verify that a site meets the cleanup criteria.

The samplers will choose the confirmation sample locations based on information from the RI, the RDI, and observations during the removal effort. Sample location rationale will be included in the Remedial Action Completion Report (RACR). Tables 1 and 2 in the Michigan DEQ *Verification of Soil Remediation* Guidance Document were used to determine the minimum number of floor and side wall samples. Two floor samples and five sidewall samples will be collected from the excavation. Samples will be analyzed for VOCs, as presented in Table 3c.

3.3.2 Waste Characterization Sampling

Samples will be collected from the soil stockpiles and analyzed for leachability according to TCLP via EPA Method 1311 in accordance with Table 3c; samples will also be analyzed for reactivity, corrosivity and ignitability (RCI). One composite sample will be collected for each excavation. At least five aliquots will be collected from each batch using a clean stainless steel spoon or hand auger. Each of the aliquots will be transferred to a clean stainless steel bowl for mixing. The composite will be placed into the appropriate sample jars for transport to the laboratory for analysis.

Samples for VOC analysis will be collected directly from the stockpile not from composited soil and according to EPA SW846 Method 5035 using a syringe. This method is thoroughly described in Section 12.4 of the November 2001, US EPA Science and Ecosystem Services Division *Environmental Investigation Standard Operating Procedures and Quality Assurance Manual* (EISOPQAM).

3.3.3 Liquid Waste Sampling

If encountered, all drums and bottles will be excavated and then sampled in accordance with the attached EPA Drum Sampling Standard Operating Procedure (SOP) (see Attachment E) and segregated from the excavated soil. If the liquid waste remains in drums, one composite sample will be taken from no more than ten drums of like waste. If collected in bulk, the liquid waste will be sampled once per bulk container (tanker truck, roll-off). The liquid waste will be sampled for the methods listed in Table 3c. The liquid waste will be sent for offsite disposal/treatment based on the sampling results.

3.3.4 Borrow Areas Sampling

At least one grab sample will be collected from each RAC-selected borrow area using stainless steel hand augers, bowls, and spoons to ensure that the excavations are backfilled with clean soil. Samples will be analyzed for select TCL/TAL parameters, as presented in Table 3c. Samples will be collected with a clean hand auger and transferred to a clean stainless steel bowl before placing the material into the appropriate sample jars for transport to the laboratory for analysis.

TCL/TAL parameters include VOCs, SVOCs, pesticides/herbicides, polychlorinated biphenyls (PCBs), and metals.

3.3.5 Air Sampling

For H&S protection of all field staff, all operations at the site will include ambient air monitoring that includes instrumentation capable of detecting explosive vapors (i.e., combustible gas indicators), oxygen content, dust levels, and organic vapors. Ambient air monitoring with a calibrated FID at regular intervals is required for the entire excavation period. In addition, ambient air measurements will be collected prior to excavation to establish ambient and background conditions and, at the end of the excavation to determine if any residual vapors exist near the disposal areas. FID monitoring will be conducted at various monitoring points selected during the background measurement collection and maintained for the entire field effort. Analytical instruments will be calibrated in accordance with the manufacturer's instructions. All measurements will be recorded in field notebooks with the date, time, and location of the recording clearly noted and noted in a daily calibration log.

During the excavation effort, screening for hazardous ambient conditions will be conducted through the use of a combustable gas indicator (CGI)/oxygen (O_2) meter and dust monitors. This sampling effort is necessary to alert personnel to potential buildup of explosive levels of gases in the disposal pits or for hazardous dust levels, especially at sites containing lead in the soil. For hazardous gas monitoring, instruments can be placed at an established monitoring point preferably close to the edge of each excavation whereas for dust monitoring, monitoring points can be established at the work perimeter or perimeter of Dunn Field. The measurements will be recorded in field notebooks with the date and time of the recording and location of the measurement clearly noted. Analytical instruments will be calibrated in accordance with the manufacturer's instructions and noted in a daily calibration log.

3.4 Soil Remedy – Fluvial Sands

The following monitoring will be conducted for the fluvial sands SVE system.

3.4.1 Soil Vapor Extraction System Monitoring

As discussed below and summarized in Table 3d, SVE system monitoring will be conducted at the following locations:

- Individual extraction wells (field screening)
- VMPs (field screening)
- Inlet and outlet of vapor treatment system (field screening and laboratory analysis)

Individual Extraction Well Locations

As summarized in Table 6, field screening using an OVA-FID will be performed at daily, weekly, quarterly, and semiannual intervals to gather semi-quantitative VOC data from the seven fluvial SVE wells. All of the fluvial extraction wells sampling locations are consolidated at the treatment equipment compound.

Field screening vapor samples should 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 should not be collected at the discharge of the pump, because hydrocarbon vapors may be entrained in the exhaust. Measurements will be collected prior to the test to establish ambient and background conditions. Prior to analysis with the calibrated OVA-FID, each sample will be collected in a Tedlar® bag. Analytical instruments will be calibrated in accordance with the manufacturer's instructions. All measurements will be recorded in field logbooks, with the date, time, and location of the recording noted clearly and noted in a daily calibration log.

The OVA-FID data will be used to track remedial progress in specific zones and subsequently emphasize treatment in potentially recalcitrant areas.

Laboratory samples will also be collected using SUMMA canisters and submitted for laboratory analysis via EPA TO-14/15 VOCs. Sample collection protocol used in the field will follow the EPA guidance document Standard Operating Procedure (SOP) 1704: SUMMA Canister Sampling (1995) and Section 14 of the EISOPQAM. 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. All field measurements will be recorded in field logbooks, with the date, time, and location of the recording clearly noted.

Vapor Monitoring Points

As summarized in Table 6, field screening using an OVA-FID will be performed at daily, weekly, quarterly, and semiannual intervals to gather semi-quantitative VOC data from the 10 vapor (and vacuum) monitoring points (see Figure 2). The field screening vapor samples will be collected and analyzed like the individual extraction well locations.

In addition, portable magnehelic differential pressure gauges of various scale ranges (for example, 0.025, 0-1, 0-5, and 0-10 inches of water) 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. Use a non-oil-based grease 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 of the recording clearly noted.

Vapor Treatment System

Extracted vapor would be treated with GAC, contained in epoxy coated steel vessels. Each vessel would contain 2,000 pounds of vapor-phase GAC. As summarized in Table 6, field screening using an OVA-FID will be performed quarterly to gather semi-quantitative VOC data from the GAC unit during the first year of operation; vapor treatment is not expected to be required beyond Year 1. The field screening vapor samples will be collected and analyzed like the individual extraction well locations.

Laboratory samples will also be collected using SUMMA canisters and submitted for laboratory analysis via EPA TO-14/15 VOCs. Sample collection protocol used in the field will follow the EPA guidance document SOP 1704: SUMMA Canister Sampling (1995) and Section 14 of the EISOPQAM. 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. All field measurements will be recorded in field logbooks, with the date, time, and location of the recording clearly noted.

3.4.2 Condensate Sampling

Condensate would be discharged to the City of Memphis POTW through the existing IRA groundwater recovery system. The condensate flow rate is expected to be low from the fluvial SVE system (less than 1 gpm) and not require treatment prior to discharge to the POTW. The condensate will be collected in a sump (within the moisture separator) and then pumped to a 535 gallon holding tank. Periodically, the contents of the tank will be removed and then discharged to the City of Memphis POTW through the existing IRA groundwater recovery system.

Initially, condensate samples will be collected prior to discharge and analyzed for ph, VOCs, SVOCs, and TAL metals in accordance with the current agreement with the City of Memphis; the sampling frequency is expected to decrease over time. 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 of the recording clearly noted.

3.4.3 Soil Sampling

Once SVE system shutdown is proposed following a pulsing and/or rebounding evaluation (see Section 5), approximately 20 to 30 randomly located soil samples will be collected from the treated areas and analyzed for VOCs. In addition to a direct comparison with baseline levels at a specific location (for example, near MW-73 in TA2), the number of samples will allow for a statistical analysis to evaluate whether the overall site is below RGs within a defined confidence level. Soil samples will also be collected based on the radius of extraction influence during treatment (that is, samples will be collected where there may have been low soil vapor flow zones).

During the drilling of each boring, soil cores will be collected in continuous sampling mode from land surface to the bottom of each boring (groundwater table). Sampling methods and equipment are summarized in Table 3c.

The core samples will be collected in plastic tube bags placed at the end of the core barrel subsequent to drilling each 10- to 20-foot length. The core samples will be cut open and examined for geologic characteristics immediately upon return to the surface. Headspace field screening (see *Field Screening SOP in Technical Memorandum SA.01 – Data Collection Plan for Long-Term Operational Areas (LTOAs), MI, Memphis Depot*) will be conducted over each core using an OVA-FID until the last core is removed from the boring. At least one soil samples will be collected where the OVA-FID measurements are highest within the formation.

The SVE system will be shut down permanently (for one or more treatment areas) if soil concentrations are at or below the RGs presented in Table 2-21G of the final Dunn Field ROD (CH2M HILL, 2004). Otherwise, strategic operation will continue. All field measurements will be recorded in field logbooks, with the date, time, and location of the recording clearly noted.

3.4.4 Velocity/Flow and Pressure Measurements

Velocity/flow and pressure will be measured through the SVE system using gauges and flow meters and the same frequency as the vapor sampling events. These data will be used with the field and analytical VOC data to calculate mass flow rates through the SVE system. 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 of the recording clearly noted.

3.5 General Construction and Waste Management

3.5.1 Excavated Soil

Soil samples will be collected from stockpiles using a hand auger or other sampling device appropriate for the field conditions encountered at the time of sampling. A sample will be obtained by collecting at least five aliquots from 250 cubic yard batches. Each of the aliquots will be transferred to a clean stainless steel bowl for mixing. The composite will be placed into the appropriate sample jars for transport to the laboratory, where they will be analyzed for leachability according to toxicity characteristic leachate procedures via EPA Method 1311 in accordance with Table 3e.

Samples for VOC analysis will be collected directly from the stockpile — not from composited soil and according to EPA SW846 Method 5035 — using a syringe. This method is thoroughly described in Section 12.4 of the November 2001 EPA Science and Ecosystem Services Division *Environmental Investigation Standard Operating Procedures and Quality Assurance Manual* (EISOPQAM).

3.5.2 Water

Surface Water

Surface water may accumulate in the excavations and staging areas due to incidental rainfall. Surface water removed from the excavations and stockpiles will be containerized in a mobile tank, as necessary. At the completion of the RA, samples will be analyzed for the target compound list (TCL)/TAL parameters presented in Table 3e to assess disposal options (for example, POTW).

Decontamination Water

Decontamination water will be collected in drums. At the completion of the RA, samples will be analyzed for the TCL/TAL parameters presented in Table 3e to assess disposal options (for example, POTW).

4.0 Sample Identification and Labeling

4.1 Sample Identification

4.1.1 Soil and Water Samples

Each soil and water sample collected from the site during the RA will be identified by a unique sample designation code. The sample designation code will be recorded on the sample label affixed to the sample container, in the field logbook, and on the chain-of-custody form accompanying the sample. These codes will be used to track each sample.

The samples will be identified by the following sample designation scheme:

Project | Date | Sampling Location | Sample Type | Sample Number

where:

project	=	Dunn Field Source Area RA (SARA)
date	=	date of sample collection (month, day, year)
sampling location	=	FE3 for Fluvial Extraction 3 T1/FM3 for Fluvial Manifold 3 from Treatment Area 1 SW1/T3 for storm water sample number 1 from Treatment Area 3 TB for trip blank RB or EB for rinseate blank or equipment blank, respectively FB for field blank
sample type	=	grab (G) or composite (C)
sample number	=	first, second, third, etc. sample collected from same location

Therefore, sample designation code SARA-081507-T1/FM3-G-01 indicates the first GRAB sample from Fluvial Manifold 3 in Treatment Area 1 that was collected on August 15, 2007. Similarly, sample designation code DSRA-081507-TB-G-1 indicates trip blank number one shipped from the site on August 15, 2007.

For organics analyses, the sample for matrix spike/matrix spike duplicate (MS/MSD) will be identified on the chain-of-custody form. Field duplicates will not be identified on the chain-of-custody form; these samples will be given fictitious sample designation codes. However, the field duplicates will be identified in the field logbook.

4.1.2 Air Samples

The field screening data collected from the OVA-FID and/or combustible gas indicator/oxygen (CGI/O_2) meters will include the following:

- Date and time
- Location of measurement/location where the sample was collected (as necessary)
- Instrument measurement

Each measurement will be handwritten into a bound field logbook and then transferred into an electronic file. Field logbooks should also contain instrument calibration completion records and background monitoring information.

4.2 Soil and Water Sample Labels

All soil and water samples obtained at the site will be placed in appropriate sample containers, as identified in Tables 3-3a to 3-3e, for shipment to the laboratory. Each sample container will be identified with a separate identification label. Labeling will be done in indelible/waterproof ink. Errors will be crossed out with a single line, dated, and initialed. Each securely affixed label will include the following information:

- Project identification
- Sample identification
- Sampler's name or initials
- Preservatives added
- Date of collection
- Time of collection
- Required analytical method numbers

4.3 Sample Logbook Documentation

The field logbooks will be maintained by the Site Manager and by personnel responsible for sampling and support activities. The logbooks will be completed in permanent blue or black ink. Errors will be corrected by crossing out with a single line and then dating and initialing. The use of correction fluid will not be permitted. The field logbooks used during the remedial activities will remain onsite during the entire field effort.

In general, these logbooks will contain the specific details supporting the tasks performed by the person maintaining the field logbook, including ambient air monitoring readings and sample documentation. Any administrative occurrences, conditions, or activities that affect the field work will also be recorded. All logbook entries will be signed and dated. The following is a partial list of the types of information that will be recorded in the field logbooks:

- Name and title of author
- Date and time of entry
- Name and address of field contact
- Names and titles of field crew for each day
- Weather conditions at the site for each day
- Documentation of health and safety activities
- Field instrument calibration information
- Type of sampled media (for example, soil or water)
- Sample identification numbers
- Observations on sample color, odor, or unusual characteristics
- The information contained on the sample bottle labels
- All field measurements, such as CGI/O_2 readings, OVA-FID measurements

- Number and type of bottles shipped to the laboratory
- Airbill number from overnight courier forms
- Decontamination procedures
- Number of coolers shipped
- Duplicate samples (these samples will not be identified as duplicates on the chain-of custody records)

5.0 SVE Rebound Testing Procedures

This section presents a brief overview of the fluvial sands SVE system rebound testing procedures. Rebound testing and analysis will be completed at various points during operation of the system to assess remediation progress.

5.1 Implementation of the Rebound Testing

Rebound testing will be conducted in two phases:

- Implementation as part of SVE operations
- Implementation leading to final shutdown

5.1.1 Implementation of Rebound Testing as Part of SVE Operations

Rebound testing will be conducted during periods of downtime for system maintenance. During those periods, adjacent monitoring points and appropriate system manifolds will be sampled using SUMMA® canisters and the procedures described in Section 3. These tests should be conducted early in the operational schedule to establish a baseline for comparison with future tests. Subsequent tests should follow at 6-month intervals or according to maintenance schedules. Data from these tests will be plotted as concentration versus time of operation and also as contour plots on a base map for assessment of remediation progress.

5.1.2 Implementation of Rebound Testing Leading to Final Shutdown

If contaminant gas concentration versus time indicates that asymptotic levels (see Figure 4) have persisted longer than 6 months at any point during the treatment period, temporary shutdown of SVE operations in particular areas or site-wide will be appropriate. The temporary shutdown will last for 4 consecutive weeks, during which time the RAC will sample those monitoring points adjacent to the testing area, as well as the appropriate manifolds, on a weekly basis. Samples will be collected using SUMMA® canisters and the procedures described in Section 3.

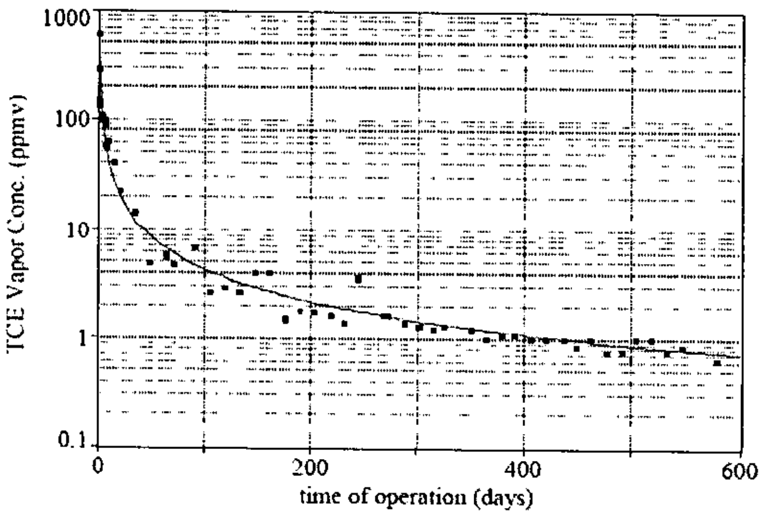


Figure 4 Example of an Asymptotic Curve for Vapor Concentration of TCE (EPA, 2001).

The analytical data obtained from the samples will be compared with indicator levels provided in Table 2-3 of the Source Areas RD.

If the data indicate that gas contaminant concentrations are at or below the indicator levels, then the RAC will make a recommendation to the Base Realignment and Closure Cleanup Team (BCT) for commencement of soil sampling as described in Section 3. If the data indicate that gas contaminant concentrations are above the indicator levels, then SVE system operations will continue for another 6-month period before another rebound test begins. The second rebound test procedure will be similar to the first. If data indicate that gas contaminant concentrations are at or below the indicator levels at any point during the rebound testing phase, then the RAC will make a recommendation to the BCT for commencement of confirmation soil sampling.

6.0 References

AFCEE. 2001. *Guidance on Soil Vapor Extraction Optimization. June 2001.* http://en.afit.af.millenv/Documents/ENVR%20772/sve%20optimization.pdf

CH2M HILL. 2002. *Remedial Investigation Report - Dunn Field.* Rev. 02. Defense Distribution Depot Memphis, Tennessee. Prepared for the U.S. Army Engineering Support Center, Huntsville, Alabama. July.

CH2M HILL. 2004. *Final Memphis Depot Dunn Field Record of Decision.* Prepared for the U.S. Army Engineering and Support Center, Huntsville, Alabama. March.

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

Gaberell, M., A. Gavaskar, E. Drescher, J. Sminchak, L. Cumming, W-S. Yoon, and S. De Silva. 2002. Soil Core Characterization Strategy at DNAPL Sites Subjected to Strong Thermal or Chemical Remediation. Paper 1E-07, in: A.R. Gavaskar and A.S.C. Chen (Eds.), Remediation of Chlorinated and Recalcitrant Compounds—2002.

MACTEC. 2004. Remedial Action Sampling and Analysis Plan Volume I: Field Sampling Plan and Volume II: Quality Assurance Project Plan. Defense Depot, Memphis, Tennessee. Rev. 0. September.

USACE. 1999. *U.S. Army Corps of Engineers Soil Vapor Extraction Performance Checklist.* HTRW Center of Expertise Library - Guidance. June. http://www.environmental.usace.army.mil/library/guide/rsechk/rsechk.html

U.S. Environmental Protection Agency (EPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA.* Office of Solid Waste and Emergency Response Directive 9355.3-01. October.

U.S. Environmental Protection Agency (EPA). 1994. *Guidance for the Data Quality Objectives Process.* EPA-600-R-96-055. September.

U.S. Environmental Protection Agency (EPA). 1995. *EPA Requirements for Quality Assurance Project Plans for Environment Data Operations.* EPA QA/R-5. November.

U.S. Environmental Protection Agency (EPA). 2001. Development of Recommendations and Methods to Support Assessment of Soil Venting Performance and Closure. Office of Research and Development. EPA/600/R-01/070. September.

Figures

LEGEND

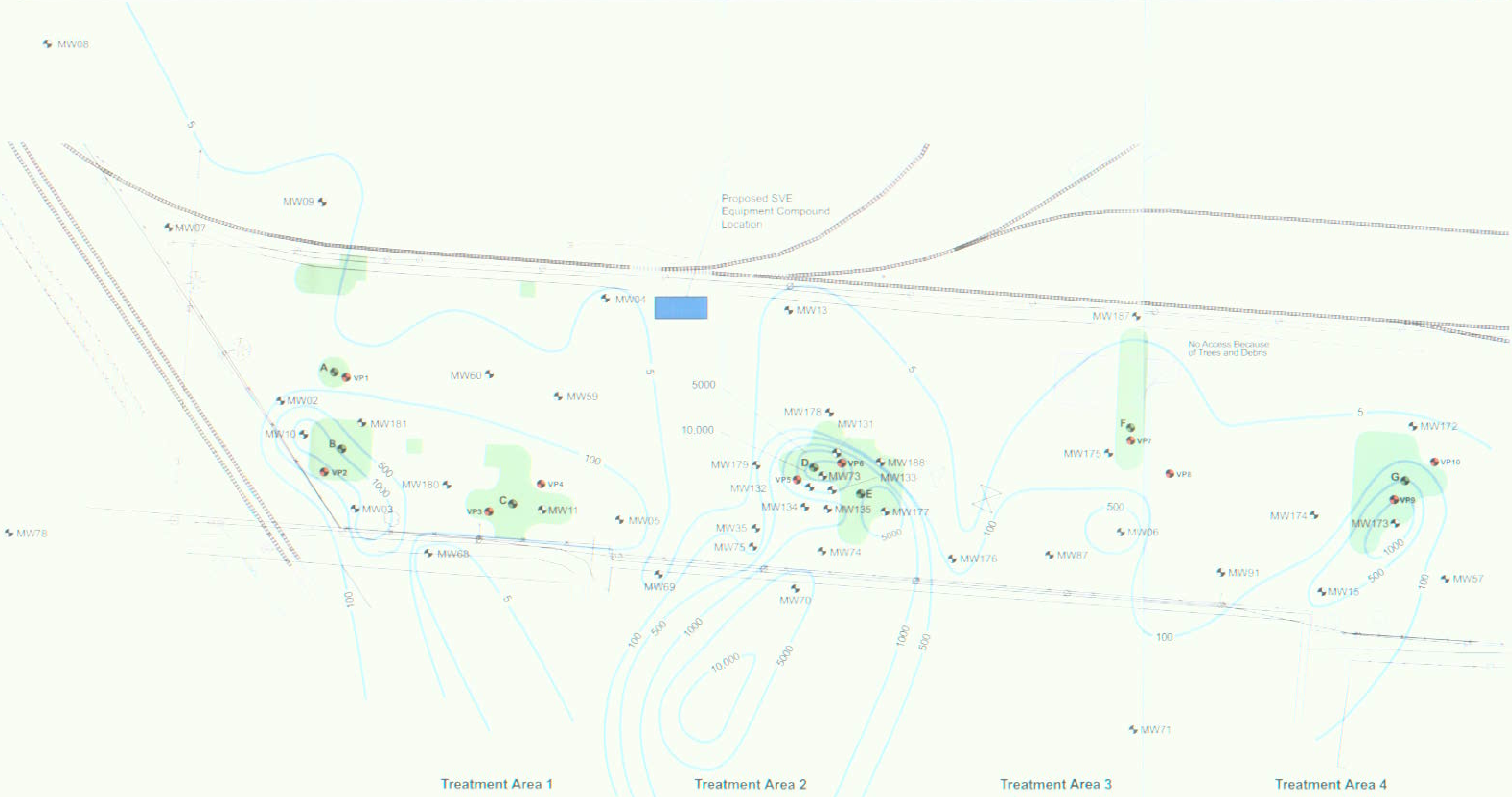
- Monitoring Well Location
- Monitoring Well Location (RA Monitoring)
- 100 — Groundwater Total CVOC Contours (µg/L) (November 2005)
- Monitoring Well Location (to be abandoned and replaced with a new stainless steel monitoring well)
- Extent of Soil Requiring Remedial Action Areas based on MIP and Soil Sample Data

FIGURE 1
Groundwater Monitoring Well Locations
Performance Standards Verification Plan
Memphis Depot Dunn Field

CH2MHILL

ES082006008ATL Memphis 112.ai

889 931



LEGEND

- Monitoring Well Location
- 100 Groundwater Total CVOC Contours (µg/L) (November 2005)
- A Fluvial Sands SVE Well
- VP1 Vapor Monitoring Point
- Extent of Soil Requiring Remedial Action: Areas based on MIP and Soil Sample Data

North

0 128 256

Approximate scale in feet

FIGURE 2
Fluvial Sands SVE Vapor Monitoring Point Locations
Performance Standards Verification Plan
Memphis Depot Dunn Field

CH2MHILL

Summary of Proposed Sample Locations				
Northing	Easting	Depth	MIP ID	PSVP ID
TA1	No. of samples= 9			
281315.36	802101.93	29-30	30B	1-1
281355.31	802104.81	21-22	31B	1-2
281355.31	802104.81	29-30	31B	1-3
281589.20	802201.24	26-27	37D	1-4
281631.85	802164.24	10-11	38C	1-5
281629.05	802204.03	18-19	38D	1-6
281623.51	802283.88	6-7	38F	1-7
281615.18	802403.54	11-12	38I	1-8
281655.05	802406.31	7-8	39I	1-9
TA2	No. of samples= 9			
280913.60	802114.08	28-29	20C	2-1
280910.79	802154.03	19-20	20D	2-2
280956.27	802076.95	29-30	21B	2-3
280953.50	802116.92	29-30	21C	2-4
280950.65	802156.81	29-30	21D	2-5
280990.56	802159.57	13-14	22D	2-6
280990.56	802159.57	29-30	22D	2-7
280987.81	802199.47	29-30	22E	2-8
281030.53	802162.39	25-26	23D	2-9
TA3	No. of samples= 6			
280588.78	802171.75	28-29	12E	3-1
not surveyed		27-28	12F	3-2
not surveyed		12-13	12F (+20)	3-3
not surveyed		27-28	12F (+20)	3-4
not surveyed		12-13	12H	3-5
not surveyed		27-28	12H (+20)	3-6
TA4	No. of samples= 3			
280232.40	802106.79	22-23	3D	4-1
280229.64	802146.71	14-15	3E	4-2
280275.07	802069.67	12-13	4C	4-3

LEGEND
- Soil Boring Location (1999 Investigation)
- Source Area Soil Boring Location (2000 Investigation)
- Monitoring Well Location
- RA Soil Sample Location
- Groundwater Total CVOC Contours (µg/L) (November 2005)
- Exceedance of Site-Specific Screening Levels To Be Protective Of Groundwater (CVOCS)
- RDI Soil Sample Location
- Extent of Loess Requiring Remedial Action

NOTE
Shaded areas based on MIP and soil sample data

FIGURE 3
Proposed Soil Sample Locations for Loess
Thermal-Enhanced SVE System Monitoring
Performance Standards Verification Plan
Memphis Depot Dunn Field

CH2MHILL

Tables

TABLE 1
Recommended Data Quality Levels
Memphis Depot Dunn Field Performance Standards Verification Plan

Sampling Activity	Data Quality Level Category
Groundwater	
Baseline and Post-ZVI Injection Groundwater Sampling (field measurements including temperature, pH, turbidity, color, visible particulate, water level measurements, redox potential, dissolved oxygen, Hach Kit for ferrous/total iron, carbon dioxide Hach digital titrator test)	Screening
Baseline and Post-ZVI Groundwater Sampling (offsite laboratory analyses)	Definitive
ZVI	
ZVI QA/QC Sampling (offsite laboratory analyses)	Definitive
ZVI/Water slurry composition (meter and visual measurement)	Screening
Soil	
Soil Sampling (field measurements using FID)	Screening
Soil Sampling (field observation of iron presence)	Screening
Soil Sampling (offsite laboratory analyses)	Definitive
Borrow Area Sampling (offsite laboratory analyses)	Definitive
GAC	
GAC trapping capacity	Screening
SVE Condensate	
Monthly Condensate Sampling (field measurements)	Definitive
Semiannual Condensate Sampling (offsite laboratory analysis)	Definitive
Vapor	
Individual extraction well locations (field measurements using FID)	Screening
Vapor monitoring points (field measurements using FID)	Screening
Extraction manifolds (field measurements using FID)	Screening
Extraction manifolds (offsite laboratory analyses)	Definitive
Inlet and outlet of vapor treatment system (field measurements using FID)	Screening
Inlet and outlet of vapor treatment system (offsite laboratory analyses)	Definitive
Ambient Air Concentrations (field measurements using OVA-FID)	Screening
Ambient Air Concentrations based on field screening (offsite laboratory analysis)	Definitive
Waste Characterization	
Waste characterization of solid and aqueous waste (offsite laboratory analyses)	Definitive

Notes:
GAC – granular activated carbon
FID – flame ionization detector
OVA – organic vapor analyzer
SVE – soil vapor extraction
VOC – volatile organic compound
ZVI – zero-valent iron

TABLE 2
Groundwater Monitoring Parameter Summary
Memphis Depot Dunn Field Performance Standards Verification Plan

Parameter	Laboratory Method
Volatile Organics	
Volatile Organics	Fixed Based Laboratory - SW846 Method 8260B
Dissolved Gases	
Methane	Fixed Based Laboratory – Microseeps Method AM 19A
Ethane	Fixed Based Laboratory – Microseeps Method AM 19A
Ethene	Fixed Based Laboratory - Microseeps Method AM 19A
Carbon Dioxide	Field Direct Reading Instrument – HACH Digital Titrator Test Kit
Dissolved Oxygen	Field Direct Reading Instrument – YSI 6820 Multimeter
Geochemical Parameters	
Color	Field/Visual
Visible particulate	Field/Visual
Turbidity	Field Direct Reading Instrument – YSI 6820 Multimeter
Alkalinity	Fixed Based Laboratory - EPA Method 310.2
Chloride	Fixed Based Laboratory - SW846 Method 9056
Nitrate/Nitrite	Fixed Based Laboratory - SW846 Method 9056
Oxygen Reduction Potential (ORP)	Field Direct Reading Instrument – YSI 6820 Multimeter
pH	Field Direct Reading Instrument – YSI 6820 Multimeter
Sulfate	Fixed Based Laboratory - SW846 Method 9056
Sulfide	Fixed Based Laboratory - EPA Method 376.1
Temperature	Field Direct Reading Instrument – YSI 6820 Multimeter
Total Organic Carbon (TOC)	Fixed Based Laboratory - EPA Method 415.1
Dissolved Metals	
Ferrous Iron	Field Direct Reading Instrument – HACH Colorimetric Meter
Total Iron	Field Direct Reading Instrument – HACH Colorimetric Meter
Total Manganese	Fixed Based Laboratory - SW846 Method 6010B

Note: Field analyses are shaded gray.

TABLE 3a

Groundwater Sample and Analysis Summary

Memphis Depot Dunn Field Performance Standards Verification Plan

Sample Task	Sample Point	Matrix	Sampling Frequency	Approx. Sample No. per Event	Sampling Method	Sampling Equipment	TAT	DQO Level/Data Package Requirement	Required Analysis	Analytical Methods	Holding Time	Sample Preservation	Containers
Baseline Groundwater Sampling Event													
Baseline Groundwater Sampling Event	26 monitoring wells	Water	Once	26, 3 dup (10%), and MS/MSD (5%)	Grab; Low flow technique	Flow-thru cell, bladder pump, Teflon-lined tubing	14 days	DQO Level III	Volatiles	8260B	14 days	Cool to 4°C	(2) 40 mL vial
	Equipment Rinsate	Water	1 per 10 samples (10%)	3	Prepared in	Analyte-free water SS	14	DQO Level III	Volatiles	8260B	14 days	HCl pH<2, Cool to 4°C	(2) 40 ml vial
	Trip Blank	Water	1 per cooler containing volatile samples	5	Prepared by Lab	N/A	14 days	DQO Level III	Volatiles	8260B	14 days	HCl pH<2 Cool to 4°C	(2) 40 ml vial
Post Treatment Groundwater Sampling													
Groundwater Monitoring (Field parameters)	26 monitoring wells	Water	Quarterly	26	Grab; Low flow technique	Flow-thru cell, bladder pump Teflon-lined tubing	14 days	DQO Level II+II3 Screening	Oxidation Reduction Potential (ORP)	Direct Read Meter/Flow-thru cell	ASAP	N/A	N/A
									Dissolved oxygen (DO		ASAP	N/A	N/A
									Temperature		ASAP	N/A	N/A
									Color	Field Visual	ASAP	N/A	N/A
									pH	Direct Read Meter/Flow-thru cell	ASAP	N/A	N/A
									Turbidity		ASAP	N/A	N/A
									Visual Particulate	Field Visual	ASAP	N/A	N/A
									Carbon Dioxide	Field Read - Hach Digital Titrator Kit	ASAP	N/A	N/A
									Total Iron	Field Read - Hach Colormetric Meter	ASAP	N/A	N/A
									Ferrous Iron		ASAP	N/A	N/A
Groundwater Monitoring (Lab Parameters)				26, 3 dup (10%), and MS/MSD (5%)				DQO Level III	Volatiles	8260B	14 days	HCl pH<2 Cool to 4°C	(2) 40 ml vial
Groundwater Monitoring (QA/QC)	Equipment Rinsate	Water	1 per 10 samples (10%)	3	Prepared in	Analyte-free water SS	14 days	DQO Level III	Volatiles	8260B	14 days	HCl pH<2, Cool to 4°C	(2) 40 ml vial
	Trip Blank		1 per cooler containing volatile samples	5	Prepared by Lab	N/A		DQO Level III, CCI Level C	Volatiles	8260B	14 days	HCl pH<2 Cool to 4°C	(2) 40 ml vial
Water Sampling													
Water sampling	Water collected from excavations etc.	Water	Variable	Variable	Grab	Sample container	14	CLP-like full package	TCL VOCs	5035/8260B	14 days	HCl pH< 2 Cool to 4°C	(2) 40 mL vials
									TCL SVOCs	8270C	14 day extr, 40 day analysis	Cool to 4°C	(1) Liter amber glass
									TCL Pesticides	8081A	14 day extr; 40 day analysis	Cool to 4°C	(1) Liter amber glass
									TCL PCBs	8082	14 day extr, 40 day analysis	Cool to 4°C	(1) Liter amber glass
									Herbicides	8151A	14 day extr, 40 day analysis	Cool to 4°C	(1) Liter amber glass
									TAL Metals	6010B/7471A	6 months	HNO_3 pH< 2, Cool to 4°C	(1) 500 mL HDPE

Notes:

1 - Wells will be purged with QED or equivalent low-flow device. Samples will be collected using teflon tubing and pump.

TAT = Turnaround time

VOC = Volatile organic compound

SVOC = Semivolatile organic compound

C = degrees Celsius

ml = milliliter

NA = Not Applicable

889 986

TABLE 3b
ZVI Sample and Analysis Summary
Memphis Depot Dunn Field Performance Standards Verification Plan

Sample Task	Sample Point	Matrix	Sampling Frequency	Approx Sample No	Sampling Method	Sampling Equipment	TAT	DQO Level/Data Package Requirement	Required Analysis	Analytical Methods	Holding Time	Sample Preservation	Containers
Zero-Valent Iron Characterization													
ZVI Character-ization Sampling	Batching location of the ZVI	Iron	5% of supersacks	1 per batch	Grab	SS Spoon, SS Bowl	14 days	DQO Level III	TCL SVOC	8270C	14 day extr; 40 day analysis	Cool to 4°C	(2) 8 oz glass
									TCL Pesticides	8081A	14 day extr; 40 day analysis		
									Herbicides	8151A	14 day extr; 40 day analysis		
									PCBs	8082	14 day extr; 40 day analysis	Cool to 4°C	(2) 8 oz glass
									TAL Metals	6010B/7000 series	6 month; Hg: 28 day		

Notes:
TAT = turnaround time
TCL/TAL = Target Compound List/Target Analyte List
VOC = Volatile organic compound
SVOC = Semivolatile organic compound
C = Celsius
NA = Not Applicable

TABLE 3c

Soil Sample and Analysis Summary

Memphis Depot Dunn Field Performance Standards Verification Plan

Sample Task	Sample Point	Matrix	Sampling Frequency	Approx Sample No	Sampling Method	Sampling Equipment	TAT	DQO Level/Data Package Requirement	Required Analysis	Analytical Methods	Holding Time	Sample Preservation	Containers
Confirmation Soil Borings													
ZVI Application Verification	Vicinity of ZVI injection	Soil	Collect soil core(s) from 70-90 bgs at 3 radial locations following every 8 ZVI injections.	15 boring locations. At least two samples per location. At least 30 total.	Grab	drill rig, SS spoon	14 days	N/A	Total Iron	Minerals Analysis	SW6010B	6 months	(2) 8 oz glass
SVE system effectiveness	Treatment area	Soil	One event per treatment area	Variable (use SW-846 to determine); plus 10% duplicates	Grab	drill rig, SS spoon	14 days	DQO Level III	TCL VOCs	5035/8260B	14 days	HCl pH< 2; Cool to 4°C	(2) 40 mL vials
Soil Excavation													
Confirmation Soil Borings	Floor and sidewalls of excavation	Soil	2 floor samples and 5 sidewall samples	7	Grab	SS spoon	24 hr	DQO Level III	TCL VOCs	5035/8260B	14 days	HCl pH< 2; Cool to 4°C	(2) 40 mL vials
Stockpiles	Stockpiles	Soil	One per excavation	1	Prepared in Field	Hand-auger device prior to compositing (except for VOCs)	4 days/7 days	CLP-like full package	TCLP VOCs	1311/8260B	14 day TCLP extr; 14 day analysis	Cool to 4°C	(4) 8oz WM glass
									TCLP SVOCs	1311/8270C	14 day TCLP extr; 7 day extr; 40 day analysis	Cool to 4°C	
									TCLP Pesticides	1311/8081A	14 day TCLP extr; 7 day extr; 40 day analysis	Cool to 4°C	
									TCLP Herbicides	1311/8151A	14 day TCLP extr; 7 day extr, 40 day analysis	Cool to 4°C	
									TCLP Metals	1311/6010B7470A	6 month TCLP extr; 6 month analysis Hg 28 day TCLP extr; 28 day analysis	Cool to 4°C	
									Reactivity (Reactive Cyanide & Reactive Sulfide)	SW7.3.3.2 & SW7.3.4.2	ASAP	Cool to 4°C	
									Corrosivity	9045C	ASAP	Cool to 4°C	
									Ignitability	1010/1030	ASAP	Cool to 4°C	

TABLE 3c
Soil Sample and Analysis Summary
Memphis Depot Dunn Field Performance Standards Verification Plan

Sample Task	Sample Point	Matrix	Sampling Frequency	Approx Sample No	Sampling Method	Sampling Equipment	TAT	DQO Level/Data Package Requirement	Required Analysis	Analytical Methods	Holding Time	Sample Preservation	Containers
Drums and Bottles	Drums and Bottles	liquid waste	Every 10 containers or once per exacavation	0	EPA SOP	COLIWASA or other appropriate	4 days/7 days	CLP-like full package	TCL VOCs	8260B	14 days	HCl pH< 2; Cool to 4°C	(4) 8oz WM glass
									TCL SVOCs	8270C	14 day extr; 40 day analysis	Cool to 4°C	
									TCL Pesticides	8081A	14 day extr; 40 day analysis	Cool to 4°C	
									TCL PCBs	8082	14 day extr; 40 day analysis	Cool to 4°C	
									Herbicides	8151A	14 day extr, 40 day analysis	Cool to 4°C	
									TAL Metals	6010B/7471A	6 months; Hg = 28 days	HNO_3 pH< 2; Cool to 4°C	
									Reactivity (Reactive Cyanide & Reactive Sulfide)	SW7.3.3.2 & SW7.3.4.2	ASAP	Cool to 4°C	
									Corrosivity	9045C	ASAP	Cool to 4°C	
									Ignitability	1010/1030	ASAP	Cool to 4°C	
Equipment Rinsate Blank		Water	1 per set of field-cleaned equipment (10%)	10% or at least one per day of sampling	Prepared in Field	Analyte-free water, SS funnel	7 days/14 days	CLP-like full package	TCL VOCs	8260B	14 days	HCl pH< 2; Cool to 4°C	(2) 40 mL vials
									TCL SVOCs	8270C	14 day extr; 40 day analysis	Cool to 4°C	(1) Liter amber glass
									TCL Pesticides	8081A	14 day extr; 40 day analysis	Cool to 4°C	(1) Liter amber glass
									TCL PCBs	8082	14 day extr; 40 day analysis	Cool to 4°C	(1) Liter amber glass
									Herbicides	8151A	14 day extr, 40 day analysis	Cool to 4°C	(1) Liter amber glass
									TAL Metals	6010B/7471A	6 months; Hg = 28 days	HNO_3 pH< 2; Cool to 4°C	(1) 500 mL HDPE
Trip Blank		Water	Once	8	Prepared by Lab	N/A	7 days/14 days	CLP-like full package	TCL VOCs	8260B	14 days	HCl pH< 2; Cool to 4°C	(2) 40 mL vials
MSDS**		Soil	1 per 20 samples	4	Prepared in Field	Same Equipment for Soil Samples	7 days/14 days	CLP-like full package	Selected by Personnel in Field	Appropriate Method	Corresponds to Method	Appropriate Measures	Appropriate Containers
Duplicates		Soil	1 per 10 samples	12	Prepared in Field	Same Equipment for Soil Samples	7 days/14 days	CLP-like full package	TCL VOCs	5035/8260B	14 days	HCl pH< 2; Cool to 4°C	(2) 40 mL vials
									TCL SVOCs	8270C	14 day extr; 40 day analysis	Cool to 4°C	(1) Liter amber glass
									TCL Pesticides	8081A	14 day extr; 40 day analysis	Cool to 4°C	(1) Liter amber glass
									TCL PCBs	8082	14 day extr, 40 day analysis	Cool to 4°C	(1) Liter amber glass
									Herbicides	8151A	14 day extr; 40 day analysis	Cool to 4°C	(1) Liter amber glass
									TAL Metals	6010B/7471A	6 months, Hg = 28 days	HNO_3 pH< 2; Cool to 4°C	(1) 500 mL HDPE

TABLE 3c
Soil Sample and Analysis Summary
Memphis Depot Dunn Field Performance Standards Verification Plan

Sample Task	Sample Point	Matrix	Sampling Frequency	Approx Sample No	Sampling Method	Sampling Equipment	TAT	DQO Level/Data Package Requirement	Required Analysis	Analytical Methods	Holding Time	Sample Preservation	Containers
Borrow Soil													
Borrow soil	Borrow area identified by RAC	Soil	1	1	Prepared in Field	Hand-auger device prior to compositing (except for VOCs)	7 days/14 days	CLP-type full package	TCL VOCs	5035/8260B	14 days	Sodium Bisulfite or Methanol; Cool to 4°C	(3) 40 mL vials: one with methanol, 2 with sodium bisulfate (pH of sample should be 2 or lower)
									TCL SVOCs	8270C	14 day extr; 40 day analysis	Cool to 4°C	(4) 8oz WM glass
									TCL Pesticides	8081A	14 day extr; 40 day analysis	Cool to 4°C	
									TCL PCBs	8082	14 day extr; 40 day analysis	Cool to 4°C	
									Herbicides	8151A	14 day extr; 40 day analysis	Cool to 4°C	
									TAL Metals	6010B/7471A	6 months; Hg = 28 days	Cool to 4°C	

Notes:
TAT = turnaround time
TCL/TAL = Target Compound List/Target Analyte List
VOC = Volatile organic compound
C = Celsius
NA = Not Applicable

TABLE 3d
Vapor Sample and Analysis Summary
Disposal Characterization Sample and Analysis Summary
Memphis Depot Dunn Field Performance Standards Verification Plan

Sample Task	Sample Point	Matrix	Sampling Frequency	Approx Sample No	Sampling Method	Sampling Equipment	TAT	DQO Level/Data Package Requirements	Required Analysis	Analytical Methods	Holding Time	Containers
Ambient Air Screening	Breathing Zones	Air	Weekly to monthly	Variable	Direct read on instrument	FID	Instant	Screening	Ambient air	Screening	NA	None
Ambient Air Sampling for VOCs	Breathing Zones		Based on screening results	Variable	SUMMA® canister and rotary vane pump	SUMMA® canister	14 days	Definitive	VOCs	TO-15	14 days	SUMMA® canister(s)
Screening with an FID for VOCs	MP wellhead and extraction		See Table 6	Variable	Fill Tedlar® bag w/ rotary vane pump and analyze w/ FID	Tedlar® bag and FID	Instant	Screening	Total VOCs	Screening	NA	Tedlar® bag
Air Sampling for VOCs	Extraction manifolds Injection manifold Treatment system inlet and outlet		See Table 6	Variable	SUMMA® canister and rotary vane pump	SUMMA® canister	14 days	Definitive	VOCs	TO-15	14 days	SUMMA® canister(s)
Pressure, Velocity, Flow	MP wellhead and extraction/injection wells		Same as screening and sampling frequency	Variable	Direct read on gauge	NA	Instant	Screening	NA	Measurement	NA	NA
Quality Assurance Samples	Dup., Equipment, and Ambient Blanks		Once per event	2 Dups., 1 Equip., & 1 Ambient	SUMMA® canister and rotary vane pump	SUMMA® canister	14 days	Definitive	VOCs	TO-15	14 days	SUMMA® canister

Notes:
TAT = turnaround time
VOC = Volatile organic compound
C = Celsius

TABLE 3e
Disposal Characterization Sample and Analysis Summary
Memphis Depot Dunn Field Performance Standards Verification Plan

Sample Task	Sample Point	Matrix	Sampling Frequency	Approx Sample No	Sampling Method	Sampling Equipment	TAT	DQO Level/Data Package Requirement	Required Analysis	Analytical Methods	Holding Time	Sample Preservation	Containers
IDW Disposal Characterization Sampling													
Disposal to POTW	Well Development, Purge Water, Decon Fluids, and Surface Water (as necessary)	Water	One Representative Sample to comply with the Memphis Depot Industrial Discharge Agreement with the City of Memphis	One	Grab	Drum thief or dip jar	14 days	DQO Level III	TCL Volatiles	8260B	14 days	HCl pH<2; Cool to 4°C	(3) 40 ml vial
									TAL Metals	6010B/7470A	6 months; Hg = 28 days	HNO_3 pH<2, Cool to 4°C	(1) 500 mL HDPE
									TCL Semi-Volatiles	8270C	7 day extr; 40 day analysis	Cool to 4°C	(1) Amber Liter Glass Jar
Soil Characterization Sampling (excavated soil stockpiles)	Soil stockpiles	Soil	Every 250 CY (maximum) for soil stockpiles	Variable	Composite comprising 5 aliquots	SS Auger, SS Spoons, SS Bowl	14 days	DQO Level III	TCLP Volatiles	1311/8260B	14 day TCLP extr; 14 day analysis	Cool to 4°C	(1) 4 oz glass
									TCLP Semi-Volatiles	1311/8270C	14 day TCLP extr; 7 day extr; 40 day analysis	Cool to 4°C	(2) 8 oz glass
									TCLP Pesticides	1311/8081A	14 day TCLP extr; 7 day extr; 40 day analysis		
									TCLP Herbicides	1311/8151A	14 day TCLP extr; 7 day extr; 40 day analysis		
									TCLP Metals	1311/6010B, 7470A	6 month TCLP extr; 6 month analysis Hg: 28 day TCLP extr; 28 day analysis	Cool to 4°C	(2) 8 oz glass
									Ignitability	1030	ASAP		
									Corrosivity	9045A	ASAP		
									Reactivity	Chapter 7.3	ASAP		
SVE System Condensate	Condensate collection system discharge	Water	Monthly	12/year	Grab	Sample container	14 days	DQO Level III	TCL Volatiles	8260B	14 days	HCl pH<2; Cool to 4°C	(3) 40 ml vial
									TAL Metals	6010B/7470A	6 months; Hg = 28 days	HNO_3 pH<2; Cool to 4°C	(1) 500 mL HDPE
									TCL Semi-Volatiles	8270C	7 day extr; 40 day analysis	Cool to 4°C	(1) Amber Liter Glass Jar

Notes:
TAT = turnaround time
TCL/TAL = Target Compound List/Target Analyte List
VOC = Volatile organic compound
SVOC = Semivolatile organic compound
CLP = EPA Contract Laboratory Program quality assurance control procedures
TCLP = Toxicity Characteristic Leachate Procedure, analysis method
C = Celsius
NA = Not Applicable

TABLE 5
RDI Soil Sample Results Summary
Memphis Depot Dunn Field Performance Standards Verification Plan

Sample ID	Field ID	Northing	Easting	MIP-ECD Response	Key CVOCs 1,1,2,2-PCA	1,1,2-TCA	1,1-DCE	1,2-DCE	CT	CF	cDCE	MC	TCE	PCE	tDCE	VC
Site-Specific Soil Screening Levels to be Protective of Groundwater* (ug/kg)					11.2	62.7	150	32.9	215	917	755	30.5	182	180.6	1,520	29.4
Treatment Area 1 (9 sample locations)																
TA1-N2160-E1080-29-30	**30B**	281315.36	802101.93	0.32						3.47	49.1		182	5.71	35.3	
TA1-N2200-E1080-21-22	**31B**	281355.31	802104.81	0.53							302		712		160	
TA1-N2200-E1080-29-30	**31B**	281355.31	802104.81	0.60							693		2,420	45.5	425	
TA1-N2240-E1360-10-11	**32I**	281375.75	802386.85	3.5						1,010						
TA1-N2440-E1160-26-27	**37D**	281589.20	802201.24	0.12	131	2.49	1.22				379		112		67.7	6.01
TA1-N2480-E1120-10-11	**38C**	281631.85	802164.24	16	950,000	8,450					174,000		541,000	6,630	58,200	
TA1-N2480-E1160-18-19	**38D**	281629.05	802204.03	16	47,700						23,000		47,100		8,430	
TA1-N2480-E1240-6-7	**38F**	281623.51	802283.88	0.58			2,340				123,000		21,500	20,800	8,160	
TA1-N2480-E1360-11-12	**38I**	281615.18	802403.54	0.95					3,350	8,080				141		
TA1-N2520-E1360-7-8	**39I**	281655.05	802406.31	20					360	4,570						
TA1-N2320-E1120-12	34C	281472.19	802152.99	0.13												
TA1-N2320-E1160-21-22	34D	281469.39	802192.88	0.07							39.5				3.56	
TA1-N2360-E1080-15-16	35B	281514.93	802115.86	0.46												
TA1-N2400-E1120-21-22	36C	281552.05	802158.56	0.35												
TA1-N2400-E1160-13-14	36D	281549.21	802198.48	0.36									0.81			
TA1-N2400-E1240-25-26	36F	281543.69	802278.32	0.68										0.85		
TA1-N2440-E1040-21-22	37A	281597.42	802081.55	0.10												
TA1-N2440-E1080-22	37B	281594.76	802121.44	0.12												
TA1-N2440-E1120-14-15	37C	281591.86	802161.33	0.47												
TA1-N2440-E1200-18-19	37E	281586.37	802241.16	0.13							16.6		3.89		6.4	2.32
TA1-N2440-E1240-27-28	37F	281583.60	802281.06	0.62												
TA1-N2440-E1400-20-21	37J	281572.43	802440.67	0.30												
TA1-N2480-E1200-13-14	38E	281626.19	802244.04	0.80												
TA1-N2480-E1320-10-11	38H	281617.96	802363.63	0.34						1.01			2.24	47.6		
TA1-N2480-E1360-26-27	38I	281615.18	802403.54	1.00						271						
TA1-N2520-E1200-21-22	39E	281666.20	802246.74	0.75												
TA1-N2520-E1240-13-14	39F	281663.39	802286.63	0.45												
TA1-N2560-E1200-8-9	40E	281706.08	802249.54	0.54				1.31			1.48					14.9
Treatment Area 2 (9 sample locations)																
TA2-N1760-E1120-28-29	**20C**	280913.60	802114.08	1.4							47.8		1,110			
TA2-N1760-E1160-19-20	**20D**	280910.79	802154.03	0.90							211		1,780			
TA2-N1800-E1080-29-30	**21B**	280956.27	802076.95	1.4									935			
TA2-N1800-E1120-29-30	**21C**	280953.50	802116.92	0.73							100		2,050			
TA2-N1800-E1160-29-30	**21D**	280950.65	802156.81	0.32	0.806					0.93	44.5		380	23	14.6	
TA2-1880-E1560-10-12 (13-	**22D**	280990.56	802159.57	11	1,850,000								170,000	21,100		
TA2-N1840-E1160-29-30	**22D**	280990.56	802159.57	16	36,400								47,000	851		
TA2-1840-E1200-29-30	**22E**	280987.81	802199.47	0.45									943			
TA2-N1880-E1160-25-26	**23D**	281030.53	802162.39	15	163,000								23,600	599		
TA2-N1720-E1200-12-13	19E	280868.10	802191.16	0.27												
TA2-N1760-E1200-19-20	20E	280908.01	802193.92	0.31	1.73	2.74				0.961	8.15		51.1	0.853	0.622	
TA2-N1760-E1240-27-28	20F	280905.23	802233.85	0.23												
TA2-N1800-E1200-17-18	21E	280947.91	802196.71	0.56									6.18	0.611		
TA2-1840-E1120-20-22	22C	280993.32	802119.64	0.30							5.34		19.5	0.681		
TA2-N1880-E1120-27-28	23C	281033.27	802122.45	0.35						1.54	23.1		92.2	1.94	22	
TA2-N1880-E1200-12-13	23E	281027.75	802202.31	0.45							1.02		90.4	1.51		
TA2-N1880-E1200-22-23	23E	281027.75	802202.31	0.47							2.5		128	1.72	1.17	
TA2-N1920-E1160-11-12	24D	281070.40	802165.13	0.45							0.666		40.5	1.56	0.792	

TABLE 5
RDI Soil Sample Results Summary
Memphis Depot Dunn Field Performance Standards Verification Plan

Sample ID	Field ID	Northing	Easting	MIP-ECD Response	Key CVOCs 1,1,2,2-PCA	1,1,2-TCA	1,1-DCE	1,2-DCE	CT	CF	cDCE	MC	TCE	PCE	tDCE	VC
Treatment Area 3 (6 sample locations)																
TA3-N1440-E1200-28-29	**12E**	280588.78	802171.75	0.62	3,110	95.2					3,350		1,560		319	174
TA3-N1440-E1260-12-13	**offset 12F**	NS	NS	No MIP	10.2	3.75		1.68			1,200		92.3	0.568	102	66.4
TA3-N1440-E1260-27-28	**offset 12F**	NS	NS	No MIP	8.18	2.39		0.779			889		79.2	0.74	65.5	31.2
TA3-N1440-E1320-12-13	**12H**	NS	NS	0.60	57.5						80.9		336			
TA3-N1440-E1330-27-28	**offset 12H**	NS	NS	No MIP	133	7.21					56.7		358	7.41	12.4	8.46
TA3-N1440-E1240-27-28	**12F**	NS	NS	0.30	26.1	4.29J	0.678J	0.828J	6.26	2.7J	948		294	3.95J	153J	3.95J
TA3-N1400-E1200-28-29	11E	280548.85	802168.89	0.23									0.506			
TA3-N1400-E1330-12-13	offset 11H	NS	NS	No MIP				0.866	1.32	32.8	62.4		4.9	2.67	11.8	3.12
TA3-N1400-E1330-27-28	offset 11H	NS	NS	No MIP							3.61				0.783	
TA3-N1400-E1360-17-18	11I	NS	NS	1.8				0.867J		35	22.2	3.13J	2.49J	0.994J	3.79J	2.13J
TA3-N1440-E1160-5-6	12D	280594.86	802131.42	0.31							103					
TA3-N1440-E1330-12-13	offset 12H	NS	NS	No MIP	1.84	0.996	1.1	0.574			13.2		29.8	0.853	2.68	3.18
TA3-N1440-E1360-12-13	12I	NS	NS	0.22						0.668						
TA3-N1480-E1200-22-23	13E	280628.59	802174.41	0.12	3.33					1.43	7.61		4.18		1.81	3.18
TA3-N1480-E1260-12-13	offset 13F	NS	NS	No MIP												
TA3-N1480-E1260-27-28	offset 13F	NS	NS	No MIP							1.09					
TA3-N1480-E1330-12-13	offset 13H	NS	NS	No MIP												
TA3-N1480-E1330-27-28	offset 13H	NS	NS	No MIP						3.6			9.18	1.39		
TA3-N1480-E1360-12-13	13I	NS	NS	0.21						1.04						
Treatment Area 4 (3 sample locations)																
TA4-N1080-1160-22-23	**3D**	280232.40	802106.79	2.2					527	2,180			968	363		
TA4-N1080-E1200-14-15	**3E**	280229.64	802146.71	16	190,000				1,850	96,200			4,280	2,360		
TA4-1120-E1120-12-13	**4C**	280275.07	802069.67	0.55					239	26			7.87	18.9		
TA4-N1000-E1160-21-22	1D	280152.64	802101.23	0.26												
TA4-N1000-E1200-26-27	1E	280149.85	802141.14	0.25												
TA4-N1040-E1160-17-18	2D	280192.52	802104.04	0.38							81.4				27.4	1.39
TA4-N1040-E1240-24-25	2F	280186.99	802183.79	0.34	2.18				35.1	25.7			16	9.12		
TA4-N1040-E1280-16-17	2G	280184.25	802223.70	No MIP												
TA4-N1080-E1120-7-8	3C	280235.18	802066.87	0.48					9.57	24.4			2.24	4.1		
TA4-N1080-E1280-16-17	3G	280224.10	802226.48	0.26												
TA4-N1120-E1280-12-13	4G	280264.03	802229.28	0.25					1.39	1.88						
TA4-N1160-E1160-11-12	5D	280312.21	802112.33	0.30					31.5	12.6				1.16		
TA4-N1160-E1200-12-13	5E	280309.44	802152.24	0.24					53.5	13.6			3.5	2.72		
TA4-N1160-E1240-12-13	5F	280306.63	802192.13	0.24					42.8	10.7				1.42		
TA4-N1160-E1280-12-13	5G	280303.90	802232.08	No MIP					0.719	0.655						

Notes:
*Taken from Table 2-21G of the *Memphis Depot, Dunn Field, Record of Decision,* Defense Distribution Center (Memphis), March 2004 - Final

NS = not surveyed
ug/kg = micrograms per kilogram
Bolded sample and field IDs have CVOC concentration(s) above RGs.
Bolded red values indicate RG exceedance

Sample locations with concentrations below RGs
Sample location within area targeted for excavation.

TABLE 6
Vapor Sampling Frequency
Memphis Depot Dunn Field Performance Standards Verification Plan

Sample		Sample Event Frequency					
Location	**No.**	**0-2 weeks**	**1-12 Months**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Fluvial extraction well locations	7	Daily field screening	Weekly to monthly field screening and quarterly lab samples	Semiannual field screening and lab samples			
Vapor treatment system inlet/outlet	2						
Vapor monitoring points	10		Weekly to monthly field screening	Semiannual field screening			
Treatment area perimeter	*	Periodic field screening					

Notes:

* = variable

ATTACHMENT A

U.S. Army Corps of Engineers Soil Vapor Extraction Subsurface Performance Checklist

U. S. Army Corps of Engineers Soil Vapor Extraction Subsurface Performance Checklist

Installation Name ______________________

Site Name / I.D. ______________________

Evaluation Team ______________________

Site Visit Date ______________________

This checklist is meant to aid in evaluating the overall performance of a soil vapor extraction (SVE) system for removing volatile organic vapors from the soil vadose zone. This checklist is divided into the following sections:

1) Evaluation team composition
2) Typical treatment objectives
3) References
4) Data collection requirements
5) Performance analysis calculations
6) Adequacy of operations and maintenance
7) Typical performance problems
8) Alternatives for possible cost savings
9) Supplemental notes and data.

The checklist provides suggestions for information gathering, and space has been provided to record data and notes from the site visit. Supplementary notes, if required, should be numbered to correspond to the appropriate checklist sections.

1) Evaluation Team Composition

The following disciplines should be included in the evaluation team for the soil vapor extraction system.

- Geologist (attend site visit, subsurface performance evaluation)
- Process Engineer (attend site visit, treatment system evaluation)
- Regulatory Specialist (regulatory requirements)
- Cost Engineer (cost of alternatives)

2) Typical Treatment Objectives

Verify that the treatment objectives established when the SVE system was designed and installed are clear and still valid. If the objectives are not clearly defined, describe reasonable objectives based on information from the owner and regulator.

06/07/99

Soil vapor extraction is typically used for removing organic vapors to remediate vadose zone soils and to remove the source of groundwater contamination. The primary objective of SVE is removal of contaminant mass, but regulations may require achieving a stipulated concentration in the soil. The goals for the soil vapor extraction system should consider the nature of the risk associated with the site. If the primary goal is protection of ground water, the SVE system should reduce the soil concentrations to levels that would not result in groundwater concentrations exceeding acceptable risk at an exposure point.

3) References

Coordinate this checklist with the Vapor/Off-gas Blower and Piping; Process Instrumentation and Control; Environmental Monitoring, Extraction and Monitoring Wells, and if applicable, the Vapor Phase Carbon checklists. The following references may also be helpful:

EM 1110-1-4001 [1]: Soil Vapor Extraction and Bioventing
EPA 600/R-96/041: Diagnostic Evaluation of In-Situ SVE-Based System Performance
EPA 542/R-97/007: Analysis of Selected Enhancements for Soil Vapor Extraction

4) Data Collection Requirements

Record the following information needed to run performance calculations and to check the operation of the SVE system. Record the appropriate units with each value.

a) Describe the objectives for the SVE system. (e.g., source removal, vapor containment)

____

____

b) What is the estimated future operation period or time for remediation? What is the basis for this estimate?

____

c) Operating Data

Collect the following SVE system data for the most recent year of operation. Any additional historical data will be helpful. Identify any missing data.

- Pressure measurements at each well and the barometric pressure at that time
- Vapor flow rate at each well and the vapor flow rate at the blower inlet
- Vapor temperature at each well, and at the blower inlet and outlet
- Relative humidity of the extracted gas (if activated carbon is being used to treat off-gas)
- Volume of liquid in the air-water separator
- Blower amperage, run-time, and on/off cycles

- Vapor contaminant concentrations at each well and monitoring point

____

____

(Contaminant monitoring might consist of sampling and field screening with a photoionization detector, flame ionization detector, field gas chromatograph, or detector tubes or might involve sampling for laboratory analysis. Refer to the Environmental Monitoring checklist.)

d) Are measurements made with adequate frequency (say every 3-12 months in a single round) to determine if capture or air throughput are affected by changes in extraction rate, soil moisture content, or groundwater levels? Are measurements made on a seasonal basis if seasonal fluctuations in parameters such as soil moisture content or water table level are expected?

____

____

e) Are flows, vacuum levels, and concentrations measured in each extraction well? Are these parameters monitored with the same frequency as at the monitoring points?

____

____

f) Have air permeability tests been conducted on the extraction wells and air conductivity values calculated for those locations?

____

g) Have tracer tests been conducted to verify air flow paths and adequate travel times/velocities? *(Normally done only where the site complexity justifies its use or where unusual vacuum/contaminant response to extraction is observed.)*

____

h) Has there been unexpected contamination found outside the capture zone or any indication of an unknown source?

____

____

i) Are measurements of water table fluctuations made to determine the possible effects on the SVE system's performance?

____

j) Record the nameplate information from the vacuum blower, pumps, and other mechanical equipment for future reference.

____

____

____

k) Sketch a process flow diagram (PFD), including valves and instrument locations, on the back of this sheet or on a separate sheet.

l) If modeling was performed, obtain a copy of the original SVE modeling done as part of the system design.
(The design modeling may be useful in evaluating the operation of the system.)

5) Performance Analysis Calculations

a) Prepare vapor flow rate versus time graphs for each extraction well. Are the vapor extraction rates the same as those in the design specifications? Have the vapor extraction rates changed since the initial period of operation?

____

____

b) Construct vacuum isopleth maps of the site. Is the vacuum distribution consistent with that predicted during design? Does the vacuum distribution (in three dimensions) indicate capture of vapors and prevention of migration to receptors?

____

____

c) Are monitoring points distributed adequately to determine vacuum distribution, flow paths, or containment? Are monitoring points distributed adequately to determine if adequate air flow or vapor capture is achieved in three dimensions? *(In most cases, vacuum monitoring points set at multiple depths are needed to verify vertical flow components.)*

____

____

d) Construct concentration versus time graphs for all contaminants of concern in each extraction well. Construct isopleth maps of the current soil gas concentrations for each contaminant of concern. Have contaminant concentrations been declining in most of the target zone?

____

____

e) Have individual wells or the system as a whole reached a consistent asymptote on the concentration versus time graph without significant rebound? *("Significant rebound" might be defined as an increase of 25-50% above the asymptote concentration value.)*

____

____

____

f) Are the well depths and screened intervals adequate to optimally direct air through the target zone? Is there evidence of preferential flow paths or hydrogeologic boundaries that were not considered in the system design? *(Prepare hydrogeologic cross sections using available well boring logs, including the extraction wells, if cross sections of the area of concern are not available.)*

____

____

____

h) Estimate travel times or velocities for air through the target zone. Do the travel times/velocities indicate adequate throughput in the entire target zone? *(Consider three-dimensional flow, particularly at open or leaky sites. Refer to EM 1110-1-4001, Chapter 5.)*

6) Adequacy of Operations and Maintenance

a) Has the entire system been operating with enough consistency to achieve its objective in a reasonable time? *(A good operational target should be 90% uptime or better.)*

b) Are monitoring points constructed and maintained so as to yield reliable results (e.g., short screens, checked for plugging/response)?

c) Would the use of active or passive air injection possibly help direct air through the target zone more effectively? Would a surface cover help direct air more effectively through the target zone (the surface cover cost would have to cost effective)?

d) Verify that the ancillary equipment are maintained per manufacturers recommendations.

e) Verify that instruments, controls, and alarms are working. Are there provisions to notify an operator of malfunctions when the unit is unattended?

f) Is the vapor extraction properly distributed among the wells to optimally treat the target zone effectively? *(It may be appropriate to recommend an optimization study if there is some indication that the system is pumping more than necessary to achieve goals.)*

g) Verify that the concentrations are sampled and analyzed in accordance with the sampling and analysis plan designed to assess the system performance. Determine if any additional monitoring is needed to evaluate the operating conditions.

7) Typical Performance Problems

a) Is there evidence of too much air flow through the soil such that travel times are too small, or that diffusion limitations hamper the effectiveness of the high extraction rates? *(If extracting air at higher rates does not increase the mass removal rate, the system may be moving more air than necessary.)*

____

____

b) Is there evidence of short-circuiting along the well casing, through nearby utility corridors, or through soil fractures or other subsurface features? Consider well replacement or relocation.

____

____

c) Have the VOC concentrations in the extracted gas (in combined influent or from most wells) approached an asymptotic concentration value? This may be caused by diffusion limitations, continuing source, or poor well placement. Consider whether reduced flows, system pulsing, additional wells. thermally enhanced SVE, or bioventing might remove additional contaminant mass.

____

____

d) Are there portions of the target zone in which contaminant concentrations have failed to decline in response to SVE? This may be due to inadequate air flow in that portion of the target zone, diffusion limitations, high soil moisture content perhaps to due to surface irrigation, or a continued source of contaminants in that area. Consider increasing air extraction rates from certain wells or the entire system, adding wells in areas of inadequate extraction, limiting irrigation, or excavating hot spot soils.

____

____

e) Are extremely high concentrations of VOCs, at or near explosive levels, present in the extracted gas? This may be due to a continuing source, floating product, high levels of residual contaminants, or accumulation of methane. Consider adding dilution air, reducing the flow rate from "hot spot" wells, or replacing the SVE off-gas treatment system with a flare or internal combustion engine (ICE) treatment system.

____

____

f) Do the VOC concentrations in the extracted gas vary significantly over time? This may be due to ground water fluctuations, soil moisture variations due to precipitation, or a periodic continuing source. Consider controlling groundwater levels, installing a surface cover, or other source removal alternatives.

____

____

g) Have the total extraction rates failed to reach the expected design rates or the extraction rates needed for efficient operation? This may be due to poor well installation, improper well design, improper flow balancing or blower design, water table upwelling, or unexpected stratigraphy. Consider replacing wells, adding wells, rebalancing the air flows in the system, controlling groundwater levels, or resizing the blower.

h) Is there evidence that contaminant vapors have escaped containment by the SVE system? This may be due to inadequate flow from certain wells to create proper capture zones, prolonged system shutdown, preferred airflow pathways, or other outside sources of contaminants. Consider increasing the extraction rates from selected wells or the entire system, adding wells in selected areas, reducing downtime, or augmenting SVE with other source removal alternatives.

i) If the SVE and off-gas treatment systems are located outside, are there provisions to drain water lines and sump(s) when the unit is shut down? Inspect the aboveground systems for proper insulation and / or heat tracing to prevent rupture of lines due to formation of ice during operation.

8) Alternatives for Possible Cost Savings.

The contaminant compounds remaining in the vadose soils and/or their concentrations may have changed sufficiently that other alternatives are more cost effective. Consider the following:

a) Has the system reached its cleanup objectives? Determine if the SVE operation is still necessary, or have the concentrations decreased so that the operation can be terminated? Can the off-gas treatment system be taken off line due to decreased levels of contaminants in the vapor stream?

b) If the cleanup objectives have not yet been met, can the system be turned off and natural attenuation be allowed to achieve the cleanup objective while remaining protective of human health and the environment? *(Refer to Air Force protocols for evaluating natural attenuation)*

c) Can individual wells be removed from the system? Can the above-ground system operate efficiently at a reduced flow rate? Evaluate the cost savings by reducing the number of wells. *(In some cases, the capacity gained by removing non-productive wells may allow higher airflow rates through more contaminated parts of the site. However, the blowers may need to be adjusted or replaced with different sized units to accommodate changes in airflow / vacuum requirements.)*

d) Can additional wells be placed in the plume or the extraction rates from existing wells be redistributed in a way that would economically speed remediation? (*New wells may replace several existing wells and may achieve objectives at a lower total flow. Detailed SVE modeling and extraction system optimization should be recommended as part of a separate study, if appropriate and justified by the potential costs savings.)*

____

____

e) In some cases, other technologies may be able to accomplish the same objectives or speed clean up. The application of these alternative technologies should be economically justified based on present worth analysis compared to the cost of the current system.

- Thermal Enhancement to SVE *(See EPA 542/R-97/007)*
- Vacuum-Enhanced Pumping or Multiphase Extraction
- Soil Excavation for source removal
- Bioventing *(Bioventing may eliminate the costs of treating off-gas, but may not adequately remediate heavy hydrocarbons.)*
- Soil Fracturing *(See EPA 542/R-97/007. Diffusion limitations may still limit mass removal.)*

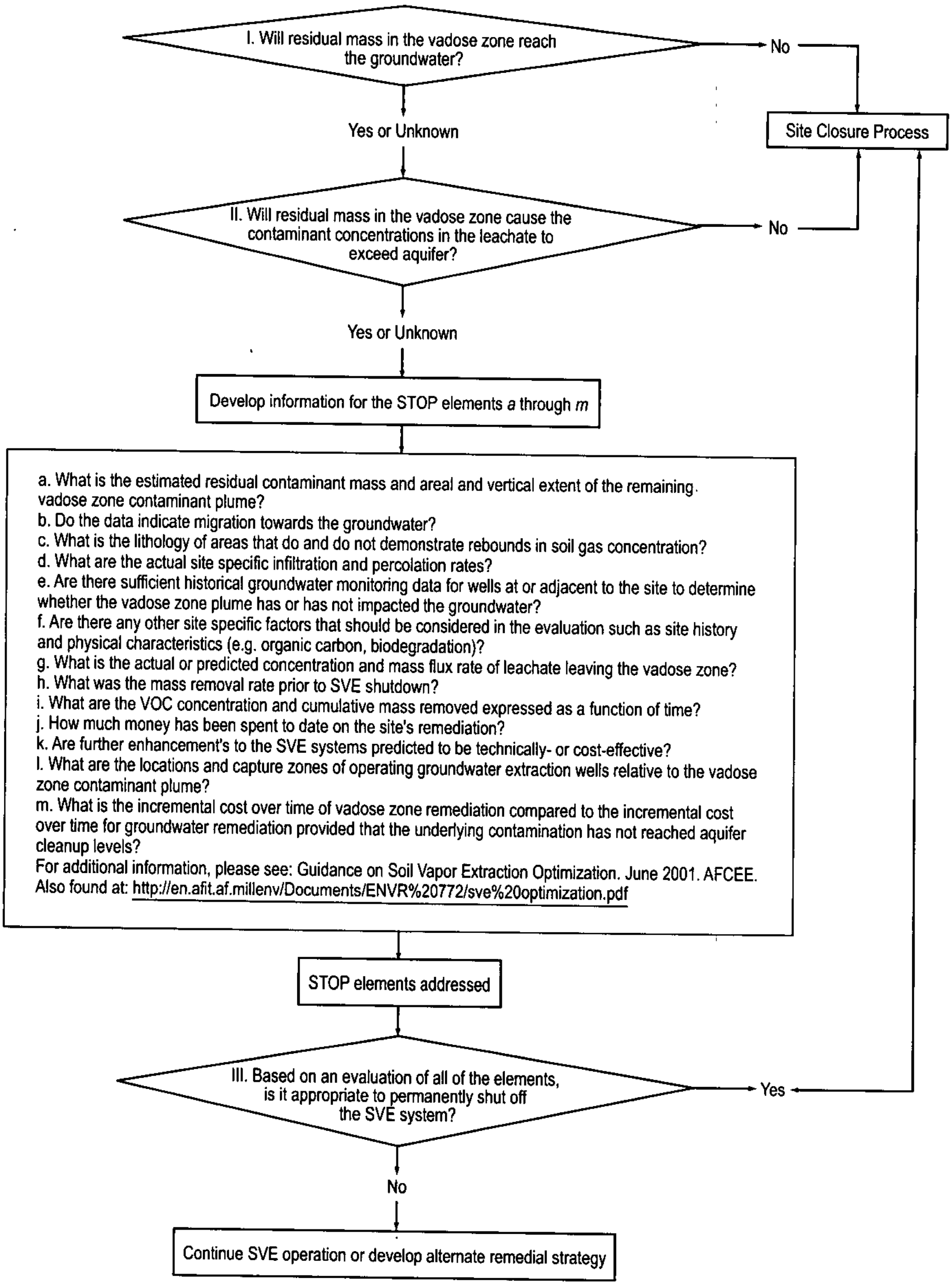
9) Supplemental Notes and Data

There are _______ pages of supplemental notes and data attached to this checklist.

[1] EM: USACE Engineering Manual, available at www.usace.army.mil/inet/usace-docs/

ATTACHMENT B

STOP Decision Process



STOP Decision Tree

8891007

ATTACHMENT C

Magnetic Separation Test Procedure

Magnetic Separation Testing Procedure

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

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

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

8891009

Equipment Required for Magnetic Separation Testing

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

ATTACHMENT D

Soil Core Characterization Strategy at DNAPL Sites Subjected to Strong Thermal or Chemical Remediation and TRS' Hot Soil Sampling Method

Paper 1E-07, in: A.R. Gavaskar and A.S.C. Chen (Eds.), *Remediation of Chlorinated and Recalcitrant Compounds—2002.* Proceedings of the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2002). ISBN 1-57477-132-9, published by Battelle Press, Columbus, OH, www.battelle.org/bookstore.

SOIL CORE CHARACTERIZATION STRATEGY AT DNAPL SITES SUBJECTED TO STRONG THERMAL OR CHEMICAL REMEDIATION

Megan Gaberell, Arun Gavaskar, Eric Drescher, Joel Sminchak, Lydia Cumming, Woong-Sang Yoon, and Sumedha De Silva (Battelle, Columbus, Ohio, USA)

ABSTRACT: At Launch Complex 34 (LC34), Cape Canaveral Air Station, Florida, high concentrations of trichloroethylene (TCE) exist in groundwater and free phase (DNAPL) has been detected in the subsurface. Characterizing or monitoring sites that are contaminated with volatile organic compounds (VOCs) such as TCE is often challenging because of the difficulties associated in minimizing VOC loss during soil sample handling and collection. New difficulties in post-demonstration soil sampling were encountered due to (1) the residual strong oxidant remaining in the soil cores of the oxidation remediation plot; and (2) the high temperatures (50-95°C) in the thermal remediation plot that persisted for several months after the remediation had been completed. To evaluate the efficiency of the soil collection and sampling method in recovering VOCs, hot soil cores were brought to the surface and spiked with a surrogate compound, 1,1,1-trichloroethane (1,1,1-TCA). The results show that between 84 and 113% of TCA in the soil was recovered using field procedures designed to minimize VOC loss while protecting personnel handling the hot soil cores. The results also indicate that any VOC loss occurring during cooling of the soil core is minimal and within the acceptable limitations of the field sampling protocol.

INTRODUCTION

Dense nonaqueous-phase liquid (DNAPL) contamination presents a persistent environmental problem at many federal and private facilities. At Launch Complex 34 (LC 34), Cape Canaveral Air Station, Florida, high concentrations of trichloroethylene (TCE) exist in groundwater and free phase (DNAPL) has been detected in the subsurface. The Interagency DNAPL Consortium (IDC), a consortium consisting of U.S. Department of Energy (DOE), U.S. Department of Defense (DoD), U.S. Environmental Protection Agency (EPA), and the National Aeronautic and Space Administration (NASA), has been assessing several innovative DNAPL remediation technologies, including those that use thermal or chemical oxidation treatment. Post-demonstration characterization was conducted to verify the effectiveness of these innovative technologies, which were demonstrated in separate test plots in the DNAPL source zone.

Characterizing or monitoring sites that are contaminated with volatile organic compounds (VOCs) such as TCE is often challenging because of the difficulties associated in minimizing VOC loss during soil sample handling and collection. At LC 34, new difficulties in post-demonstration soil sampling were encountered due to (1) the residual strong oxidant remaining in soil cores of the chemical oxidation remediation plot; and (2) the high temperatures (50-95°C) in the thermal remediation plots that persisted for several months after the remediation had been completed. Field procedures for soil core handling and sampling were designed to take into account the safety issues posed by the strong oxidant (potassium permanganate) used at LC34 in the chemical oxidation plot (Battelle, 1999). Field procedures for collecting soil cores and soil samples from the thermal remediation plot were modified in an effort to minimize VOC losses that can occur as a result of contaminant volatilization associated with elevated soil temperature (Battelle, 2001). Because additional consideration must be given to issues such as personnel safety when handling hot soil cores, there is the possibility that increased handling times during soil coring and sample collection may result in an increase in VOC losses. An experiment was conducted using soil samples spiked with a surrogate compound to investigate the effectiveness of the field procedures developed for LC34 in minimizing VOC losses. Because the soil sampling procedures were similar for both the chemical oxidation and thermal remediation strategies, the remainder of this paper focuses on issues associated with the collection and sampling of soil at elevated temperatures.

MATERIALS AND METHODS

Soil cores were collected in a 2-inch diameter, 4-foot long acetate sleeve that was placed tightly inside a 2-inch diameter stainless steel core barrel. The acetate sleeve was immediately capped on both ends with a protective polymer covering. The sleeve was placed in an ice bath to cool the heated core to below ambient groundwater temperatures (approximately 20°C). The temperature of the soil core was monitored during the cooling process with a meat thermometer that was pushed into one end cap (see Figure 1). Approximately 30 minutes was required to cool each 4-foot long, 2-inch diameter soil core from 50-95°C to below 20°C. Upon reaching ambient temperature, the core sleeve was then uncapped and cut open along its length to collect the soil sample for contaminant analysis (see Figure 2).

Soil samples were collected in relatively large quantities (approximately 200 g) along the entire length of the core rather than sampling small aliquots of the soil within

FIGURE 1. A soil core capped and cooling in an ice bath. The thermometer is visible in the end cap.

FIGURE 2. A soil sample being collected from along the length of the core into a bottle containing methanol.

the core, as required by the conventional method (EPA SW5035). This modification is advantageous because the resultant data provide an understanding of the continuous VOC distribution with depth. VOC losses during sampling were further minimized by placing the recovered soil samples directly into bottles containing methanol (approximately 250 mL) and extracting them on site. The extracted methanol was centrifuged and sent to an off-site laboratory for VOC analysis. Soil samples taken from the chemical oxidation plot were handled similarly, although they did not require cooling. The soil sampling and extraction strategy is described in more detail in Gavaskar et al. (2000).

To evaluate the efficiency of the sampling method in recovering VOCs, hot soil cores were extracted from 14 through 24 feet below ground surface and spiked with a surrogate compound, 1,1,1-trichloroethane (1,1,1-TCA). The surrogate was added to the intact soil core by using a 6" needle to inject 25 μL of surrogate into each end of the core for a total of 50 μL of 1,1,1-TCA. In order to evaluate the effect of the cooling period on VOC loss, three soil cores were spiked with TCA prior to cooling in the ice bath and three cores were spiked with TCA after cooling in the ice bath. In the pre-cooling test, the surrogate was injected as described above and the core barrels were subsequently capped and placed in the ice bath for the 30 minutes of cooling time required to bring the soil core to below 20°C. A thermometer was inserted through the cap to monitor the temperature of the soil core.

In the post-cooling test, the soil cores were injected with TCA after the soil core had been cooled in the ice bath to below 20°C. After cooling, the caps on the core barrel were removed and the surrogate compound was injected in the same manner, 25 μL per each end of the core barrel using a 6" syringe. The core was recapped and allowed to equilibrate for a few minutes before it was opened and samples were collected. Only for the purpose of the surrogate recovery tests, the entire contents of the sampling sleeve were collected and extracted on site with methanol. The soil: methanol ratio was kept approximately the same as during the regular soil sample collection and extraction. Several (four) aliquots of soil and several (four) bottles of methanol were required to extract the entire contents of the sample sleeve.

Two different capping methods were used during this experiment to evaluate the effectiveness of each cap type. Two of the soil cores were capped using flexible polymer sheets attached to the sleeve with rubber bands. The remaining four soil cores were capped with tight-fitting rigid polymer end caps. One reason that the polymer sheets were preferred over the rigid caps was that the flexible sheets were better positioned to handle any contraction of the sleeve during cooling.

RESULTS AND DISCUSSION

The results from the surrogate spiking experiment are shown in Table 1. Soil cores 1, 3, and 5 received the surrogate spike prior to cooling in the ice bath. Soil cores 2, 4, and 6 received the surrogate spike after cooling in the ice bath. The results show that between 84 and 113% of the surrogate spike was recovered from the soil cores. Recovery comparison is not expected to be influenced significantly by soil type because all samples were collected from a fine grained to medium fine-grained sand unit. The results also indicate that the timing of the surrogate spike (i.e., pre- or post-cooling) appeared to have only a slight effect on the amount of surrogate recovered. Slightly less surrogate was recovered from the soil cores spiked prior to cooling. This implies that any

8891014

losses of TCA in the soil samples spiked prior to cooling are minimal and acceptable, within the limitations of the field sampling protocol. The field sampling protocol was designed to process up to 300 soil samples that were collected over a 3-week period, during each monitoring event.

TABLE 1. Recovery in soil cores spiked with 1,1,1-TCA surrogate

Soil Cores Spiked <u>Prior</u> to Cooling	Capping Method	1,1,1-TCA Recovery (%)	Soil Cores Spiked <u>After</u> Cooling	Capping Method	1,1,1-TCA Recovery (%)
Core 1	Flexible polymer sheet with rubber bands	96.3	Core 2	Flexible polymer sheet with rubber bands	98.7
Core 3	Rigid End Cap	101.0	Core 4	Rigid End Cap	112.6
Core 5	Rigid End Cap	84.3	Core 6	Rigid End Cap	109.6

The capping method (flexible versus rigid cap) did not show any clear differences in the surrogate recoveries. The flexible sheets are easier to use and appear to be sufficient to ensure good target compound recovery.

This experiment demonstrates that the soil core handling procedures developed for use at LC34 were successful in minimizing volatility losses associated with the extreme temperatures of the soil cores. It also shows that collecting and extracting larger aliquots of soil in the field is a good way of characterizing DNAPL source zones.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the IDC members, and Tom Holdsworth (EPA) and Jackie Quinn (NASA) in particular, for their support during the site characterization and performance assessment at LC34. DHL Analytical provided analytical support during this demonstration.

REFERENCES

Battelle, 1999. *Quality Assurance Project Plan for Performance Evaluation of In-Situ Oxidation for DNAPL Destruction at Launch Complex 34, Cape Canaveral, Florida.* Prepared by Battelle for the Air Force Research Laboratory, Tyndall AFB, FL. September, 1999.

Battelle, 2001. *Quality Assurance Project Plan for Performance Evaluation of In-Situ Thermal Remediation System for DNAPL Removal at Launch Complex 34, Cape Canaveral, Florida.* Prepared by Battelle for Naval Facilities Engineering Service Center, June, 2001.

Gavaskar, A., S. Rosansky, S. Naber, N. Gupta, B. Sass, J. Sminchak, P. DeVane, and T. Holdsworth. 2000. "DNAPL Delineation with Soil and Groundwater Sampling." Proceedings of the Second International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California, May 22-25. Battelle Press. 2(2): 49-58.

THERMAL REMEDIATION services inc.

Sampling of Hot Soil

Mark Bowen
Project Engineer
Anderson Mulholland & Associates

Greg Beyke, PE
VP - Engineering
Thermal Remediation Services

8891015

THERMAL REMEDIATION services inc.

8891016

Hot Soil Sample Procedure

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

THERMAL REMEDIATION services inc.

Hot Soil Sample Procedure

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

Meat thermometer

8S01017

THERMAL REMEDIATION services inc.

Hot Soil Sample Procedure

8801018

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

THERMAL REMEDIATION services inc.

What if the Hot Soil Sample Procedure is not followed?

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

THERMAL REMEDIATION services inc.

8891020

Lawrence Livermore National Laboratory Study - 1993

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

THERMAL REMEDIATION services inc.

Battelle - Interagency DNAPL Consortium Study - 2001

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

ATTACHMENT E

EPA Drum Sampling Standard Operating Procedures

DRUM SAMPLING

SOP#: 2009
DATE: 11/16/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide technical guidance on implementing safe and cost-effective response actions at hazardous waste sites containing drums with unknown contents. Container contents are sampled and characterized for disposal, bulking, recycling, segregation, and classification purposes.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Prior to sampling, drums must be excavated, (if necessary), inspected, staged, and opened. Drum excavation must be performed by qualified personnel. Inspection involves the observation and recording of visual qualities of each drum and any characteristics pertinent to the classification of the drum's contents. Staging involves the physical grouping of drums according to classifications established during the physical inspection. Opening of closed drums can be performed manually or remotely. Remote drum opening is recommended for worker safety. The most widely used method of sampling a drum involves the use of a glass thief. This method is quick, simple, relatively inexpensive, and requires no decontamination. The contents of a drum can be further characterized by performing various field tests.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Samples collected from drums are considered waste samples and as such, adding preservatives is not required due to the potential reaction of the sample with the preservative. Samples should, however, be cooled to 4°C and protected from sunlight in order to minimize any potential reaction due to the light sensitivity of the sample.

Sample bottles for collection of waste liquids, sludges, or solids are typically wide mouth amber jars with Teflon-lined screw caps. Actual volume required for analysis should be determined in conjunction with the laboratory performing the analysis.

Waste sample handling procedures should be as follows:

1. Label the sample container with the appropriate sample label and complete the appropriate field data sheet(s). Place sample container into two resealable plastic bags.

2. Place each bagged sample container into a shipping container which has been lined with plastic. Pack the container with enough non-combustible, absorbent, cushioning material to minimize the possibility of containers breaking, and to absorb any material which may leak.

   Note: Depending on the nature and quantity of the material to be shipped, different packaging may be required. The transportation company or a shipping/receiving expert should be consulted prior to packing the samples.

3. Complete a chain of custody record for each shipping container, place into a resealable

plastic bag, and affix to the inside lid of the shipping container.

4. Secure and custody seal the lid of the shipping container. Label the shipping container appropriately and arrange for the appropriate transportation mode consistent with the type of hazardous waste involved.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

If buried drums are suspected, geophysical investigation techniques such as magnetometry or ground penetrating radar may be employed in an attempt to determine the location and depth of drums. During excavation, the soil must be removed with great caution to minimize the potential for drum rupture.

Until the contents are characterized, sampling personnel should assume that unlabelled drums contain hazardous materials. Labelled drums are frequently mislabelled, especially drums that are reused. Because a drum's label may not accurately describe its contents, extreme caution must be exercised when working with or around drums.

If a drum which contains a liquid cannot be moved without rupture, its contents may be immediately transferred to a sound drum using an appropriate method of transfer based on the type of waste. In any case, preparations should be made to contain the spill (i.e., spill pads, dike, etc.) should one occur.

If a drum is leaking, open, or deteriorated, then it must be placed immediately in overpack containers.

The practice of tapping drums to determine their contents is neither safe nor effective and should not be used if the drums are visually overpressurized or if shock-sensitive materials are suspected. A laser thermometer may be effective in order to determine the level of the drum contents via surface temperature differences.

Drums that have been overpressurized to the extent that the head is swollen several inches above the level of the chime should not be moved. A number of devices have been developed for venting critically swollen drums. One method that has proven to be effective is a tube and spear device. A light aluminum tube (3 meters long) is positioned at the vapor space of the drum. A rigid, hooking device attached to the tube, goes over the chime and holds the tube securely in place. The spear is inserted in the tube and positioned against the drum wall. A sharp blow on the end of the spear drives the sharpened tip through the drum and the gas vents along the grooves. Venting should be done from behind a wall or barricade. Once the pressure has been relieved, the bung can be removed and the drum sampled.

Because there is potential for accidents to occur during handling, particularly initial handling, drums should only be handled if necessary. All personnel should be warned of the hazards prior to handling drums. Overpack drums and an adequate volume of absorbent material should be kept near areas where minor spills may occur. Where major spills may occur, a containment berm adequate to contain the entire volume of liquid in the drums should be constructed before any handling takes place. If drum contents spill, personnel trained in spill response should be used to isolate and contain the spill.

5.0 EQUIPMENT/APPARATUS

The following are standard materials and equipment required for sampling:

C Personal protection equipment
C Wide-mouth amber glass jars with Teflon cap liner, approximately 500 mL volume
C Other appropriate sample jars
C Uniquely numbered sample identification labels with corresponding data sheets
C Drum/Tank Sampling Data Sheets and Field Test Data Sheets for Drum/Tank Sampling
C Chain of Custody records
C Decontamination materials
C Glass thieving tubes or COLIWASA
C Coring device
C Stainless steel spatula or spoons
C Laser thermometer
C Drum overpacks
C Absorbent material for spills
C Drum opening devices

Bung Wrench

A common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of a non-sparking metal alloy (i.e., brass, bronze/manganese, aluminum, etc.) formulated to reduce the likelihood of sparks. The use of a "NON-SPARKING" wrench does not completely eliminate the possibility of a spark being produced.

Drum Deheader

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums. Drums with removable heads must be opened by other means.

Hand Pick, Pickaxe, and Hand Spike

These tools are usually constructed of brass or a non-sparking alloy with a sharpened point that can penetrate the drum lid or head when the tool is swung. The hand picks or pickaxes that are most commonly used are commercially available; whereas, the spikes are generally uniquely fabricated four foot long poles with a pointed end.

Backhoe Spike

Another means used to open drums remotely for sampling is a metal spike attached or welded to a backhoe bucket. This method is very efficient and is often used in large-scale operations.

Hydraulic Drum Opener

Recently, remotely operated hydraulic devices have been fabricated to open drums. This device uses hydraulic pressure to force a non-sparking spike through the wall of a drum. It consists of a manually operated pump which pressurizes fluid through a length of hydraulic line.

Pneumatic Devices

A pneumatic bung remover consists of a compressed air supply that is controlled by a two-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill, which is adapted to turn bung fitting selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

6.0 REAGENTS

Reagents are not typically required for preserving drum samples. However, reagents will be utilized for decontamination of sampling equipment.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and

mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Drum Excavation

If it is presumed that buried drums are on-site and prior to beginning excavation activities, geophysical investigation techniques should be utilized to approximate the location and depth of the drums. In addition, it is important to ensure that all locations where excavation will occur are clear of utility lines, pipes and poles (subsurface as well as above surface).

Excavating, removing, and handling drums are generally accomplished with conventional heavy construction equipment. These activities should be performed by an equipment operator who has experience in drum excavation. During excavation activities, drums must be approached in a manner that will avoid digging directly into them.

The soil around the drum should be excavated with non-sparking hand tools or other appropriate means and as the drums are exposed, a visual inspection should be made to determine the condition of the drums. Ambient air monitoring should be done to determine the presence of unsafe levels of volatile organics, explosives, or radioactive materials. Based on this preliminary visual inspection, the appropriate mode of drum excavation and handling may be determined.

Drum identification and inventory should begin before excavation. Information such as location, date of removal, drum identification number, overpack status, and any other identification marks should be recorded on the Drum/Tank Sampling Data Sheet (Attachment 1, Appendix A).

7.3 Drum Inspection

Appropriate procedures for handling drums depend on the contents. Thus, prior to any handling, drums should be visually inspected to gain as much information as possible about their contents. The drums should be inspected for the following:

1. Drum condition, corrosion, rust, punctures, bungs, and leaking contents.

2. Symbols, words, or other markings on the drum indicating hazards (i.e., explosive, radioactive, toxic, flammable), or further identifying the drums.

3. Signs that the drum is under pressure.

4. Shock sensitivity.

Monitoring should be conducted around the drums using instruments such as radiation meters, organic vapor analyzers (OVA) and combustible gas indicators (CGI).

Survey results can be used to classify the drums into categories, for instance:

C Radioactive
C Leaking/deteriorating
C Bulging
C Lab packs
C Explosive/shock sensitive
C Empty

All personnel should assume that unmarked drums contain hazardous materials until their contents have been categorized. Once a drum has been visually inspected and any immediate hazard has been eliminated by overpacking or transferring the drum's contents, the drum is affixed with a numbered tag and transferred to a staging area. Color-coded tags, labels or bands should be used to identify the drum's category based on visual inspection. A description of each drum, its condition, any unusual markings, the location where it was buried or stored, and field monitoring information are recorded on a Drum/Tank Sampling Data Sheet (Attachment 1, Appendix A). This data sheet becomes the principal record keeping tool for tracking the drum on-site.

7.4 Drum Staging

Prior to sampling, the drums should be staged to allow easy access. Ideally, the staging area should be located just far enough from the drum opening area to prevent a chain reaction if one drum should explode or catch fire when opened.

During staging, the drums should be physically separated into the following categories: those containing liquids, those containing solids, those containing lab packs, and those which are empty. This is done because the strategy for sampling and handling drums/containers in each of these categories will be different. This may be achieved by visual inspection of the drum and its labels, codes, etc. Solids and sludges are typically disposed of in open top drums. Closed head drums with a bung opening generally contain liquid.

Where there is good reason to suspect that drums contain radioactive, explosive, or shock-sensitive materials, these drums should be staged in a separate, isolated area. Placement of explosives and shock-sensitive materials in diked and fenced areas will minimize the hazard and the adverse effects of any premature detonation of explosives.

Where space allows, the drum opening area should be physically separated from the drum removal and drum staging operations. Drums are moved from the staging area to the drum opening area one at a time using forklift trucks equipped with drum grabbers or a barrel grappler. In a large-scale drum handling operation, drums may be conveyed to the drum opening area using a roller conveyor. Drums may be restaged as necessary after opening and sampling.

7.5 Drum Opening

There are three basic techniques available for opening drums at hazardous waste sites:

- Manual opening with non-sparking bung wrenches
- Drum deheading
- Remote drum puncturing or bung removal

The choice of drum opening techniques and accessories depends on the number of drums to be opened, their waste contents, and physical condition. Remote drum opening equipment should always be considered in order to protect worker safety. Under OSHA 1910.120, manual drum opening with bung wrenches or deheaders should be performed ONLY with structurally sound drums and waste contents that are known to be non-shock sensitive, non-reactive, non-explosive, and non-flammable.

7.5.1 Manual Drum Opening with a Bung Wrench

Manual drum opening with bung wrenches (Figure 1, Appendix B) should not be performed unless the drums are structurally sound (no evidence of bulging or deformation) and their contents are known to be non-shock sensitive, non-reactive, non-explosive or non-flammable. If opening the drum with bung wrenches is deemed safe, then certain procedures should be implemented to minimize the hazard:

- Field personnel should be fully outfitted with protective gear.
- Drums should be positioned upright with the bung up, or, for drums with bungs on the side, laid on their sides with the bung plugs up.
- The wrenching motion should be a slow, steady pull across the drum. If the length of the bung wrench handle provides inadequate leverage for unscrewing the plug, a "cheater bar" can be attached to the handle to improve leverage.

7.5.2 Manual Drum Opening with a Drum Deheader

Drums are opened with a drum deheader (Figure 2, Appendix B) by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote method prior to using the deheader.

Self-propelled drum openers which are either electrically or pneumatically driven are available and can be used for quicker and more efficient deheading.

The drum deheader should be decontaminated, as necessary, after each drum is opened to avoid cross contamination and/or adverse chemical reactions from incompatible materials.

7.5.3 Manual Drum Opening with a Hand Pick, Pickaxe, or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, then it can be opened for sampling by using a hand pick, pickaxe, or spike (Figure 3, Appendix B). Often the drum lid or head must be hit with a great deal of force in order to penetrate it. Because of this, the potential for splash or spraying is greater than with other opening methods and therefore, this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums, some of which may be under pressure, cannot be opened slowly with these tools, spray from drums is common and appropriate safety measures must be taken. The pick or spike should be decontaminated after each drum is opened to avoid cross contamination and/or adverse chemical reaction from incompatible materials.

7.5.4 Remote Drum Opening with a Backhoe Spike

Remotely operated drum opening tools are the safest available means of drum opening. Remote drum opening is slow, but provides a high degree of safety compared to manual methods of opening.

In the opening area, drums should be placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike (Figure 4, Appendix B) should be decontaminated after each drum is opened to prevent cross contamination and/or adverse reaction from incompatible material. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This combined with the normal personal protection gear should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board airline system.

7.5.5 Remote Drum Opening with Hydraulic Devices

A piercing device with a non-sparking, metal point is attached to the end of a hydraulic line and is pushed into the drum by the hydraulic pressure (Figure 5, Appendix B). The piercing device can be attached so that a hole for sampling can be made in either the side or the head of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place if desired and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

7.5.6 Remote Drum Opening with Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely (Figure 6, Appendix B). Prior to opening the drum, a bung fitting must be selected to fit the bung to be removed. The adjustable bracketing system is then attached to the drum and the pneumatic drill is aligned over the bung. This must be done before the drill can be operated. The operator then moves away from the drum to operate the equipment. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

7.6 Drum Sampling

After the drum has been opened, preliminary monitoring of headspace gases should be performed first with an explosimeter/oxygen meter. Afterwards, an OVA or other instruments should be used. If possible, these instruments should be intrinsically safe. In most cases it is impossible to observe the contents of these sealed or partially sealed drums. Since some layering or stratification is likely in any solution left undisturbed, a sample that represents the entire depth of the drum must be taken.

When sampling a previously sealed drum, a check should be made for the presence of a bottom sludge. This is easily accomplished by measuring the depth to apparent bottom then comparing it to the known interior depth.

7.6.1 Glass Thief Sampler

The most widely used implement for sampling drum liquids is a glass tube commonly referred to as a glass thief (Figure 7, Appendix B). This tool is cost effective, quick, and disposable. Glass thieves are typically 6mm to 16mm I.D. and 48 inches long.

Procedures for Use:

1. Remove the cover from the sample container.

2. Insert glass tubing almost to the bottom of the drum or until a solid layer is encountered. About one foot of tubing should extend above the drum.

3. Allow the waste in the drum to reach its natural level in the tube.

4. Cap the top of the sampling tube with a tapered stopper or thumb, ensuring liquid does not come into contact with stopper.

5. Carefully remove the capped tube from the drum and insert the uncapped end into the appropriate sample container.

6. Release stopper and allow the glass thief to drain until the container is approximately two-thirds full.

7. Remove tube from the sample container, break it into pieces and place the pieces in the drum.

8. Cap the sample container tightly and label it. Place the sample container into a carrier.

9. Replace the bung or place plastic over the drum.

10. Log all samples in the site logbook and on Drum/Tank Sampling Data Sheets.

11. Perform hazard categorization analyses if included in the project scope.

12. Transport the sample to the decontamination zone and package it for transport to the analytical laboratory, as necessary. Complete chain of custody records.

In many instances a drum containing waste material will have a sludge layer on the bottom. Slow insertion of the sample tube into this layer; then a gradual withdrawal will allow the sludge to act as a bottom plug to maintain the fluid in the tube. The plug can be gently removed and placed into the sample container by the use of a stainless steel lab spoon.

It should be noted that in some instances disposal of the tube by breaking it into the drum may interfere with eventual plans for the removal of its contents. The use of this technique should be cleared with the project officer or other glass thief disposal techniques should be evaluated.

7.6.2 COLIWASA Sampler

The Composite Liquid Waste Sampler (COLIWASA) and modifications thereof are equipment that collect a sample from the full depth of a drum and maintain it in the transfer tube until delivery to the sample bottle. The COLIWASA (Figure 8, Appendix B) is a much cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. One configuration consists of a 152 cm by 4 cm I.D. section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end.

Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper. One model of the COLIWASA is shown in Appendix B; however, the design can be modified and/or adapted somewhat to meet the needs of the sampler.

The major drawbacks associated with using a COLIWASA concern decontamination and costs. The sampler is difficult to decontaminate in the field and its high cost in relation to alternative procedures (glass tubes) make it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use

1. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.

2. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.

3. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

4. Slowly withdraw the sample from the waste container with one hand while wiping the sampler tube with a disposable cloth or rag with the other hand.

5. Carefully discharge the sample into the appropriate sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.

6. Cap the sample container tightly and label it. Place the sample container in a carrier.

7. Replace the bung or place plastic over the drum.

8. Log all samples in the site logbook and on Drum/Tank Sampling Data Sheets.

9. Perform hazard categorization analyses if included in the project scope.

10. Transport the sample to the decontamination zone and package for transport to the analytical laboratory, as necessary. Complete the Chain of Custody records.

7.6.3 Coring Device

A coring device may be used to sample drum solids. Samples should be taken from different areas within the drum. This sampler consists of a series of extensions, a T- handle, and the coring device.

Procedures for use:

1. Assemble the sampling equipment.

2. Remove the cover from the sample container.

3. Insert the sampling device to the bottom of the drum. The extensions and the "T" handle should extend above the drum.

4. Rotate the sampling device to cut a core of material.

5. Slowly withdraw the sampling device so that as much sample material as possible is retained within it.

6. Transfer the sample to the appropriate sample container, and label it. A stainless steel spoon or scoop may be used as necessary.

7. Cap the sample container tightly and place it in a carrier.

8. Replace the bung or place plastic over the drum.

9. Log all samples in the site log book and on Drum/Tank Sampling Data Sheets.

10. Perform hazard categorization analyses if included in the project scope.

11. Transport the sample to the decontamination zone and package it for transport to the analytical laboratory, as necessary. Complete chain of custody records.

7.7 Hazard Categorization

The goal of characterizing or categorizing the contents of drums is to obtain a quick, preliminary assessment of the types and levels of pollutants contained in the drums. These activities generally involve rapid, non-rigorous methods of analysis. The data obtained from these methods can be used to make decisions regarding drum staging or restaging, bulking or compositing of the drum contents.

As a first step in obtaining these data, standard tests should be used to classify the drum contents into general categories such as auto-reactives, water reactives, inorganic acids, organic acids, heavy metals, pesticides, cyanides, inorganic oxidizers, and organic oxidizers. In some cases, further analyses should be conducted to more precisely identify the drum contents.

There are several methods available to perform these tests:

C the HazCat[R] chemical identification system
C the Chlor-N-Oil Test Kit
C Spill-fyter Chemical Classifier Strips
C Setaflash (for ignitability)

These methods must be performed according to the manufacturers' instructions and the results must be documented on the Field Test Data Sheet for Drum/Tank Sampling (Attachment 2, Appendix A).

Other tests which may be performed include:

C Water Reactivity
C Specific Gravity Test (compared to water)
C Water Solubility Test
C pH of Aqueous Solution

The tests must be performed in accordance with the instructions on the Field Test Data Sheet for Drum/Tank Sampling and results of the tests must be documented on these data sheets.

The specific methods that will be used for hazard categorization must be documented in the Quality Assurance Work Plan.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

The following general quality assurance procedures apply:

1. All data must be documented on Chain of Custody records, Drum/Tank Sampling Data Sheets, Field Test Data Sheet for Drum/Tank Sampling, or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures.

More specifically, the opening of closed containers is one of the most hazardous site activities. Maximum efforts should be made to ensure the safety of the sampling team. Proper protective equipment and a general awareness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended.

12.0 REFERENCES

Guidance Document for Cleanup of Surface Tank and Drum Sites, OSWER Directive 9380.0-3.

Drum Handling Practices at Hazardous Waste Sites, EPA-600/2-86-013.

APPENDIX A

Attachments

ATTACHMENT 1. Drum/Tank Sampling Data Sheet

Samplers: ____________________ Date: ____________________

Site Name: ____________________ Work Order Number: 3347-040-001-__________

Container Number/Sample Number: ______ REAC Task Leader: ____________________

SITE INFORMATION:

1. Terrain, drainage description: ____________________

2. Weather conditions (from observation): ____________________

   MET station on site: No Yes

CONTAINER INFORMATION:

1. Container type: Drum Tank Other: ____________________

2. Container dimensions: Shape: ____________________

   Approximate size: ____________________

3. Label present: No
   Yes: ____________________

   Other Markings: ____________________

4. Spill or leak present: No Yes Dimensions: ____________________

5. Container location: (Circle one) N/A See Map Other: ____________________

8891034

APPENDIX A (Cont'd)

Attachments

ATTACHMENT 1. Drum/Tank Sampling Data Sheet (cont'd)

SAMPLE INFORMATION:

1. Description: _____ liquid _____ solid (_____ powder or _____ crystals) _____ sludge

2. Color: ______________________ Vapors: ____________________
   Other: ____

3. Local effects present: (damage - environmental, material) ____

FIELD MONITORING:

1. PID: ____________________ Background (clean zone)

   ____________________ Probe used/Model used

   ____________________ Reading from container opening

2. FID: ____________________ Background (clean zone)

   ____________________ Reading from container opening

3. Radiation Meter:

   ____________________ Model used

   ____________________ Background (clean zone)

   ____________________ Reading from container opening

4. Explosimeter/Oxygen Meter:

   ____________________ Oxygen level from container opening

   ____________________ LEL level from container opening

APPENDIX A (Cont'd)

Attachments

ATTACHMENT 2. Field Test Data Sheet for Drum/Tank Sampling

Samplers: ______________________________ Date: ______________________

Site Name: _____________________________ Work Order Number: 3347-040-001-__________

Container Number/Sample Number: ______________ REAC Task Leader: ________________________

SAMPLE MONITORING INFORMATION:

1. PID: ____________________ Background (clean zone)

____________________ Probe used/Model used

____________________ Reading from sample

2. FID: ____________________ Background (clean zone)

____________________ Reading from sample

3. Radiation Meter: ________________ Model used

________________ Background (clean zone)

________________ Reading from sample

4. Explosimeter/Oxygen Meter: ____________ Oxygen level (sample)

____________ LEL level (sample)

SAMPLE DESCRIPTION:

________ Liquid ________ Solid ________ Sludge ________ Color ________ Vapors

WATER REACTIVITY:

1. Add small amount of sample to water: _____ bubbles _____ color change to _______________

_____ vapor formation _____ heat _____ No Change

SPECIFIC GRAVITY TEST (compared to water):

1. Add small amount of sample to water: _____ sinks _____ floats

2. If liquid sample sinks, screen for chlorinated compounds. If liquid sample floats and appears to be oily, screen for PCBs (Chlor-N-Oil kit).

APPENDIX A (Cont'd)

Attachments

ATTACHMENT 2. Field Test Data Sheet for Drum/Tank Sampling (cont'd)

CHLOR N OIL TEST KIT INFORMATION:

1. Test kit used for this sample: Yes No

2. Results: _____ PCB not present _____ PCB present, less than 50 ppm

   _____ PCB present, greater than 50 ppm _____ 100% PCB present

WATER SOLUBILITY TEST:

1. Add approximately one part sample to five parts water. You may need to stir and heat gently. **[DO NOT HEAT IF WATER REACTIVE!]** Results: ________ total ________ partial ________ no solubility

pH OF AQUEOUS SOLUTION:

1. Using 0-14 pH paper, check pH of water/sample solution: __________________.

SPILL-FYTER CHEMICAL CLASSIFIER STRIPS:

1. Acid/Base Risk: (Circle one)	Color Change
Strong acid (0)	RED
Moderately acidic (1-3)	ORANGE
Weak acid (5)	YELLOW
Neutral (7)	GREEN
Moderately basic (9-11)	Dark GREEN
Strong Base (13-14)	Dark BLUE
2. Oxidizer Risk: (Circle one)	
Not Present	WHITE
Present	BLUE, RED, OR ANY DIVERGENCE FROM WHITE
3. Fluoride Risk: (Circle one)	
Not Present	PINK
Present	YELLOW

APPENDIX A (Cont'd)

Attachments

ATTACHMENT 2. Field Test Data Sheet for Drum/Tank Sampling (cont'd)

4. Petroleum Product, Organic Solvent Risk: (Circle one)

Not Present	LIGHT BLUE
Present	DARK BLUE

5. Iodine, Bromine, Chlorine Risk: (Circle one)

Not Present	PEACH
Present	WHITE OR YELLOW

SETAFLASH IGNITABILITY TEST:

140°F	Ignitable: ________	Non-Ignitable ________
160°F	Ignitable: ________	Non-Ignitable ________
______	Ignitable: ________	Non-Ignitable ________
______	Ignitable: ________	Non-Ignitable ________
______	Ignitable: ________	Non-Ignitable ________
______	Ignitable: ________	Non-Ignitable ________

Comments:
____
____
____
____
____
____

HAZCAT KIT TESTS:

1. Test: ______________________________ Outcome: ______________________________

Comments:____
____

2. Test: ______________________________ Outcome: ______________________________

Comments:____

APPENDIX A (Cont'd)

Attachments

ATTACHMENT 2. Field Test Data Sheet for Drum/Tank Sampling (cont'd)

3. Test: ____________________ Outcome: ____________________

Comments: ____________________

____

4. Test: ____________________ Outcome: ____________________

Comments: ____________________

____

5. Test: ____________________ Outcome: ____________________

Comments: ____________________

____

HAZCAT PESTICIDES KIT:

Present: ____________________ Not Present: ____________________

Comments: ____________________

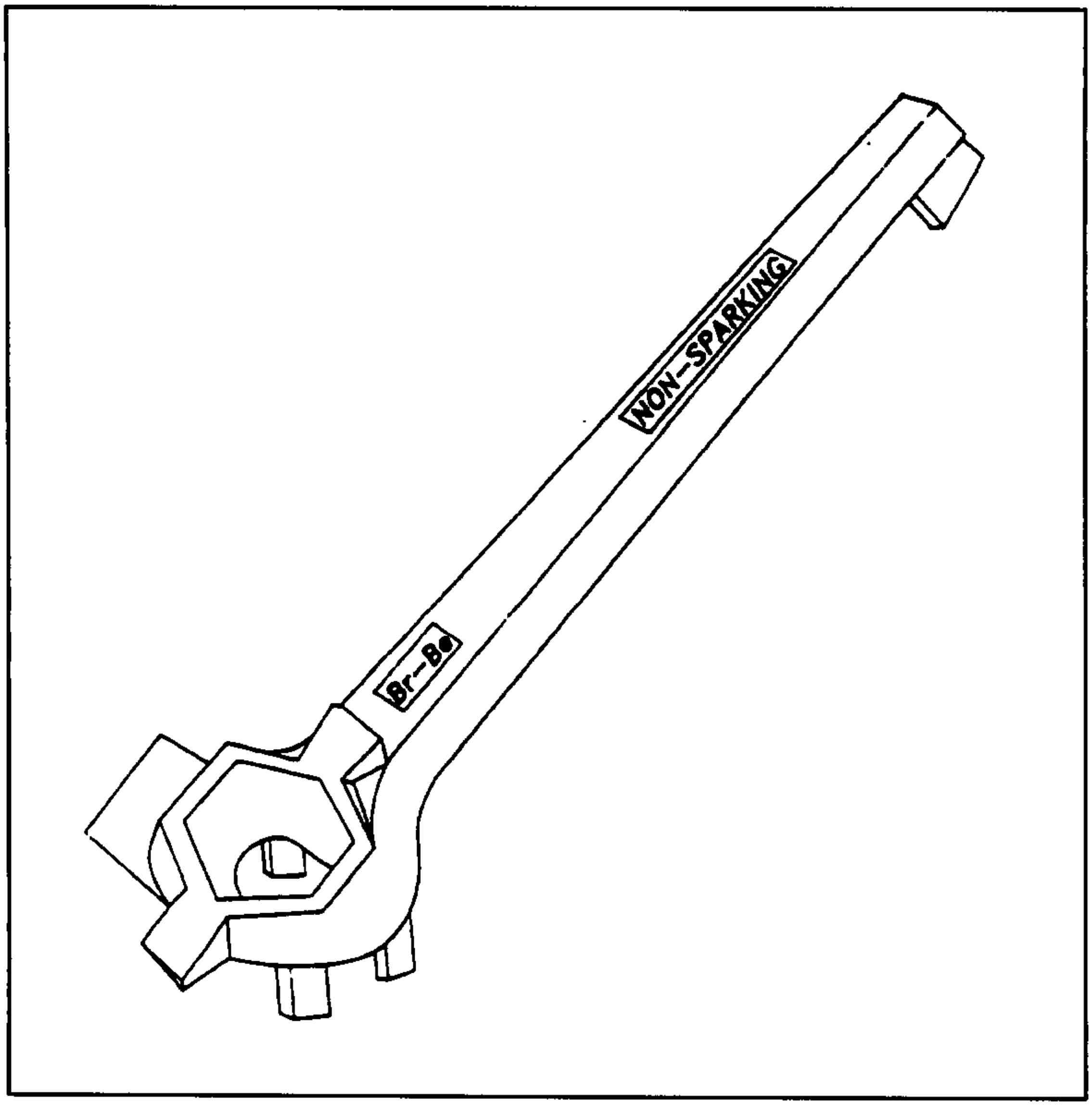
____

____

APPENDIX B

Figures

Figure 1. Universal Bung Wrench

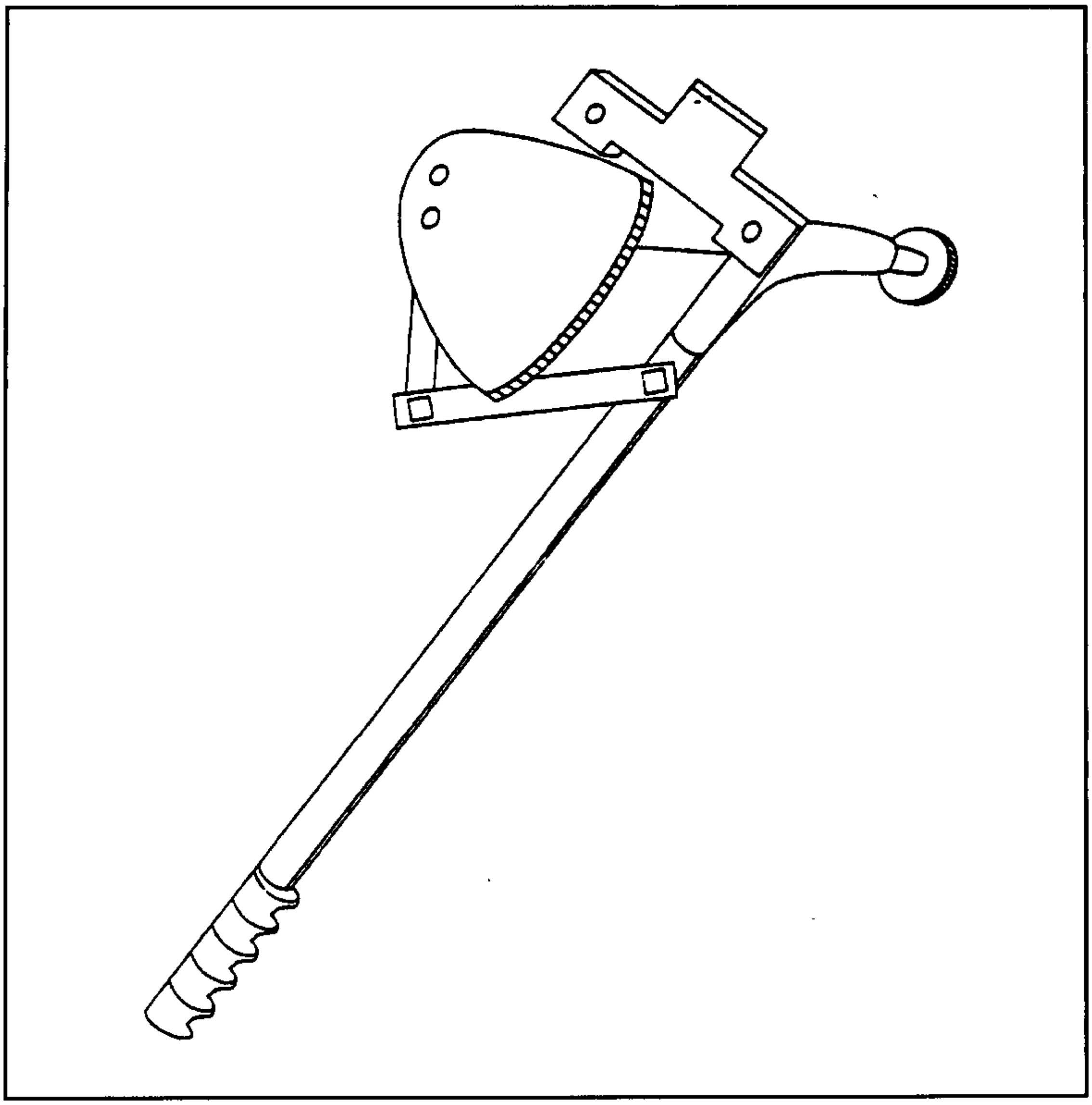


8891040

APPENDIX B (Cont'd)

Figures

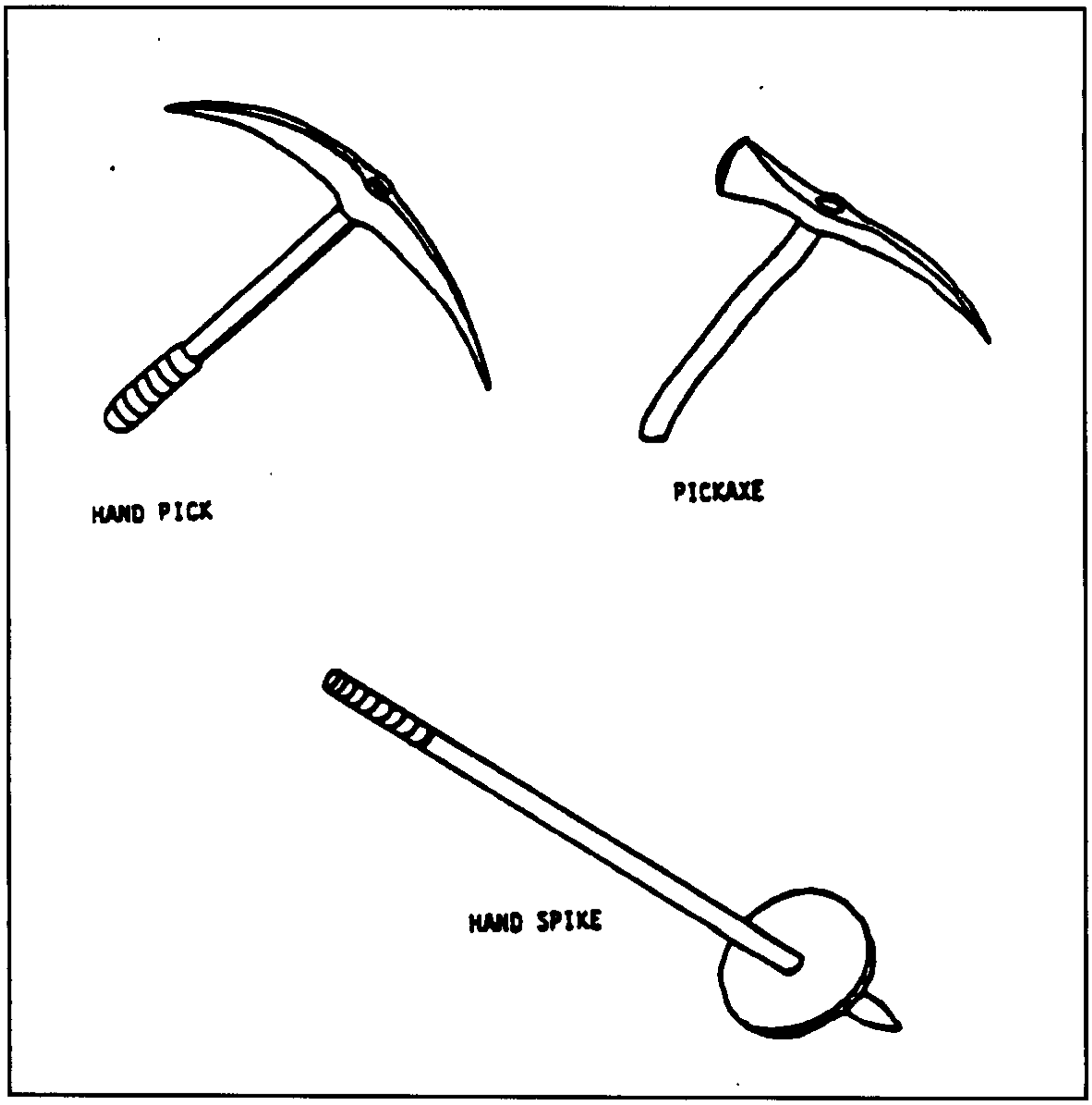
Figure 2. Drum Deheader



APPENDIX B (Cont'd)

Figures

Figure 3. Hand Pick, Pickaxe, and Hand Spike

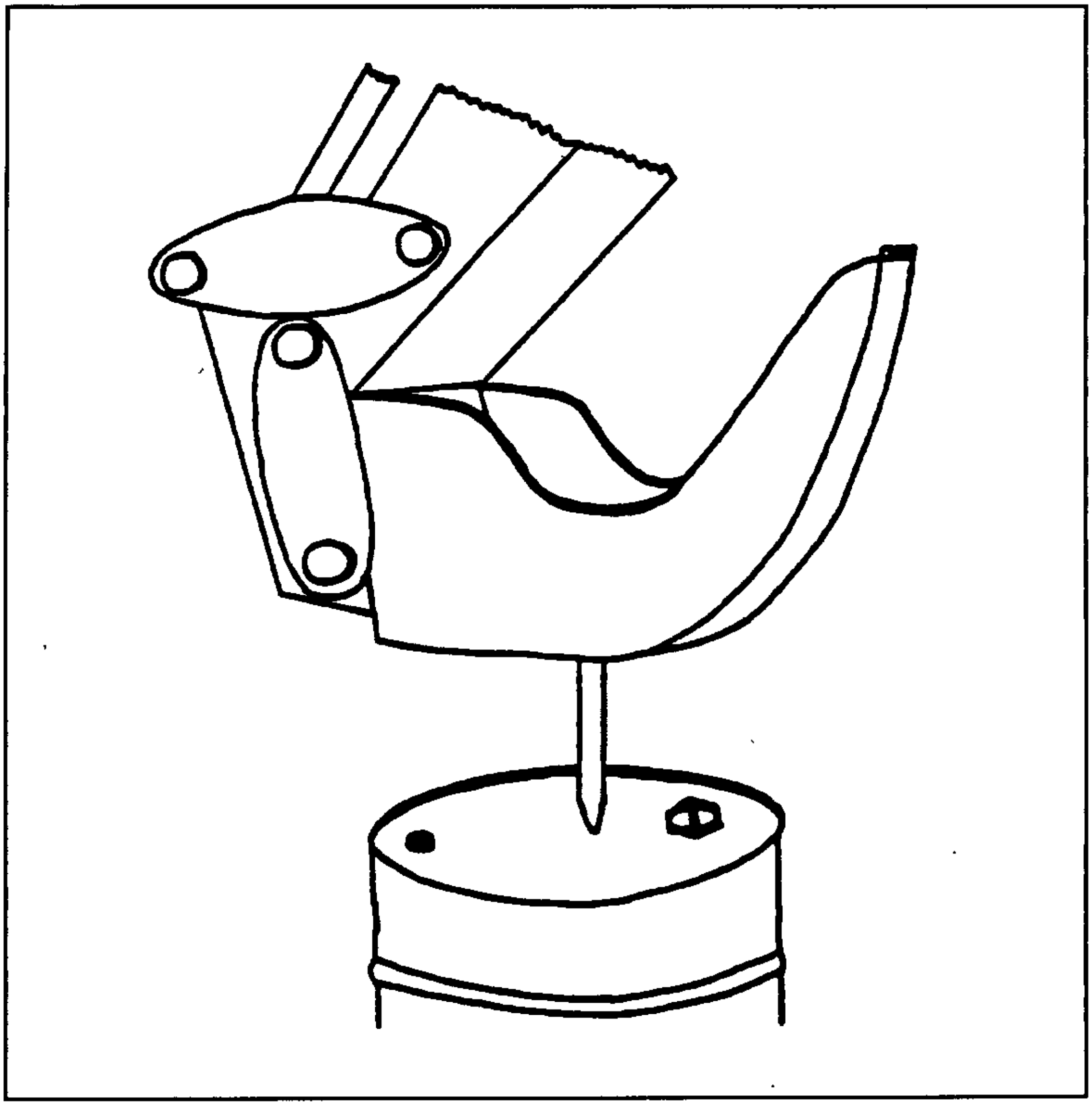


8891042

APPENDIX B (Cont'd)

Figures

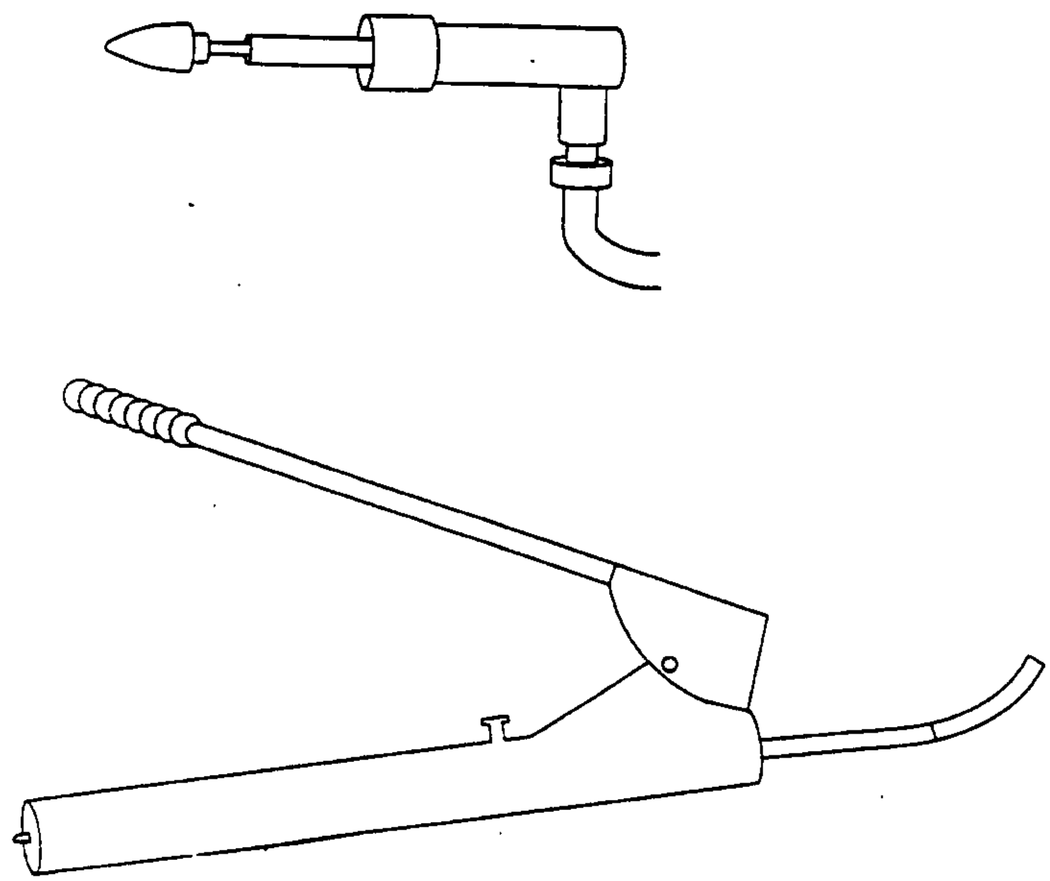
Figure 4. Backhoe Spike



APPENDIX B (Cont'd)

Figures

Figure 5. Hydraulic Drum Opener

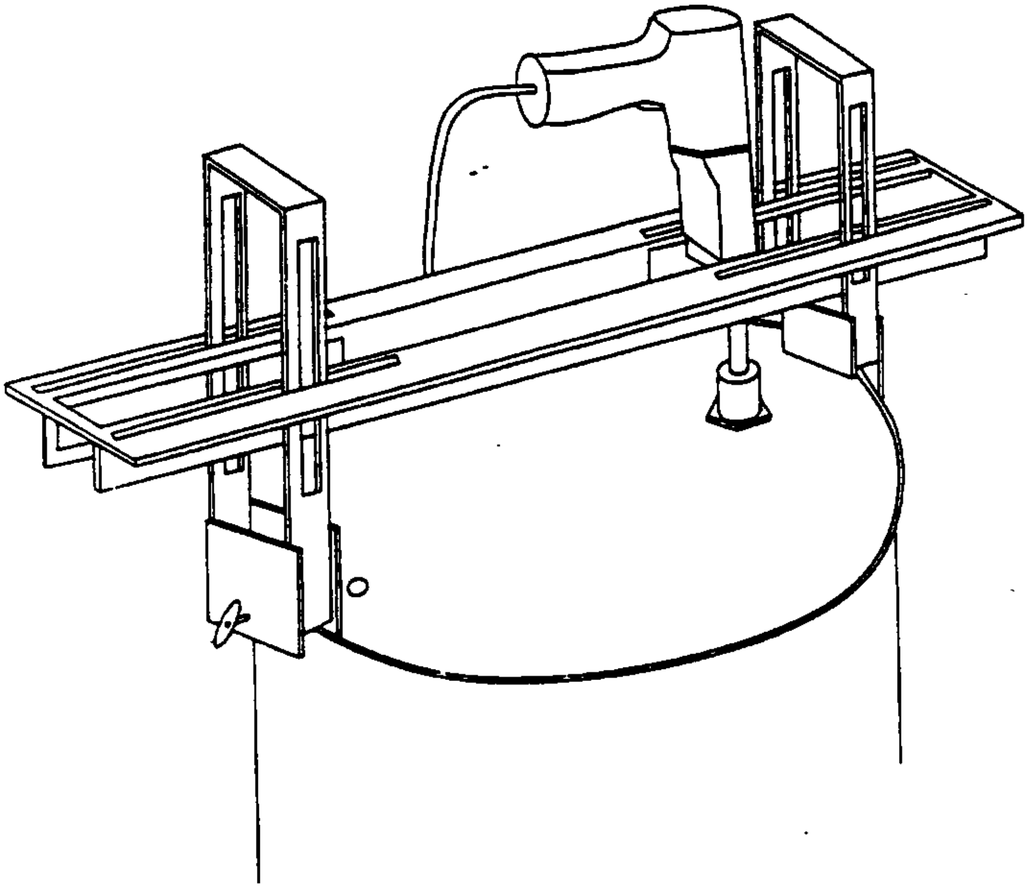


8891044

APPENDIX B (Cont'd)

Figures

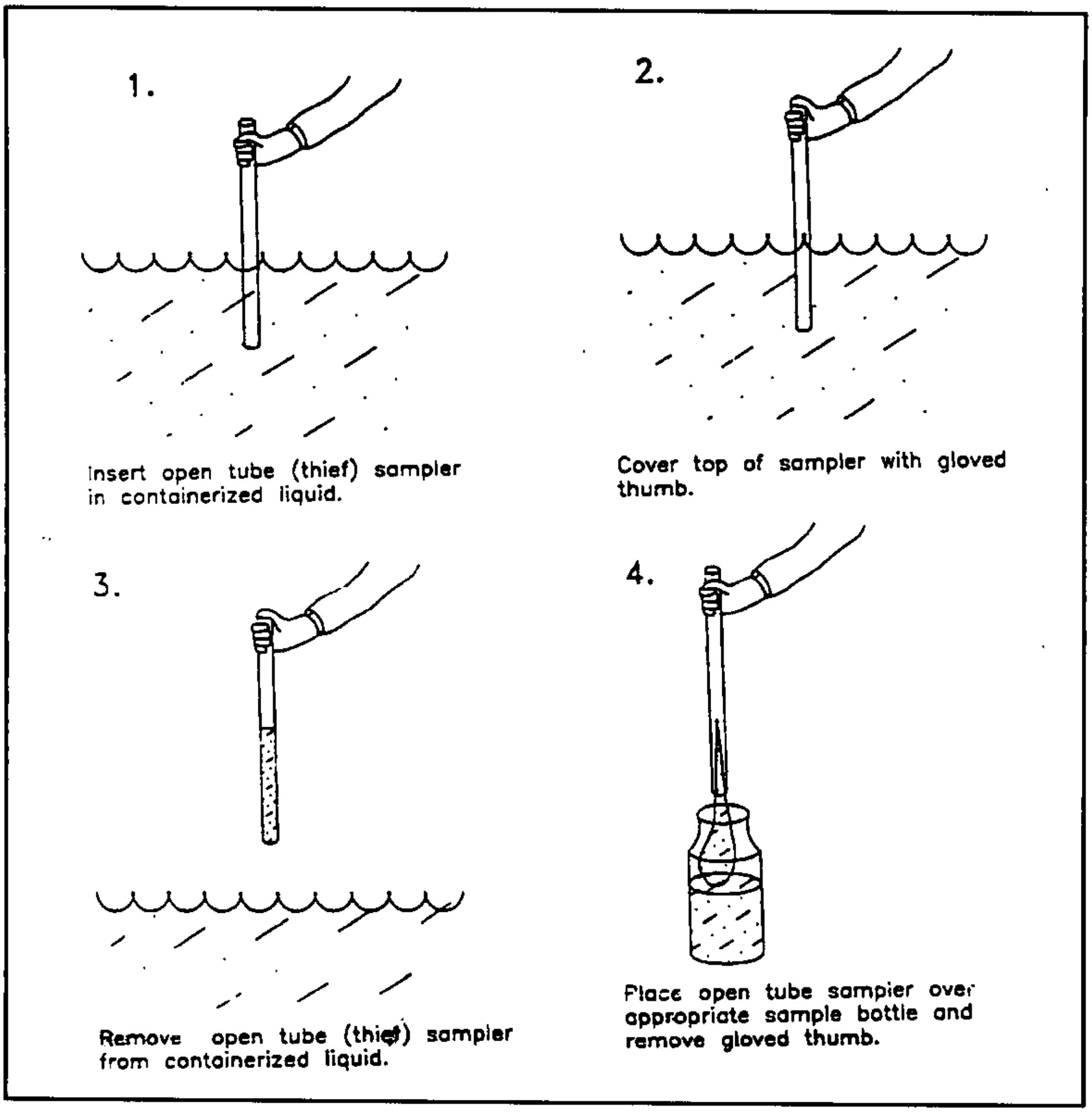
Figure 6. Pneumatic Bung Remover



APPENDIX B (Cont'd)

Figures

Figure 7. Glass Thief



1. Insert open tube (thief) sampler in containerized liquid.

2. Cover top of sampler with gloved thumb.

3. Remove open tube (thief) sampler from containerized liquid.

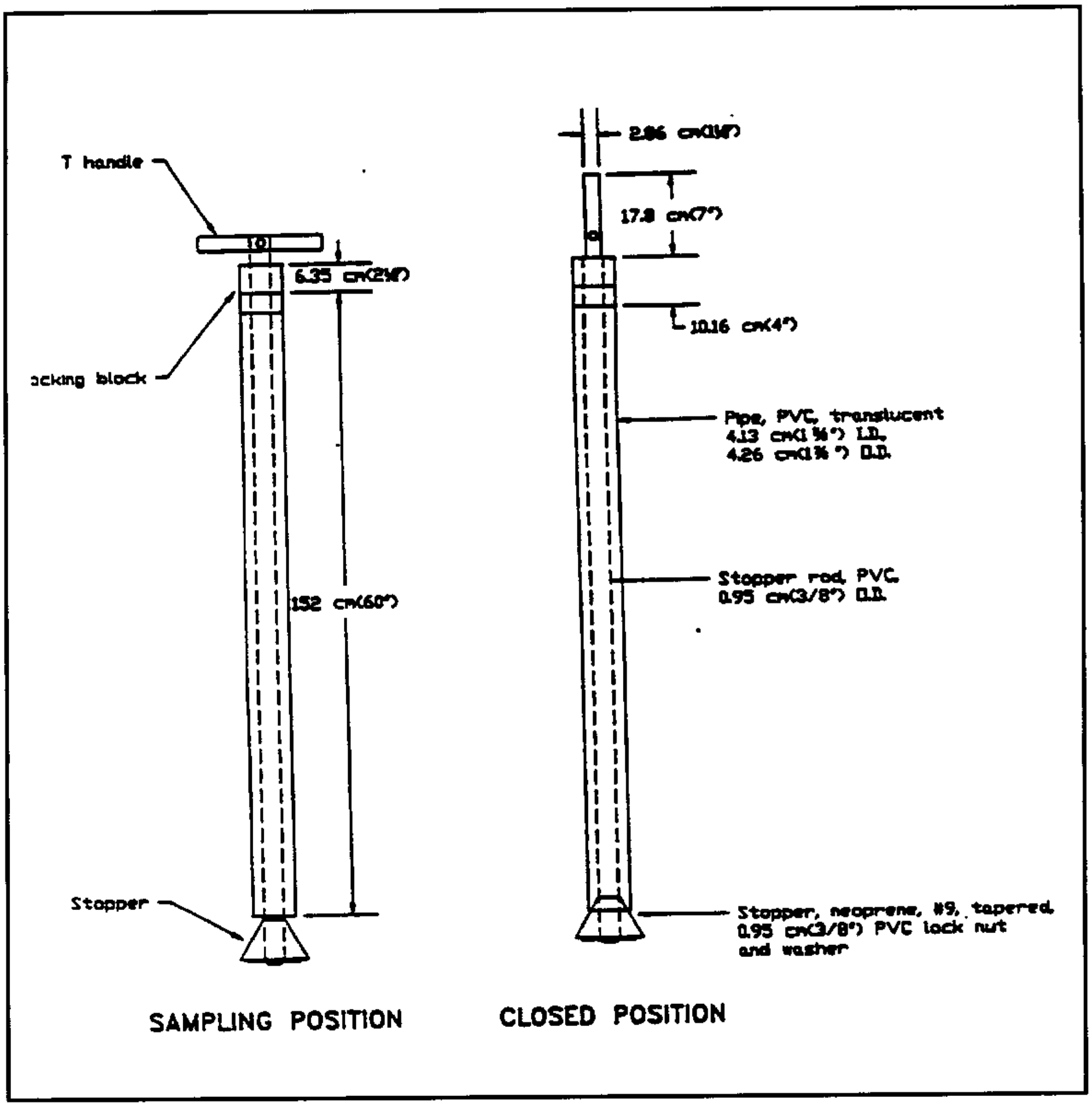
4. Place open tube sampler over appropriate sample bottle and remove gloved thumb.

8891046

APPENDIX B (Cont'd)

Figures

Figure 8. COLIWASA



Paper 1E-07, in: A.R. Gavaskar and A.S.C. Chen (Eds.), *Remediation of Chlorinated and Recalcitrant Compounds—2002.* Proceedings of the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2002). ISBN 1-57477-132-9, published by Battelle Press, Columbus, OH, www.battelle.org/bookstore.

SOIL CORE CHARACTERIZATION STRATEGY AT DNAPL SITES SUBJECTED TO STRONG THERMAL OR CHEMICAL REMEDIATION

Megan Gaberell, Arun Gavaskar, Eric Drescher, Joel Sminchak, Lydia Cumming, Woong-Sang Yoon, and Sumedha De Silva (Battelle, Columbus, Ohio, USA)

ABSTRACT: At Launch Complex 34 (LC34), Cape Canaveral Air Station, Florida, high concentrations of trichloroethylene (TCE) exist in groundwater and free phase (DNAPL) has been detected in the subsurface. Characterizing or monitoring sites that are contaminated with volatile organic compounds (VOCs) such as TCE is often challenging because of the difficulties associated in minimizing VOC loss during soil sample handling and collection. New difficulties in post-demonstration soil sampling were encountered due to (1) the residual strong oxidant remaining in the soil cores of the oxidation remediation plot; and (2) the high temperatures (50-95°C) in the thermal remediation plot that persisted for several months after the remediation had been completed. To evaluate the efficiency of the soil collection and sampling method in recovering VOCs, hot soil cores were brought to the surface and spiked with a surrogate compound, 1,1,1-trichloroethane (1,1,1-TCA). The results show that between 84 and 113% of TCA in the soil was recovered using field procedures designed to minimize VOC loss while protecting personnel handling the hot soil cores. The results also indicate that any VOC loss occurring during cooling of the soil core is minimal and within the acceptable limitations of the field sampling protocol.

INTRODUCTION

Dense nonaqueous-phase liquid (DNAPL) contamination presents a persistent environmental problem at many federal and private facilities. At Launch Complex 34 (LC 34), Cape Canaveral Air Station, Florida, high concentrations of trichloroethylene (TCE) exist in groundwater and free phase (DNAPL) has been detected in the subsurface. The Interagency DNAPL Consortium (IDC), a consortium consisting of U.S. Department of Energy (DOE), U.S. Department of Defense (DoD), U.S. Environmental Protection Agency (EPA), and the National Aeronautic and Space Administration (NASA), has been assessing several innovative DNAPL remediation technologies, including those that use thermal or chemical oxidation treatment. Post-demonstration characterization was conducted to verify the effectiveness of these innovative technologies, which were demonstrated in separate test plots in the DNAPL source zone.

Characterizing or monitoring sites that are contaminated with volatile organic compounds (VOCs) such as TCE is often challenging because of the difficulties associated in minimizing VOC loss during soil sample handling and collection. At LC 34, new difficulties in post-demonstration soil sampling were encountered due to (1) the residual strong oxidant remaining in soil cores of the chemical oxidation remediation plot; and (2) the high temperatures (50-95°C) in the thermal remediation plots that persisted for several months after the remediation had been completed. Field procedures for soil core handling and sampling were designed to take into account the safety issues posed by the strong oxidant (potassium permanganate) used at LC34 in the chemical

8891043

oxidation plot (Battelle, 1999). Field procedures for collecting soil cores and soil samples from the thermal remediation plot were modified in an effort to minimize VOC losses that can occur as a result of contaminant volatilization associated with elevated soil temperature (Battelle, 2001). Because additional consideration must be given to issues such as personnel safety when handling hot soil cores, there is the possibility that increased handling times during soil coring and sample collection may result in an increase in VOC losses. An experiment was conducted using soil samples spiked with a surrogate compound to investigate the effectiveness of the field procedures developed for LC34 in minimizing VOC losses. Because the soil sampling procedures were similar for both the chemical oxidation and thermal remediation strategies, the remainder of this paper focuses on issues associated with the collection and sampling of soil at elevated temperatures.

MATERIALS AND METHODS

Soil cores were collected in a 2-inch diameter, 4-foot long acetate sleeve that was placed tightly inside a 2-inch diameter stainless steel core barrel. The acetate sleeve was immediately capped on both ends with a protective polymer covering. The sleeve was placed in an ice bath to cool the heated core to below ambient groundwater temperatures (approximately 20°C). The temperature of the soil core was monitored during the cooling process with a meat thermometer that was pushed into one end cap (see Figure 1). Approximately 30 minutes was required to cool each 4-foot long, 2-inch diameter soil core from 50-95°C to below 20°C. Upon reaching ambient temperature, the core sleeve was then uncapped and cut open along its length to collect the soil sample for contaminant analysis (see Figure 2).

Soil samples were collected in relatively large quantities (approximately 200 g) along the entire length of the core rather than sampling small aliquots of the soil within

FIGURE 1. A soil core capped and cooling in an ice bath. The thermometer is visible in the end cap.

FIGURE 2. A soil sample being collected from along the length of the core into a bottle containing methanol.

the core, as required by the conventional method (EPA SW5035). This modification is advantageous because the resultant data provide an understanding of the continuous VOC distribution with depth. VOC losses during sampling were further minimized by placing the recovered soil samples directly into bottles containing methanol (approximately 250 mL) and extracting them on site. The extracted methanol was centrifuged and sent to an off-site laboratory for VOC analysis. Soil samples taken from the chemical oxidation plot were handled similarly, although they did not require cooling. The soil sampling and extraction strategy is described in more detail in Gavaskar et al. (2000).

To evaluate the efficiency of the sampling method in recovering VOCs, hot soil cores were extracted from 14 through 24 feet below ground surface and spiked with a surrogate compound, 1,1,1-trichloroethane (1,1,1-TCA). The surrogate was added to the intact soil core by using a 6" needle to inject 25 μL of surrogate into each end of the core for a total of 50 μL of 1,1,1-TCA. In order to evaluate the effect of the cooling period on VOC loss, three soil cores were spiked with TCA prior to cooling in the ice bath and three cores were spiked with TCA after cooling in the ice bath. In the pre-cooling test, the surrogate was injected as described above and the core barrels were subsequently capped and placed in the ice bath for the 30 minutes of cooling time required to bring the soil core to below 20°C. A thermometer was inserted through the cap to monitor the temperature of the soil core.

In the post-cooling test, the soil cores were injected with TCA after the soil core had been cooled in the ice bath to below 20°C. After cooling, the caps on the core barrel were removed and the surrogate compound was injected in the same manner, 25 μL per each end of the core barrel using a 6" syringe. The core was recapped and allowed to equilibrate for a few minutes before it was opened and samples were collected. Only for the purpose of the surrogate recovery tests, the entire contents of the sampling sleeve were collected and extracted on site with methanol. The soil: methanol ratio was kept approximately the same as during the regular soil sample collection and extraction. Several (four) aliquots of soil and several (four) bottles of methanol were required to extract the entire contents of the sample sleeve.

Two different capping methods were used during this experiment to evaluate the effectiveness of each cap type. Two of the soil cores were capped using flexible polymer sheets attached to the sleeve with rubber bands. The remaining four soil cores were capped with tight-fitting rigid polymer end caps. One reason that the polymer sheets were preferred over the rigid caps was that the flexible sheets were better positioned to handle any contraction of the sleeve during cooling.

RESULTS AND DISCUSSION

The results from the surrogate spiking experiment are shown in Table 1. Soil cores 1, 3, and 5 received the surrogate spike prior to cooling in the ice bath. Soil cores 2, 4, and 6 received the surrogate spike after cooling in the ice bath. The results show that between 84 and 113% of the surrogate spike was recovered from the soil cores. Recovery comparison is not expected to be influenced significantly by soil type because all samples were collected from a fine grained to medium fine-grained sand unit. The results also indicate that the timing of the surrogate spike (i.e., pre- or post-cooling) appeared to have only a slight effect on the amount of surrogate recovered. Slightly less surrogate was recovered from the soil cores spiked prior to cooling. This implies that any

8891050

losses of TCA in the soil samples spiked prior to cooling are minimal and acceptable, within the limitations of the field sampling protocol. The field sampling protocol was designed to process up to 300 soil samples that were collected over a 3-week period, during each monitoring event.

TABLE 1. Recovery in soil cores spiked with 1,1,1-TCA surrogate

Soil Cores Spiked Prior to Cooling	Capping Method	1,1,1-TCA Recovery (%)	Soil Cores Spiked After Cooling	Capping Method	1,1,1-TCA Recovery (%)
Core 1	Flexible polymer sheet with rubber bands	96.3	Core 2	Flexible polymer sheet with rubber bands	98.7
Core 3	Rigid End Cap	101.0	Core 4	Rigid End Cap	112.6
Core 5	Rigid End Cap	84.3	Core 6	Rigid End Cap	109.6

The capping method (flexible versus rigid cap) did not show any clear differences in the surrogate recoveries. The flexible sheets are easier to use and appear to be sufficient to ensure good target compound recovery.

This experiment demonstrates that the soil core handling procedures developed for use at LC34 were successful in minimizing volatility losses associated with the extreme temperatures of the soil cores. It also shows that collecting and extracting larger aliquots of soil in the field is a good way of characterizing DNAPL source zones.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the IDC members, and Tom Holdsworth (EPA) and Jackie Quinn (NASA) in particular, for their support during the site characterization and performance assessment at LC34. DHL Analytical provided analytical support during this demonstration.

REFERENCES

Battelle, 1999. *Quality Assurance Project Plan for Performance Evaluation of In-Situ Oxidation for DNAPL Destruction at Launch Complex 34, Cape Canaveral, Florida.* Prepared by Battelle for the Air Force Research Laboratory, Tyndall AFB, FL. September, 1999.

Battelle, 2001. *Quality Assurance Project Plan for Performance Evaluation of In-Situ Thermal Remediation System for DNAPL Removal at Launch Complex 34, Cape Canaveral, Florida.* Prepared by Battelle for Naval Facilities Engineering Service Center, June, 2001.

Gavaskar, A., S. Rosansky, S. Naber, N. Gupta, B. Sass, J. Sminchak, P. DeVane, and T. Holdsworth. 2000. "DNAPL Delineation with Soil and Groundwater Sampling." Proceedings of the Second International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California, May 22-25. Battelle Press. 2(2): 49-58.

THERMAL
REMEDIATION
services inc.

Sampling of Hot Soil

Mark Bowen
Project Engineer
Anderson Mulholland & Associates

Greg Beyke, PE
VP - Engineering
Thermal Remediation Services

8891051

THERMAL REMEDIATION services inc.

8891052

Hot Soil Sample Procedure

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

THERMAL REMEDIATION services inc.

Hot Soil Sample Procedure

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

Meat thermometer

8891053

THERMAL REMEDIATION services inc.

Hot Soil Sample Procedure

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

8891054

THERMAL REMEDIATION services inc.

What if the Hot Soil Sample Procedure is not followed?

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

8891055

8891056

THERMAL REMEDIATION services inc.

Lawrence Livermore National Laboratory Study - 1993

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

THERMAL REMEDIATION services inc.

Battelle - Interagency DNAPL Consortium Study - 2001

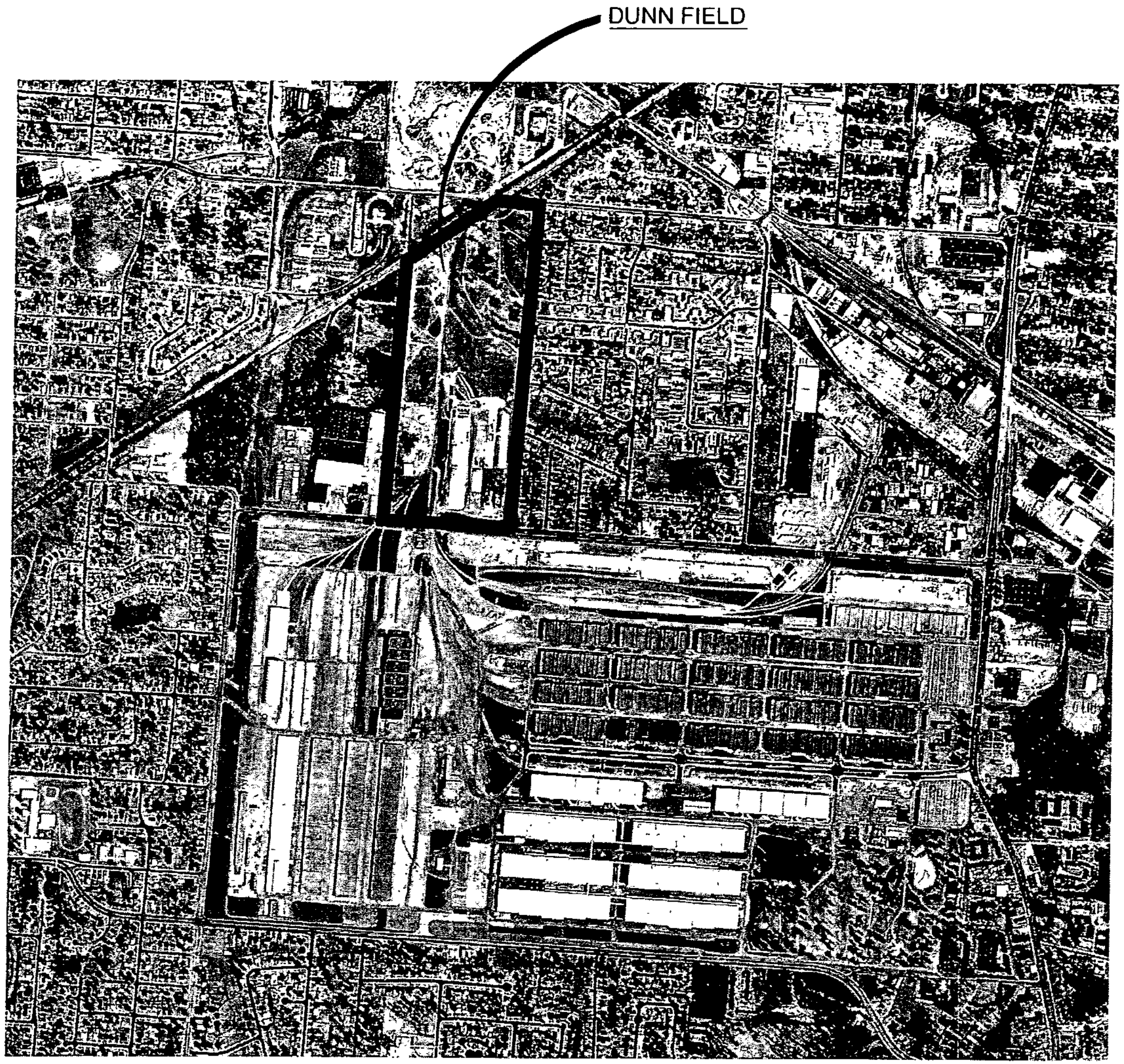
- Specifically designed to test the Hot Soil Sample procedure.
- Funded and reviewed by DOE, DoD, NASA, and US EPA.
- Battelle spiked hot soil samples with 1,1,1-TCA.
- Three hot soil sample cores were spiked and the average spike recovery was 94%.

APPENDIX D

Construction Drawings

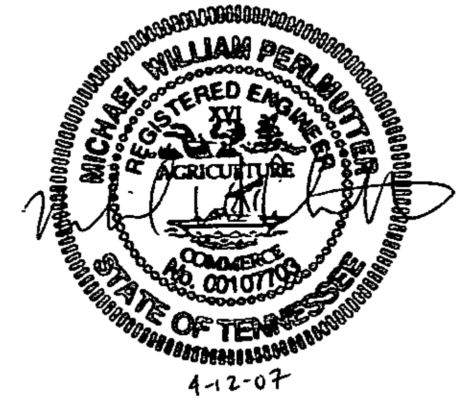
8891059

MEMPHIS DEPOT DUNN FIELD SOURCE AREAS REMEDIAL DESIGN MEMPHIS, TENNESSEE



LOCATION MAP

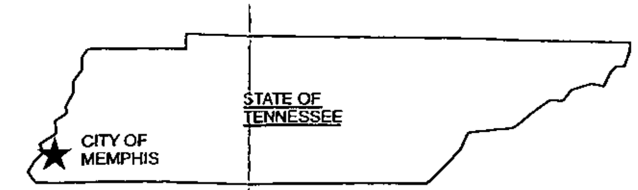
NTS



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	SITE MAP
3	F-1	SVE SYSTEM LAYOUT
4	F-2	CONVEYANCE PIPING CROSS SECTIONS
5	F-3	PROCESS FLOW DIAGRAM
6	F-4	PROCESS AND INSTRUMENTATION DIAGRAM
7	F-5	EQUIPMENT COMPOUND
8	F-6	BUILDING DETAILS
9	F-7	FENCE DETAIL
10	F-8	DETAILS
11	L-1	NORTH LOESS TREATMENT AREAS
12	L-2	SOUTH LOESS TREATMENT AREAS
13	GW-1	NORTH ZVI INJECTION LOCATIONS
14	GW-2	SOUTH ZVI INJECTION LOCATIONS



VICINITY MAP

NTS

NO.	DATE	REVISION	BY	APVD

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

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

GENERAL
TITLE SHEET, LOCATION MAP, AND INDEX TO DRAWINGS

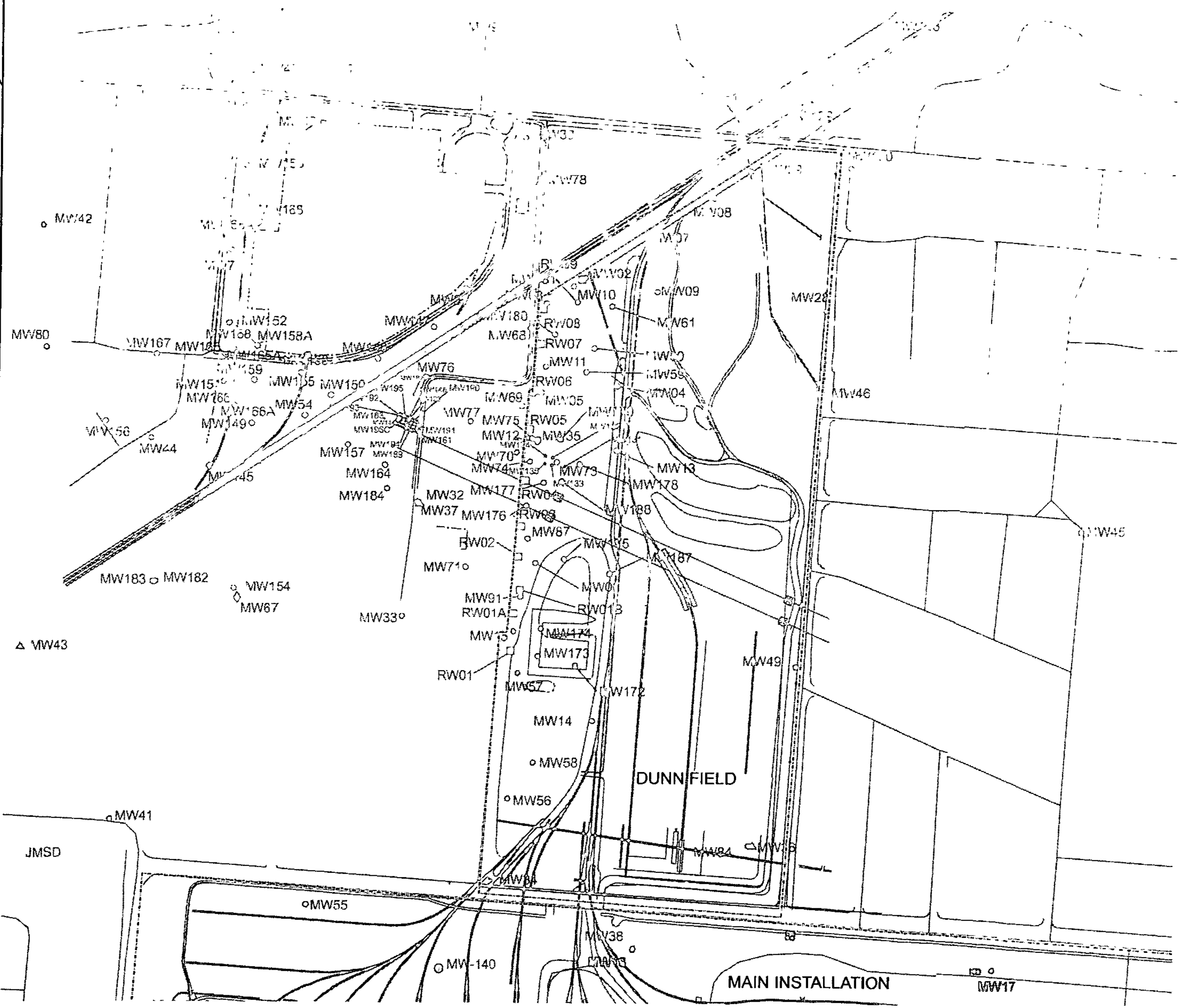
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

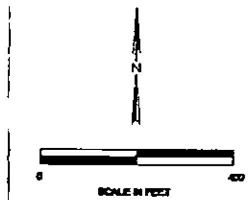
DATE	SEPTEMBER, 2006
PROJ	177556
DWG	G-1
SHEET	1

USER: EGRIGGS TAB: T1

ATL/PROJ/148071 DDMT/SARD 2006 FILENAME: SHEET 1 (COVER).DWG PLOT DATE: 1-Sep-06 PLOT TIME: 5:30:15 PM

8891060





LEGEND:

- DEPOT BOUNDARY
- ○ MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- △ MW MONITORING WELL SCREENED IN INTERMEDIATE AQUIFER
- □ RW GROUNDWATER EXTRACTION WELL
- ◇ MW MONITORING WELL SCREENED IN MEMPHIS AQUIFER

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

4-12-07

NO.	DATE	REVISION	BY	APVD

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

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

GENERAL
SITE MAP

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

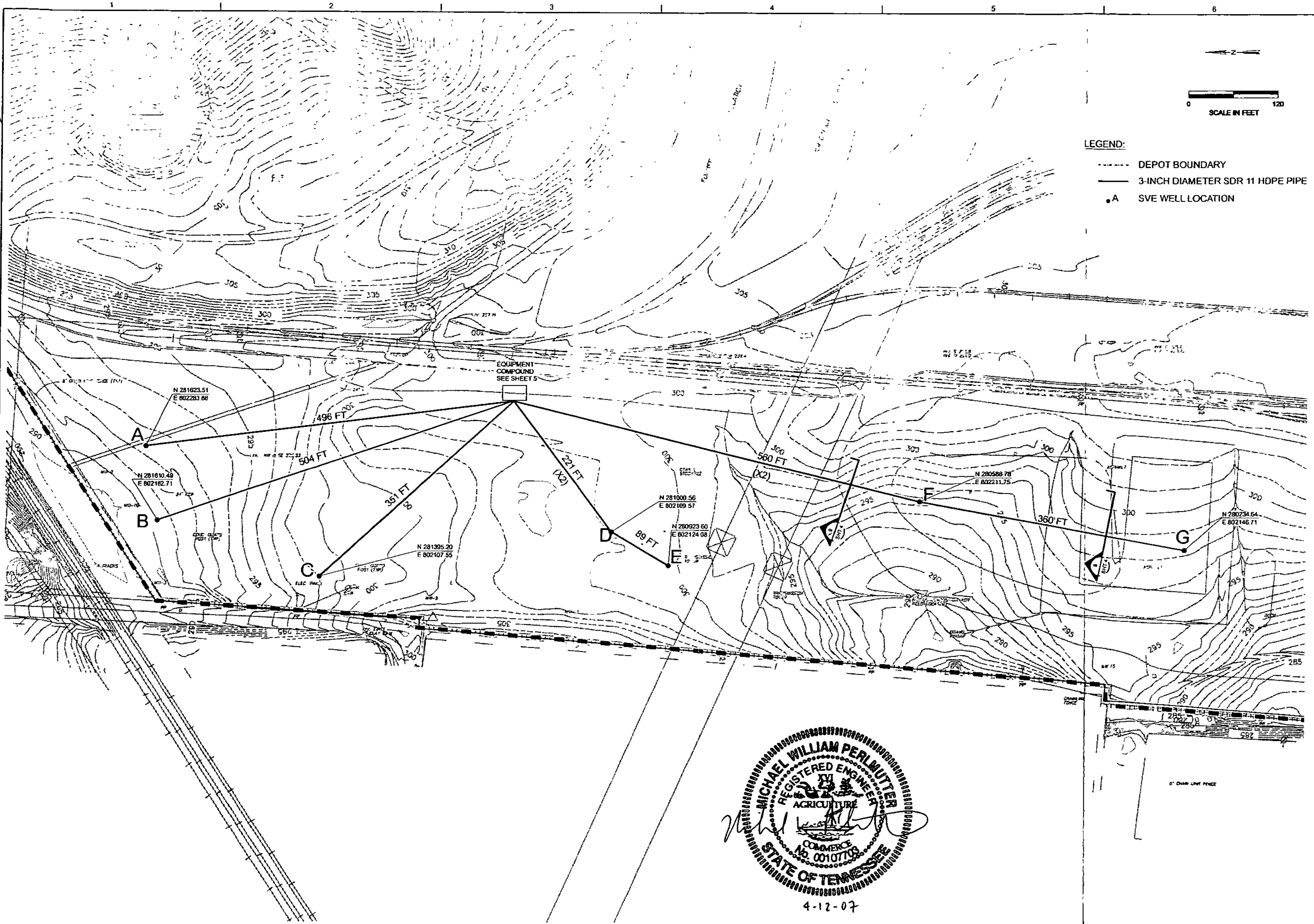
DATE	SEPTEMBER, 2006
PROJ	177556
DWG	G-2
SHEET	2

ATL/PROJ/148071 DDMT/SARD 2006

USER: EGRIGGS TAB: DLAYOUT

FILENAME: SHEET 2 SITE MAP.DWG PLOT DATE: 7-Jul-06 PLOT TIME: 1:10:40 PM

8891061



NO.	DATE	REVISION	BY	APVD

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

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

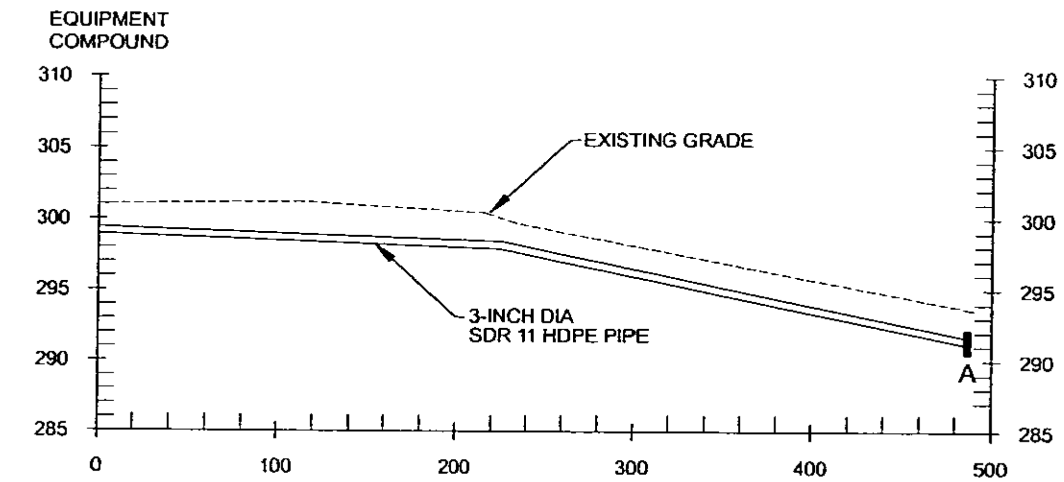
FLUVIAL SANDS SVE
SVE SYSTEM LAYOUT

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

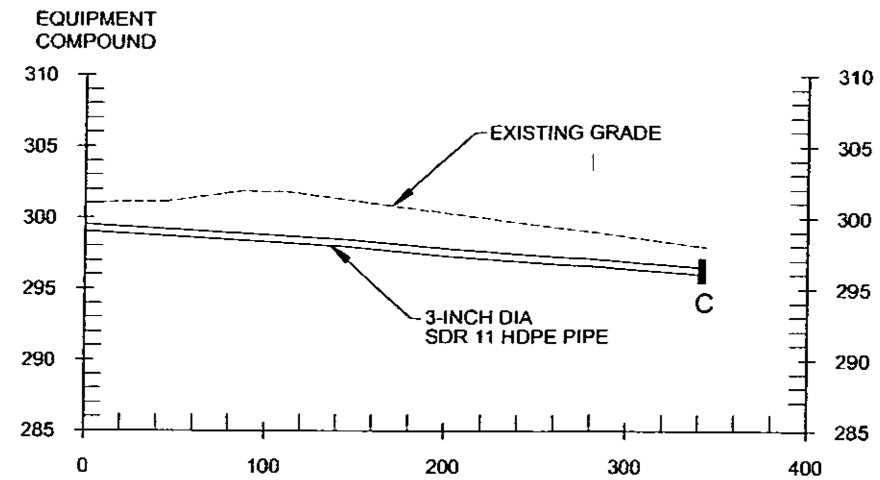
DATE	SEPTEMBER, 2006
PROJ	177556
DWG	F-1
SHEET	3

USER: EGRIGGS TAB: DLAYOUT
ATL/PROJ/148071 DDMT/Cap Addendum.DWG
FILENAME: SVE SYSTEM LAYOUT.DWG PLOT DATE: 7-Jul-06 PLOT TIME: 1:10:40 PM

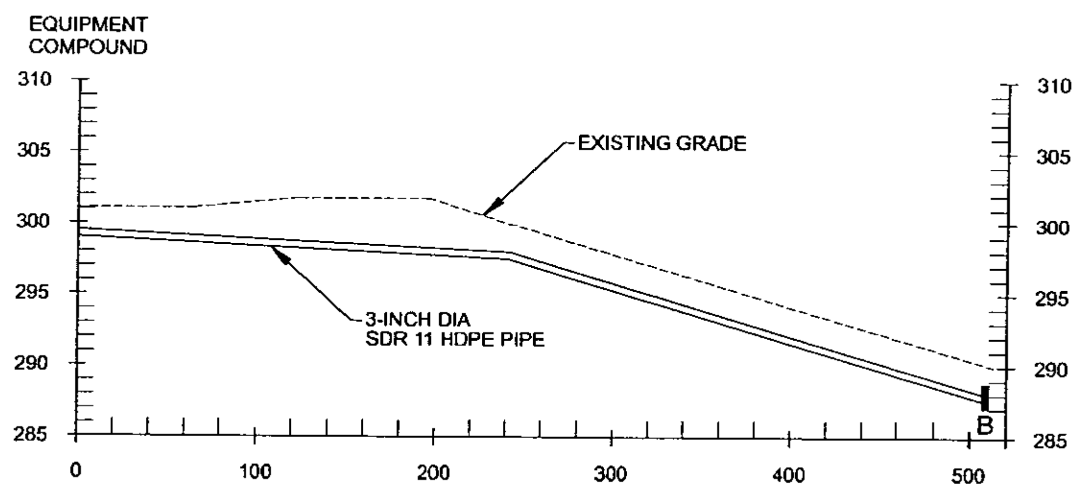
8891062



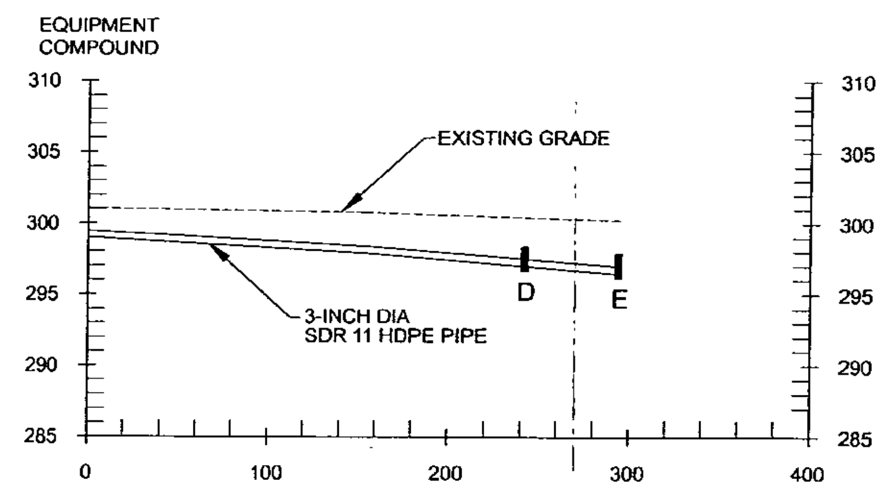
EQUIPMENT COMPOUND TO SVE WELL A



EQUIPMENT COMPOUND TO SVE WELL C

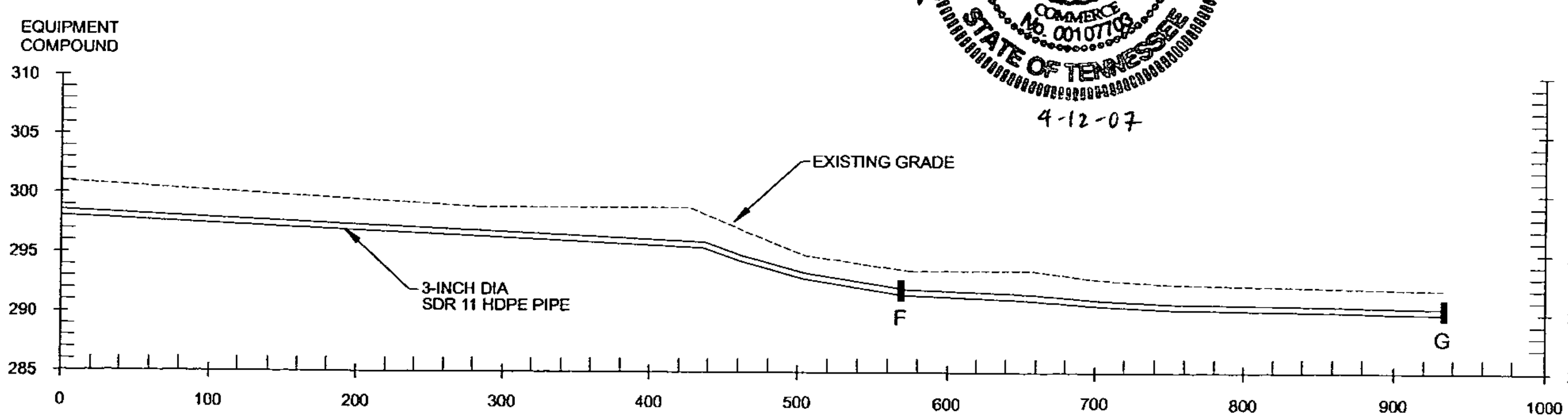


EQUIPMENT COMPOUND TO SVE WELL B



EQUIPMENT COMPOUND TO SVE WELL D AND E

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



EQUIPMENT COMPOUND TO SVE WELL F AND G

NOTES:

1. CROSS-SECTIONS REPRESENT FINAL PIPING LOCATION. CONVEYANCE PIPING TO BE PLACED ABOVE GRADE DURING OPERATION OF LOESS DEPOSITS THERMAL-ENHANCED SVE.
2. HDPE PIPE TO BE MINIMUM 2 - FEET BELOW EXISTING GRADE FOLLOWING DECOMMISIONING OF LOESS DEPOSITS THERMAL-ENHANCED SVE SYSTEM.
3. MAINTAIN 0.5% SLOPE TO SVE WELLS TO PROMOTE CONDENSATE RETURN.

NO.	DATE	REVISION	BY	APVD

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

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

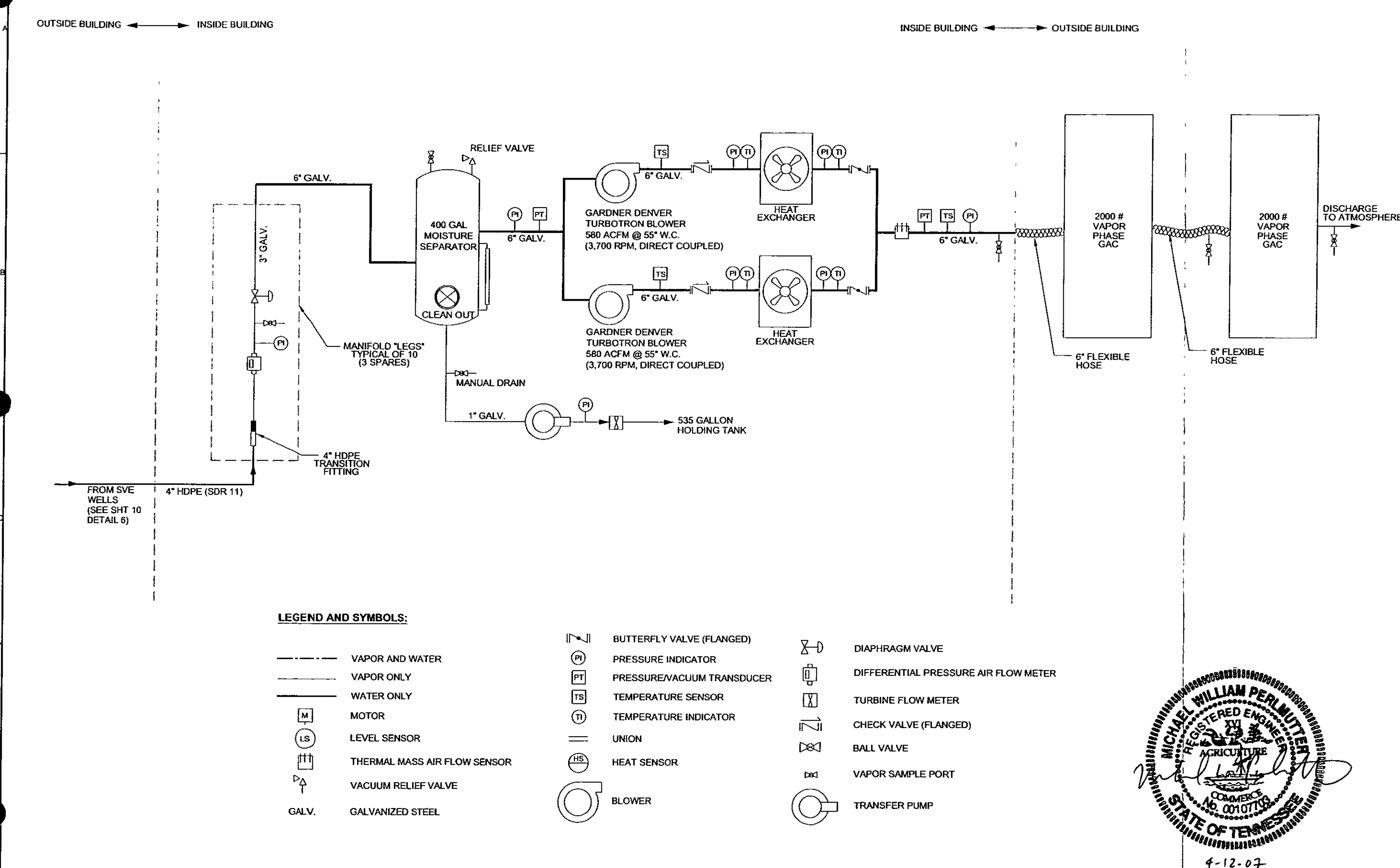
CH2MHILL

FLUVIAL SANDS SVE
CONVEYANCE PIPING CROSS
SECTIONS

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

DATE	SEPTEMBER, 2006
PROJ	177556
DWG	F-2
SHEET	4

8891063



CH2MHILL

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

FLUVIAL SANDS SVE
PROCESS FLOW DIAGRAM

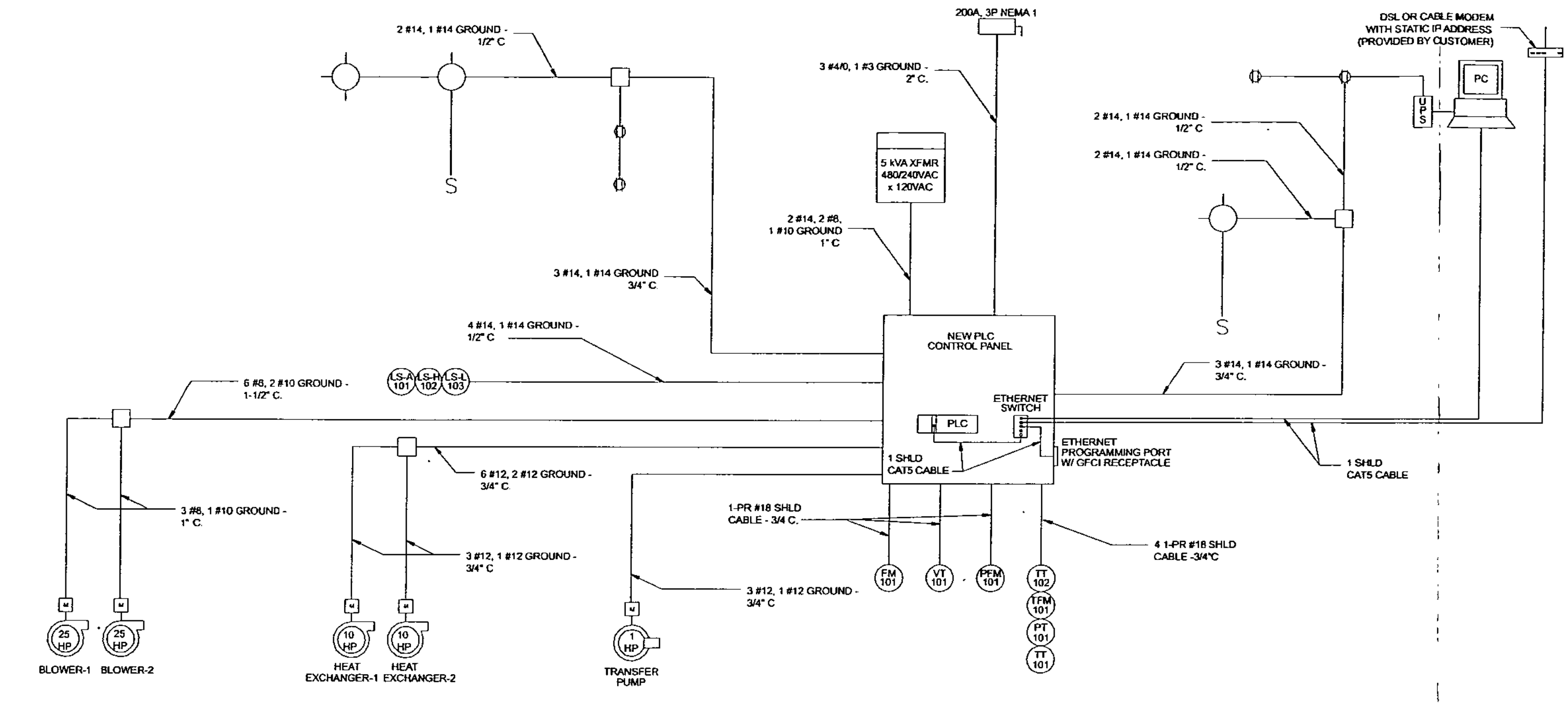
NO.	DATE	REVISION	BY	APVD

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

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

DATE MARCH 2007
PROJ 177556
DWG F-3
SHEET 5

8891064



PROCESS EQUIPMENT LEGEND

- MOTOR
- BLOWER
- TRANSFER PUMP
- LIGHT FIXTURE
- DUPLEX RECEPTACLE
- INSTRUMENT FIELD MOUNTED
- DISCONNECT SWITCH
- S SWITCH - 1P

MICHAEL WILLIAM PERLMUTTER
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No. 00107709
STATE OF TENNESSEE
4-12-07

PROCESS ABBREVIATIONS

FM — FLOW METER
LS-H — LEVEL SWITCH - HIGH LEVEL
LS-H — LEVEL SWITCH - HIGH LEVEL
LS-L — LEVEL SWITCH - LOW LEVEL
PT — PRESSURE TRANSDUCER
TFM — THERMAL FLOW METER
TT — TEMPERATURE TRANSDUCER
VT — VACUUM TRANSDUCER

NO.	DATE	REVISION	BY	APVD

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

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

FLUVIAL SANDS SVE
PROCESS AND
INSTRUMENTATION DIAGRAM

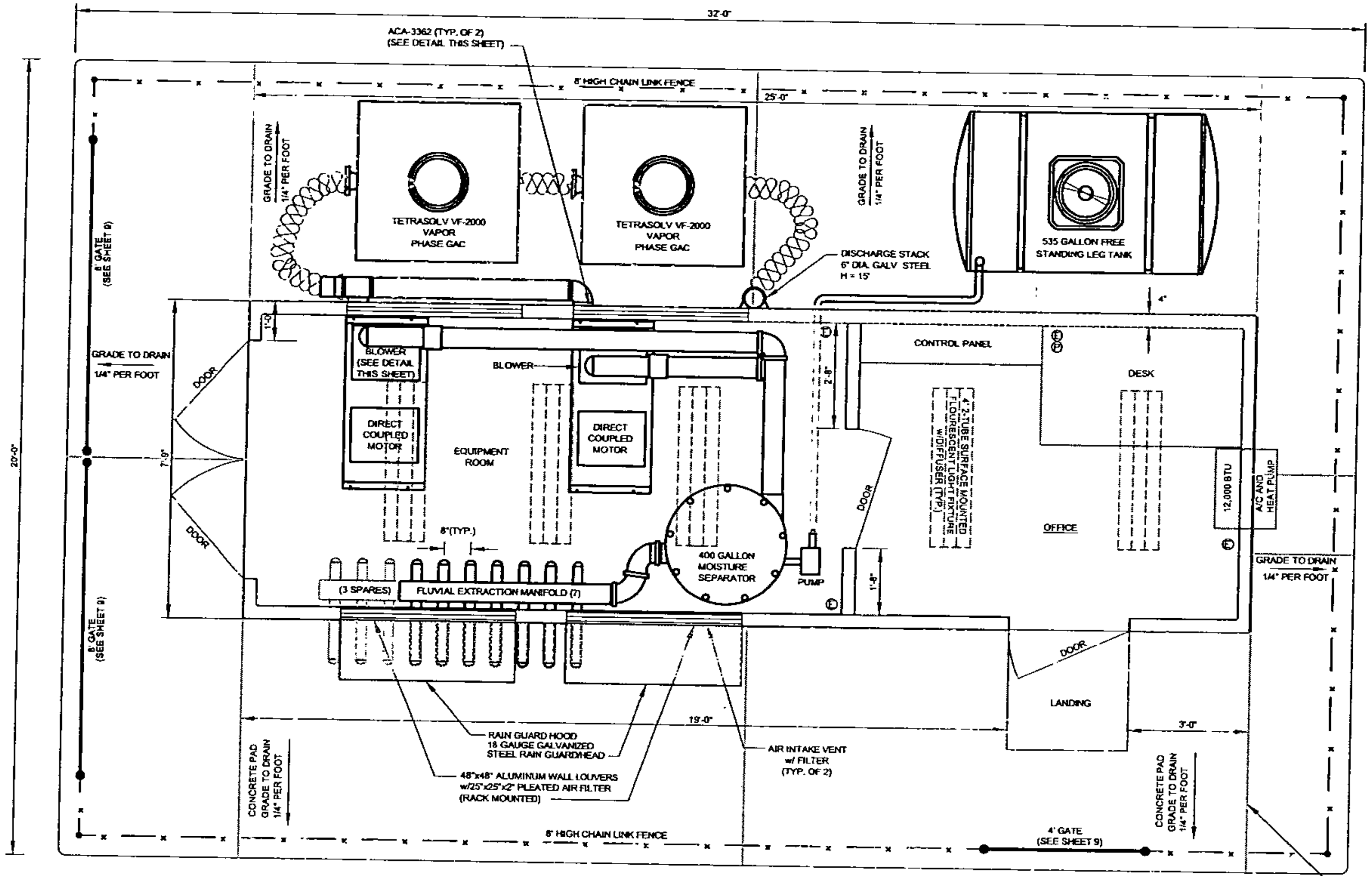
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

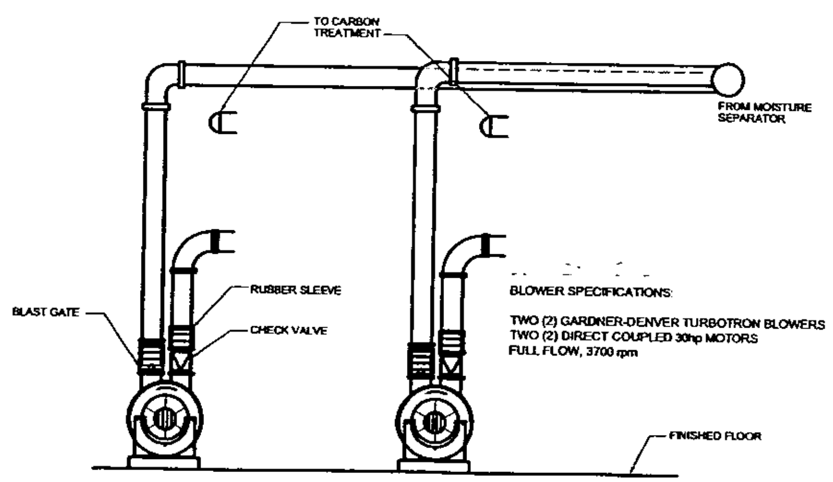
DATE	SEPTEMBER, 2006
PROJ	177556
DWG	F-4
SHEET	6

USER: EGRIGGS TAB: LAYOUT1

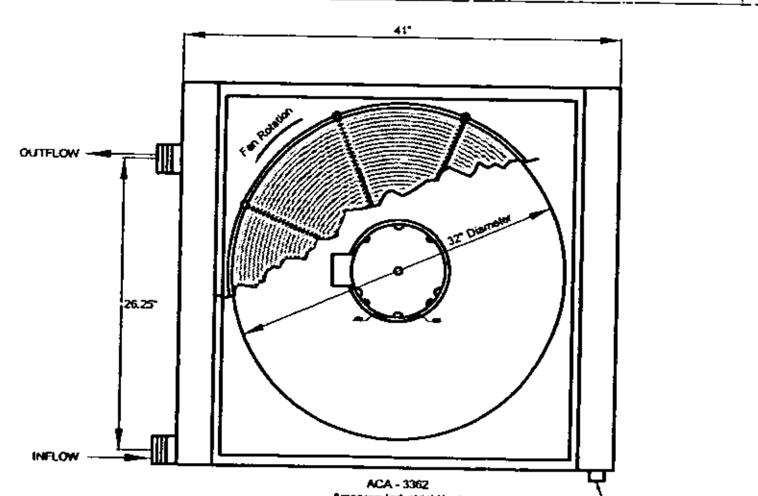
ATL/PROJ/148071 DDMT/SARD 2006 FILENAME: SHEET 6 (PROCESS & INSTRUMENT).DWG PLOT DATE: 7-Sep-06 PLOT TIME: 3:31:01 PM

8891065





BLOWER DETAIL
N.T.S.



AFTERCOOLER DETAIL
N.T.S.

BUILDING SPECIFICATIONS

1 PERIMETER FRAME. Perimeter tubular 2" x 6" frame members (13 ga.) with structural steel "C" channel 2" x 8" set perpendicular to and inletted into side tubular members. Channel is utilized as forklift slots for handling. All frame parts are coated with a corrosive resistant (black in color) paint. Anchor bldg. to concrete foundation per manufacturer's recommendation.

2. METAL WEATHER SHIELD. Galvanized steel construction. The shield covers the entire floor assembly and is located between frame and underside of floor joists.

3 FLOOR JOISTS. joists are nominal 2 x 4 steel joists spaced in a lateral configuration, 12" O.C.

4 FLOOR INSULATION. Fiberglass batt-type insulation between floor joists is R-11 and entirely fills any and all voids.

5. FLOOR COVERING. 3/16" smooth steel floor (painted black).

6. WALL STUDS. Studs are 3 ½" 20 ga. Galvanized steel studs spaced 16" O.C. Top and bottom runners are 3 ½" x 18 ga.

7 WALL INSULATION. Fiberglass batt-type insulation between studs is R-11 and entirely fills any and all voids.

8. INTERIOR WALL COVERING. 5/16" thick gypsum board with laminated vinyl covering is fastened to the inside of the studs with screws and gypsum adhesive; material has a class "A" flame spread rating. 4" vinyl base cove is applied at the base. Sound loss for this unit will be approximately 20 decibels from outside to inside.

9 EXTERIOR WALL SHEATHING. Under steel siding structural sheathing is secured to entire exterior, per manufacturer's recommendations. Sheathing is 1/8" foil laminated on both sides.

10. ROOF FRAMING. Rafters are nominal 4" 16 ga. galvanized steel spaced in lateral configuration 12" O.C.

11 INTERIOR CEILING: Ceiling material is 1/2" gypsum with a white stucco pre-finish, fastened securely to roof rafters with screws. Material has a class "A" flame spread rating.

12. ROOF INSULATION. Fiberglass batt-type insulation between roof rafters is R-11 and entirely fills any and all voids.

13. EXTERIOR ROOF SHEATHING: The top side of the rafter has 16 ga. Smooth steel sheathing fastened securely to roof rafters. Covered completely with a minimum 4 mil. polyvinyl vapor barrier.

14. ROOF COVERING. 30 ga. galvanized steel construction. Roof metal covers entire roof assembly.

15. EXTERIOR SIDING: Galvanized steel siding is 29 ga. pre-finished (on both sides) commercial type with appropriate top and bottom trim fastened securely to studs. Seven standard colors are available. 20-year guarantee.

16. EXTERIOR DOORS. Doors are a steel door with steel jamb. Jambs will have ball bearing hinges. Door will have a tempered ½ lite and a heavy duty closer.

17 FULL DEPTH FORK POCKETS: All sizes 2 1/2" x8" structural "C" channel (3 1/2" x 7" opening).

18. INTERIOR LIGHT FIXTURES. All light fixtures are 4' - 0" (four foot) twin tube with an acrylic wrap-around type diffuser cover.

19 INTERIOR CEILING HEIGHT: The dimension from the finished floor surface to the finished ceiling surface is 8'-0".

20. ELECTRIC SERVICE PANEL. Prewire service entrance panel is equipped with a 100-amp main breaker, a 15-amp breaker (for lights), a 20-amp breaker (for receptacles), and any additional breakers necessary. Entrance conduit is through the exterior wall for ease of hook-up. All electric components U.L. listed and wired to National Electrical Code. Standard service is 240/120v, single phase, 60 cycle.

21 HVAC. One thru the wall G.E. 12,000 BTU air conditioner

LEGEND

Ⓔ ELECTRICAL OUTLET

Ⓟ PHONE JACK

MICHAEL WILLIAM PERLMUTTER
REGISTERED ENGINEER
XVI
AGRICULTURE
COMMERCE
No. 00107709
STATE OF TENNESSEE

4-12-07

NO.	DATE	REVISION	BY	APVD

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

REUSE OF DOCUMENTS: THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF CH2M HILL AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CH2MHILL.

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

FLUVIAL SANDS SVE
EQUIPMENT COMPOUND

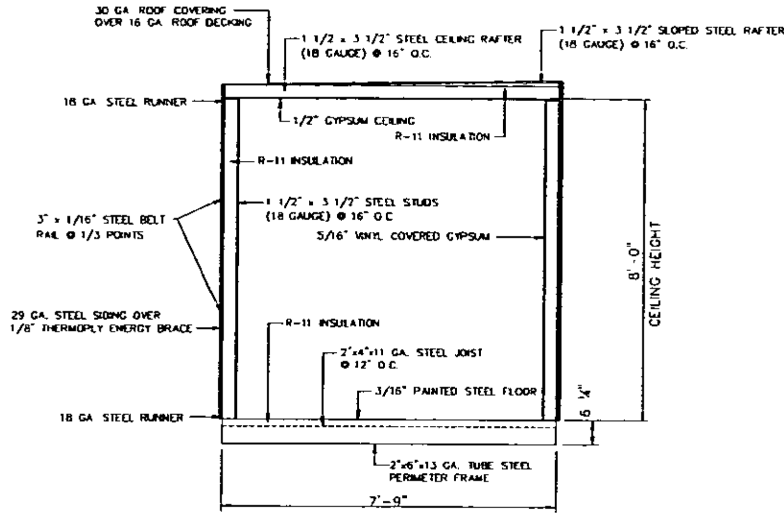
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2007
PROJ	177556
DWG	F-5
SHEET	7

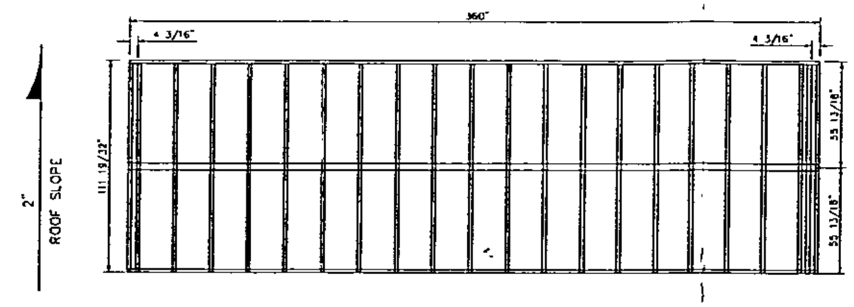
ATL/PROJ/148071 DDMT/SARD 2006

FILENAME: SHEET 7 (EQUIPMENT COMPOUND).DWG PLOT DATE: 19-Feb-07 PLOT TIME: 4:59:17 PM

8891066

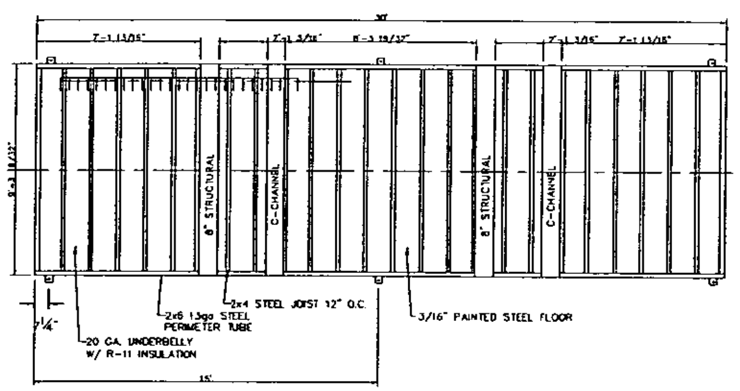


CROSS SECTION

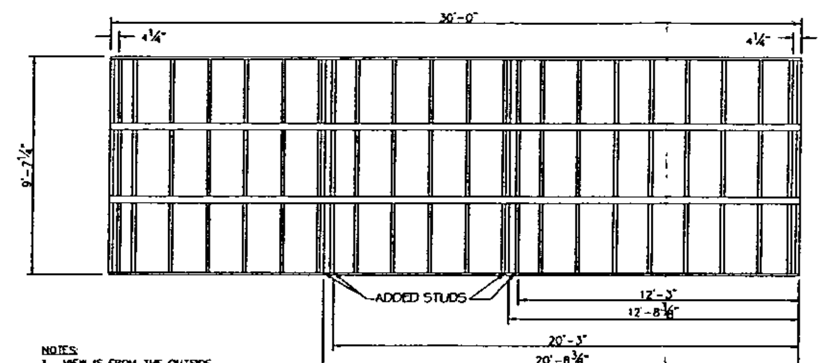


ROOF FRAMING

NOTES:
1. VIEW IS FROM THE TOP LOOKING DOWN
2. 4" RAFTERS TO BE ON 16" CENTERS
3. 3" BELT RAILS TO BE 46 1/2" CENTER TO CENTER
4. WIRE KNOCK OUTS TO BE APPROX. SAME HEIGHT

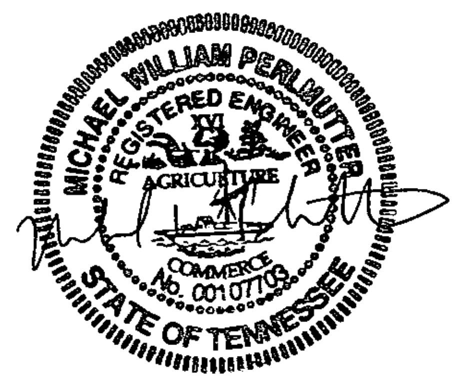


FRAME DETAIL

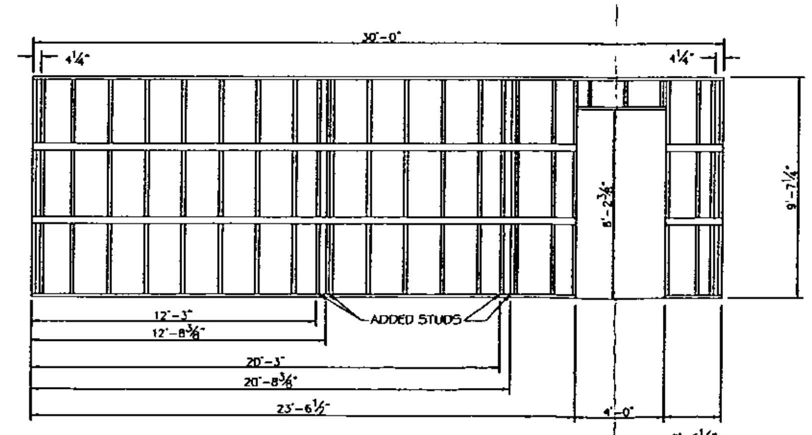


NOTES:
1. VIEW IS FROM THE OUTSIDE LOOKING INSIDE
2. 3 1/2" STUDS TO BE ON 16" CENTERS
3. 3" BELT RAILS TO BE ON 32" CENTERS
4. WIRE KNOCK OUTS TO BE APPROX. SAME HEIGHT

EAST WALL FRAMING

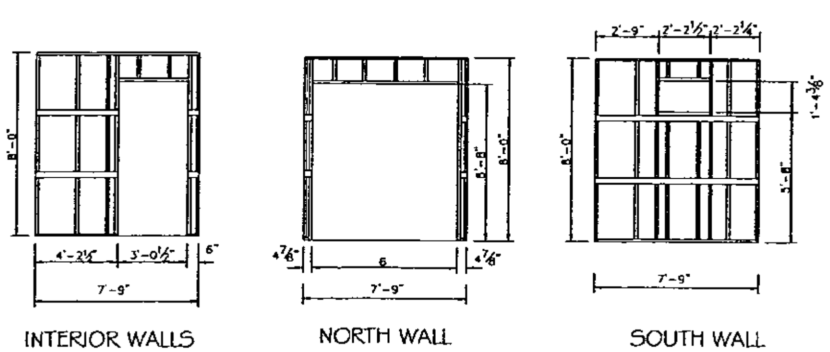


4-12-07



NOTES:
1. VIEW IS FROM THE OUTSIDE LOOKING INSIDE
2. 3 1/2" STUDS TO BE ON 16" CENTERS
3. 3" BELT RAILS TO BE ON 32" CENTERS
4. WIRE KNOCK OUTS TO BE APPROX. SAME HEIGHT

WEST WALL FRAMING



NOTES:
1. VIEW IS FROM THE OUTSIDE LOOKING INSIDE
2. 3 1/2" STUDS TO BE ON 16" CENTERS
3. 3" BELT RAILS TO BE ON 32" CENTERS
4. WIRE KNOCK OUTS TO BE APPROX. SAME HEIGHT

NORTH/SOUTH WALL FRAMING

NO.	DATE	REVISION	BY	APVD

DSGN	M. PERLMUTTER
DR	G. HARTLEY
CHK	M. STRONG
APVD	D. NELSON

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

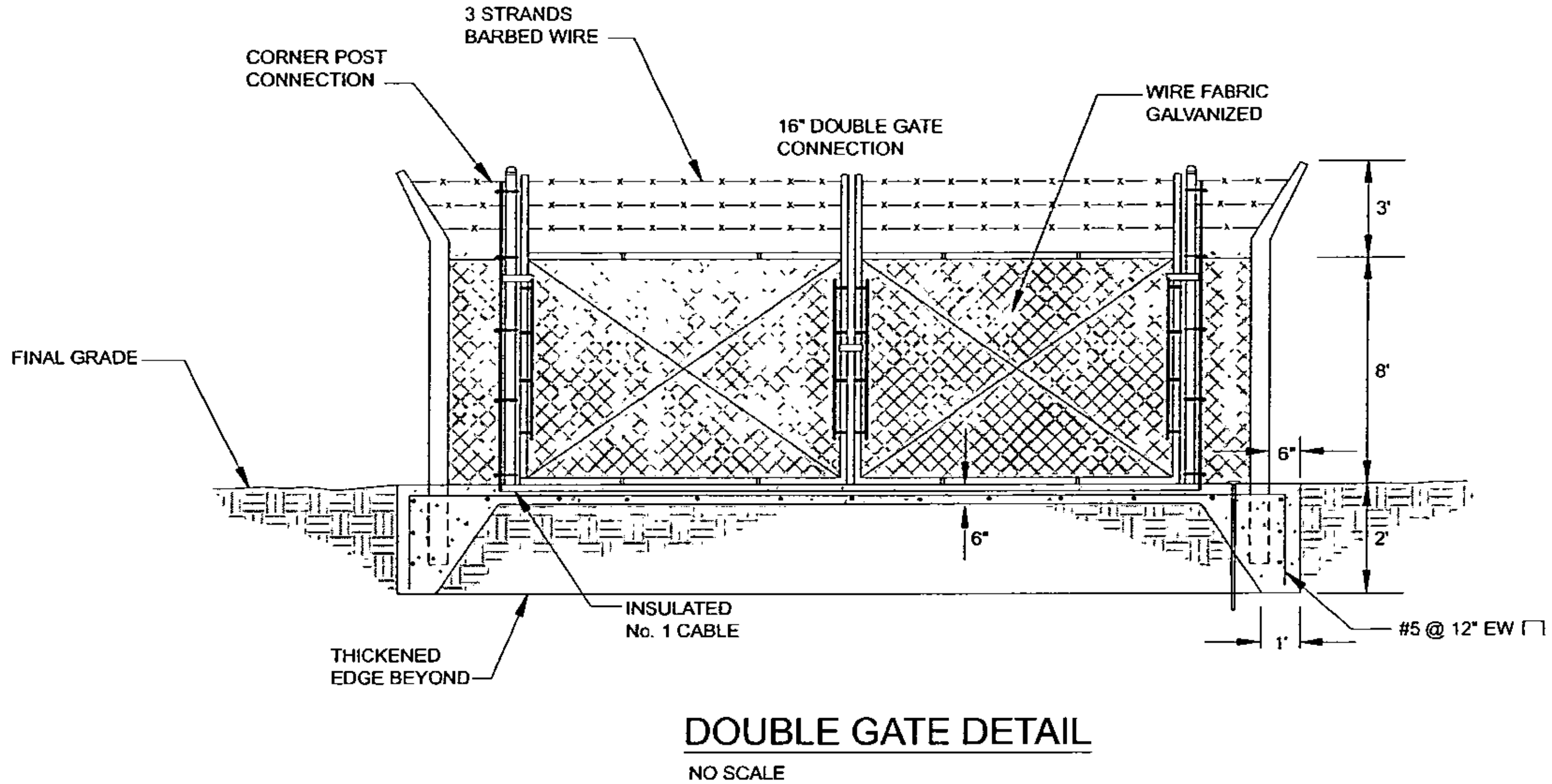
CH2MHILL

FLUVIAL SANDS SVE
BUILDING DETAILS

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

DATE	SEPTEMBER, 2006
PROJ	177556
DWG	F-6
SHEET	8

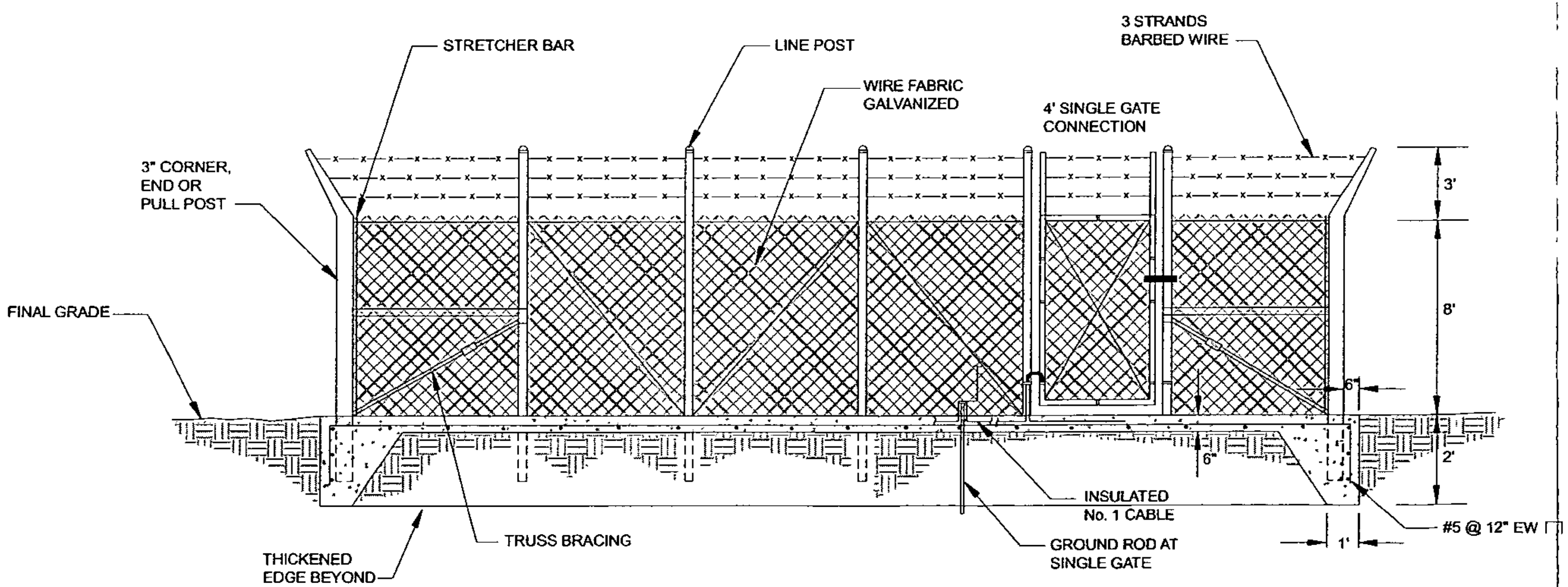
8891067



DOUBLE GATE DETAIL

NO SCALE

NOTES:
WHEN ANCHORAGE OF EQUIPMENT TO PAD IS REQUIRED, USE CONCRETE ANCHORS SPECIFIED



CHAIN LINK FENCE & CONCRETE PAD DETAIL

NO SCALE

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

4-12-07

CH2MHILL

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

FLUVIAL SANDS SVE
FENCE DETAIL

NO.	DATE	REVISION	BY	APVD

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

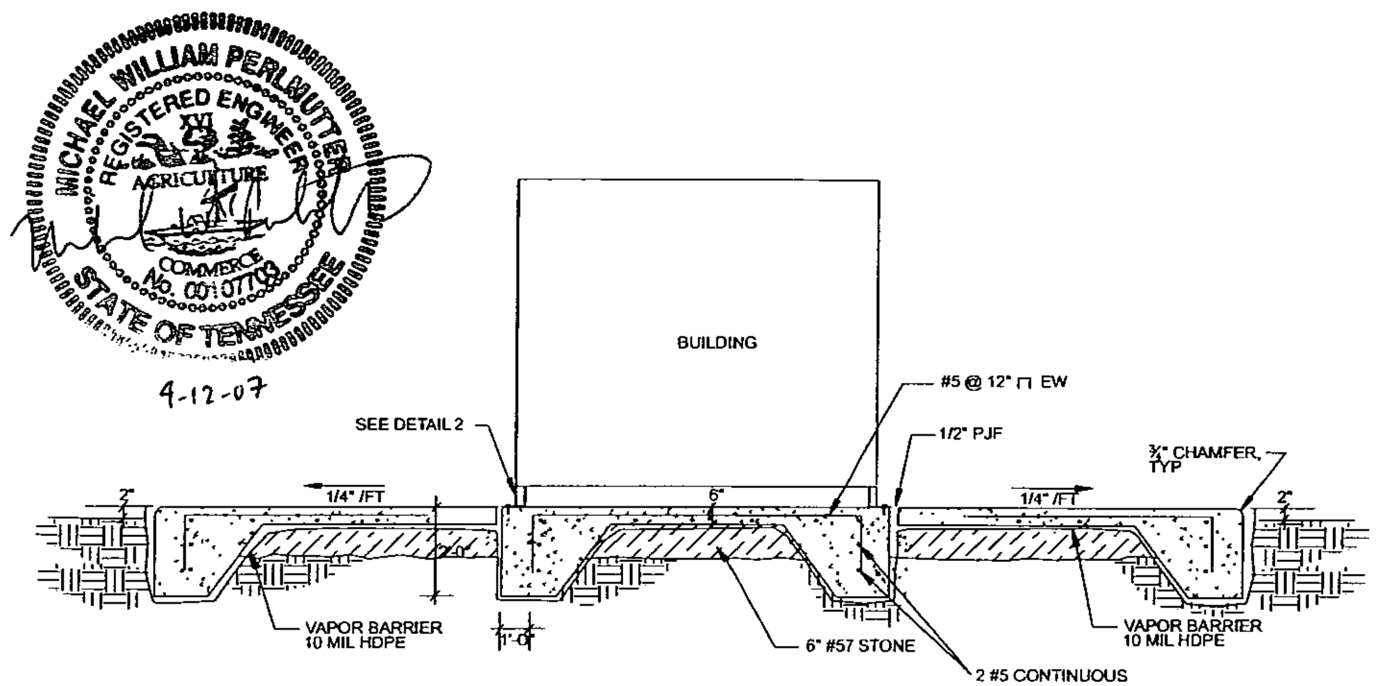
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEPTEMBER, 2006
PROJ	177556
DWG	F-7
SHEET	9

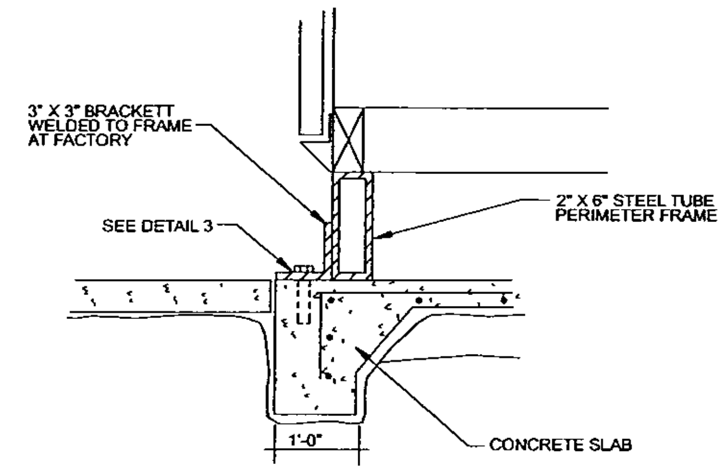
FILENAME: SHEET 9 (FENCE DETAIL).DWG PLOT DATE: 7-Jul-06 PLOT TIME: 1:10:40 PM

ATL/PROJ/148071 DDMT/SARD 2006

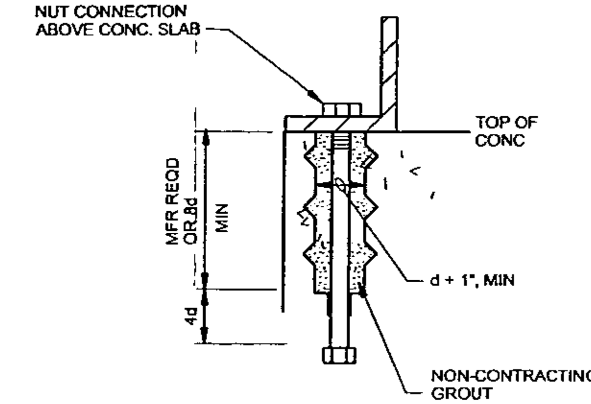
USER: EGRIGGS TAB: DLAYOUT



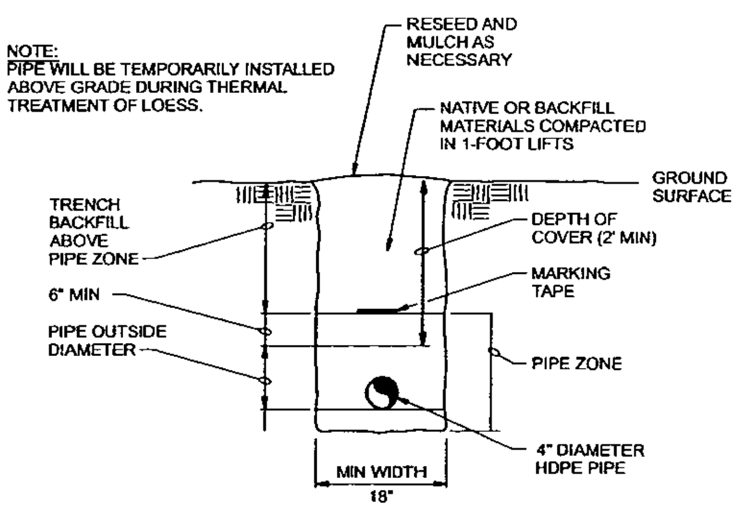
1 BUILDING FOUNDATION DETAIL
NTS



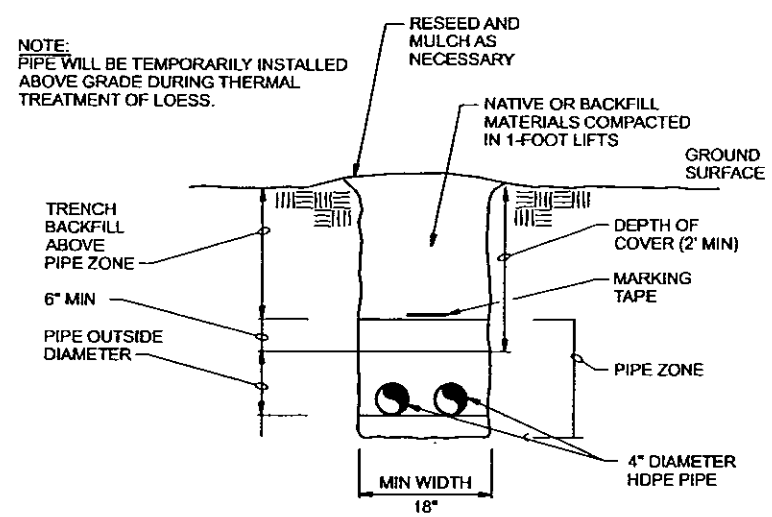
2 ATTACHMENT DETAIL
NTS



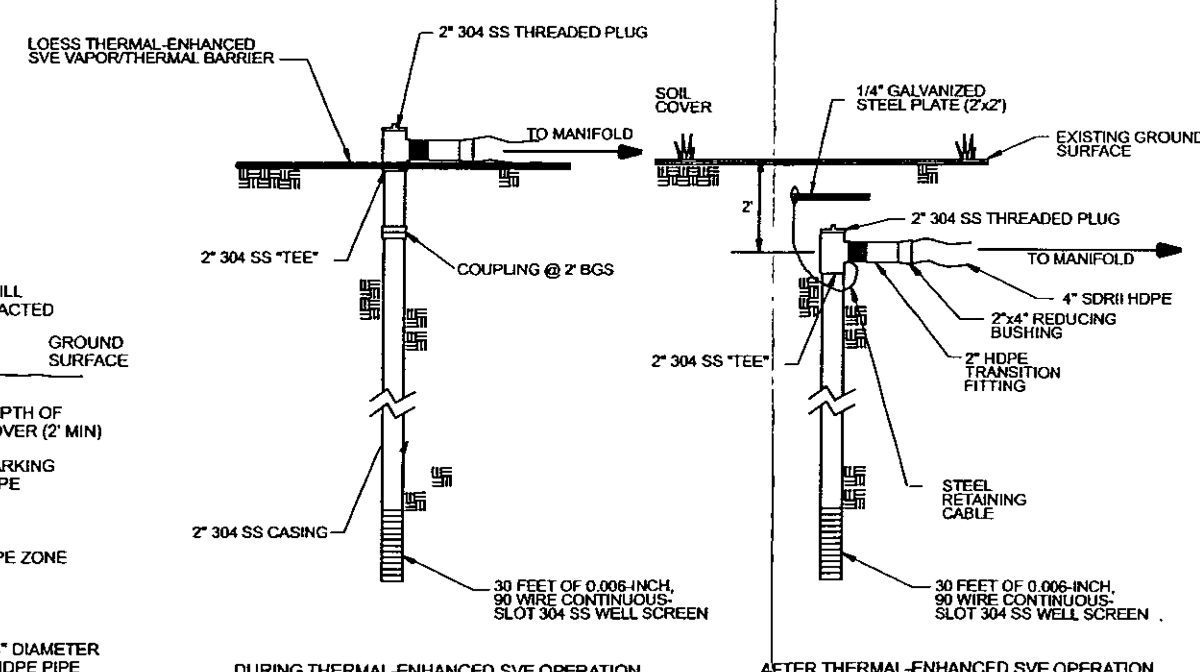
3 ANCHOR BOLT DETAIL
NTS



4 SINGLE PIPE SECTION
NTS



5 DOUBLE PIPE SECTION
NTS



6 SVE WELL HEAD DETAIL
NTS

NO.	DATE	REVISION	BY	APVD

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

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

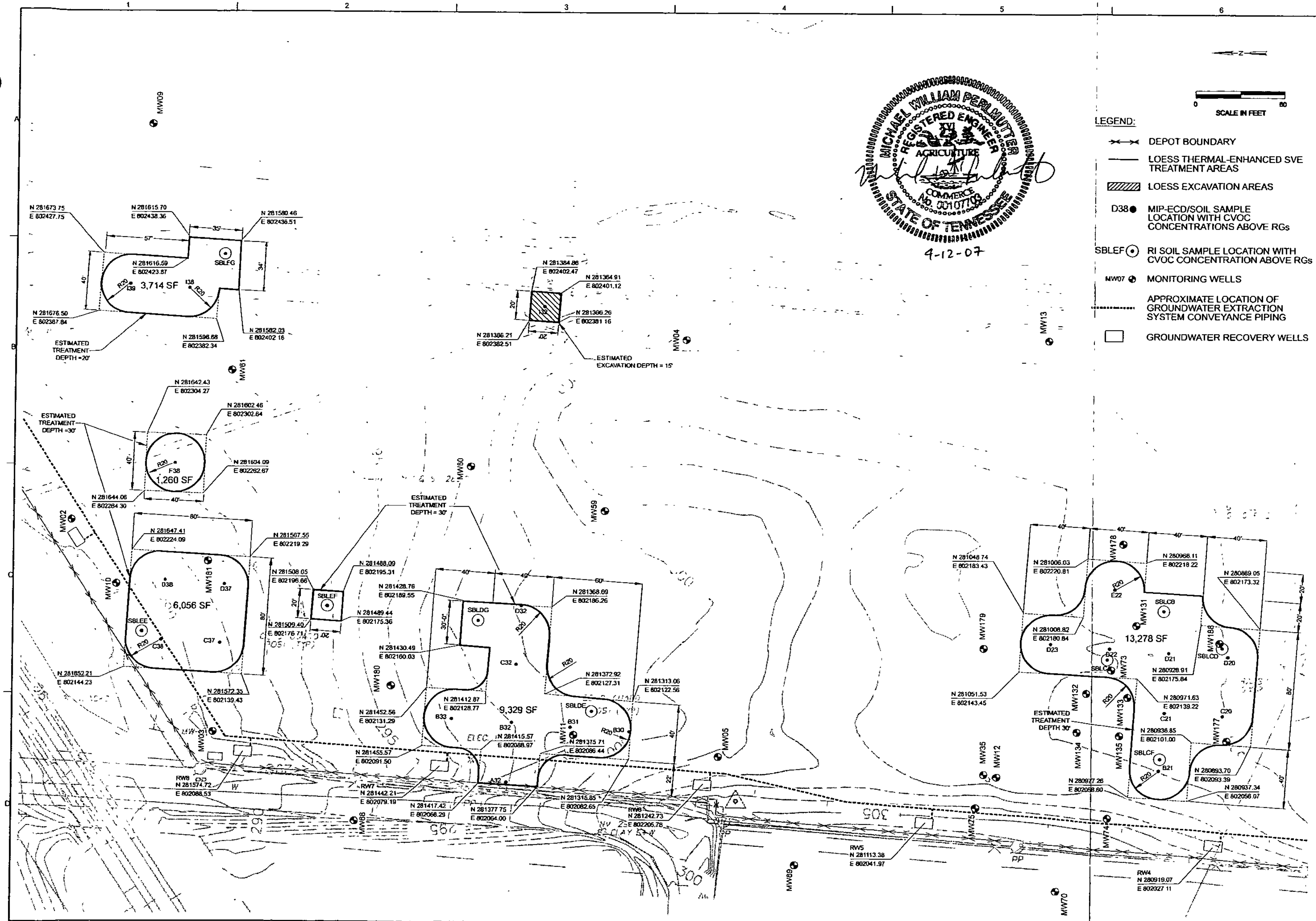
CH2MHILL

FLUVIAL SANDS SVE
DETAILS

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

DATE	MARCH, 2007
PROJ	177556
DWG	F-8
SHEET	10

8891069



CH2MHILL

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

NORTH LOESS TREATMENT AREAS

NO.	DATE	REVISION	BY	APVD

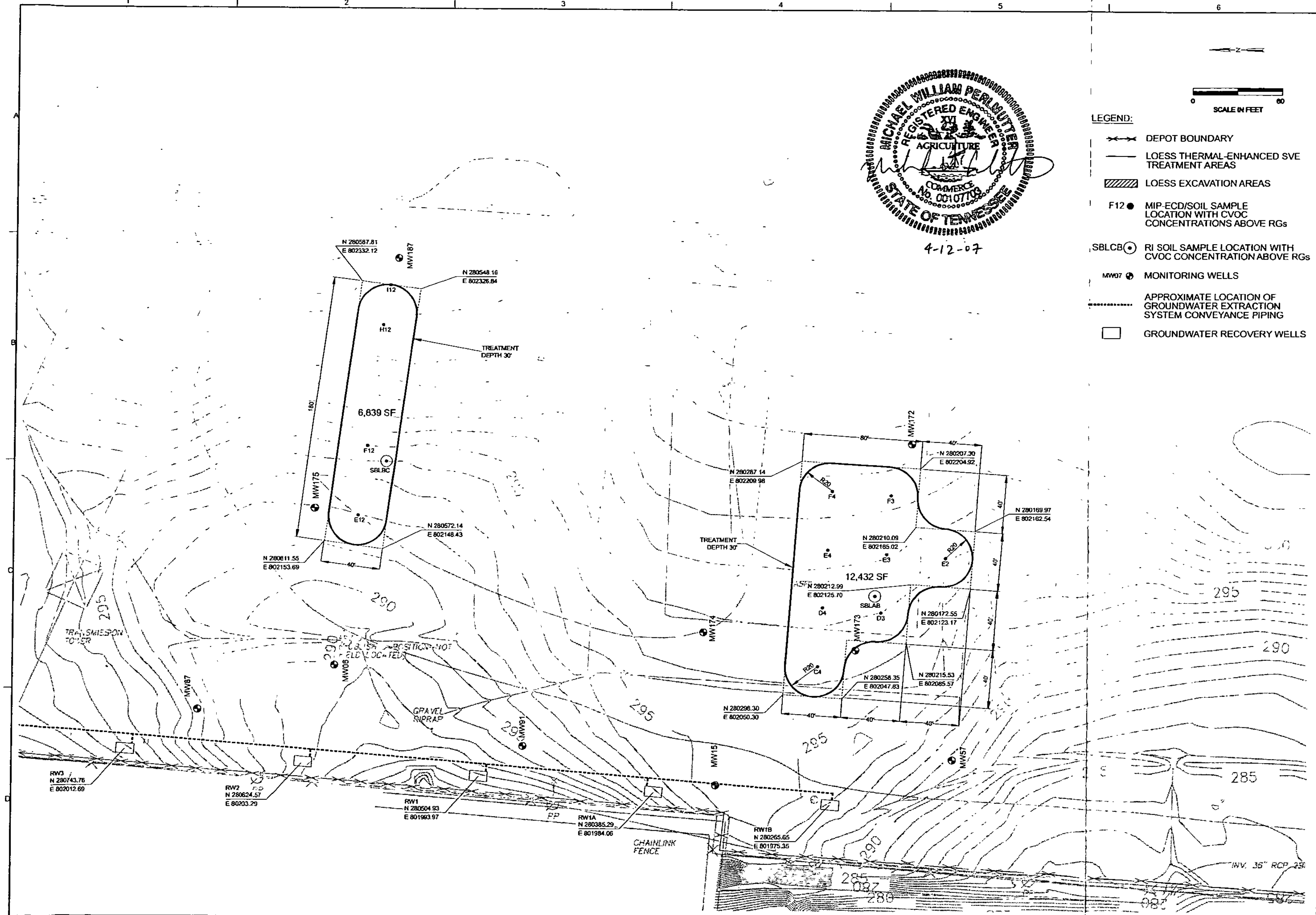
DSGN M. PERLMUTTER | DR E. GRIGGS | CHK M. STRONG | APVD D. NELSON

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

DATE	MARCH, 2007
PROJ	177556
DWG	L-1
SHEET	11

USER: EGRIGGS TAB: DLAYOUT
ATL/PROJ/148071 DDMT/SARD 2006/SARD/NEW FOLDER/SHEET 11 LOESS 1.DWG
FILENAME SVE SYSTEM LAYOUT.DWG PLOT DATE 6-Mar-07 PLOT TIME: 5:06:19 PM

8891070



CH2MHILL

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

SOUTH LOESS TREATMENT AREAS

NO.	DATE	REVISION	BY	APVD

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

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

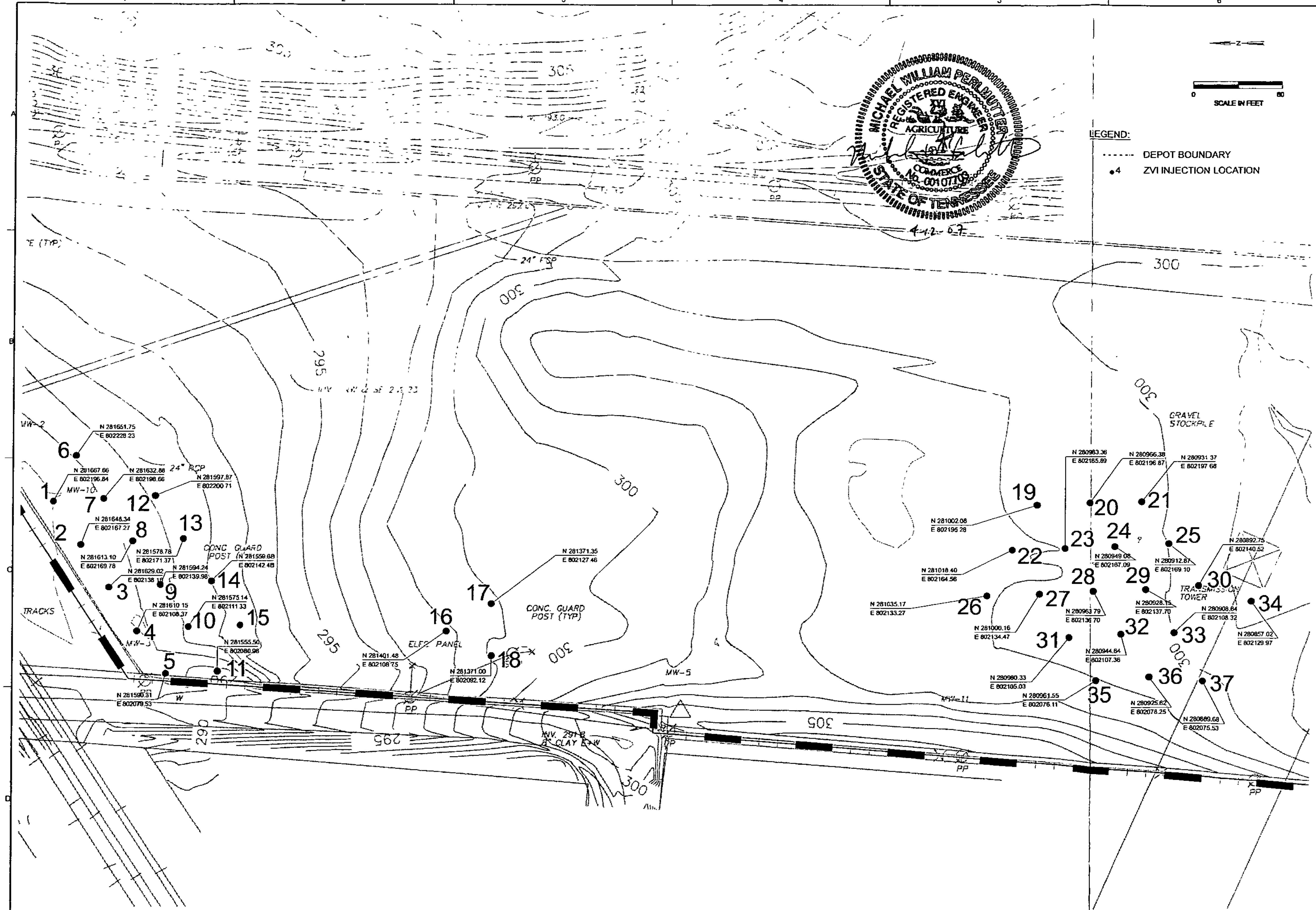
DATE	MARCH, 2007
PROJ	177556
DWG	L-2
SHEET	12

USER: EGRIGGS TAB: DLAYOUT

ATL/PROJ/148071 DDMT/SARD 2006/SARD/NEW FOLDER.SHEET 12 LOESS 2DWG

FILENAME: SVE SYSTEM LAYOUT.DWG PLOT DATE 6-Mar-07 PLOT TIME. 5:07:36 PM

8891071



CH2MHILL

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

GROUNDWATER
NORTH ZVI INJECTION LOCATIONS

NO.	DATE	REVISION	BY	APVD

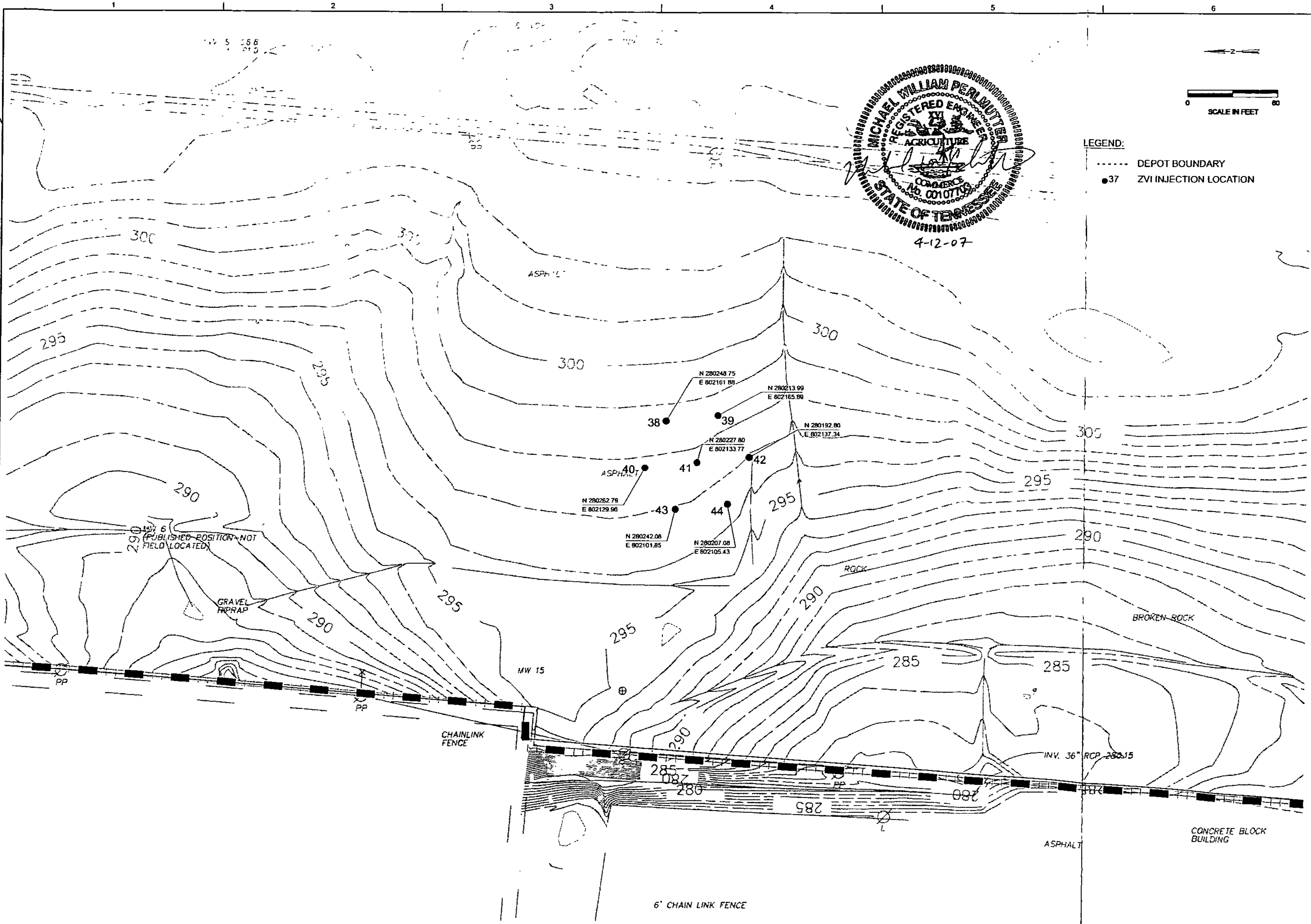
DSGN M. PERLMUTTER | DR E. GRIGGS | CHK M. STRONG | APVD D. NELSON

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

DATE	SEPTEMBER, 2006
PROJ	177556
DWG	GW-1
SHEET	13

USER: EGRIGGS TAB: DLAYOUT
ATL/PROJ/148071 DDMT/SARD 2006.DWG
FILENAME: SVE SYSTEM LAYOUT.DWG PLOT DATE: 7-Jul-06 PLOT TIME: 1:10:40 PM

8891072



NO.	DATE	REVISION	BY	APVD

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

REUSE OF DOCUMENTS: THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF CH2M HILL AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CH2M HILL.

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

GROUNDWATER
SOUTH ZVI INJECTION LOCATIONS

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

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

USER: EGRIGGS TAB: DLAYOUT

ATL/PROJ/148071 DDMT/SARD 2008.DWG

FILENAME: SVE SYSTEM LAYOUT.DWG PLOT DATE: 7-Jul-08 PLOT TIME: 1:10:40 PM

APPENDIX E

Construction Specifications and Draft Statements of Work

- Soil Excavation, Transportation, and Disposal Draft Statement of Work
- Fluvial Sands SVE Draft Statement of Work
- Loess Deposits Thermal-Enhanced SVE Draft Statement of Work
- ZVI Injection Draft Statement of Work

Draft Statement of Work
Loess Deposits Soil Excavation
Memphis Depot Dunn Field
Memphis, TN

1.0 Introduction

This Statement of Work (SOW) describes the tasks necessary to excavate, characterize, transport, and dispose contaminated soils at Dunn Field, which is across Dunn Avenue from the north-northwest portion of the Main Installation (MI) of the Memphis Depot (the Depot) (formerly known as the Defense Distribution Depot Memphis, Tennessee). The SOW has been prepared for the U.S. Army Corps of Engineers (USACE) – Huntsville Center as part of Task Order 6 under contract number DACA87-02-D-0006.

1.1 Site Background

The Memphis Depot (Depot), which is located in southeastern Memphis, Tennessee (Figure 2-1), originated as a military facility in the early 1940s. Its initial mission and function was to provide stock control, materiel storage, and maintenance services for the U.S. Army (Memphis Depot Caretaker, 1998). In 1995, the Depot was placed on the list of Department of Defense (DoD) facilities to be closed under the Base Realignment and Closure (BRAC). Storage and distribution of materiel for all U.S. military services and some civil agencies continued until the Depot closed in September 1997.

The Depot is located approximately 5 miles east of the Mississippi River and just northeast of Interstate 240. The property consists of approximately 642 acres and includes two components: the MI, with includes open storage areas, warehouses, military family housing, and outdoor recreational areas; and Dunn Field, which includes former mineral storage and waste disposal areas.

Dunn Field, comprising approximately 64 acres of undeveloped land, is bounded by the Illinois Central Gulf Railroad and Person Avenue to the north, Hays Road to the east, and Dunn Avenue to the south. Dunn Field is partially bounded to the west by: (1) Kyle Street; (2) a Memphis Light, Gas, and Water (MLGW) powerline corridor (which bisects Dunn Field); (3) undeveloped property; and (4) a light industrial/warehouse facility (Figure 2-2). All of DunnField (and the MI) is currently zoned as Light Industrial (I-L).

Approximately two-thirds of the area is grassed, and the remaining area is covered with crushed rock and paved surfaces. Dunn Field was used for bulk mineral storage (bauxite and fluorspar) and waste disposal.

8891075

2.0 Scope of Work

The scope of work for this project includes the following activities:

- Submittal and review/acceptance of the following:
  - Work Plan
  - Site-Specific Health and Safety Plan (SSHASP)
  - Waste Management Plan
  - Sampling and Analysis Plan, including Quality Assurance/Quality Control (QA/QC) Plan
- Mobilization of all personnel, equipment, and supplies
- Site preparation including installation of temporary erosion and sediment controls
- Excavation/removal, transportation, and disposal of targeted materials at offsite hazardous and/or non-hazardous landfills. Per RAC direction, excavated soil may be treated onsite as part of the thermal-enhanced SVE treatment system.
- Backfilling, compaction, and grading
- Solid waste management, characterization and disposal
- Liquid waste management, characterization, and disposal
- Site restoration
- Final decontamination and demobilization

Approximately 225 cubic yards (CY) of soil (and debris if encountered) will be excavated from one area in Treatment Area 1 (Sheet 11), characterized, and transported offsite for disposal. The excavation will then be excavated and restored to pre-construction conditions.

3.0 Project Schedule

Subcontractor shall provide whatever resources necessary to complete the SOW within the timeframe presented in the final project schedule. The proposed site operations are 7:00 AM to 5:00 PM Monday through Saturday.

It is anticipated that mobilization to the site will begin within 10 days from notice to proceed. This information shall be provided in the form of a project schedule using critical path method (CPM) logic.

Depending on the magnitude of adverse weather and its potential impact to the project schedule, time lost during the scheduled workweek may be made up on an accelerated schedule at the discretion of the Project Manager.

4.0 Technical Specifications

4.1 Safety

Subcontractor's personnel shall abide by the applicable OSHA guidelines 29 CFR 1910 for general personal safety around operating heavy equipment. Required safety equipment shall be used at all times during work onsite. Subcontractor shall provide all required personal safety equipment for Subcontractors employees including, but not limited to, gloves, hearing protection, safety glasses, hard hats, steel-toed boots, and air-supplied respirators (if required) and appropriate hazardous waste level protection.

4.2 Mobilization

Subcontractor shall mobilize all resources necessary to efficiently and completely perform the scope of work. The resources include, but are not limited to, personnel, equipment, materials, supplies, lower-tier subcontractors, and support facilities (e.g., project support trailer, decontamination facilities, waste containment facilities, material and equipment storage, cellular phones, water, portable sanitary facilities, etc.) to support the work activities at the site. An onsite staging/lay down area will be designated by the Remedial Action Contractor (RAC).

4.3 Site Preparation

Site preparation activities shall include installation of warning signs, removal of surficial debris, and preparation for the SOW to be performed.

4.3.1 Erosion and Storm Water Control and Maintenance

Erosion control measures shall be implemented for excavation and stockpile areas. Silt fence, hay bales, site modification for ditches, and/or other devices shall be used to control storm water and erosion as detailed in the project specifications and drawings. As needed, water spray on haul roads shall be used to prevent dust clouds from hampering and hindering site traffic.

4.3.2 Utility Survey

A utility survey of the area shall be completed by the Subcontractor 1 week prior to the beginning of work. Documentation of the survey (including water, electricity, natural gas, telephone, or other utility lines) and its results shall be provided to the RAC, authorizing work to proceed at the site. Any utilities identified adjacent to the work area shall be clearly marked and identified. Once work begins, the progress of excavation conducted with heavy equipment shall be continuously monitored for evidence of subsurface obstructions.

4.4 Contaminated Material Excavation

The contaminated material locations shall be marked in the field from the coordinates shown on the construction drawings and then excavated. The need for additional excavation will be evaluated based on confirmatory sampling results.

A tracked excavator will be used to remove the CVOC-impacted soil, which will be stockpiled on 20-mil polyvinyl chloride (PVC) liners surrounded by a clean soil berm and covered with another 10-mil liner. The stockpiled soil will be loaded onto trucks and transported to an appropriate disposal facility when it has been characterized and manifested. If encountered, waste in bottles, drums, and /or bulk will be staged, segregated and sampled by the RAC to characterize for the appropriate treatment/disposal method. Empty containers will be transported offsite for disposal.

If onsite treatment is chosen by the RAC, soil could be directly loaded onto trucks and then transported to one of the four thermal-enhanced SVE treatment areas. No stockpiles will be required.

The excavation is expected to be approximately 15 feet deep, and will remain open until confirmation sampling is performed. Side-wall shoring or sloping (via step-downs) may be required to stabilize the open excavations, which will be encircled with protective fence and flagging to prevent unauthorized personnel from inadvertently entering the excavations. Once the proposed limit of excavation is reached, confirmation soil samples will be collected from the sides and bottom by the RAC to determine if additional excavation will be required. Samples will be analyzed on rush basis to minimize open excavation time.

Soil Stockpiles

A section of 20-mil PVC liner will be placed adjacent to the excavation in an area that has been cleared of material that might puncture the liner. Depending on the site configuration and size, the excavator will place the targeted soil directly onto the liner or onto a truck that transports the soil to the nearby stockpile area. A 10-mil cover will be placed atop the stockpile when all of the targeted soil has been excavated or at the end of a work day. Equipment will be used to form a clean soil berm around the stockpile to help secure the top liner and to divert storm water runoff.

Dewatering

The Subcontractor shall maintain appropriate means to collect and remove standing water in the excavations and stockpiles during excavation, sampling, and backfill operations. Standing water may be allowed to remain in the excavations between period of excavation and backfill of approved by the RAC. All water from active excavations shall be collected and disposed of as discussed below.

4.5 Waste Characterization Sampling

Soil

Representative sample(s) from the stockpiled excavated soil shall be obtained by the Subcontractor to characterize the soil for offsite transport and disposal. The samples shall be analyzed using EPA SW-846 procedures and Level III QA/QC protocols by a Navy-, Air Force Center for Environmental Excellence (AFCEE)-, or U.S. Army Corps of Engineers - Missouri River District (USACE-MRD) -approved laboratory (on a rush turnaround time) for the following analytical methods:

Parameter	Method (SW-846)
TCLP Volatiles	1311/8260B
TCLP Semivolatiles	1311/8270C
TCLP Pesticides	1311/8081A
TCLP Herbicides	1311/8151

Parameter	Method (SW-846)
TCLP Pesticides	1311/8082
TCLP Metals	1311/6010B/7471
Reactivity, corrosivity, ignitability (RCI)	1010 or 1020A, 9040B, chapter 7.3
TCLP = toxicity characteristic leachate procedure	

Additional analytical parameters may be required by the disposal facility for characterization purposes and shall be included in Subcontractor's bid.

Liquid Waste Characterization

If necessary, the Subcontractor shall collect representative samples for waste characterization by collecting equal amounts of waste from no more than ten containers (drums or bottles) of similar material using a COLIWASA, or other appropriate sampling apparatus (see Attachment A). An equal amount of liquid waste shall be taken from each container and deposited in a non-reactive container (e.g. Pyrex). The sample shall be thoroughly mixed in the container and divided into the sampling containers. Decontaminated sampling equipment shall be used for each composite sample.

Sample(s) shall be analyzed at a Navy, AFCEE, or USACE-MRD -approved laboratory for the following parameters using EPA SW-846 procedures and Level III QA/QC protocols (7 day TAT):

Parameter	Method (SW-846)
Volatiles	8260B
Semivolatiles	8270C
Pesticides	8081A
Herbicides	8151
Pesticides	8082
Metals	6010B/7471
Reactivity, corrosivity, ignitability (RCI)	1010 or 1020A, 9040B, chapter 7.3

Additional analytical parameters may be required by the disposal facility for characterization purposes and shall be included in Subcontractor's bid.

Water

As necessary, the Subcontractor shall sample containerized liquids (i.e., any contact water from the excavations, decontamination fluids, etc.) for waste characterization. One representative sample from each container shall be collected and analyzed at a Navy, AFCEE, or USACE-MRD--approved laboratory for the following parameters using EPA SW-846 procedures and Level III QA/QC protocols:

Parameter	Method (SW-846)
TCL Volatiles	8260B
TCL Semivolatiles	8270C
TCL Pesticides	8081A
Herbicides	8151A
TCL Pesticides	8082
TAL Metals	6010B/7470A
TCL/TAL = target compound list/target analyte list	

Additional analytical parameters may be required by the disposal facility for characterization purposes and shall be included in Subcontractor's bid.

4.6 Contaminated Material Transportation and Offsite Disposal

Prior to offsite disposal of any waste, the RAC will generate a waste approval package for each waste stream, including the following to be provided to the generator for signature:

- Waste profile identifying the Defense Distribution Center as the generator of the waste
- Analytical summary table(s) applicable to the waste (based on pre-RA data collection and further onsite characterization).
- Letter of approval from the proposed waste disposal facility to accept the waste
- Land disposal restriction (LDR) notifications/certifications (for hazardous wastes only)
- A completed sample manifest

Upon receipt of notice to proceed, the RAC contractor will load and transport all waste and/or contaminated materials to a permitted disposal facility in compliance with applicable state solid waste or hazardous waste disposal requirements and in good standing with federal, state and local regulatory agencies. Certificates of destruction/disposal and weigh tickets from State-certified scales will be provided for this activity. Copies of facility signed manifests will also be provided to document soil disposal.

4.7 Backfill and Compaction

Borrow material used onsite will come from a clean site identified by the RAC. The excavations will be backfilled with the borrow material in horizontal lifts of uniform thickness (not to exceed 8 inches), in a manner that avoids segregation; each lift will be compacted with at least four (4) passes of a footed compactor to achieve an unyielding surface prior to placing succeeding lifts. The moisture content of the compacted material will be maintained sufficient to achieve the proper compaction. The compacted fill will be capable of supporting loaded dump trucks without formation of ruts or depressions. The backfilled sites will be graded and shaped to establish approximate original grades and positive surface drainage.

4.8 Site Restoration

Disturbed areas will be seeded, fertilized, and mulched to minimize erosion. The areas will be graded smooth and uniform with the surrounding areas. Large stone, debris, and materials will be removed and if necessary disposed offsite. The grass mix will be installed per the specifications through the course of the project, since the sites are widespread and will be completed at various times.

4.9 Final Decontamination and Demobilization

The Subcontractor shall perform a final cleanup of all areas impacted by its activities to the satisfaction of the RAC. Personnel and equipment shall be decontaminated prior to leaving the area to avoid the possibility of inadvertently spreading contamination. Equipment shall be properly decontaminated to remove all contamination that may be adhering to the equipment components as a result of the interim remedial action. The Subcontractor, solely at the

Subcontractor's expense, will restore any cross-contamination of Dunn Field property or public thoroughfare. All debris and rinsate generated by the treatment activities shall be properly containerized, sampled, analyzed, and disposed offsite as specified in this SOW. Decontamination of personnel and equipment shall be performed in accordance with the Site Health and Safety Plan and the applicable provisions of 29 CFR 1910.120.

Following approval from the RAC, all personnel, equipment, temporary facilities and utilities shall be demobilized from the site. In addition, any remaining debris or other wastes generated during the work shall be removed and properly disposed.

4.10 Project Submittals

The RAC Site Supervisor will be responsible for preparing a field activity summary, which describes the work performed, and estimated quantities of contaminated materials removed each day. The Subcontractor shall cooperate with and provide information as necessary in support of preparing this report. To this end, the Subcontractor shall complete the applicable portions of the RAC Quality Control Report and the RAC Production Report. These reports shall be submitted to the RAC by 9:00 AM Central time the following business day. In addition, the subcontractor will be required to submit copies of all analytical results and chain of custody forms to the RAC. Copies of shipping manifests and profile forms for waste disposal will also be submitted to the RAC. Additional submittals during the work have been previously identified in this SOW.

The Subcontractor is required to submit a schedule of values as outlined the Subcontract Agreement. RAC payment to the Subcontractor will be dependent upon weekly submission and, the RAC acceptance, of certified payroll reports.

Within 15 calendar days following Subcontractor's demobilization, the Subcontractor shall submit to the RAC a Final Report, which shall include the following, as a minimum:

- Field notes
- Daily logs
- Photographs (minimum of twenty 4"x 5", including description)
- Site map
- A chronology of significant events that occurred during the project
- Analytical results
- Documentation of proper transport and disposal of all materials
- Problems encountered
- Sample Log
- Transportation and Disposal Log
- Recommendations and Conclusions

This Final Report shall be submitted for the RAC's review.

5.0 Technical References

This section presents a list of applicable design documents that will be used and referenced during the RA. These documents include (1) USACE engineer manuals, pamphlets, regulations, and technical letters, and technical manuals, (2) construction specifications, and (3) construction drawings. Standard construction specifications were included to minimize costs. The USACE technical specifications and guidance documents are provided at the following web sites.

- http://www.usace.army.mil/publications/design-guides/all.htm
- http://www.usace.army.mil/inet/usace-docs/eng-manuals/em.htm
- http://www.usace.army.mil/publications/eng-pamphlets/ep.htm
- http://www.usace.army.mil/inet/usace-docs/eng-regs/er.htm
- http://www.usace.army.mil/publications/eng-tech-ltrs/etl-all.html

5.1 USACE Technical Specifications and Guidance Documents

Engineer Manuals

EM 200-1-1	Validation of Analytical Chemistry Laboratories
EM 200-1-2	Technical Project Planning Process
EM 200-1-3	Requirements for the Preparation of Sampling and Analysis Plans
EM 200-1-6	Chemical Quality Assurance for Hazardous, Toxic, and Radioactive Waste (HTRW) Projects
EM 385-1-1	Safety and Health Requirements Manual
EM 1110-1-502	Technical Guidelines for Hazardous & Toxic Waste Treatment and Cleanup Activities
EM 1110-1-1005	Topographic Surveying
EM 1110-1-2909	Geospatial Data and Systems
EM 1110-1-4007	Safety and Health Aspects of HTRW Remediation Technologies
EM 1110-2-38	Environmental Quality in Design of Civil Works Projects
EM 1110-2-1909	Calibration of Laboratory Soils Testing Equipment
EM 1110-3-136	Drainage and Erosion Control – Mobilization Construction

Engineer Pamphlets

EP 415-1-5	Construction Contracts
EP 415-1-261 (Vol. 1)	Quality Assurance Representative's Guide – General Information and Site Work
EP 1110-1-19	A Guide to Preparing and Reviewing Remedial Action Reports of Cost and Performance

Engineer Regulations

ER 385-1-92	Safety and Occupational Health Requirements for HTRW Activities
ER 415-1-10	Contractor Submittal Procedures CH1
ER 1110-1-12	Quality Management
ER 1110-1-261	Quality Assurance of Laboratory Testing Procedures
ER 1110-1-263	Chemical Data Quality Management for Hazardous, Toxic, Radioactive Waste remedial Activities
ER 1110-1-1901	Completion Report for Major USACE Projects

ER 1110-2-1150	Engineering and Design for Civil Works Projects
ER 1110-2-8154	Water Quality and Environmental Management for Corps Civil Works Projects
ER 1110-345-100	Design Policy for Military Construction
ER 1110-345-700	Design Analysis, Drawings and Specifications
ER 1165-2-132	HTRW Guidance for Civil Works Projects
ER 1180-1-6	Construction Quality Management

Engineer Technical Letters

TL 1110-1-151	Erosion Control to Meet NPDES Requirements
TL 1110-3-459	Hazardous Waste Storage Criteria

Technical Manuals

TM 5-814-7	Hazardous Waste Land Disposal/Land Treatment Facilities
TM 5-830-3	Dust Control for Roads, Airfields, and Adjacent Areas

5.2 Construction Specifications

Applicable construction specifications are listed below and included in Attachment B.

Division 1 – General Requirements

01010 Summary of Work
01025 Measurements and Payments
01040 Coordination
01300 Submittals
01310 Progress schedules
01500 Construction Facilities and Temporary Controls
01780 Contract Closeout

Division 2 – Site Construction

02100 Site Preparation
02140 Dewatering
02160 Excavation Support
02315 Excavation
02316 Fill and Backfill
02317 Borrow Pits
02370 Soil Stabilization
02999 Transportation and Disposal of Contaminated Materials

Figures

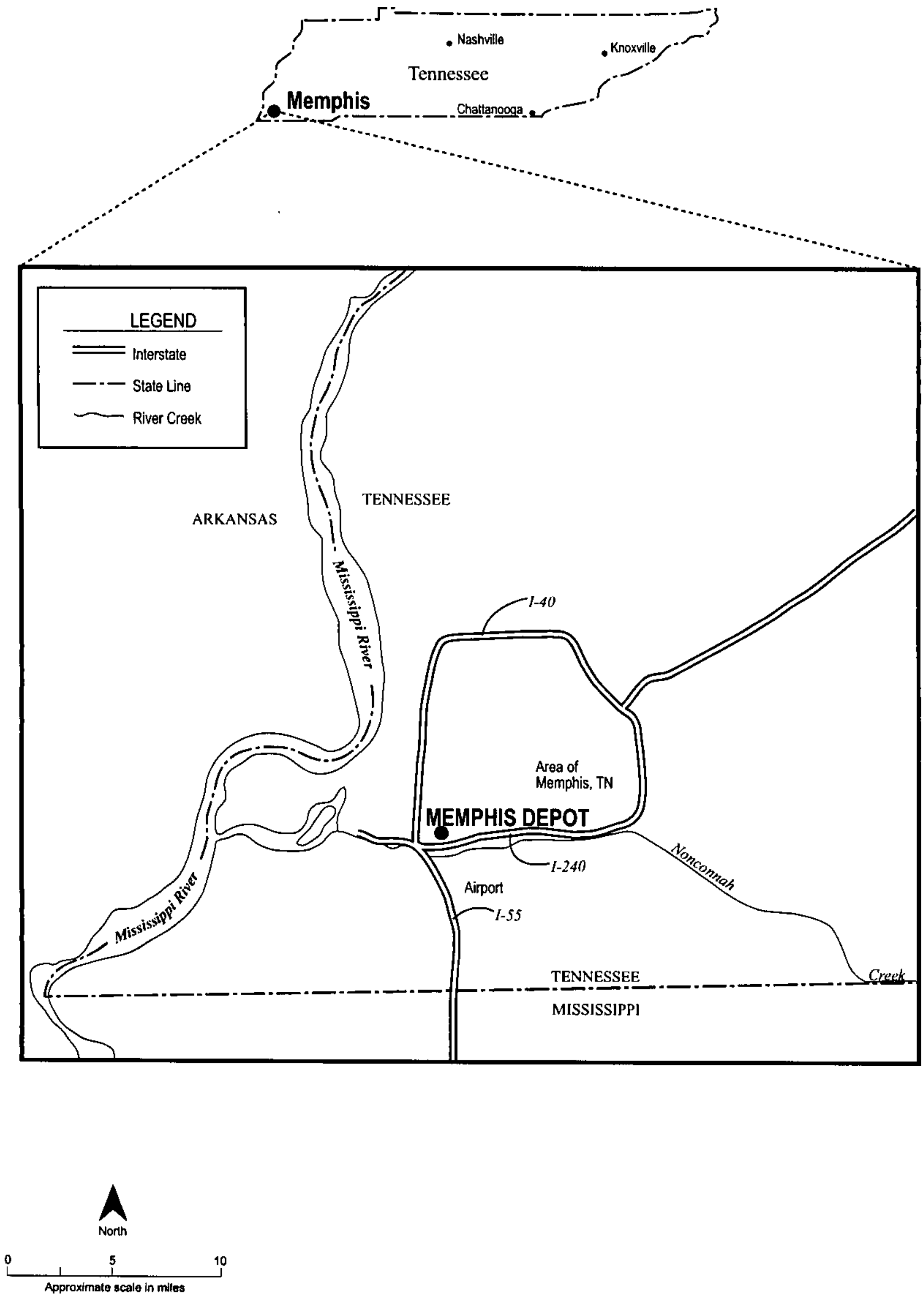


FIGURE 2-1
Memphis Depot Location In The Memphis Metropolitan Area
Memphis Depot Dunn Field Remedial Design

CH2MHILL

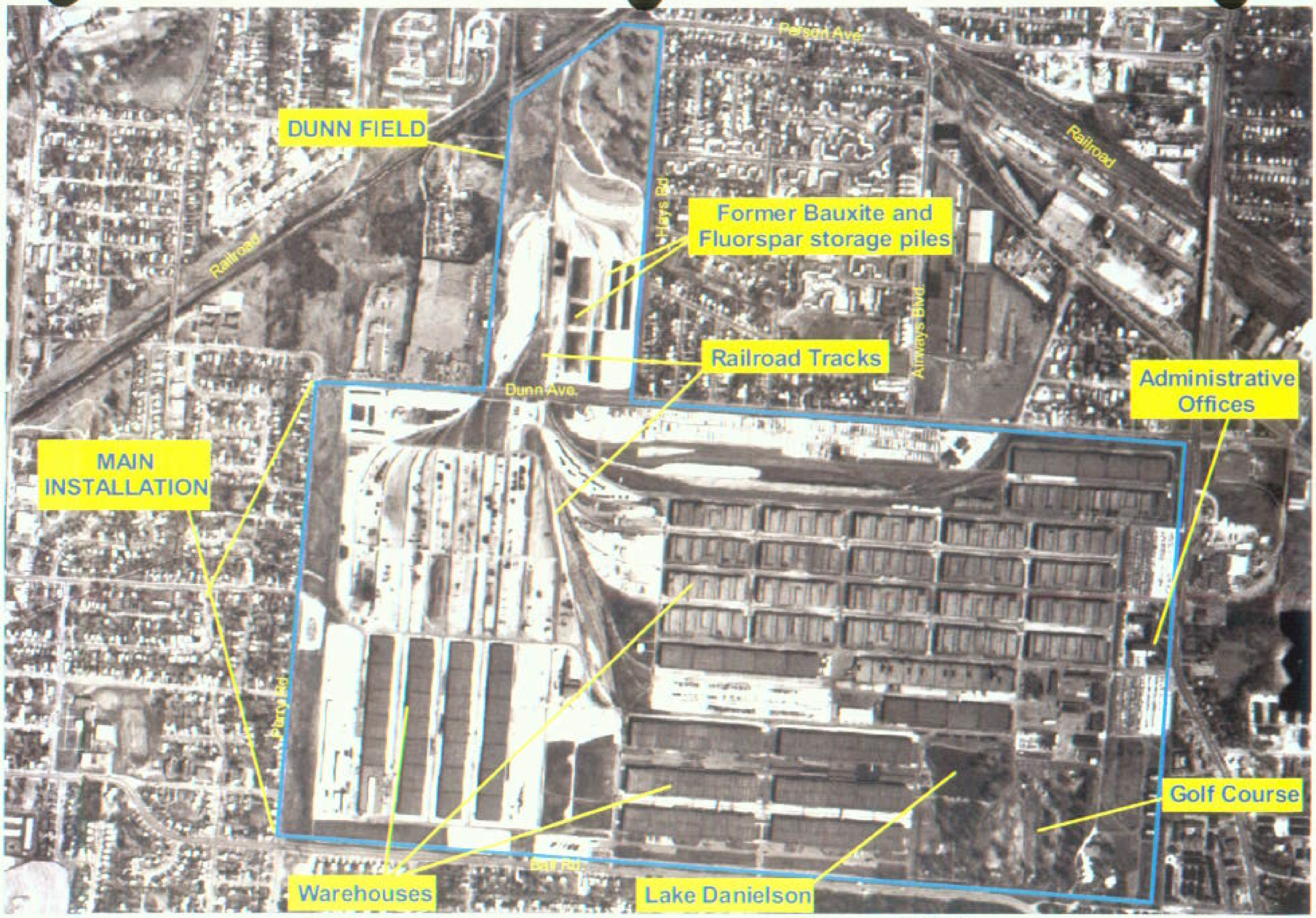


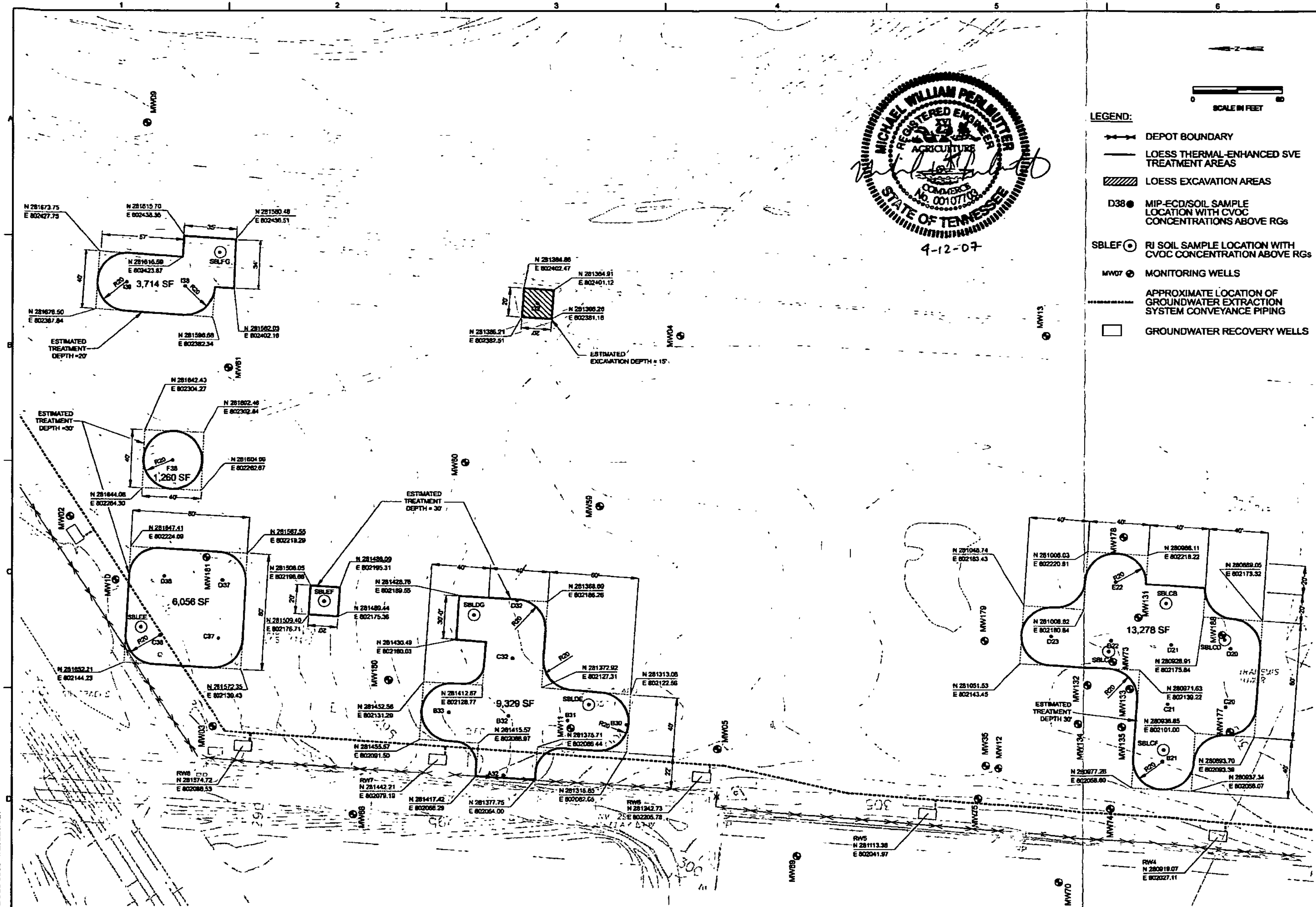
FIGURE 2-2
Major Features of the Memphis Depot
Aerial Photo Date: 1997
Memphis Depot Dunn Field Remedial Design

CH2MHILL

ES082006008ATL Memphis 102.ai

8891085

8891086



CH2MHILL	
MEMPHIS DEPOT DUNN FIELD SOURCE AREAS REMEDIAL DESIGN MEMPHIS, TN	NORTH LOESS TREATMENT AREAS

NO.	DATE	REVISION	BY	APVD

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

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

DATE	MARCH, 2007
PROJ	177556
DWG	I-1
SHEET	11

ATL/PROJ/148071 DDMT/SARD 2006/SARD/NEW FOLDER/SHEET 11 LOESS 1.DWG
FILENAME: SVE SYSTEM LAYOUT.DWG PLOT DATE: 6-Mar-07 PLOT TIME: 5:06:19 PM
USER: EGRIGGS TAB: DLAYOUT

ATTACHMENT A

EPA Drum Sampling Standard Operating Procedures

SOP#: 2009
DATE: 11/16/94
REV. #: 0.0

DRUM SAMPLING

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide technical guidance on implementing safe and cost-effective response actions at hazardous waste sites containing drums with unknown contents. Container contents are sampled and characterized for disposal, bulking, recycling, segregation, and classification purposes.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Prior to sampling, drums must be excavated, (if necessary), inspected, staged, and opened. Drum excavation must be performed by qualified personnel. Inspection involves the observation and recording of visual qualities of each drum and any characteristics pertinent to the classification of the drum's contents. Staging involves the physical grouping of drums according to classifications established during the physical inspection. Opening of closed drums can be performed manually or remotely. Remote drum opening is recommended for worker safety. The most widely used method of sampling a drum involves the use of a glass thief. This method is quick, simple, relatively inexpensive, and requires no decontamination. The contents of a drum can be further characterized by performing various field tests.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Samples collected from drums are considered waste samples and as such, adding preservatives is not required due to the potential reaction of the sample with the preservative. Samples should, however, be cooled to 4°C and protected from sunlight in order to minimize any potential reaction due to the light sensitivity of the sample.

Sample bottles for collection of waste liquids, sludges, or solids are typically wide mouth amber jars with Teflon-lined screw caps. Actual volume required for analysis should be determined in conjunction with the laboratory performing the analysis.

Waste sample handling procedures should be as follows:

1. Label the sample container with the appropriate sample label and complete the appropriate field data sheet(s). Place sample container into two resealable plastic bags.

2. Place each bagged sample container into a shipping container which has been lined with plastic. Pack the container with enough non-combustible, absorbent, cushioning material to minimize the possibility of containers breaking, and to absorb any material which may leak.

   Note: Depending on the nature and quantity of the material to be shipped, different packaging may be required. The transportation company or a shipping/receiving expert should be consulted prior to packing the samples.

3. Complete a chain of custody record for each shipping container, place into a resealable

plastic bag, and affix to the inside lid of the shipping container.

4. Secure and custody seal the lid of the shipping container. Label the shipping container appropriately and arrange for the appropriate transportation mode consistent with the type of hazardous waste involved.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

If buried drums are suspected, geophysical investigation techniques such as magnetometry or ground penetrating radar may be employed in an attempt to determine the location and depth of drums. During excavation, the soil must be removed with great caution to minimize the potential for drum rupture.

Until the contents are characterized, sampling personnel should assume that unlabelled drums contain hazardous materials. Labelled drums are frequently mislabelled, especially drums that are reused. Because a drum's label may not accurately describe its contents, extreme caution must be exercised when working with or around drums.

If a drum which contains a liquid cannot be moved without rupture, its contents may be immediately transferred to a sound drum using an appropriate method of transfer based on the type of waste. In any case, preparations should be made to contain the spill (i.e., spill pads, dike, etc.) should one occur.

If a drum is leaking, open, or deteriorated, then it must be placed immediately in overpack containers.

The practice of tapping drums to determine their contents is neither safe nor effective and should not be used if the drums are visually overpressurized or if shock-sensitive materials are suspected. A laser thermometer may be effective in order to determine the level of the drum contents via surface temperature differences.

Drums that have been overpressurized to the extent that the head is swollen several inches above the level of the chime should not be moved. A number of devices have been developed for venting critically swollen drums. One method that has proven to be effective is a tube and spear device. A light aluminum tube (3 meters long) is positioned at the vapor space of the drum. A rigid, hooking device attached to the tube, goes over the chime and holds the tube securely in place. The spear is inserted in the tube and positioned against the drum wall. A sharp blow on the end of the spear drives the sharpened tip through the drum and the gas vents along the grooves. Venting should be done from behind a wall or barricade. Once the pressure has been relieved, the bung can be removed and the drum sampled.

Because there is potential for accidents to occur during handling, particularly initial handling, drums should only be handled if necessary. All personnel should be warned of the hazards prior to handling drums. Overpack drums and an adequate volume of absorbent material should be kept near areas where minor spills may occur. Where major spills may occur, a containment berm adequate to contain the entire volume of liquid in the drums should be constructed before any handling takes place. If drum contents spill, personnel trained in spill response should be used to isolate and contain the spill.

5.0 EQUIPMENT/APPARATUS

The following are standard materials and equipment required for sampling:

C Personal protection equipment
C Wide-mouth amber glass jars with Teflon cap liner, approximately 500 mL volume
C Other appropriate sample jars
C Uniquely numbered sample identification labels with corresponding data sheets
C Drum/Tank Sampling Data Sheets and Field Test Data Sheets for Drum/Tank Sampling
C Chain of Custody records
C Decontamination materials
C Glass thieving tubes or COLIWASA
C Coring device
C Stainless steel spatula or spoons
C Laser thermometer
C Drum overpacks
C Absorbent material for spills
C Drum opening devices

Bung Wrench

A common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of a non-sparking metal alloy (i.e., brass, bronze/manganese, aluminum, etc.) formulated to reduce the likelihood of sparks. The use of a "NON-SPARKING" wrench does not completely eliminate the possibility of a spark being produced.

Drum Deheader

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums. Drums with removable heads must be opened by other means.

Hand Pick, Pickaxe, and Hand Spike

These tools are usually constructed of brass or a non-sparking alloy with a sharpened point that can penetrate the drum lid or head when the tool is swung. The hand picks or pickaxes that are most commonly used are commercially available; whereas, the spikes are generally uniquely fabricated four foot long poles with a pointed end.

Backhoe Spike

Another means used to open drums remotely for sampling is a metal spike attached or welded to a backhoe bucket. This method is very efficient and is often used in large-scale operations.

Hydraulic Drum Opener

Recently, remotely operated hydraulic devices have been fabricated to open drums. This device uses hydraulic pressure to force a non-sparking spike through the wall of a drum. It consists of a manually operated pump which pressurizes fluid through a length of hydraulic line.

Pneumatic Devices

A pneumatic bung remover consists of a compressed air supply that is controlled by a two-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill, which is adapted to turn bung fitting selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

6.0 REAGENTS

Reagents are not typically required for preserving drum samples. However, reagents will be utilized for decontamination of sampling equipment.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and

mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Drum Excavation

If it is presumed that buried drums are on-site and prior to beginning excavation activities, geophysical investigation techniques should be utilized to approximate the location and depth of the drums. In addition, it is important to ensure that all locations where excavation will occur are clear of utility lines, pipes and poles (subsurface as well as above surface).

Excavating, removing, and handling drums are generally accomplished with conventional heavy construction equipment. These activities should be performed by an equipment operator who has experience in drum excavation. During excavation activities, drums must be approached in a manner that will avoid digging directly into them.

The soil around the drum should be excavated with non-sparking hand tools or other appropriate means and as the drums are exposed, a visual inspection should be made to determine the condition of the drums. Ambient air monitoring should be done to determine the presence of unsafe levels of volatile organics, explosives, or radioactive materials. Based on this preliminary visual inspection, the appropriate mode of drum excavation and handling may be determined.

Drum identification and inventory should begin before excavation. Information such as location, date of removal, drum identification number, overpack status, and any other identification marks should be recorded on the Drum/Tank Sampling Data Sheet (Attachment 1, Appendix A).

7.3 Drum Inspection

Appropriate procedures for handling drums depend on the contents. Thus, prior to any handling, drums should be visually inspected to gain as much information as possible about their contents. The drums should be inspected for the following:

1. Drum condition, corrosion, rust, punctures, bungs, and leaking contents.

2. Symbols, words, or other markings on the drum indicating hazards (i.e., explosive, radioactive, toxic, flammable), or further identifying the drums.

3. Signs that the drum is under pressure.

4. Shock sensitivity.

Monitoring should be conducted around the drums using instruments such as radiation meters, organic vapor analyzers (OVA) and combustible gas indicators (CGI).

Survey results can be used to classify the drums into categories, for instance:

C Radioactive
C Leaking/deteriorating
C Bulging
C Lab packs
C Explosive/shock sensitive
C Empty

All personnel should assume that unmarked drums contain hazardous materials until their contents have been categorized. Once a drum has been visually inspected and any immediate hazard has been eliminated by overpacking or transferring the drum's contents, the drum is affixed with a numbered tag and transferred to a staging area. Color-coded tags, labels or bands should be used to identify the drum's category based on visual inspection. A description of each drum, its condition, any unusual markings, the location where it was buried or stored, and field monitoring information are recorded on a Drum/Tank Sampling Data Sheet (Attachment 1, Appendix A). This data sheet becomes the principal record keeping tool for tracking the drum on-site.

7.4 Drum Staging

Prior to sampling, the drums should be staged to allow easy access. Ideally, the staging area should be located just far enough from the drum opening area to prevent a chain reaction if one drum should explode or catch fire when opened.

During staging, the drums should be physically separated into the following categories: those containing liquids, those containing solids, those containing lab packs, and those which are empty. This is done because the strategy for sampling and handling drums/containers in each of these categories will be different. This may be achieved by visual inspection of the drum and its labels, codes, etc. Solids and sludges are typically disposed of in open top drums. Closed head drums with a bung opening generally contain liquid.

Where there is good reason to suspect that drums contain radioactive, explosive, or shock-sensitive materials, these drums should be staged in a separate, isolated area. Placement of explosives and shock-sensitive materials in diked and fenced areas will minimize the hazard and the adverse effects of any premature detonation of explosives.

Where space allows, the drum opening area should be physically separated from the drum removal and drum staging operations. Drums are moved from the staging area to the drum opening area one at a time using forklift trucks equipped with drum grabbers or a barrel grappler. In a large-scale drum handling operation, drums may be conveyed to the drum opening area using a roller conveyor. Drums may be restaged as necessary after opening and sampling.

7.5 Drum Opening

There are three basic techniques available for opening drums at hazardous waste sites:

- Manual opening with non-sparking bung wrenches
- Drum deheading
- Remote drum puncturing or bung removal

The choice of drum opening techniques and accessories depends on the number of drums to be opened, their waste contents, and physical condition. Remote drum opening equipment should always be considered in order to protect worker safety. Under OSHA 1910.120, manual drum opening with bung wrenches or deheaders should be performed ONLY with structurally sound drums and waste contents that are known to be non-shock sensitive, non-reactive, non-explosive, and non-flammable.

7.5.1 Manual Drum Opening with a Bung Wrench

Manual drum opening with bung wrenches (Figure 1, Appendix B) should not be performed unless the drums are structurally sound (no evidence of bulging or deformation) and their contents are known to be non-shock sensitive, non-reactive, non-explosive or non-flammable. If opening the drum with bung wrenches is deemed safe, then certain procedures should be implemented to minimize the hazard:

- Field personnel should be fully outfitted with protective gear.
- Drums should be positioned upright with the bung up, or, for drums with bungs on the side, laid on their sides with the bung plugs up.
- The wrenching motion should be a slow, steady pull across the drum. If the length of the bung wrench handle provides inadequate leverage for unscrewing the plug, a "cheater bar" can be attached to the handle to improve leverage.

7.5.2 Manual Drum Opening with a Drum Deheader

Drums are opened with a drum deheader (Figure 2, Appendix B) by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote method prior to using the deheader.

Self-propelled drum openers which are either electrically or pneumatically driven are available and can be used for quicker and more efficient deheading.

The drum deheader should be decontaminated, as necessary, after each drum is opened to avoid cross contamination and/or adverse chemical reactions from incompatible materials.

7.5.3 Manual Drum Opening with a Hand Pick, Pickaxe, or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, then it can be opened for sampling by using a hand pick, pickaxe, or spike (Figure 3, Appendix B). Often the drum lid or head must be hit with a great deal of force in order to penetrate it. Because of this, the potential for splash or spraying is greater than with other opening methods and therefore, this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums, some of which may be under pressure, cannot be opened slowly with these tools, spray from drums is common and appropriate safety measures must be taken. The pick or spike should be decontaminated after each drum is opened to avoid cross contamination and/or adverse chemical reaction from incompatible materials.

7.5.4 Remote Drum Opening with a Backhoe Spike

Remotely operated drum opening tools are the safest available means of drum opening. Remote drum opening is slow, but provides a high degree of safety compared to manual methods of opening.

In the opening area, drums should be placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike (Figure 4, Appendix B) should be decontaminated after each drum is opened to prevent cross contamination and/or adverse reaction from incompatible material. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This combined with the normal personal protection gear should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board airline system.

7.5.5 Remote Drum Opening with Hydraulic Devices

A piercing device with a non-sparking, metal point is attached to the end of a hydraulic line and is pushed into the drum by the hydraulic pressure (Figure 5, Appendix B). The piercing device can be attached so that a hole for sampling can be made in either the side or the head of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place if desired and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

7.5.6 Remote Drum Opening with Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely (Figure 6, Appendix B). Prior to opening the drum, a bung fitting must be selected to fit the bung to be removed. The adjustable bracketing system is then attached to the drum and the pneumatic drill is aligned over the bung. This must be done before the drill can be operated. The operator then moves away from the drum to operate the equipment. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

7.6 Drum Sampling

After the drum has been opened, preliminary monitoring of headspace gases should be performed first with an explosimeter/oxygen meter. Afterwards, an OVA or other instruments should be used. If possible, these instruments should be intrinsically safe. In most cases it is impossible to observe the contents of these sealed or partially sealed drums. Since some layering or stratification is likely in any solution left undisturbed, a sample that represents the entire depth of the drum must be taken.

When sampling a previously sealed drum, a check should be made for the presence of a bottom sludge. This is easily accomplished by measuring the depth to apparent bottom then comparing it to the known interior depth.

7.6.1 Glass Thief Sampler

The most widely used implement for sampling drum liquids is a glass tube commonly referred to as a glass thief (Figure 7, Appendix B). This tool is cost effective, quick, and disposable. Glass thieves are typically 6mm to 16mm I.D. and 48 inches long.

Procedures for Use:

1. Remove the cover from the sample container.

2. Insert glass tubing almost to the bottom of the drum or until a solid layer is encountered. About one foot of tubing should extend above the drum.

3. Allow the waste in the drum to reach its natural level in the tube.

4. Cap the top of the sampling tube with a tapered stopper or thumb, ensuring liquid does not come into contact with stopper.

5. Carefully remove the capped tube from the drum and insert the uncapped end into the appropriate sample container.

6. Release stopper and allow the glass thief to drain until the container is approximately two-thirds full.

7. Remove tube from the sample container, break it into pieces and place the pieces in the drum.

8. Cap the sample container tightly and label it. Place the sample container into a carrier.

9. Replace the bung or place plastic over the drum.

10. Log all samples in the site logbook and on Drum/Tank Sampling Data Sheets.

11. Perform hazard categorization analyses if included in the project scope.

12. Transport the sample to the decontamination zone and package it for transport to the analytical laboratory, as necessary. Complete chain of custody records.

In many instances a drum containing waste material will have a sludge layer on the bottom. Slow insertion of the sample tube into this layer; then a gradual withdrawal will allow the sludge to act as a bottom plug to maintain the fluid in the tube. The plug can be gently removed and placed into the sample container by the use of a stainless steel lab spoon.

It should be noted that in some instances disposal of the tube by breaking it into the drum may interfere with eventual plans for the removal of its contents. The use of this technique should be cleared with the project officer or other glass thief disposal techniques should be evaluated.

7.6.2 COLIWASA Sampler

The Composite Liquid Waste Sampler (COLIWASA) and modifications thereof are equipment that collect a sample from the full depth of a drum and maintain it in the transfer tube until delivery to the sample bottle. The COLIWASA (Figure 8, Appendix B) is a much cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. One configuration consists of a 152 cm by 4 cm I.D. section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end.

Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper. One model of the COLIWASA is shown in Appendix B; however, the design can be modified and/or adapted somewhat to meet the needs of the sampler.

The major drawbacks associated with using a COLIWASA concern decontamination and costs. The sampler is difficult to decontaminate in the field and its high cost in relation to alternative procedures (glass tubes) make it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use

1. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.

2. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.

3. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

4. Slowly withdraw the sample from the waste container with one hand while wiping the sampler tube with a disposable cloth or rag with the other hand.
5. Carefully discharge the sample into the appropriate sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.

6. Cap the sample container tightly and label it. Place the sample container in a carrier.

7. Replace the bung or place plastic over the drum.

8. Log all samples in the site logbook and on Drum/Tank Sampling Data Sheets.

9. Perform hazard categorization analyses if included in the project scope.

10. Transport the sample to the decontamination zone and package for transport to the analytical laboratory, as necessary. Complete the Chain of Custody records.

7.6.3 Coring Device

A coring device may be used to sample drum solids. Samples should be taken from different areas within the drum. This sampler consists of a series of extensions, a T- handle, and the coring device.

Procedures for use:

1. Assemble the sampling equipment.

2. Remove the cover from the sample container.

3. Insert the sampling device to the bottom of the drum. The extensions and the "T" handle should extend above the drum.

4. Rotate the sampling device to cut a core of material.

5. Slowly withdraw the sampling device so that as much sample material as possible is retained within it.

6. Transfer the sample to the appropriate sample container, and label it. A stainless steel spoon or scoop may be used as necessary.

7. Cap the sample container tightly and place it in a carrier.

8. Replace the bung or place plastic over the drum.

9. Log all samples in the site log book and on Drum/Tank Sampling Data Sheets.

10. Perform hazard categorization analyses if included in the project scope.

11. Transport the sample to the decontamination zone and package it for transport to the analytical laboratory, as necessary. Complete chain of custody records.

7.7 Hazard Categorization

The goal of characterizing or categorizing the contents of drums is to obtain a quick, preliminary assessment of the types and levels of pollutants contained in the drums. These activities generally involve rapid, non-rigorous methods of analysis. The data obtained from these methods can be used to make decisions regarding drum staging or restaging, bulking or compositing of the drum contents.

As a first step in obtaining these data, standard tests should be used to classify the drum contents into general categories such as auto-reactives, water reactives, inorganic acids, organic acids, heavy metals, pesticides, cyanides, inorganic oxidizers, and organic oxidizers. In some cases, further analyses should be conducted to more precisely identify the drum contents.

There are several methods available to perform these tests:

C the HazCat[R] chemical identification system
C the Chlor-N-Oil Test Kit
C Spill-fyter Chemical Classifier Strips
C Setaflash (for ignitability)

These methods must be performed according to the manufacturers' instructions and the results must be documented on the Field Test Data Sheet for Drum/Tank Sampling (Attachment 2, Appendix A).

Other tests which may be performed include:

C Water Reactivity
C Specific Gravity Test (compared to water)
C Water Solubility Test
C pH of Aqueous Solution

The tests must be performed in accordance with the instructions on the Field Test Data Sheet for Drum/Tank Sampling and results of the tests must be documented on these data sheets.

The specific methods that will be used for hazard categorization must be documented in the Quality Assurance Work Plan.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

The following general quality assurance procedures apply:

1. All data must be documented on Chain of Custody records, Drum/Tank Sampling Data Sheets, Field Test Data Sheet for Drum/Tank Sampling, or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures.

More specifically, the opening of closed containers is one of the most hazardous site activities. Maximum efforts should be made to ensure the safety of the sampling team. Proper protective equipment and a general awareness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended.

12.0 REFERENCES

Guidance Document for Cleanup of Surface Tank and Drum Sites, OSWER Directive 9380.0-3.

Drum Handling Practices at Hazardous Waste Sites, EPA-600/2-86-013.

8891098

APPENDIX A

Attachments

ATTACHMENT 1. Drum/Tank Sampling Data Sheet

Samplers: ______________________ Date: ______________________

Site Name: ______________________ Work Order Number: 3347-040-001-__________

Container Number/Sample Number: ______ REAC Task Leader: ______________________

SITE INFORMATION:

1. Terrain, drainage description: ____

2. Weather conditions (from observation): ______________________________________

   MET station on site: No Yes

CONTAINER INFORMATION:

1. Container type: Drum Tank Other: ______________________________

2. Container dimensions: Shape: ______________________________

   Approximate size: ______________________________

3. Label present: No
Yes: ____

   Other Markings: ______________________________
   ____
   ____
   ____

4. Spill or leak present: No Yes Dimensions: ______________________________

5. Container location: (Circle one) N/A See Map Other: ______________

8891099

APPENDIX A (Cont'd)

Attachments

ATTACHMENT 1. Drum/Tank Sampling Data Sheet (cont'd)

SAMPLE INFORMATION:

1. Description: _____ liquid _____ solid (_____ powder or _____ crystals) _____ sludge

2. Color: ________________________ Vapors: ____________________
   Other: ____

3. Local effects present: (damage - environmental, material)____

FIELD MONITORING:

1. PID: ____________________ Background (clean zone)

   ____________________ Probe used/Model used

   ____________________ Reading from container opening

2. FID: ____________________ Background (clean zone)

   ____________________ Reading from container opening

3. Radiation Meter:

   ____________________ Model used

   ____________________ Background (clean zone)

   ____________________ Reading from container opening

4. Explosimeter/Oxygen Meter:

   ____________________ Oxygen level from container opening

   ____________________ LEL level from container opening

APPENDIX A (Cont'd)

Attachments

ATTACHMENT 2. Field Test Data Sheet for Drum/Tank Sampling

Samplers: ____________________ Date: ____________________

Site Name: ____________________ Work Order Number: 3347-040-001-__________

Container Number/Sample Number: __________ REAC Task Leader: ____________________

SAMPLE MONITORING INFORMATION:

1. PID: ____________ Background (clean zone)

____________ Probe used/Model used

____________ Reading from sample

2. FID: ____________ Background (clean zone)

____________ Reading from sample

3. Radiation Meter: ____________ Model used

____________ Background (clean zone)

____________ Reading from sample

4. Explosimeter/Oxygen Meter: __________ Oxygen level (sample)

__________ LEL level (sample)

SAMPLE DESCRIPTION:

_______ Liquid _______ Solid _______ Sludge _______ Color _______ Vapors

WATER REACTIVITY:

1. Add small amount of sample to water: _____ bubbles _____ color change to __________

_____ vapor formation _____ heat _____ No Change

SPECIFIC GRAVITY TEST (compared to water):

1. Add small amount of sample to water: _____ sinks _____ floats

2. If liquid sample sinks, screen for chlorinated compounds. If liquid sample floats and appears to be oily, screen for PCBs (Chlor-N-Oil kit).

APPENDIX A (Cont'd)

Attachments

ATTACHMENT 2. Field Test Data Sheet for Drum/Tank Sampling (cont'd)

CHLOR N OIL TEST KIT INFORMATION:

1. Test kit used for this sample: Yes No

2. Results: _____ PCB not present _____ PCB present, less than 50 ppm

_____ PCB present, greater than 50 ppm _____ 100% PCB present

WATER SOLUBILITY TEST:

1. Add approximately one part sample to five parts water. You may need to stir and heat gently. **[DO NOT HEAT IF WATER REACTIVE!]** Results: _______ total _______ partial _______ no solubility

pH OF AQUEOUS SOLUTION:

1. Using 0-14 pH paper, check pH of water/sample solution: _________________.

SPILL-FYTER CHEMICAL CLASSIFIER STRIPS:

1. Acid/Base Risk: (Circle one)	Color Change
Strong acid (0)	RED
Moderately acidic (1-3)	ORANGE
Weak acid (5)	YELLOW
Neutral (7)	GREEN
Moderately basic (9-11)	Dark GREEN
Strong Base (13-14)	Dark BLUE
2. Oxidizer Risk: (Circle one)	
Not Present	WHITE
Present	BLUE, RED, OR ANY DIVERGENCE FROM WHITE
3. Fluoride Risk. (Circle one)	
Not Present	PINK
Present	YELLOW

APPENDIX A (Cont'd)

Attachments

ATTACHMENT 2. Field Test Data Sheet for Drum/Tank Sampling (cont'd)

4. Petroleum Product, Organic Solvent Risk: (Circle one)

Not Present	LIGHT BLUE
Present	DARK BLUE

5. Iodine, Bromine, Chlorine Risk: (Circle one)

Not Present	PEACH
Present	WHITE OR YELLOW

SETAFLASH IGNITABILITY TEST:

140°F	Ignitable: ________	Non-Ignitable ________
160°F	Ignitable: ________	Non-Ignitable ________
______	Ignitable: ________	Non-Ignitable ________
______	Ignitable: ________	Non-Ignitable ________
______	Ignitable: ________	Non-Ignitable ________
______	Ignitable: ________	Non-Ignitable ________

Comments:

____
____
____
____
____
____

HAZCAT KIT TESTS:

1. Test: ______________________________ Outcome: ______________________________

Comments: ____

____

2. Test: ______________________________ Outcome: ______________________________

Comments: ____

APPENDIX A (Cont'd)

Attachments

ATTACHMENT 2. Field Test Data Sheet for Drum/Tank Sampling (cont'd)

3. Test: ______________________ Outcome: ______________________

Comments: ____

____

4. Test: ______________________ Outcome: ______________________

Comments: ____

____

5. Test: ______________________ Outcome: ______________________

Comments: ____

____

HAZCAT PESTICIDES KIT:

Present: ______________________ Not Present: ______________________

Comments: ____

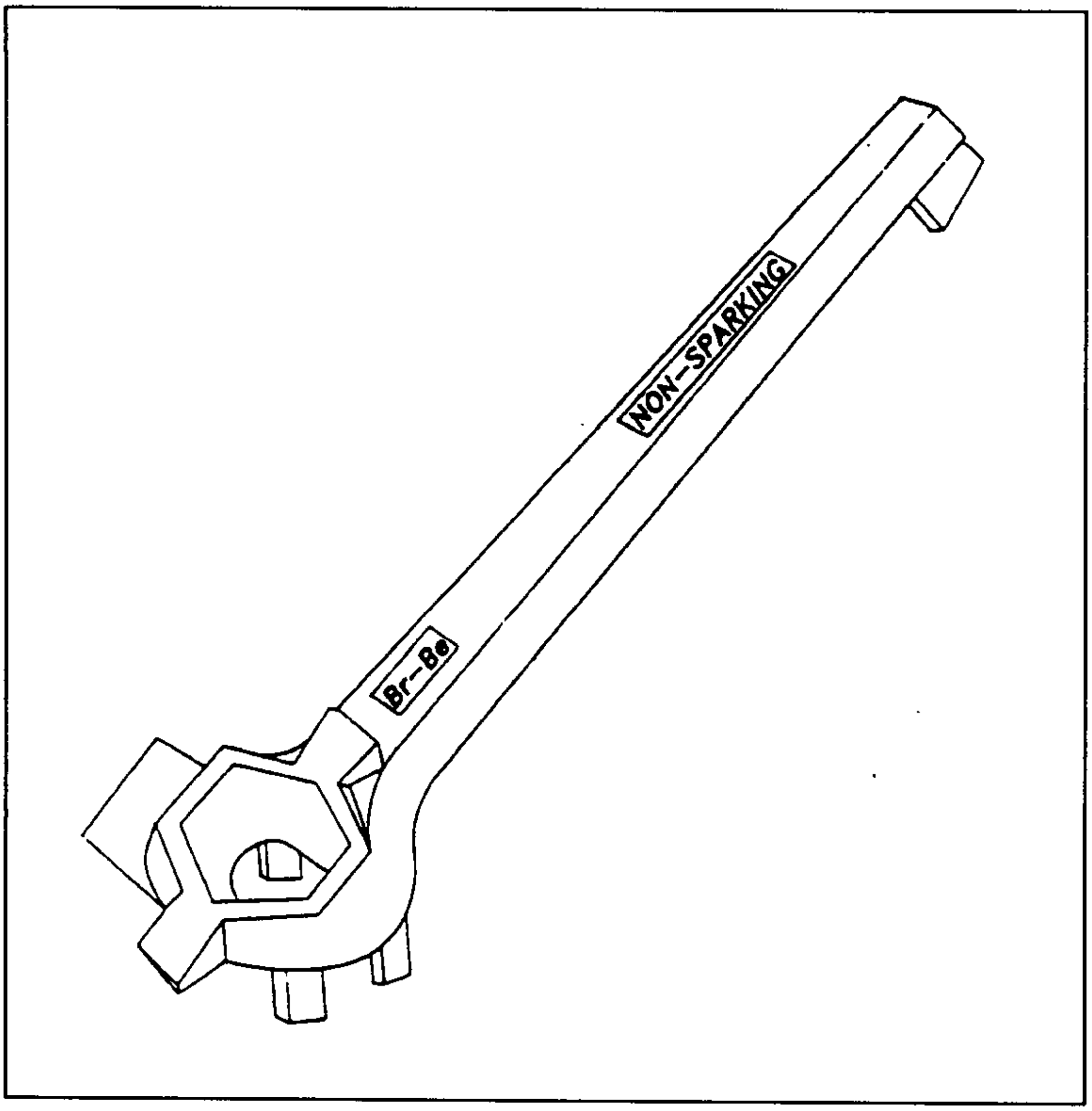
____

____

APPENDIX B

Figures

Figure 1. Universal Bung Wrench

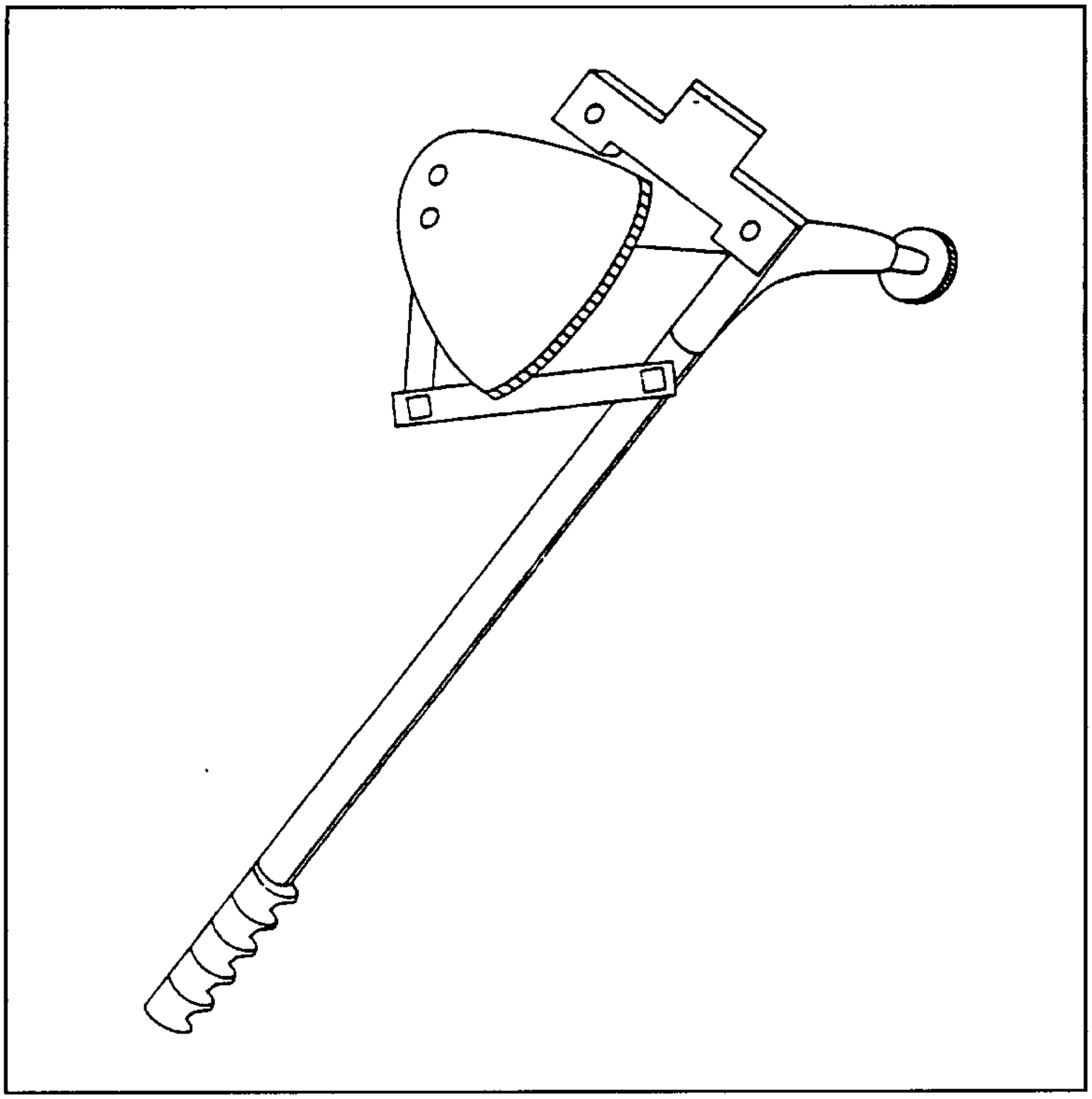


8891105

APPENDIX B (Cont'd)

Figures

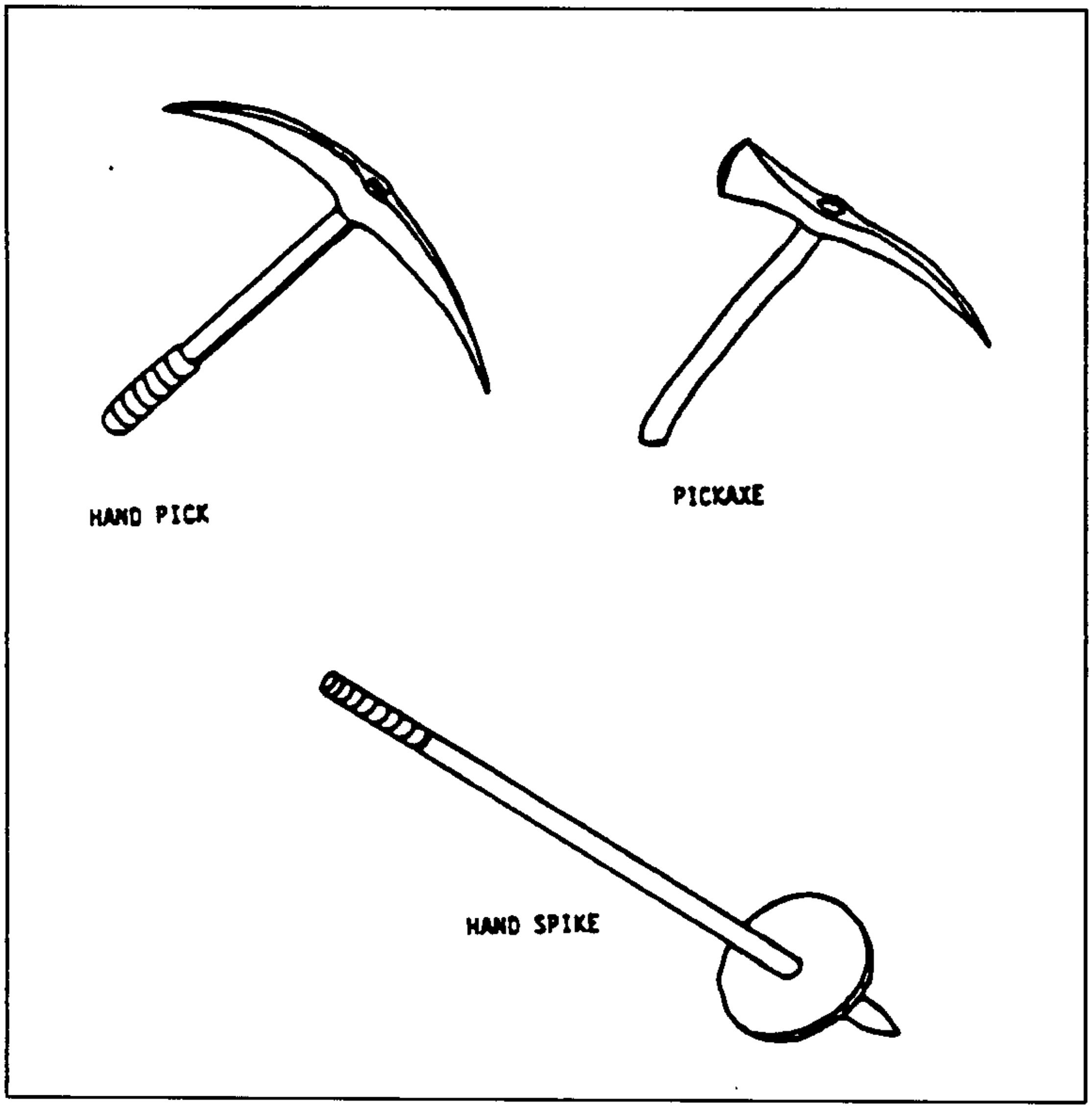
Figure 2. Drum Deheader



APPENDIX B (Cont'd)

Figures

Figure 3. Hand Pick, Pickaxe, and Hand Spike

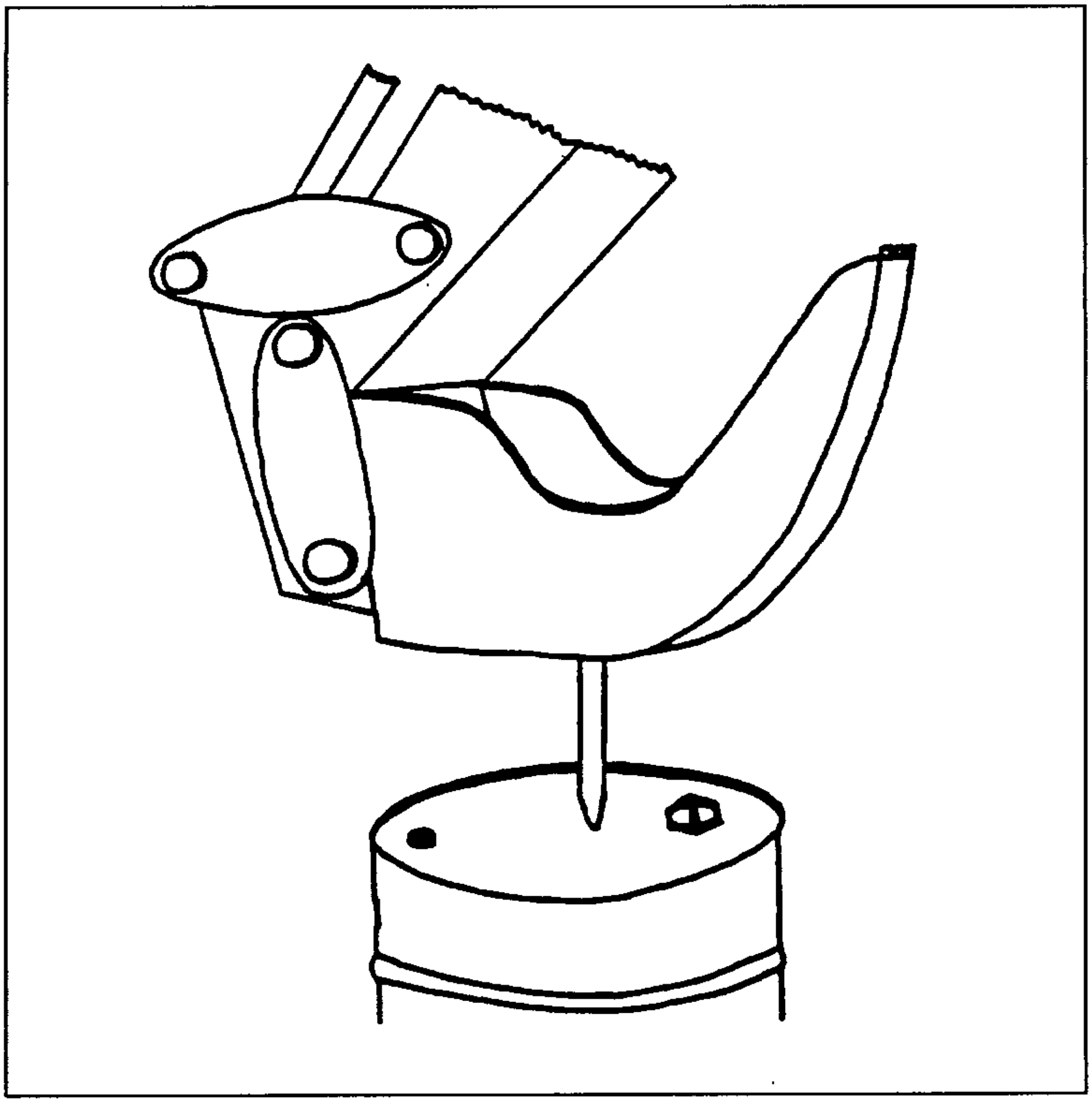


8891107

APPENDIX B (Cont'd)

Figures

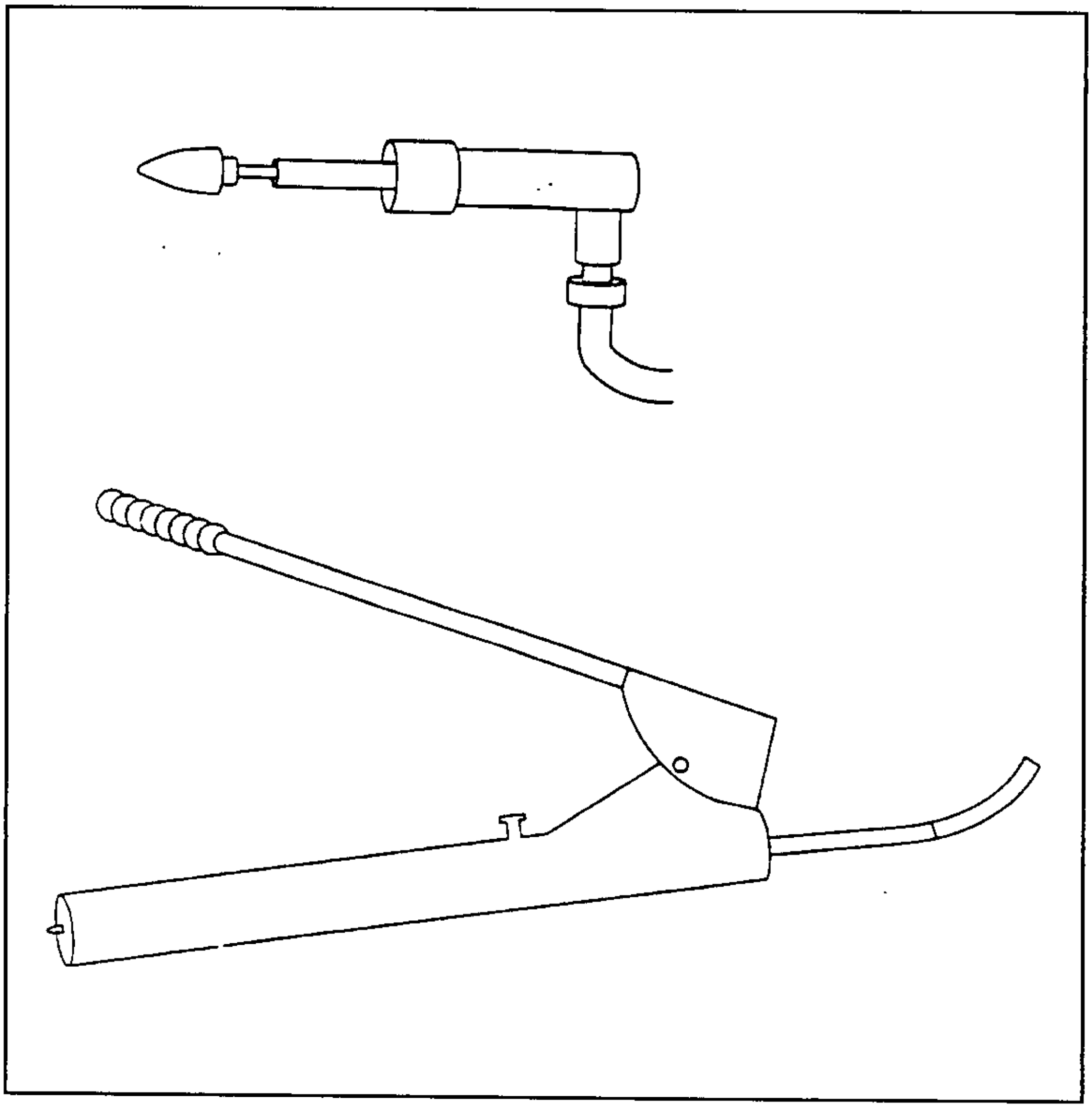
Figure 4. Backhoe Spike



APPENDIX B (Cont'd)

Figures

Figure 5. Hydraulic Drum Opener

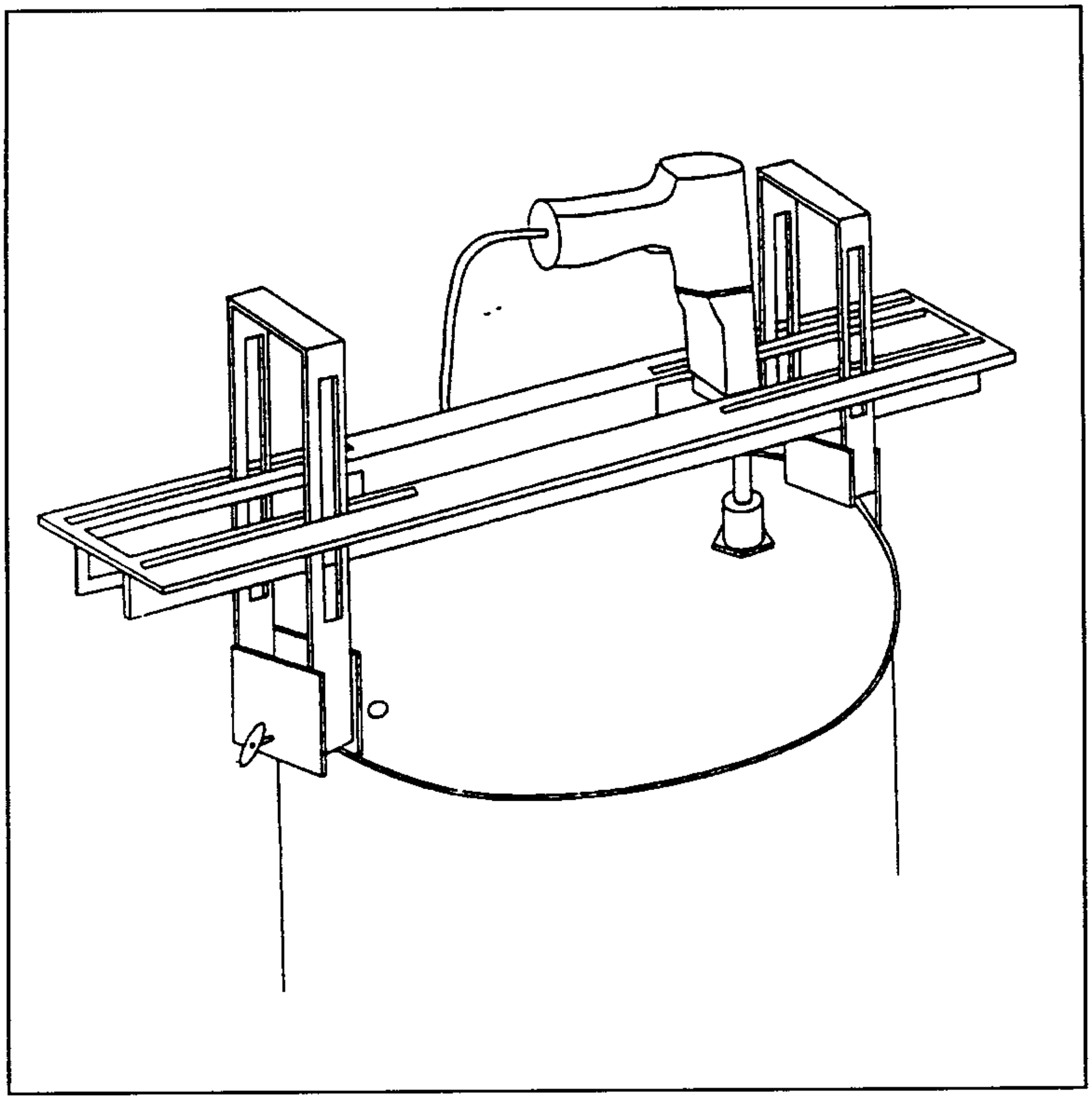


8891109

APPENDIX B (Cont'd)

Figures

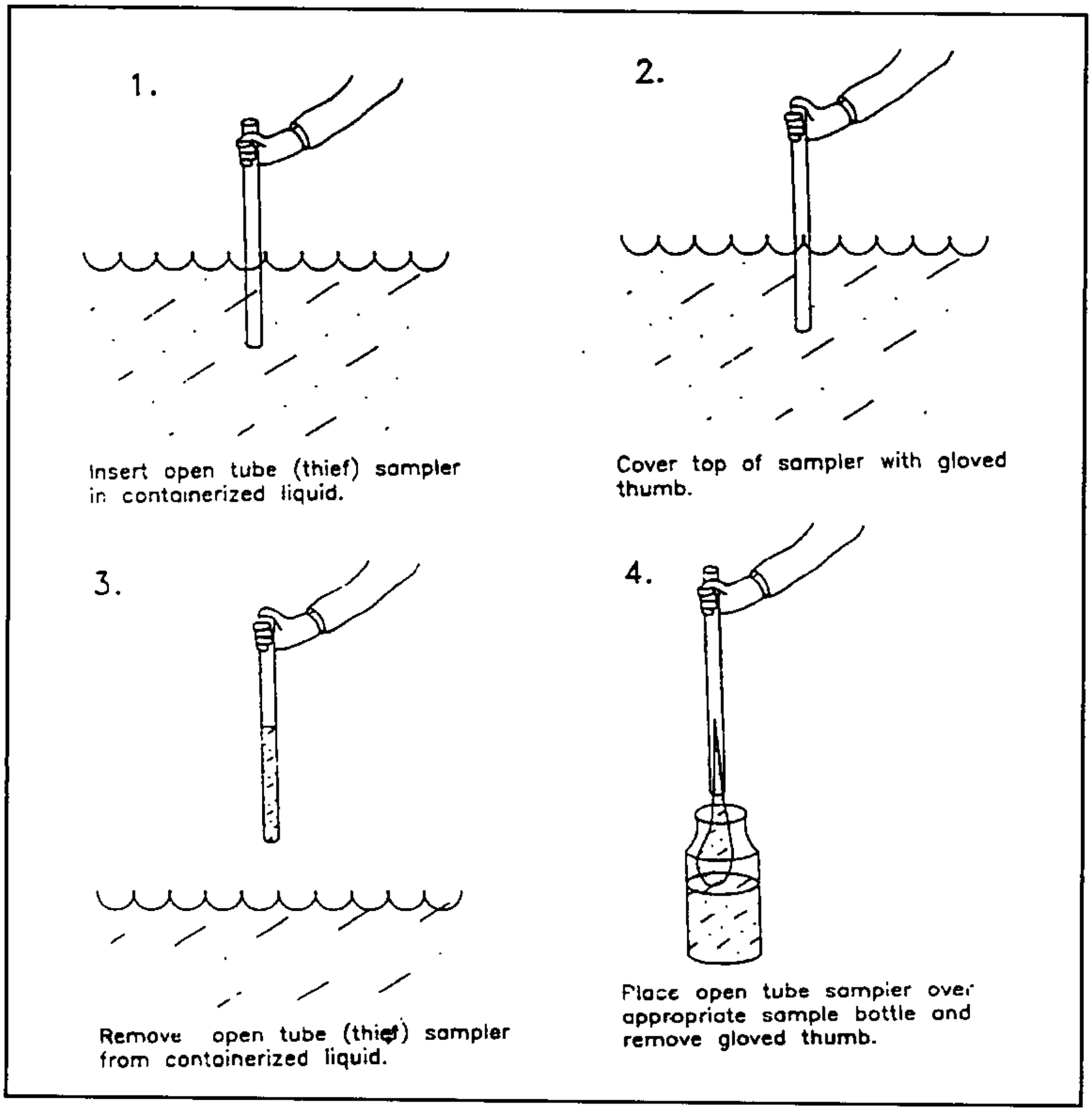
Figure 6. Pneumatic Bung Remover



APPENDIX B (Cont'd)

Figures

Figure 7. Glass Thief

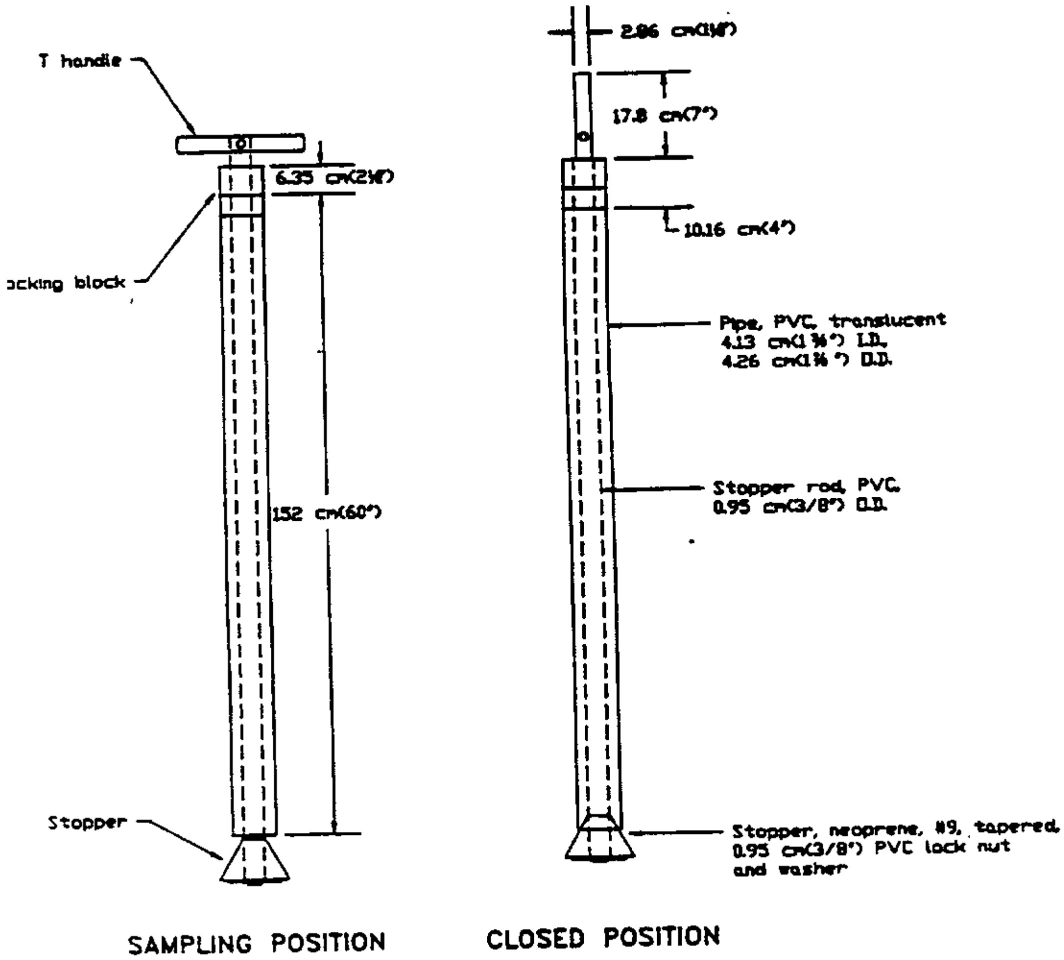


8891111

APPENDIX B (Cont'd)

Figures

Figure 8. COLIWASA



ATTACHMENT B

Specifications

CONTENTS

DIVISION 14—CONVEYING SYSTEMS (NOT USED)

DIVISION 15—MECHANICAL (NOT USED)

DIVISION 16—ELECTRICAL (NOT USED)

END OF SECTION

SECTION 01010
SUMMARY OF WORK

PART 1 GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

A. The completed Work includes the excavation, characterization, transportation, and offsite disposal of contaminated soil and debris from Memphis Depot Dunn Field Disposal Sites.

1. The Memphis Depot originated as a military facility in the early 1940s. Its initial mission and function was to provide stock control, materiel storage, and maintenance services for the U.S. Army. In 1995, the Depot was placed on the list of Department of Defense (DoD) facilities to be closed under Base Realignment and Closure (BRAC). Storage and distribution of materiel for all U.S. military services and some civil agencies continued until the Depot closed in September 1997.

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

B. Contaminated soil shall be excavated from two areas shown on the drawings (Sheet 11) and disposed of in RCRA permitted hazardous and/or non-hazardous landfill. After confirmation sampling, the excavations hall be backfilled with clean, offsite borrow materials.

1. The work consists of the excavation of approximately 500 cubic yards of soil (and possibly debris including glass bottles and crushed drums). Following confirmation sampling, the excavation, will be backfilled, compacted, and reseeded. Soil (and debris) will be transported to and disposed of in a permitted hazardous or non-hazardous landfill.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01025
MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.1 SUBMITTALS

A. Informational:

1. Schedule of Values: Submit on Contractor's standard form
2. Schedule of Estimated Progress Payments: Submit with initially acceptable Schedule of Values
3. Application for Payment
4. Final Application for Payment

1.2 SCHEDULE OF VALUES

A. Prepare a separate Schedule of Values for each schedule of the Work under the Agreement.

B. Upon request of the Contracting Officer, provide support documentation to support the accuracy of the Schedule of Values.

C. Unit Price Work: Reflect unit price quantity and price breakdown from conformed Bid Form.

D. Lump Sum Work: Reflect Schedule of Values format included in conformed Bid Form, specified allowances, alternates, and equipment selected by Owner, as applicable.

E. An unbalanced or front-end loaded schedule will not be acceptable.

F. Summation of the complete Schedule of Values representing all the Work shall equal the Contract Price.

1.3 APPLICATION FOR PAYMENT

A. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment for each schedule and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized officer of Contractor.

B. Use detailed Application for Payment Form suitable to the Contracting Officer.

C. Provide separate form for each schedule as applicable.

D. Include accepted Schedule of Values for each schedule or portion of Work, the unit price breakdown for the Work to be paid on unit price basis, a listing of Owner selected equipment, if applicable, and allowances, as appropriate.

E. Preparation:

1. Round values to nearest dollar.
2. List each Change Order executed prior to date of submission as separate line item. Totals to equal those shown on the Transmittal Summary Form for each schedule as applicable.
3. Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form(s) for each schedule as applicable, a listing of materials on hand for each schedule as applicable, and such supporting data as may be requested by The Contracting Officer.

1.4 MEASUREMENT—GENERAL

A. Weighing, measuring, and metering devices used to measure quantity of materials for Work shall be suitable for purpose intended and conform to tolerances and specifications as specified in National Institute of Standards and Technology, Handbook 44.

B. Whenever pay quantities of material are determined by weight, material shall be weighed on scales furnished by Contractor and certified accurate by state agency responsible. Weight or load slip shall be obtained from weigher and delivered to Owner's representative at point of delivery of material.

C. Vehicles used to haul material being paid for by weight shall be weighed empty daily and at such additional times as required by the Contracting Officer. Each vehicle shall bear a plainly legible identification mark.

D. Materials that are specified for measurement by the cubic yard measured in the vehicle shall be hauled in vehicles of such type and size that actual contents may be readily and accurately determined. Unless all vehicles are of uniform capacity, each vehicle must bear a plainly legible identification mark indicating its water level capacity. Vehicles shall be loaded to at least their water level capacity. Loads hauled in vehicles not meeting above requirements or loads of a quantity less than the capacity of the vehicle, measured after being leveled off as above provided, will be subject to rejection, and no compensation will be allowed for such material.

E. Units of measure shown on Bid Form shall be as follows, unless specified otherwise.

Item	Method of Measurement
AC	Acre—Field Measure by the Contracting Officer
CY	Cubic Yard—Field Measure by the Contracting Officer within limits specified or shown
CY-VM	Cubic Yard—Measured in Vehicle by Volume
EA	Each—Field Count by the Contracting Officer
GAL	Gallon—Field Measure by the Contracting Officer
HR	Hour
LB	Pound(s)—Weight Measure by Scale
LF	Linear Foot—Field Measure by the Contracting Officer
SF	Square Foot
SY	Square Yard
TON	Ton—Weight Measure by Scale (2,000 pounds)

F. Measurement of Items:

Item	Unit	Description
Mobilization and demobilization	LS	Includes mobilization and demobilization of personnel and equipment to the site, project management tasks (e g., invoices, schedule), and submittals.
Erosion control	LS	Includes support fence and filter fabric installation, maintenance, and removal.
Site preparation	LS	Includes installing a removing site security measures, clearing, grubbing, and stripping.
Staging area construction	LS	Includes placement of bottom and top liners, construction of storm water diversion berms, and disposal of liners at the completion of the RA
Excavation	CY	Includes excavation of soil and debris and placement in staging areas
Backfill	CY	Includes transportation of clean soil from offsite, backfill, and compaction.
Loading	CY	Includes the loading of characterized soil form the staging areas to trucks for offsite disposal
Non-hazardous soil transportation and disposal	TN	Includes transportation and disposal of non-hazardous soil
Hazardous soil transportation and disposal	TN	Includes transportation and disposal of hazardous soil
Water management	GAL	Management of storm water pumped from excavations or soil staging areas.
Decontamination	LS	Decontamination of heavy equipment.
Site restoration	LS	Includes seeding and fertilizing and confirming the adequate growth of as determined by the Contracting Officer.

8891119

1.5 PAYMENT

A. General:

1. Progress payments will be made monthly.
2. The date for Contractor's submission of monthly Application for Payment shall be established at the Preconstruction Conference.

B. Payment for all the Work shown or specified in Contract Documents is included in the Lump Sum or Unit Price Contract Price as described in the Bid Form and as described herein.

1.6 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

A. Payment will not be made for following:

1. Loading, hauling, and disposing of rejected material.
2. Quantities of material wasted or disposed of in manner not called for under Contract Documents.
3. Rejected loads of material, including material rejected after it has been placed by reason of failure of Contractor to conform to provisions of Contract Documents.
4. Material not unloaded from transporting vehicle.
5. Defective Work not accepted by Owner.
6. Material remaining on hand after completion of Work.

1.7 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Partial Payment: No partial payments will be made for materials and equipment delivered or stored unless Shop Drawings or preliminary operation and maintenance manuals are acceptable to the Contracting Officer.

B. Final Payment: Will be made only for products incorporated in Work; remaining products, for which partial payments have been made, shall revert to Contractor unless otherwise agreed, and partial payments made for those items will be deducted from final payment.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01040
COORDINATION

PART 1 GENERAL

1.1 UTILITY NOTIFICATION AND COORDINATION

A. Coordinate the Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during Work.

1. Electricity Company: MLGW
   a. Telephone: (901) 544-MLGW (6549)
2. Water Department: MLGW
   a. Telephone: (901) 544-MLGW (6549)
3. Public Works: City of Memphis
   a. Contact Person: Jerry Collins, Director
   b. Telephone: (901) 576-6742

1.2 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

1. After Effective Date of the Agreement and before Work at Site is started, Contractor, the Contracting Officer, and affected property owners and utility owners shall make a thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which could be damaged by construction operations.

1.3 REFERENCE POINTS AND SURVEYS

A. Contractor's Responsibilities:

1. Provide additional survey and layout required to layout the Work.
2. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
3. In event of discrepancy in data or staking provided by Owner, request clarification before proceeding with Work.
4. Maintain complete accurate log of survey Work as it progresses as a Record Document.
5. On request of the Contracting Officer, submit documentation.
6. Provide competent employee(s), tools, stakes, and other equipment and materials as the Contracting Officer may require to:
   a. Establish control points, lines, and easement boundaries.]

b. Check layout, survey, and measurement Work performed by others.
c. Measure quantities for payment purposes.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01300
SUBMITTALS

PART 1 GENERAL

1.1 DEFINITIONS

A. Action Submittal: Written and graphic information submitted by Contractor that requires the Contracting Officer's approval.

B. Informational Submittal: Information submitted by Contractor that does not require the Contracting Officer's approval.

1.2 PROCEDURES

A. Direct submittals to the Contracting Officer

B. Transmittal of Submittal:

1. Contractor shall: Review each submittal and check for compliance with Contract Documents.
2. Complete, sign, and transmit with each submittal package, one Transmittal of Contractor's Submittal form in format approved by the Contracting Officer.
3. Identify each submittal with the following:
    a. Numbering and Tracking System:
        1) Sequentially number each submittal.
        2) Resubmission of submittal shall have original number with sequential alphabetic suffix.
    b. Specification section and paragraph to which submittal applies.
    c. Project title and the Contracting Officer's project number.
    d. Date of transmittal.
    e. Names of Contractor, Subcontractor or Supplier, and manufacturer as appropriate.
4. Identify and describe each deviation or variation from Contract Documents.

C. Format:

1. Do not base Shop Drawings on reproductions of Contract Documents.
2. Package submittal information by individual Specification section. Do not combine different Specification sections together in submittal package, unless otherwise directed in Specification.
3. Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Contract Documents.

4. Index with labeled tab dividers in orderly manner.

D. Timeliness: Schedule and submit in accordance Schedule of Submittals, and requirements of individual Specification sections.

E. Processing Time:

1. Time for review shall commence on the Contracting Officer's receipt of submittal.
2. Contracting Officer will act upon Contractor's submittal and transmit response to Contractor not later than 30 days after receipt, unless otherwise specified.
3. Resubmittals will be subject to same review time.
4. No adjustment of Contract Times or Price will be allowed due to delays in progress of Work caused by rejection and subsequent resubmittals.

F. Resubmittals: clearly identify each correction or change made.

G. Incomplete Submittals:

1. Contracting Officer will return entire submittal for Contractor's revision if preliminary review deems it incomplete.
2. When any of the following are missing, submittal will be deemed incomplete:
   a. Transmittal of Contractor's Submittal, completed and signed.
   b. Insufficient number of copies.

H. Submittals not required by Contract Documents:

1. Will not be reviewed.
2. Contracting Officer will keep one copy and return all remaining copies to Contractor.

1.3 ACTION SUBMITTALS

A. Prepare and submit Action Submittals required by individual Specification sections.

B. Shop Drawings:

1. Copies: Six.
2. Identify and Indicate:
   a. Applicable Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.

b. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
c. Project-specific information drawn accurately to scale.
3. Manufacturer's standard schematic drawings and diagrams as follows:
a. Modify to delete information that is not applicable to the Work.
b. Supplement standard information to provide information specifically applicable to the Work.
4. Product Data: Provide as specified in individual Specifications.

C. Samples:

1. Copies: Two, unless otherwise specified in individual Specifications.
2. Preparation: Mount, display, or package Samples in manner specified to facilitate review of quality. Attach label on unexposed side that includes the following:
a. Manufacturer name.
b. Model number.
c. Material.
d. Sample source.
3. Full size Samples:
a. Size as indicated in individual Specification section.
b. Prepared from same materials to be used for the Work.
c. Physically identical with product proposed for use.

D. Action Submittal Dispositions: Contracting Officer will review, mark, and stamp as appropriate, and distribute marked-up copies as noted:

1. Approved:
a. Contractor may incorporate product(s) or implement Work covered by submittal.
b. Distribution:
1) One copy furnished Resident Project Representative.
2) One copy retained in the Contracting Officer's file.
3) Remaining copies returned to Contractor appropriately annotated.
2. Approved as Noted:
a. Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with the Contracting Officer's notations.
b. Distribution:
1) One copy furnished Resident Project Representative.
2) One copy retained in the Contracting Officer's file.
3) Remaining copies returned to Contractor appropriately annotated.

3. Partial Approval, Resubmit as Noted:
    a. Make corrections or obtain missing portions, and resubmit.
    b. Except for portions indicated, Contractor may begin to incorporate product(s) or implement Work covered by submittal, in accordance with the Contracting Officer's notations.
    c. Distribution:
        1) One copy furnished Resident Project Representative.
        2) One copy retained in the Contracting Officer's file.
        3) Remaining copies returned to Contractor appropriately annotated.
4. Revise and Resubmit:
    a. Contractor may not incorporate product(s) or implement Work covered by submittal.
    b. Distribution:
        1) One copy furnished Resident Project Representative.
        2) One copy retained in the Contracting Officer's file.
        3) Remaining copies returned to Contractor appropriately annotated.

1.4 INFORMATIONAL SUBMITTALS

A. General:

1. Copies: Submit three copies, unless otherwise indicated in individual Specification section.
2. Refer to individual Specification sections for specific submittal requirements.
3. Contracting Officer will review each submittal. If submittal meets conditions of the Contract, the Contracting Officer will forward copies to appropriate parties. If the Contracting Officer determines submittal does not meet conditions of the Contract and is therefore considered unacceptable, the Contracting Officer will retain one copy and return remaining copies with review comments to Contractor, and require that submittal be corrected and resubmitted.

B. Application for Payment: In accordance with Section 01025, Measurement and Payment.

C. Certificates:

1. General:
    a. Provide notarized statement that includes signature of entity responsible for preparing certification.
    b. Signed by officer or other individual authorized to sign documents on behalf of that entity.

2. Installer: Prepare written statements on manufacturer's letterhead certifying that installer complies with requirements as specified in individual Specification sections.
3. Material Test: Prepared by qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
4. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in individual Specification sections.

D. Schedules:

1. Schedule of Submittals: Prepare separately or in combination with Progress Schedule as specified in Section 01310, Progress Schedules.
    a. Show for each, at a minimum, the following:
        1) Specification section number.
        2) Identification by numbering and tracking system as specified under Paragraph Transmittal of Submittal.
        3) Estimated date of submission to the Contracting Officer, including reviewing and processing time.
    b. On a monthly basis, submit updated schedule to the Contracting Officer if changes have occurred or resubmittals are required.

2. Schedule of Values: In accordance with Section 01025, Measurement and Payment.

3. Progress Schedules: In accordance with Section 01310, Progress Schedules.

E. Special Guarantee: Supplier's written guarantee as required in individual Specification sections.

F. Statement of Qualification: Evidence of qualification, certification, or registration as required in Contract Documents to verify qualifications of professional land surveyor, engineer, materials testing laboratory, specialty Subcontractor, trade, Specialist, consultant, installer, and other professionals.

G. Submittals Required by Laws, Regulations, and Governing Agencies:

1. Submit promptly notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
2. Transmit to the Contracting Officer for Owner's records one copy of correspondence and transmittals (to include enclosures and attachments) between Contractor and governing agency.

H. Test and Inspection Reports:

1. General: Shall contain signature of person responsible for test or report.
2. Factory:
   a. Identification of product and Specification section, type of inspection or test with referenced standard or code.
   b. Date of test, Project title and number, and name and signature of authorized person.
   c. Test results.
   d. If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
   e. Provide interpretation of test results, when requested by the Contracting Officer.
   f. Other items as identified in individual Specification sections.
3. Field: As a minimum, include the following:
   a. Project title and number.
   b. Date and time.
   c. Record of temperature and weather conditions.
   d. Identification of product and Specification section.
   e. Type and location of test, Sample, or inspection, including referenced standard or code.
   f. Date issued, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
   g. If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
   h. Provide interpretation of test results, when requested by the Contracting Officer.
   i. Other items as identified in individual Specification sections.

1.5 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION", are part of this Specification.

1. Forms: Transmittal of Contractor's Submittal

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

TRANSMITTAL OF CONTRACTOR'S SUBMITTAL
(ATTACH TO EACH SUBMITTAL)

Date:	
To:	Submittal No.:
	New Submittal
	Resubmittal
From:	Project No.:
	Specification Section No.: **(Cover only one section with each Transmittal)**
	Schedule Date of Submittal:

SUBMITTAL TYPE: Shop Drawing Sample Informational

THE FOLLOWING ITEMS ARE HEREBY SUBMITTED:

Number of Copies	Description of Item Submitted (Type, Size, Model Number, Etc.)	Spec. and Para. No.	Drawing or Brochure Number	Contains Variation to Contract	
				No	Yes

Contractor hereby certifies that (i) Contractor has complied with the requirements of Contract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Contract Documents and requirements of laws and regulations and governing agencies.

By:______________________ __________

Contractor (Authorized Signature)

SECTION 01310
PROGRESS SCHEDULES

PART 1 GENERAL

1.1 SUBMITTALS

A. Informational Submittals:

1. Preliminary Progress Schedule: Submit at least 7 days prior to preconstruction conference.

1.2 PRELIMINARY PROGRESS SCHEDULE

A. In addition to basic requirements outlined in General Conditions, show a detailed schedule, beginning with Notice to Proceed through Final Completion.

B. Show activities including, but not limited to the following:

1. Notice to Proceed.
2. Permits.
3. Initial Site work.
4. Earthwork.
5. Specified Work sequences and construction constraints.
6. Contract Milestone and Completion Dates.
7. Owner-furnished products delivery dates or ranges of dates.
8. Project close-out summary.
9. Demobilization summary.

C. Format: In accordance with Article Progress Schedule—Bar Chart.

1.3 PROGRESS SCHEDULE—BAR CHART

A. General: Comprehensive bar chart schedule, generally as outlined in Associated General Contractors of America (AGC) Publication No. 1107.1, "Construction Planning and Scheduling, latest edition.

1.4 SCHEDULE ACCEPTANCE

A. Contracting Officer's acceptance will demonstrate agreement that:

1. Proposed schedule is accepted with respect to:

a. Contract Times, including Final Completion and all intermediate Milestones are within the specified times.

b. Specified Work sequences and constraints are shown as specified.

2. In all other respects, the Contracting Officer's acceptance of Contractor's schedule indicates that, in the Contracting Officer's judgement, schedule represents reasonable plan for constructing Project in accordance with the Contract Documents. Contracting Officer's review will not make any change in Contract requirements. Lack of comment on any aspect of schedule that is not in accordance with the Contract Documents will not thereby indicate acceptance of that change, unless Contractor has explicitly called the nonconformance to the Contracting Officer's attention in submittal. Schedule remains Contractor's responsibility and Contractor retains responsibility for performing all activities, for activity durations, and for activity sequences required to construct Project in accordance with the Contract Documents.

B. Unacceptable Preliminary Progress Schedule:

1. Make requested corrections; resubmit within 10 days.
2. Until acceptable to the Contracting Officer as Baseline Progress Schedule, continue review and revision process, during which time Contractor shall update schedule on a monthly basis to reflect actual progress and occurrences to date.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01500
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Federal Emergency Management Agency.
2. U.S. Department of Agriculture, "Urban Hydrology for Small Watersheds".
3. U.S. Weather Bureau, "Rainfall-frequency Atlas of the U.S. for Durations From 30 Minutes to 24 Hours and Return Periods From 1 to 100 Years".

1.2 SUBMITTALS

A. Informational Submittals:

1. Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.

2. Temporary Construction Submittals:
   a. Contractor's field office, storage yard, and storage building plans, including gravel surfaced area.
   b. Fencing and protective barrier locations and details.
   c. Staging area location plan.

3. Temporary Control Submittals:
   b. Plan for disposal of waste materials and intended haul routes.

1.3 MOBILIZATION

A. Mobilization shall include, but not be limited to, these principal items:

1. Obtaining required permits.
2. Moving Contractor's field office and equipment onto Site.
3. Providing onsite communication facilities, including telephones.
4. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
5. Arranging for and erection of Contractor's work and storage yard.
6. Posting OSHA required notices and establishing safety programs and procedures.
7. Having Contractor's superintendent at Site full time.

1.4 PROTECTION OF WORK AND PROPERTY

A. Comply with Owner's safety rules while on Owner's property.
B. Keep Owner informed of serious onsite accidents and related claims.
C. Use of Explosives: No blasting or use of explosives will be allowed onsite.

PART 2 PRODUCTS

2.1 CONTRACTING OFFICER'S FIELD OFFICES

A. Furnish equipment specified for exclusive use of the Contracting Officer and its representatives.
B. Ownership of equipment furnished under this article will remain, unless otherwise specified, that of Contractor.
C. Equipment furnished shall be new or like new in appearance and function.

PART 3 EXECUTION

3.1 TEMPORARY UTILITIES

A. Power:

1. No electric power is available at Site.

B. Water:

1. No construction or potable water is available at Site. Make arrangements for and bear costs of providing water required for construction purposes and for drinking by construction personnel during construction.

2. Hydrant Water:
a. Is available from nearby hydrants. Secure written permission for connection and use from water department and meet requirements for use. Notify fire department before obtaining water from fire hydrants.
b. Use only special hydrant-operating wrenches to open hydrants. Make certain hydrant valve is open full, since cracking valve causes damage to hydrant. Repair damaged hydrants and notify appropriate agency as quickly as possible. Hydrants shall be completely accessible to fire department at all times.]
c. Include costs to connect and transport water to construction areas in Contract Price.

C. Sanitary and Personnel Facilities:
1. Provide and maintain facilities for Contractor's employees, Subcontractors, and all other onsite employers' employees. Service, clean, and maintain facilities and enclosures.

D. Telephone Service:

1. Contractor: Arrange and provide onsite telephone service for use during construction.

3.2 PROTECTION OF WORK AND PROPERTY

A. General:

1. Perform Work within right-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.
2. No residence or business shall be cut off from vehicular traffic.
3. Maintain in continuous service all existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and all other utilities encountered along line of the Work, unless other arrangements satisfactory to owners of said utilities have been made.
4. Where completion of the Work requires temporary or permanent removal or relocation of existing utility, coordinate all activities with owner of said utility and perform all work to their satisfaction.
5. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
6. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
7. In areas where Contractor's operations are adjacent to or near a utility (such as gas, telephone, television, electric power, water, sewer, or irrigation system) and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by Contractor.
8. Notify property owners and utility offices that may be affected by construction operation at least 2 days in advance.
   a. Before exposing a utility, obtain utility owner's permission. Should service of utility be interrupted due to Contractor's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.

9. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.
10. Maintain original Site drainage wherever possible.

B. Site Security:

2. Provide and maintain additional temporary security fences as necessary to protect the Work and Contractor-furnished products not yet installed.

C. Barricades and Lights:

1. Provide as necessary to prevent unauthorized entry to construction areas and affected roads, streets, and alleyways, inside and outside of fenced area, and as required to ensure public safety and the safety of Contractor's employees, other employer's employees, and others who may be affected by the Work.
2. Provide to protect existing facilities and adjacent properties from potential damage.
3. Locate to enable access by facility operators and property owners.
4. Protect streets, roads, highways, and other public thoroughfares that are closed to traffic by effective barricades with acceptable warning signs.

D. Signs and Equipment:

1. Conform to requirements of manual published by the Tennessee DOT.
2. Traffic Cones: Provide to delineate traffic lanes to guide and separate traffic movements.
3. Provide at obstructions, such as material piles and equipment.
4. Use to alert general public of construction hazards, which would include surface irregularities, unramped walkways, grade changes, and trenches or excavations in roadways and in other public access areas.

E. Waterways:

1. Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.

F. Dewatering: Construct, maintain, and operate cofferdams, channels, flume drains, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain, and operate necessary pumping and other equipment for the environmentally safe removal and disposal of water from the various parts of the Work. Maintain foundations and parts of the Work free from water.

G. Archaeological Finds:

1. General: Should finds of an archaeological or paleontological nature be made within the limits of the Site, immediately notify Owner and the Contracting Officer and proceed in accordance with the General Conditions. Continue the Work in other areas without interruption.

H. Endangered Species:

1. Take precautions necessary and prudent to protect native endangered flora and fauna.
2. Notify the Contracting Officer of construction activities that might threaten endangered species or their habitats.
3. Contracting Officer will mark areas known as habitats of endangered species prior to commencement of onsite activities.
4. Additional areas will be marked by the Contracting Officer as other habitats of endangered species become known during construction.

3.4 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations.
2. Burning:
   a. Of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.
3. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.
4. Provide and maintain temporary dust-tight partitions, bulkheads, or other protective devices during construction to permit normal operation of existing facilities. Construct partitions of plywood, insulating board, plastic sheets, or similar material. Construct partitions in such a manner that dust and dirt from demolition and cutting will not enter other parts of existing building or facilities. Remove temporary partitions as soon as need no longer exists.

C. Water Pollution Control:

1. Divert sanitary sewage and non-storm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to existing waterway.
2. Prior to commencing excavation and construction, obtain the Contracting Officer's agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and stormwater flow, including dewatering pump discharges.
3. Comply with procedures outlined in U.S. Environmental Protection Agency manuals entitled, "Guidelines for Erosion and Sedimentation Control Planning" and "Implementation, Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activity," and "Erosion and Sediment Control-Surface Mining in Eastern United States."
4. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.

D. Erosion, Sediment, and Flood Control:

1. Provide, maintain, and operate temporary facilities to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.
2. Design erosion and sediment controls to handle peak runoff resulting from 25-year, 24-hour storm event based on U.S. Weather Bureau, "Rainfall-Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years," Technical Paper No. 40, 1981.
3. Size temporary stormwater conveyances based on procedures presented in U.S. Department of Agriculture, "Urban Hydrology for Small Watersheds," Soil Conservation Service Engineering Technical Release No. 55, 1986.

3.5 STORAGE YARDS AND BUILDINGS

A. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions.

3.6 VEHICULAR TRAFFIC

A. Comply with Laws and Regulations regarding closing or restricting use of public streets or highways. No public or private road shall be closed, except by written permission of proper authority. Assure the least possible obstruction to traffic and normal commercial pursuits.

B. Conduct the Work to interfere as little as possible with public travel, whether vehicular or pedestrian.

C. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks(whether public or private), provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.

D. When flaggers and guards are required by regulation or when deemed necessary for safety, furnish them with approved orange wearing apparel and other regulation traffic control devices.

3.7 CLEANING DURING CONSTRUCTION

A. In accordance with General Conditions, as may be specified in other Specification sections, and as required herein.

B. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least at weekly intervals, dispose of such waste materials, debris, and rubbish offsite.

C. At least weekly, brush sweep entry drive and roadways, and all other streets and walkways affected by the Work and where adjacent to the Work.

END OF SECTION

SECTION 01780
CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 SUBMITTALS

A. Informational Submittals:

1. Submit prior to application for final payment.
   a. Record Documents: As required in General Conditions.
   b. Consent of Surety to Final Payment: As required in General Conditions.
   c. Releases or Waivers of Liens and Claims: As required in General Conditions.
   d. Releases from Agreements.
   e. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01025, Measurement and Payment.

1.2 RECORD DOCUMENTS

A. Quality Assurance:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
2. Accuracy of Records:
   a. Coordinate changes within record documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
   b. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.
3. Make entries within 24 hours after receipt of information that a change in the Work has occurred.
4. Prior to submitting each request for progress payment, request the Contracting Officer's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral by the Contracting Officer to recommend whole or any part of Contractor's Application for Payment, either partial or final.

1.3 RELEASES FROM AGREEMENTS

A. Furnish Owner written releases from property owners or public agencies where side agreements or special easements have been made, or where Contractor's operations have not been kept within the Owner's construction right-of-way.

B. In the event Contractor is unable to secure written releases:

1. Inform Owner of the reasons.
2. Owner or its representatives will examine the Site, and Owner will direct Contractor to complete the Work that may be necessary to satisfy terms of the side agreement or special easement.
3. Should Contractor refuse to perform this Work, Owner reserves right to have it done by separate contract and deduct cost of same from Contract Price, or require Contractor to furnish a satisfactory bond in a sum to cover legal Claims for damages.
4. When Owner is satisfied that the Work has been completed in agreement
   with Contract Documents and terms of side agreement or special easement, right is reserved to waive requirement for written release if: (i) Contractor's failure to obtain such statement is due to grantor's refusal to sign, and this refusal is not based upon any legitimate Claims that Contractor has failed to fulfill terms of side agreement or special easement, or (ii) Contractor is unable to contact or has had undue hardship in contacting grantor.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 MAINTENANCE OF RECORD DOCUMENTS

A. General:

1. Promptly following commencement of Contract Times, secure from the Contracting Officer at no cost to Contractor, one complete set of Contract Documents. Drawings will be full size.
2. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large printed letters.
3. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.

B. Preservation:

1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
2. Make documents and Samples available at all times for observation by the Contracting Officer.

C. Making Entries on Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
   a. Color Coding:
      1) Green when showing information deleted from Drawings.
      2) Red when showing information added to Drawings.
      3) Blue and circled in blue to show notes.
2. Date entries.
3. Call attention to entry by "cloud" drawn around area or areas affected.
4. Legibly mark to record actual changes made during construction, including, but not limited to:
   a. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
   b. Changes made by Addenda and Field Orders, Work Change Directive, Change Order, and the Contracting Officer's written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
5. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
   a. Clearly identify the item by accurate note such as "cast iron drain," "galv. water," and the like.
   b Show, by symbol or note, vertical location of item ("under slab," "in ceiling plenum," "exposed," and the like).
   c. Make identification so descriptive that it may be related reliably to Specifications.

3.2 FINAL CLEANING

A. At completion of the Work or of a part thereof and immediately prior to Contractor's request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to Contractor's notice of completion, clean entire Site or parts thereof, as applicable.

1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Owner and the Contracting Officer.

B. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

END OF SECTION

SECTION 02200
SITE PREPARATION

PART 1 GENERAL

1.1 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2 inches caliper to a depth of 6 inches below subgrade.

D. Scalping: Removal of sod without removing more than upper 3 inches of topsoil.

E. Stripping: Removal of topsoil remaining after applicable scalping is completed.

F. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.2 SCHEDULING AND SEQUENCING

A. Prepare site only after adequate erosion and sediment controls are in place.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

A. Clear, grub, and strip areas actually needed for waste disposal, borrow, or site improvements within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

3.2 LIMITS

A. As follows, but not to extend beyond Project limits. Excavation: 5 feet beyond top of cut slopes.

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.3 CLEARING

A. Clear areas within limits shown or specified.

3.4 GRUBBING

A. Grub areas within limits shown or specified.

3.5 SCALPING

A. Scalp areas within limits shown or specified.

3.6 STRIPPING

A. Do not remove topsoil until after scalping is completed.

B. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.

3.7 DISPOSAL

A. Clearing and Grubbing Debris:

1. Dispose of debris offsite.
2. Burning of debris onsite will not be allowed.
3. Limit offsite disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.

B. Scalpings: As specified for clearing and grubbing debris.

C. Strippings:

1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil offsite.
2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION

SECTION 02240
DEWATERING

PART 1 GENERAL

1.1 SUBMITTALS

A. Information Submittals:

1. Water storage container.
2. Water disposal location.
3. Discharge permits.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

A. Remove and control water during periods when necessary to properly accomplish Work.

3.2 SURFACE WATER CONTROL

A. See Section 01500, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS, Article TEMPORARY CONTROLS.

B. Remove surface runoff controls when no longer needed.

3.3 DEWATERING SYSTEMS

A. Maintain excavations free of water, regardless of source, and until backfill and compacted.

B. Contain water collected from the excavation(s) in a Contracting Officer - approved storage tank until authorized for disposal.

C. Dispose of the water collected form the excavation(s) at a Contracting Officer -approved location.

3.4 MONITORING FLOWS

A. Monitor volume of water pumped per calendar day from excavations, as Work progresses.

END OF SECTION

SECTION 02315
EXCAVATION

PART 1 GENERAL

1.1 DEFINITIONS

A. Common Excavation: Removal of material not classified as rock excavation.

1.2 SUBMITTALS

A. Informational Submittals:

1. Excavation Plan, detailing:

   a. Methods and sequencing of excavation.
   b. Proposed locations of stockpiled excavated material.
   c. Proposed onsite and offsite spoil disposal sites.
   d. Numbers, types, and sizes of equipment proposed to perform excavations.

1.3 DESCRIPTION OF WORK

The Work consists of the elements described in Section 01010, Summary of Work.

1.4 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized over-excavation.

1.5 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees Fahrenheit (°F) shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.6 SEQUENCING AND SCHEDULING

A. The Contractor shall verify the limits of excavation and contaminated soil requirements prior to the start of any excavations at each Disposal Site. Currently estimated limits of excavation are shown on the Drawings and shall be staked or otherwise marked by the Contractor prior to excavation.

The final excavation limits may change based upon the results of confirmation sampling.

B. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 02200, Site Preparation, prior to excavating.

C. Excavation Support: Install and maintain, as specified in Section 02260, Excavation Support and Protection, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

D. No excavations or other surface soil disturbances shall begin until all security, drainage, erosion, and sediment control devices, exclusion zones, and protective markings for utilities and other items to be protected are properly installed and approved by the Contracting Officer.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. The excavation shall be performed in a manner that will limit the potential for contaminated material to be mixed with uncontaminated materials. A log of materials and any visible signs of contamination encountered during excavation shall be maintained for each disposal site.

B. Do not over-excavate without written authorization of the Contracting Officer.

C. Remove or protect obstructions as shown and as specified in Section 01500, Construction Facilities and Temporary Controls, Article Protection of Work and Property.

3.2 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.3 DRAINAGE AND DEWATERING

A. All excavations will be above the water table. Drainage and dewatering will include control of surface water drainage and collection and disposal of precipitation that falls into the excavation.

B. Surface water shall be directed away from excavation areas in a manner that will prevent flooding and erosion. Diversion ditches, dikes, and grading shall be provided and maintained throughout excavation and backfill operations. Work shall be sequenced in a manner that each work site, areas adjacent to each work site, and affected operations shall be effectively drained.

C. The contractor shall maintain appropriate means to collect and remove standing water in the excavations during excavation, sampling, and backfill operations. Standing water may be allowed to remain in the excavations between period of excavation and backfill of approved by the Contracting Officer. All water from active excavations shall be collected and disposed of in accordance with Section 02316, TRANSPORTATION AND DISPOSAL OF CONTAMINATED MATERIALS.

3.4 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed. Segregate excavated material suitable for backfill from material proposed for offsite disposal.

B. Non-hazardous contaminated materials stockpiles shall be constructed to isolate the excavated material from the environment. Non-hazardous material stockpiles shall be constructed to include:

1. A chemical resistant geomembrane liner. Non-reinforced geomembrane liners shall have a minimum thickness of 20 mils. Scrim reinforced geomembranes shall have a minimum weight of 40 lbs per 1,000 square feet. The ground surface on which the geomembrane is to be placed shall be prepared in accordance with Section 02200, SITE PREPARATION.
2. Geomembrane cover to prevent precipitation from entering the stockpile. Non-reinforced geomembrane liners shall have a minimum thickness of 10 mils. Scrim reinforced geomembranes shall have a minimum weight of 26 lbs per 1,000 square feet. The cover material shall be anchored with sand bags or other measures approved by the Contracting Officer to prevent the cover from being removed by the wind.
3. Construct berms, minimum of 12 inches in height, around the stockpile using clean soil from onsite or offsite source to secure the cover and divert storm water runoff. Vehicle access points shall also be bermed.
4. The contractor shall maintain appropriate means to collect and remove standing water in the stockpiles during the Work. All water shall be collected and disposed op in accordance with Section 02316, TRANSPORTATION AND DISPOSAL OF CONTAMINATED MATERIALS.

C. Hazardous materials shall be stored in water-tight roll-off containers. An impermeable cover shall be placed over the units to prevent precipitation from contacting the stored material. The units shall be located on the project site at locations approved by the Contracting Officer.

D. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

E. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

F. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

END OF SECTION

SECTION 02317
BORROW EXCAVATION

PART 1 GENERAL

1.1 SUBMITTALS

A. Information Submittal: Borrow Pit Plan, detailing development, operation, and reclamation of each pit.

1.2 WEATHER LIMITATIONS

A. Except as approved by the Contracting Officer, do not operate borrow pits when borrow is too wet to achieve required compaction.

1.3 SEQUENCING AND SCHEDULING

A. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 02200, SITE PREPARATION, prior to borrow pit development.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 BORROW PIT OPERATION

A. Review Borrow Pit Plan with the Contracting Officer prior to excavating from borrow pits. Obtain the Contracting Officer's acceptance of deviations from Borrow Pit Plan prior to their implementation.

B. Do not excavate more borrow material than required for Work. Leave surplus material in place.

3.2 RECLAMATION

A. Grade borrow pits and replace topsoil, as specified in Section 02315, FILL AND BACKFILL, to drain without ponding surface water and to blend graded surfaces neatly with surrounding terrain at completion of borrow operations.

B. Final Slopes:

1. Maximum: Three horizontal to one vertical.
2. Minimum: 5 percent.

C. Do not use borrow pits for disposal, unless otherwise specified or shown.

END OF SECTION

SECTION 02370
SOIL STABILIZATION

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials International (ASTM):
    a. D4355, Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon Arc Type Apparatus).
    b. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

1.2 DEFINITIONS

A. Maintenance Period: Begin maintenance immediately after each area is planted and continue for a period of 8 weeks after all planting under this section is completed.

B. Satisfactory Stand: Grass or section of grass that has:

1. No bare spots larger than 3 square feet.
2. Not more than 10 percent of total area with bare spots larger than 1 square foot.
3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.3 SUBMITTALS

A. Shop Drawings: Product Data: Commercial products.

B. Information Submittals:

1. Construction Period Drainage and Erosion/Sedimentation Control Plan and Procedures.
2. Manufacturer's Installation Instructions: Commercial products.
3. Seed certifications.
4. Copies of delivery invoices or other proof of quantities of mulch and fertilizer.

1.4 DELIVERY, STORAGE, AND PROTECTION

A. Seed:

1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
2. Keep dry during storage.

B. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.5 SEQUENCING AND SCHEDULING

A. Contracting Officer's acceptance of Construction Period Erosion/Sedimentation Control Plan required prior to starting earth disturbing activities.

B. Prepare topsoil as specified in Section 02911, SOIL PREPARATION, before starting Work of this section.

C. Complete soil preparation, seeding, fertilizing, and mulching immediately after final grades have been reached.

D. Seeding: Perform under favorable weather conditions during seasons that are normal for such Work as determined by acceptable local practice.

PART 2 PRODUCTS

2.1 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.

B. Fertilizer shall have the following minimum percentage of plant food by weight:

1. Summer Hydroseed Mix:
   a. Nitrogen: 20 percent.
   b. Phosphoric Acid: 10 percent.
   c. Potash: 10 percent.

2. Winter Hydroseed Mix:
   a. Nitrogen: 16 percent.
   b. Phosphoric Acid: 8 percent.
   c. Potash: 0 percent.

2.2 SEED

A. Fresh, clean new-crop seed that complies with the tolerance for purity and germination established by Official Seed Analysts of North America.

2.3 MULCH

A. Wood Cellulose Fiber Mulch:

1. Specially processed wood fiber containing no growth or germination inhibiting factors.
2. Dyed a suitable color to facilitate inspection of material placement.
3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers will become uniformly suspended to form homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

B. Straw:

1. Clean salt hay or threshed straw of oats, wheat, barley, or rye, free from seed of noxious weeds. Suitable for spreading with mulch blower equipment.
2. Average Stalk Length: 6 inches.
3. Seasoned before baling or loading.

2.4 CLEARING LIMIT FENCE

A. Pervious Sheet: Polyester, polypropylene, or nylon filaments, woven into a uniform pattern, distinct and measurable openings.

1. Filaments: Resistant to damage from exposure to ultraviolet rays and heat.
2. Material Edges: Finish so filaments retain their relative positions under stress.

B. In accordance with requirements of Table 1:

TABLE 1
Filter Fence

Physical Property	Required Value	Test Method
Weight, oz/sq yd, min	4	ASTM D3776
Equivalent Opening Size, max.	50-70	U.S. Standard Sieve
Grab Tensile Strength, lb, min	160	ASTM D4632
Ultraviolet Radiation Resistance, % Strength Retention	70	ASTM D4355

2.5 SUPPORT FENCE

A. Wire Mesh Material: As recommended by manufacturer of geotextile; strong enough to support applied loads.

B. Support Posts: As recommended by manufacturer of geotextile.

C. Fasteners: Heavy-duty wire staples at least 1 inch long, tie wires, or hog rings, as recommended by manufacturer of geotextile.

2.6 STRAW BALES

A. Machine baled clean salt hay or straw of oats, wheat, barley, or rye, free from seed of noxious weeds, using standard baling wire or string.

2.7 POSTS FOR STRAW BALES

A. 2-inch by 2-inch untreated wood or commercially manufactured metal posts.

PART 3 EXECUTION

3.1 SOIL PREPARATION

A. Before start of hydroseeding, and after surface has been shaped and graded, and lightly compacted to uniform grade, scarify soil surface to minimum depth of 1 inch.

3.2 SEEDING

A. Prepare 1-inch deep seed bed; obtain the Contracting Officer's acceptance prior to proceeding.

B. Apply by seeding or hydroseeding method on moist soil, but only after free surface water has drained away. Prevent drift and displacement of mixture into other areas.

3.3 MULCHING

A. Apply uniformly on disturbed areas.

B. Application: Sufficiently loose to permit penetration of sunlight and air circulation, and sufficiently dense to shade ground, reduce evaporation rate, and prevent or materially reduce erosion of underlying soil.

1. Straw: Apply by hand or mechanical means to minimum depth of 2 inches.
2. Wood Cellulose Fiber: 1,000 to 1,500 pounds per acre.

3.4 CLEARING LIMIT FENCE

A. Install in accordance with manufacturer's standard instructions and before beginning clearing and grubbing operations.

3.5 SUPPORT FENCE AND GEOTEXTILE

A. Install prior to starting earth disturbing activities upslope of fence.

B. One-piece geotextile or continuously sewn to make one-piece geotextile for full height of the fence, including portion buried in the toe trench.

C. When joints are necessary, splice geotextile together only at a support post, with a minimum 6-inch overlap, and securely fasten both ends to support post.

D. Geotextile shall not extend more than 24 inches above the ground surface. Securely fasten to upslope side of each support post using ties. Geotextile shall not be stapled to existing trees.

E. Fasten wire mesh material support fence securely to upslope side of post fasteners. Extend wire into the trench a minimum of 4 inches, and not more than 36 inches above the ground surface.

F. Take precaution not to puncture geotextile during installation. Repair or replace damaged area.

G. Remove support fence for geotextile after upslope area has been permanently stabilized. Immediately dress sediment deposits remaining after the geotextile fence has been removed to conform to existing grade. Prepare and seed graded area.

3.6 SOIL STOCKPILES

A. Protect from erosion with 20 mil PVC liner.

3.7 STRAW BALES

A. Imbed minimum of 4 inches in flat-bottomed trench.

B. Place with ends tightly abutting or overlapped. Corner abutment is not acceptable.

C. Install so that bale bindings are oriented around the sides and not over the top and bottom of the bale.

D. Use two posts for each bale. Drive posts through the bale until top of post is flush with top of bale.

E. Wedge loose straws in any gaps between bales.

END OF SECTION

SECTION 02999
TRANSPORTATION AND DISPOSAL OF CONTAMINATED MATERIALS

PART 1 GENERAL

1.1 REFERENCES

A. The publications listed below form part of this specification to the extent referenced. The publications are referred to in the text by their basic designations only.

Code of Federal Regulations

40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 266	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities.
40 CFR 268	Land Disposal Restrictions
40 CFR 300	National Oil and Hazardous Substance Pollution Contingency Plan
40 CFR 302	Designation, Reportable Quantities, and Notification
49 CFR 107	Hazardous Materials Program Procedures
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communication, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings
49 CFR 178	Specifications for Packagings

1.2 Submittals

A. Prior to the start of Work, a Contaminated Materials Plan detailing the manner in which contaminated material shall be managed.

B. Information necessary to file state annual or EPA reports for all contaminated materials transported, treated, stored, or disposed of under this contract. The contractor shall forward these data to the Contracting Officer at the specified time. The submittal shall contain all of the information necessary for filing of the formal reports in the form and format required by the governing federal or state agency. A cover letter shall accompany the data to include the contract number, Contractor name, and project location.

B. In the event of a spill or release of a hazardous substance (as designated in 40 CFR 302), or pollutants or contaminants, or soil (as governed by the Oil Pollution Act [OPA], 33 USC 2701 et seq.), the Contractor shall notify the Contracting Officer immediately. If the spill exceeds a reporting threshold, the Contractor shall follow the pre-established procedures for immediate reporting to the Contracting Officer.

C. A letter certifying that EPA considers the facilities to be used for offsite disposal of hazardous waste to be acceptable in accordance with the Offsite policy in 40 CFR 300, Section 440. This certification shall be provided for wastes from RCRA sites as well as from CERCLA responses.

D. Letters or other documentation verifying that the proposed disposal and/or treatment sites for non-hazardous waste and/or liquid materials are compliant with current State and Federal regulations and that they are licenses to accept the wastes proposed for disposal. In addition, the verification documents hall state the limitations and requirements (e.g., waste characterization, analytical data, maximum concentrations, etc.(of the disposal facility to accept such wastes.

E. Certificates documenting the ultimate disposal of contaminated materials within 180 days of initial shipment. Receipt of these certificates will be required for final payment.

F. All transportation related shipping documents to the Contracting Officer, including draft waste manifests, draft bills of lading, lists of corresponding proposed labels, packages, marks, and placards to be used for shipment, and supporting waste analysis documents, for review a minimum of 2 days prior to anticipated pickup. Packaging assurances shall be furnished prior to transporting contaminated material; "generator copies" of waste manifests, bills of lading, and supporting waste analysis documents shall be furnished when shipments are originated.

G. Notices of non-compliance of notices of violation by a federal, state, local regulatory agency issued to the Contractor in relation to any Work performed under this contract. The Contractor shall immediately provide copies of such notices to the Contracting Officer. The Contractor shall also furnish all relevant documents regarding the incident and any information requested by the Contracting Officer.

1.3 QUALIFICATIONS

A. The Contractor shall designate, by position and title, one person to act as the Transportation and Disposal Coordinator (TDC) for this contract. The TDC shall serve as the single pint of contact for all environmental regulatory matters and shall have overall responsibility of total environmental compliance at the site including but not limited to accurate identification of hazardous and non-hazardous wastes; determination of proper shipping names; identification of marking, labeling, packaging, and placarding requirements; completion of waste profiles, waste manifests, bills of lading, exception and discrepancy reports; and all other environmental documentation.

1.4 LAWS AND REGULATIONS REQUIREMENTS

A. Work shall meet or exceed the minimum requirements established by Federal, state, and local laws and regulations that are applicable. These requirements are amended frequently and the Contractor shall be responsible for complying with amendments as they become effective. In the event that compliance exceeds the scope of work or conflicts with specific requirements of the contract, the Contractor shall notify the Contracting Officer immediately.

1.5 DEFINITIONS

A. Contaminated Materials - Soil, water, debris, etc. that have become contaminated, or that are suspected of being contaminated, by chemical constituents above regulatory limits.

B. Hazardous Waste - A waste which meets criteria established in RCRA or specified by the EPA in 40 CFR 261 or which has been designated as hazardous by a RCRA authorized state program.

C. Non-hazardous Waste - Waste, soil, water, or debris that do not meet the hazardous waste criteria specified above.

PART 2 PRODUCTS

2.1 MATERIALS

The contractor shall provide all of the materials required for the packaging, labeling, marking, placarding, and transportation of the contaminated materials in conformance with DOT standards. Details in this specification shall not be construed as establishing the limits of the Contractor's responsibility.

A. The Contractor shall provide bulk and/or non-bulk containers for packaging contaminated materials (contaminated soil, water, and/or debris). Containers for hazardous waste must be consistent with the authorizations referenced in the Hazardous Materials Table in 49 CFR 172, Section 101, column 8. Bulk and non-bulk packaging shall meet the corresponding specifications in 49 CFR 173 referenced in the Hazardous Materials Table, 40 CFR 172, Section 101. Each packaging shall conform to the general packaging requirements of Subpart B of 49 CFR 173, tot he requirements of 49 CFR 178 at the specified packaging group performance level, to the requirements of special provisions of column 7 of the Hazardous Materials Table in 49 CFR 172, Section 101, and shall be compatible with the material to be packaged as required by 40 CFR 262.

B. The Contractor shall provide, as appropriate, markings for each contaminated soil, water, or debris package, freight container, and transport vehicle consistent with the requirements of 49 CFR 172, Subpart D and 40 CFR 262, Section 32 (for hazardous waste).

C. The Contractor shall provide primary and subsidiary labels for contaminated materials consistent with the requirements in the Hazardous Materials Table in 49 CFR 172, Section 101, column 6. Labels shall meet design specifications required by 49 CFR 172, Subpart E including size, shape, color, printing, and symbol requirements.

D. For each offsite shipment of contaminated materials, the Contractor shall provide, as necessary, primary and subsidiary placards consistent with the requirements of 49 CFR 172, Subpart F. Placards hall be provided for each side and each end of bulk packaging, freight container, and transport vehicles requiring such placarding.

2.2 EQUIPMENT AND TOOLS

The Contractor shall provide miscellaneous equipment and tools necessary to handle contaminated materials, including hazardous waste, in a safe and environmentally sound manner.

PART 3 EXECUTION

3.1 OFFSITE HAZARDOUS AND NON-HAZARDOUS WASTE MANAGEMENT

The Contractor shall be responsible for arranging transportation to and disposal of all contaminated materials at an appropriate treatment, disposal, or storage (TSD) facility licensed to accept the materials. The Work shall include all sampling and analysis necessary to determine the disposal requirements and for acceptance of the waste as the TSD facility.

A. The Contractor shall provide the Contracting Officer with EPA ID numbers, names, locations, and telephone numbers of proposed TSD facilities and transporters. Letters of acceptance of the waste by the proposed TSD facility shall be provided, including limitations on acceptance and analytical/testing requirements for waste acceptance. This information shall be contained in the Waste Management Plan for approval prior to waste disposal.

1. Hazardous wastes shall be disposed of in RCRA Subtitle C permitted facilities which meet the requirements of 40 CFR 264 ort facilities operating under interim status and meeting the requirements of 40 CFR 265. Offsite TSD facilities with significant RCRA vi9loations or compliance problems shall not be used.
2. Facilities receiving hazardous waste must be permitted in accordance with 40 CFR 270, must be operating under interim status in accordance with 40 CFR 265 requirements, or must be permitted by an authorized state program. Prior to using the TSD facility, the Contractor shall determine the status of the facility and document all information necessary to satisfy the requirements of the EPA Offsite policy and furnish this information to the Contracting Officer.
3. Non-hazardous waste materials shall be disposed of at a non-hazardous TSD facility currently licensed to accept the type(s) of waste being disposed. The Contractor shall obtain waste verification requirements and acceptance criteria for the facility in writing.

B. Prior to shipment of any hazardous material offsite, the Contractor's TDC shall provide written certification to the Contracting Officer that the contaminated materials have been properly packaged, labeled, and marked in accordance with the applicable DOT and EPA requirements.

C. The Contractor shall use manifests for transporting wastes as required by 40 CFR 263 or any applicable state or local law or regulation. Transportation shall comply with all requirements in the DOT referenced regulations in the 49 CFR series. Manifests shall be completed using instructions in 40 CFR 262, Subpart B and nay applicable state or local law or regulation. Manifests and waste profiles shall be submitted to the Contracting Officer for review and approval. In addition, the Contractor shall prepare LDR notifications as required by 40 CFR 268 or any applicable state or local law or regulation for each shipment of hazardous waste. Notifications shall be submitted with the manifest to the Contracting Officer for review and approval.

D. The waste shall be transported to an approved TSD facility within 90 days of the accumulation start date on each container. The Contractor shall ship hazardous wastes only to facilities which are properly permitted to accept waste.

3.2 HAZARDOUS MATERIAL MANAGEMENT

A. The Contractor, in consultation with the Contracting Officer, shall evaluate prior to shipment of any material offsite whether or not the material is regulated as a hazardous waste. This shall be done for the purpose of determining proper shipping descriptions, marking requirements, etc., as described.

1. The Contractor shall use 49 CFR 172, Section 101 to identify proper shipping names for each hazardous material (including hazardous wastes) to be shipped offsite.
2. The Contractor shall package, label, and mark hazardous materials/wastes using the specified materials and in accordance with the referenced authorizations.
3. The Contractor shall ensure that each shipment of hazardous materials sent offsite is accompanied by the properly completed shipping documents.

3.3 WASTE MINIMIZATION

The Contractor shall minimize the generation of hazardous waste to the maximum extent practicable. The Contractor shall take all necessary precautions to avoid mixing clean and contaminated wastes.

3.4 RECORD KEEPING

The Contractor shall be responsible for maintaining adequate records to support information provided to the Contracting Officer regarding exception reports, annual reports, and biennial reports.

3.5 SPILL RESPONSE

The Contractor shall be responsible to any spill of contaminated materials (including hazardous materials, non-hazardous materials) which are in the custody or care of the Contractor pursuant to this contract. Any direction form the Contracting Officer concerning a spill or release shall not be considered a change under the contract. The Contractor shall comply with all applicable requirements of Federal, state, or local laws of regulations regarding and spill incident.

3.6 EMERGENCY CONTACTS

The Contractor shall be responsible for complying with the emergency contact provision in 49 CFR 172, Section 604. Whenever the Contractor ships hazardous materials, the Contractor shall provide a 24-hour emergency response contact and phone number of a person knowledgeable about the contaminated materials being shipped and who has the comprehensive emergency response and incident mitigation information for that materials, or has immediate access to a person who possesses such knowledge and information. The phone must be monitored on a 24-hour basis at all times when the hazardous materials are in transportation including during storage incidental to transportation. The Contractor shall ensure that information regarding this emergency contact and phone numbers are placed on all contaminated materials shipping documents. The Contractor shall designate an emergency coordinator and post the following information at all areas in which contaminated materials are managed:

A. The name of the emergency coordinator.

B. Phone number through which the emergency coordinator can be contacted on a 24 hour basis.

C. The phone number of the local fire department.

D. The location of the fire extinguishers and spill control materials.

END OF SECTION

Draft Statement of Work
Fluvial Sands SVE System
Memphis Depot Dunn Field
Memphis, TN

1.0 Introduction

This Statement of Work (SOW) describes the tasks necessary to implement the fluvial sands soil vapor extraction (SVE) system at Dunn Field, which is across Dunn Avenue from the north-northwest portion of the Main Installation (MI) of the Memphis Depot (the Depot) (formerly known as the Defense Distribution Depot Memphis, Tennessee). The SOW has been prepared for the U.S. Army Corps of Engineers (USACE) - Huntsville Center as part of Task Order 6 under contract number DACA87-02-D-0006.

1.1 Site Background

The Memphis Depot (Depot), which is located in southeastern Memphis, Tennessee (Figure 2-1), originated as a military facility in the early 1940s. Its initial mission and function was to provide stock control, materiel storage, and maintenance services for the U.S. Army (Memphis Depot Caretaker, 1998). In 1995, the Depot was placed on the list of Department of Defense (DoD) facilities to be closed under the Base Realignment and Closure (BRAC). Storage and distribution of materiel for all U.S. military services and some civil agencies continued until the Depot closed in September 1997.

The Depot is located approximately 5 miles east of the Mississippi River and just northeast of Interstate 240. The property consists of approximately 642 acres and includes two components: the MI, with includes open storage areas, warehouses, military family housing, and outdoor recreational areas; and Dunn Field, which includes former mineral storage and waste disposal areas.

Dunn Field, comprising approximately 64 acres of undeveloped land, is bounded by the Illinois Central Gulf Railroad and Person Avenue to the north, Hays Road to the east, and Dunn Avenue to the south. Dunn Field is partially bounded to the west by: (1) Kyle Street; (2) a Memphis Light, Gas, and Water (MLGW) powerline corridor (which bisects Dunn Field); (3) undeveloped property; and (4) a light industrial/warehouse facility (Figure 2-2). All of DunnField (and the MI) is currently zoned as Light Industrial (I-L).

Approximately two-thirds of the area is grassed, and the remaining area is covered with crushed rock and paved surfaces. Dunn Field was used for bulk mineral storage (bauxite and fluorspar) and waste disposal.

8891164

2.0 Scope of Work

The RAC requires Subcontractor assistance to install and construct the fluvial sands SVE system at Dunn Field. The subcontractor shall furnish all labor, equipment, materials, lower-tier Subcontractors, supplies, and all else necessary to completely perform the scope of work identified herein. All work shall be completed in compliance with current federal, state, and local regulations and in accordance with standard industry practice.

The proposal submitted in response to this solicitation shall include the following information:

- A comprehensive technical and management approach, including site specific concerns, to accomplish the work.
- A proposed schedule for completing the work.
- The anticipated personnel and equipment required to complete the work.
- A statement of any exceptions or assumptions that have been taken to this SOW.
- Other information as required by this RFP.

The Bidder shall carefully examine the site and make all inspections necessary in order to determine the full extent of the work required to make the completed work conform to the bid requirements. The Bidder shall satisfy himself as to the nature and location of the work, conditions, the conformation and condition of the existing ground surface, and the character of equipment and facilities needed for the prosecution of the work. The Bidder shall satisfy himself as to the character, quality, and quantity of surface and subsurface materials or obstacles to be encountered. Any inaccuracies or discrepancies between the actual field conditions and the bid documents must be brought to the RAC's attention in order to clarify the exact nature of the work included in the bid requirements.

3.0 Project Schedule

Subcontractor shall provide whatever resources necessary to complete the SOW within the timeframe presented in the final project schedule developed for the project. Work is limited to daylight hours with work on the weekends acceptable as needed.

The Subcontractor is requested to state in the proposal the estimated duration of performing the various major tasks required to complete Subcontractor's work, including all submittals, and the total estimated duration of performing the total project. This information shall be provided in the form of a project schedule indicating all tasks to complete the work, long lead time items, and indicating the sequence of work.

Period of Performance

The period of performance has been initially set for April 2, 2007 through August 2, 2007.

4.0 Technical Specifications

4.1 Safety

Subcontractor's personnel shall abide by the applicable OSHA guidelines 29 CFR 1910 for general personal safety around operating heavy equipment. Required safety equipment shall be used at all times during work onsite. Subcontractor shall provide all required personal safety equipment for Subcontractors employees including, but not limited to, gloves, hearing protection, safety glasses, hard hats, steel-toed boots, and air-supplied respirators (if required) and appropriate hazardous waste level protection.

4.2 Mobilization

Subcontractor shall mobilize all resources necessary to efficiently and completely perform the scope of work. The resources include, but are not limited to, personnel, equipment, materials, supplies, lower-tier subcontractors, and support facilities (e.g., project support trailer, decontamination facilities, waste containment facilities, material and equipment storage, cellular phones, water, portable sanitary facilities, etc.) to support the work activities at the site. An onsite staging/lay down area will be designated by the Remedial Action Contractor (RAC).

4.3 Site Preparation

Site preparation activities shall include installation of warning signs, removal of surficial debris, and preparation for the SOW to be performed.

A utility survey of the area shall be completed by the Subcontractor 1 week prior to the beginning of work. Documentation of the survey (including water, electricity, natural gas, telephone, or other utility lines) and its results shall be provided to the RAC, authorizing work to proceed at the site. Any utilities identified adjacent to the work area shall be clearly marked and identified. Once work begins, the progress of excavation conducted with heavy equipment shall be continuously monitored for evidence of subsurface obstructions.

Sheet 1 (construction drawings cover) and Sheet 2 (overall site map) are attached to this SOW.

4.4 Extraction Well Locations

The fluvial sands extraction well locations are based on the chemical analyses of soil samples collected during the RI and RDI and the SVE treatability study results. Figure 6-2 and Sheet 3 shows the SVE well layout. Seven fluvial sands extraction wells are currently planned. Prior to performance of the work, the SVE locations will be surveyed and inspected to identify potential access issues, such as utility interference and buildings or structures that may be impacted. Some SVE locations may have to be changed to avoid impacts to utilities, buildings, traffic, or other site features. The total adjustment of any SVE location will typically be less than 15 ft in any direction. If greater adjustments are needed, additional SVE wells will be considered to ensure adequate vacuum influence in the targeted subsurface zones.

4.5 SVE Well Construction

Four-inch diameter soil borings will be advanced to approximately 5 ft above the top of the saturated zone (approximately 65 to 70 ft bgs depending on location) using rotasonic drilling methods. Depending on the thickness of the fluvial unsaturated zone, a 30- or to 35-ft section of 0.006-inch, 90 wire continuous slot 304 stainless steel screen will be installed, with stainless steel casing extending to an elevation of approximately 2 feet above ground surface. The top of the screen will be at least 5 feet below the bottom of the loess. Stainless steel well construction will allow the loess deposits and fluvial sands SVE system to operate concurrently. Well casings will be new, unused, decontaminated, 2-inch inside diameter 304 stainless steel with internal flush-joined threaded joints.

In accordance with the *Remedial Action Sampling and Analysis Plan* (MACTEC, 2005d), the annular space will be filled with well material consisting of the filter pack, bentonite seal, and grout as the rotasonic casing is withdrawn from the borehole. Because of the high temperatures from the loess thermal-enhanced SVE system, the grout will include Portland cement with 30 percent silica flour (for example, Haliburton Class G grout). The depth of placement of the screen and well material will be directed by the FTL.

4.6 SVE Blower Specifications

Two Gardner Denver Turbotron vacuum blowers will be used for the fluvial sands SVE system (cut sheet provided in Appendix E). Each blower is capable of producing 490 actual cubic feet per minute (acfm) at approximately 80 inches of water (6 inches Hg) and 3,700 revolutions per minute (rpm). The blower vacuum requirements account for the pressure loss across the GAC vessels and the HDPE conveyance piping. The total flow of these blowers will be nearly 1,000 acfm, allowing the SVE system to operate at a higher extraction rate than the 100 scfm design flow per well. The dual blower configuration also permits uninterrupted SVE system operation if one of the units is being serviced.

The Gardner Denver Turbotron blowers are known for their reliability and low maintenance. Although significant groundwater and/or condensate recovery is not expected, a 400-gallon moisture separator tank, level controls, and transfer pump will be installed (see Sheets 5, 6, and 7).

4.7 SVE System Conveyance Piping and Trenching

Individual conveyance piping will be routed to each extraction well to ensure maximum system operation flexibility and to allow flow to be balanced between each well from a central location. Piping will consist of 4-inch diameter standard dimension ratio 11 or 13.5 HDPE. The piping layout is shown on Sheet 3 and 4.

The 4-inch diameter HDPE conveyance piping will be temporarily installed on top of the loess deposits thermal vapor barrier. As shown on Sheet 10, temporary connections above the vapor barrier will consist of 4-inch diameter transition fittings and stainless steel 90-degree elbows. After loess treatment is complete, the fluvial sands SVE system will be temporarily deactivated while the conveyance piping is buried.

Final (buried) wellhead connection details are illustrated on Sheet 10. HDPE connections will be made using 4-inch transition fittings. Each vertical well will be sealed with a conventional expanding plug provided by the drilling contractor. A 2-ft square, ¼-inch thick steel plate will be buried above the wellhead to protect the well and also to assist in locating it in the future. The wellhead will also be protected below the steel plate with a 2-inch diameter threaded stainless steel plug. The SVE well controls will be installed at the equipment compound; there will be no field access.

The piping will be trenched from the SVE well to the equipment compound. The pipes will be covered with at least 24 inches of compacted soil. Some of the pipes will be grouped to minimize the number of trenches around the site. Trench backfill identified by the RAC will be compacted in 1-ft lifts using a vibratory tamping device. Compaction will be verified by the field engineer. The number of fused joints will be minimized by using coiled pipe as possible. The HDPE will be butt fusion-welded by trained personnel.

Conveyance piping will be routed to the equipment compound or building. 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 after it is delivered. As shown on Sheet 10, concrete will be poured to support the building. As delivered by the equipment vendor, SVE manifold piping will penetrate the building sides and the spacing and orientation of each manifold leg (wall penetration) will be supplied by the equipment vendor in advance of the project.

4.8 Treatment Compound, Control Building, and Interior Piping

As shown on Sheet 7, the individual SVE manifold legs, blowers, aftercoolers, moisture separator, and system controls will be located inside the treatment system building. Treatment system building details are provided on Sheet 8. The vapor treatment system will be positioned outside of the building. The entire concrete-covered compound will be enclosed with a chainlink fence with 3-strand barbed-wire (see Sheet 9). As shown on Sheet 5, each individual SVE manifold leg will contain the following elements:

- 4-inch diameter HDPE transition fitting
- Differential pressure air flow meter
- Pressure indicator
- Manually actuated diaphragm and ball valves
- Sample port

All manifold piping will consist of hot-dip galvanized or epoxy coated steel (coatings applied to pipe exterior only).

4.9 Vapor Treatment

Purged vapor will be treated using GAC contained in epoxy coated steel vessels. Each vessel will contain 2,000 pounds of vapor phase GAC (Attachment A). Due to the estimated mass in the fluvial sands, extracted vapor treatment is not expected to be required beyond Year 1.

4.10 Condensate Management

Condensate will be discharged to the City of Memphis POTW through the existing IRA groundwater recovery system. A revision to the existing Industrial Wastewater Discharge Agreement (Permit S-NN3-097) (see Appendix H) will be submitted to the City of Memphis Division of Public Works and Memphis Depot Caretaker to acknowledge the discharge of water from the thermal-enhanced loess and fluvial sands SVE systems. Currently this discharge permit is being used for the discharge of untreated groundwater recovered from a groundwater extraction system dictated by an April 1996 interim record of decision for an interim groundwater RA that was implemented in November 1998.

If the City will not accept the current condensate management strategy, then a vacuum truck will be used to remove the condensate generated from the thermal-enhanced and conventional SVE systems and transport the waste to a City of Memphis POTW waste portal. The condensate will be sampled and analyzed for site-specific and other (that is, reactivity, corrosivity, and ignitability) characteristics before it is transported offsite by the vacuum truck. A copy of the data will be supplied to the City for their written approval of discharge of the waste to the POTW.

The condensate flow rate from the fluvial sands SVE system is expected to be low (less than 1 gpm) and not require treatment prior to discharge to the POTW. As shown on Sheets 5, 6, and 7, the condensate will be collected in a sump (within the moisture separator) and then pumped to a 535-gallon holding tank. Periodically, the contents of the tank will be removed and then discharged to the City of Memphis POTW through the existing IRA groundwater recovery system. Condensate samples will be collected in accordance with the PSVP (see Appendix D of the RD). Condensate collection rates are expected to be well below 1 gpm over time.

4.11 Site Restoration

Disturbed areas will be seeded, fertilized, and mulched to minimize erosion. The areas will be graded smooth and uniform with the surrounding areas. Large stone, debris, and materials will be removed and if necessary disposed offsite. The grass mix will be installed per the specifications through the course of the project, since the sites are widespread and will be completed at various times.

4.12 Final Decontamination and Demobilization

The Subcontractor shall perform a final cleanup of all areas impacted by its activities to the satisfaction of the RAC. Personnel and equipment shall be decontaminated prior to leaving the area to avoid the possibility of inadvertently spreading contamination. Equipment shall be properly decontaminated to remove all contamination that may be adhering to the equipment components as a result of the interim remedial action. The Subcontractor, solely at the Subcontractor's expense, will restore any cross-contamination of Dunn Field property or public thoroughfare. All debris and rinsate generated by the treatment activities shall be properly containerized, sampled, analyzed, and disposed offsite as specified in this SOW. Decontamination of personnel and equipment shall be performed in accordance with the Site Health and Safety Plan and the applicable provisions of 29 CFR 1910.120.

Following approval from the RAC, all personnel, equipment, temporary facilities and utilities shall be demobilized from the site. In addition, any remaining debris or other wastes generated during the work shall be removed and properly disposed.

Figures

8891170

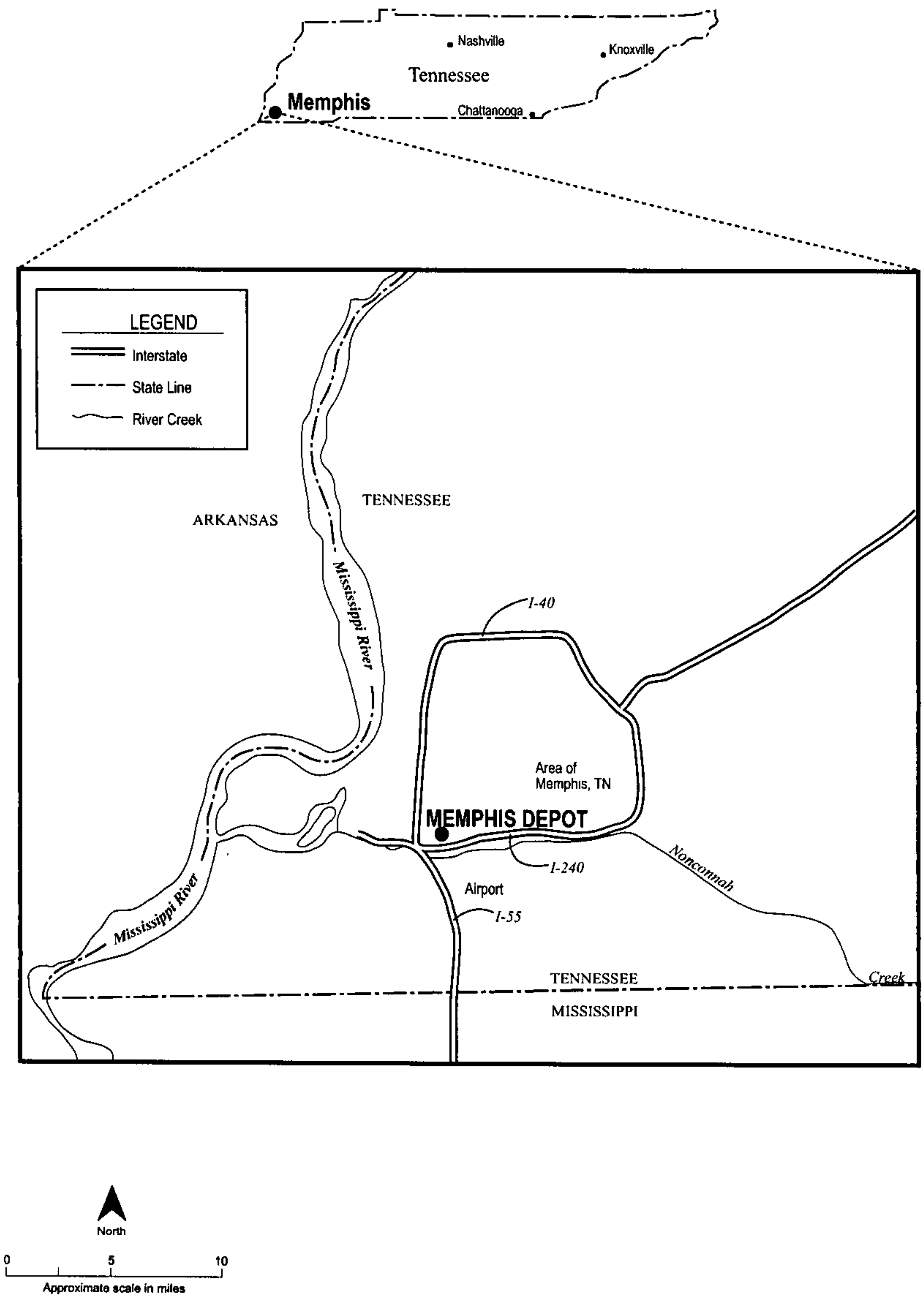


FIGURE 2-1
Memphis Depot Location In The Memphis Metropolitan Area
Memphis Depot Dunn Field Remedial Design

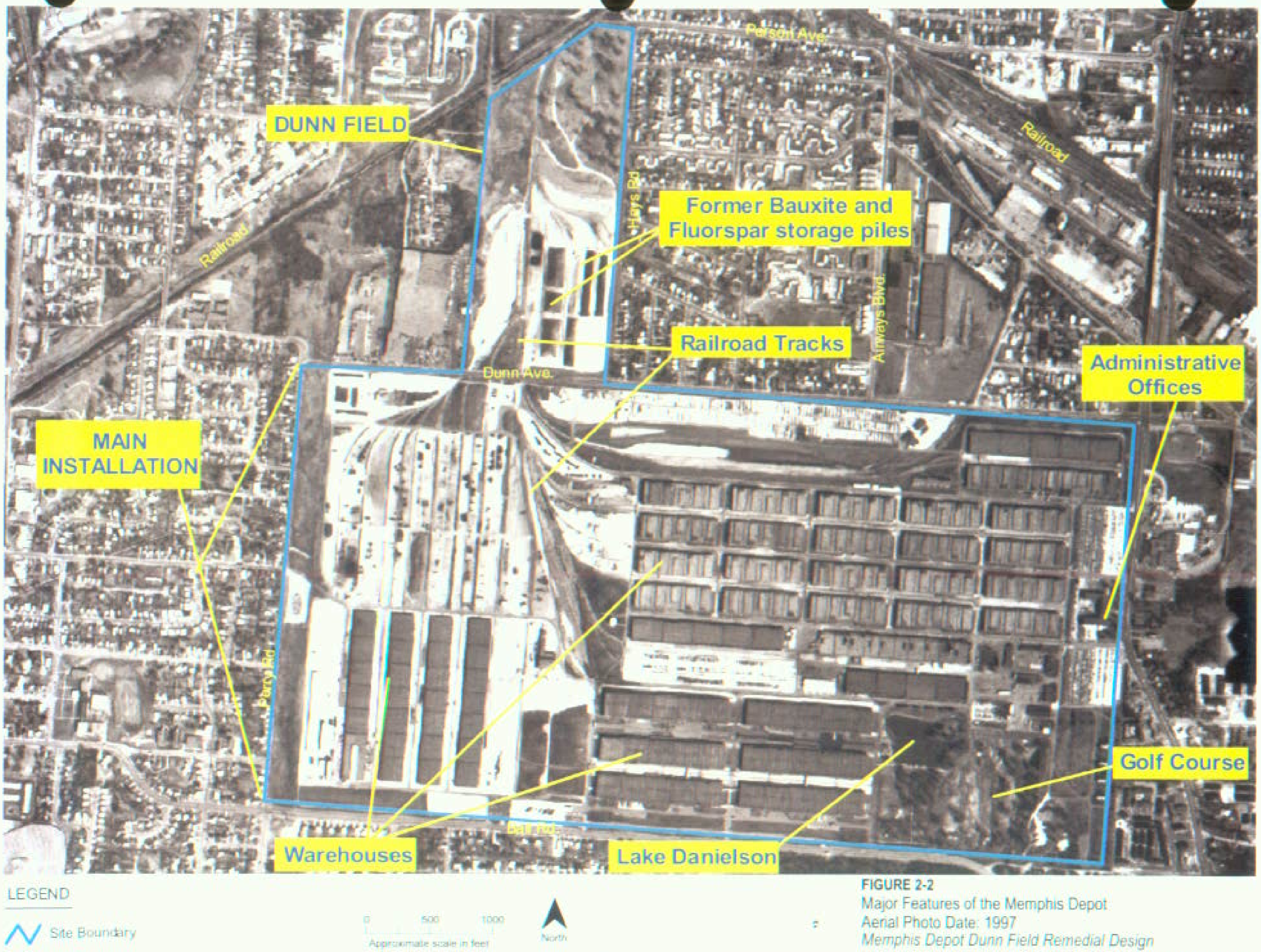


FIGURE 2-2
Major Features of the Memphis Depot
Aerial Photo Date: 1997
Memphis Depot Dunn Field Remedial Design

CH2MHILL

ES082006008ATL Memphis 102.ai

8891171

8891172

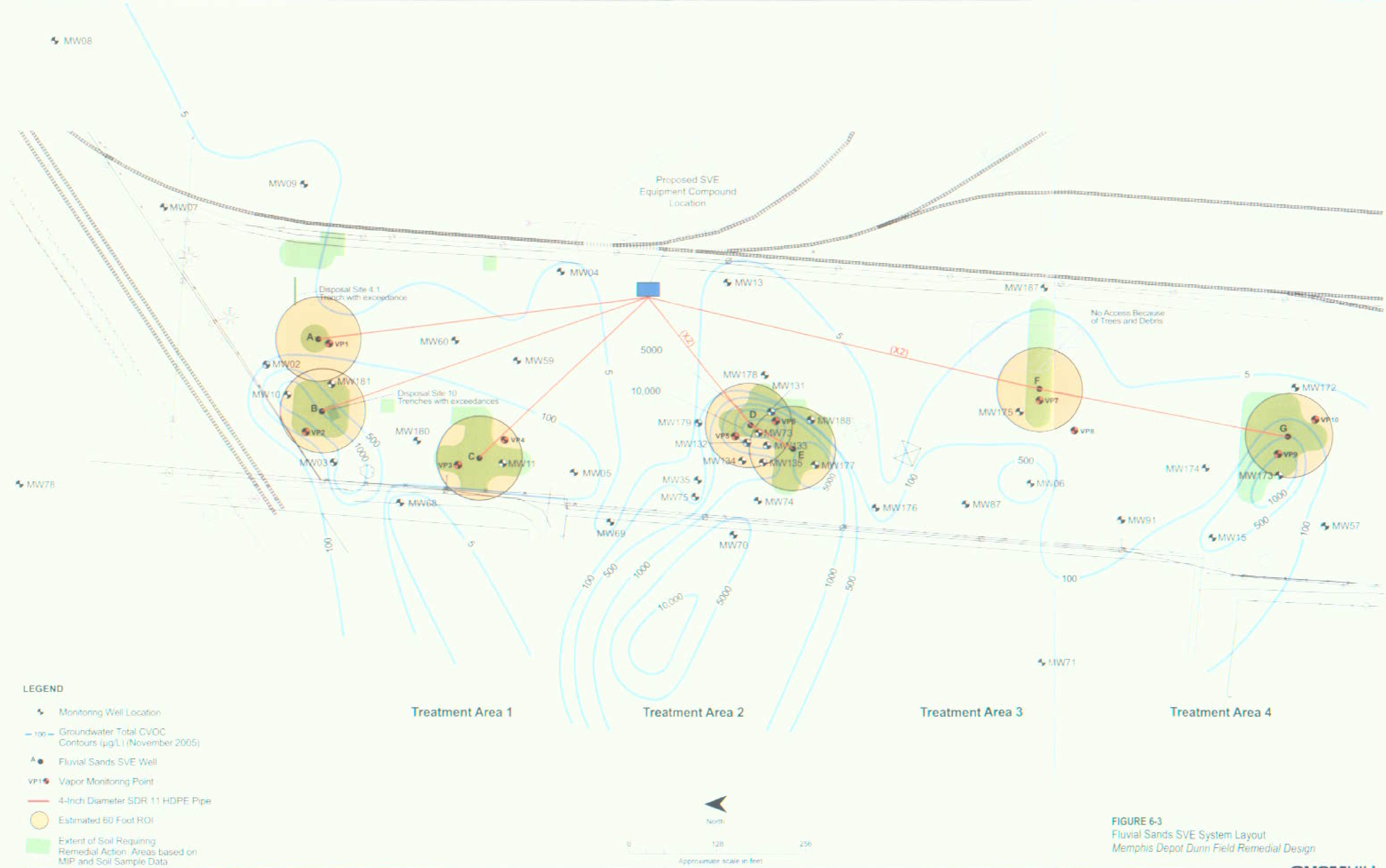
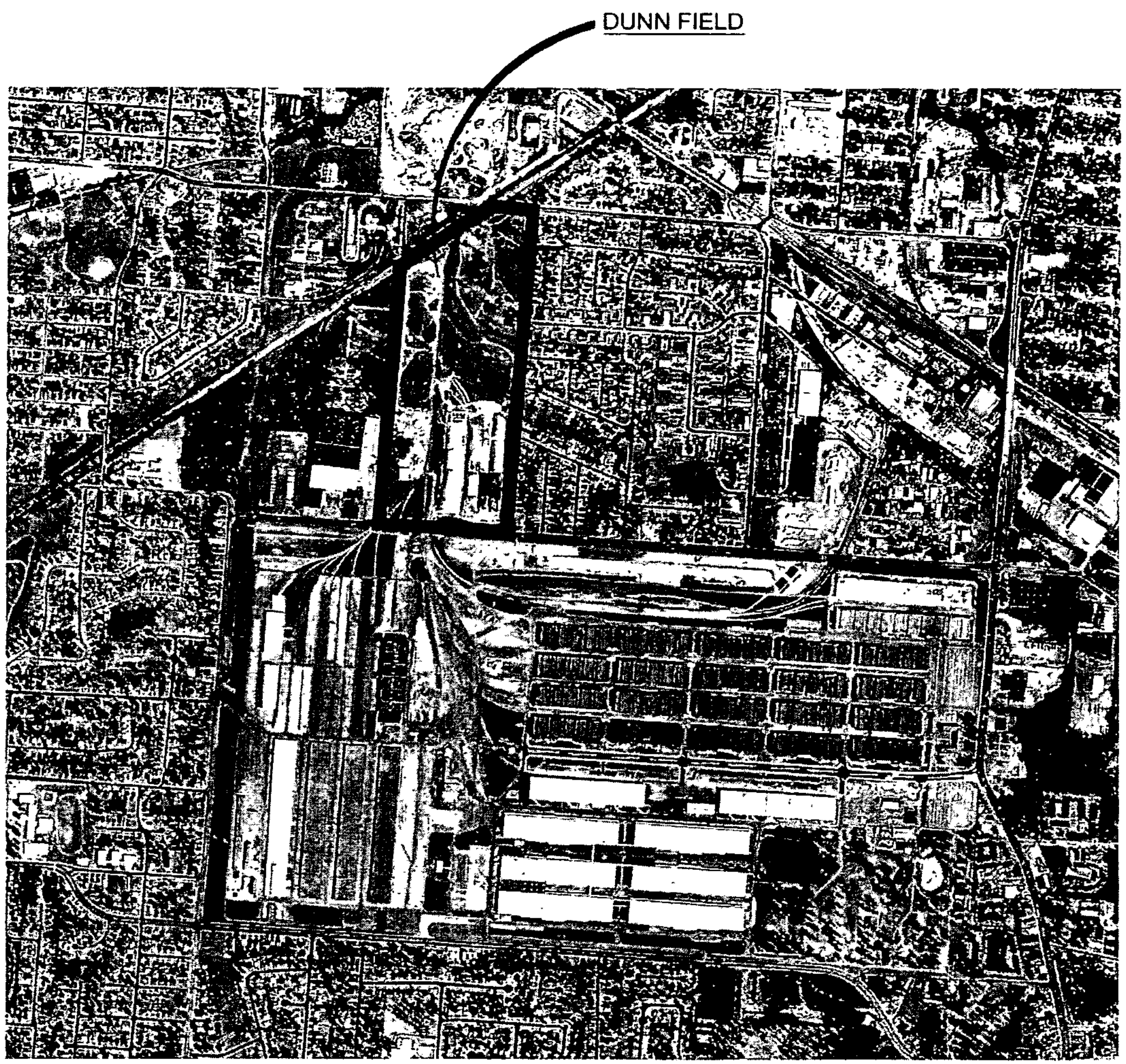


FIGURE 6-3
Fluvial Sands SVE System Layout
Memphis Depot Dunn Field Remedial Design

CH2MHILL

8891173

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS REMEDIAL DESIGN
MEMPHIS, TENNESSEE



LOCATION MAP
NTS

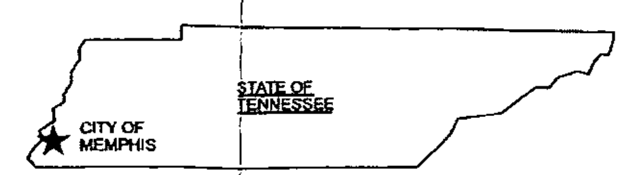
MICHAEL WILLIAM PERLMUTTER REGISTERED ENGINEER AGRICULTURE COMMERCE No. 00107703 STATE OF TENNESSEE

4-12-07

U.S. Army Engineering and Support Center, Huntsville

INDEX TO DRAWINGS

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



VICINITY MAP
NTS

NO	DATE	REVISION	BY	APVD

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

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

GENERAL
TITLE SHEET, LOCATION MAP,
AND INDEX TO DRAWINGS

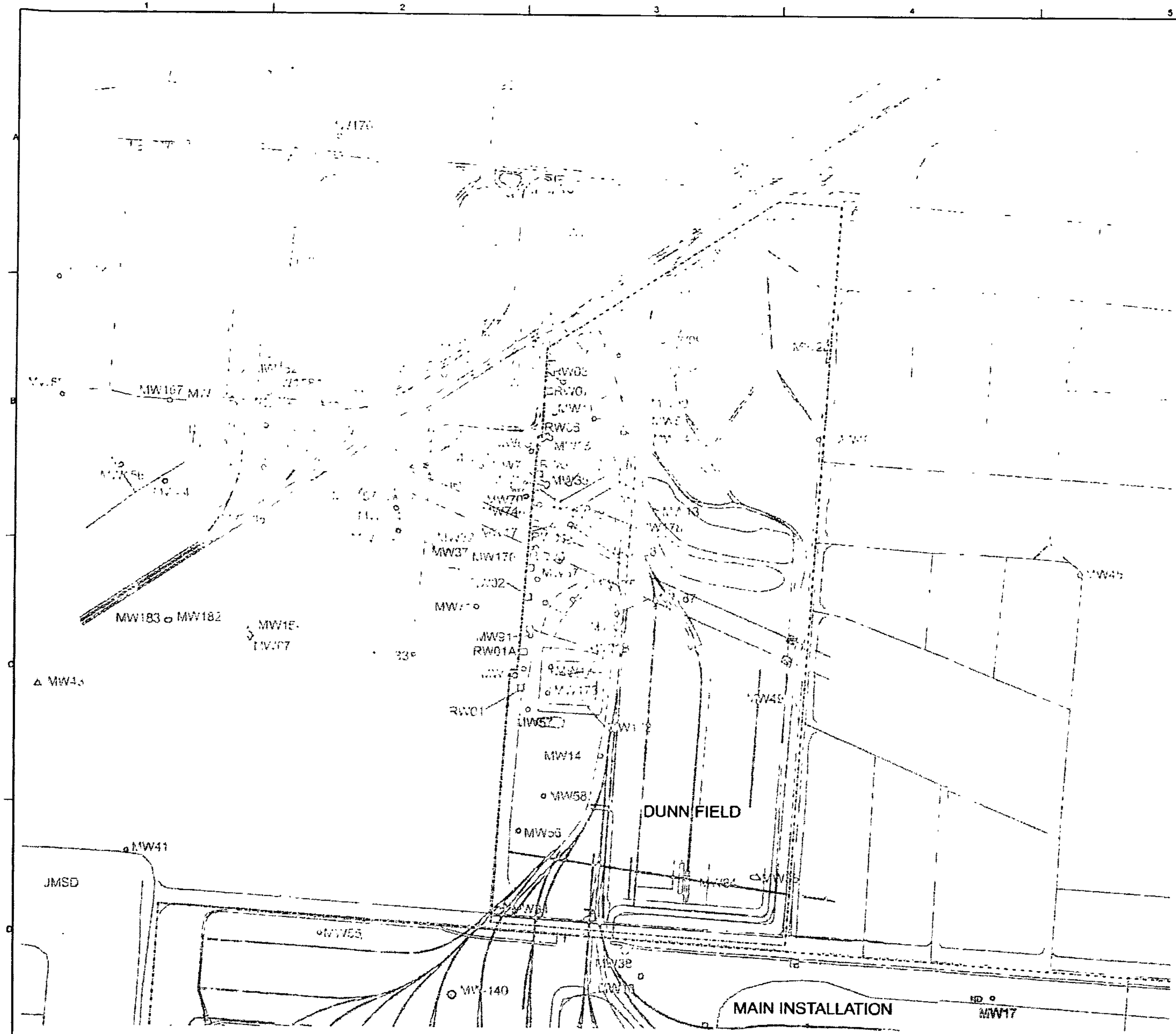
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

DATE SEPTEMBER, 2006
PROJ 177336
DWG G-1
SHEET 1

USER: EGRIGGS TAB: LAYOUT1

ATL/PROJ/148071 DDMT/SARD 2006 FILENAME: SHEET 1 (COVER).DWG PLOT DATE: 1-Sep-06 PLOT TIME: 5:30:15 PM

8891174



LEGEND

- DEPOT BOUNDARY
- MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- MONITORING WELL SCREENED IN INTERMEDIATE AQUIFER
- RW GROUNDWATER EXTRACTION WELL
- MONITORING WELL SCREENED IN MEMPHIS AQUIFER

SCALE IN FEET

MICHAEL WILLIAM PERLMUTTER
REGISTERED ENGINEER
AGRICULTURE COMMERCE
No. 00107
STATE OF TENNESSEE

4-12-07

NO.	DATE	REVISION	BY	APVD

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

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

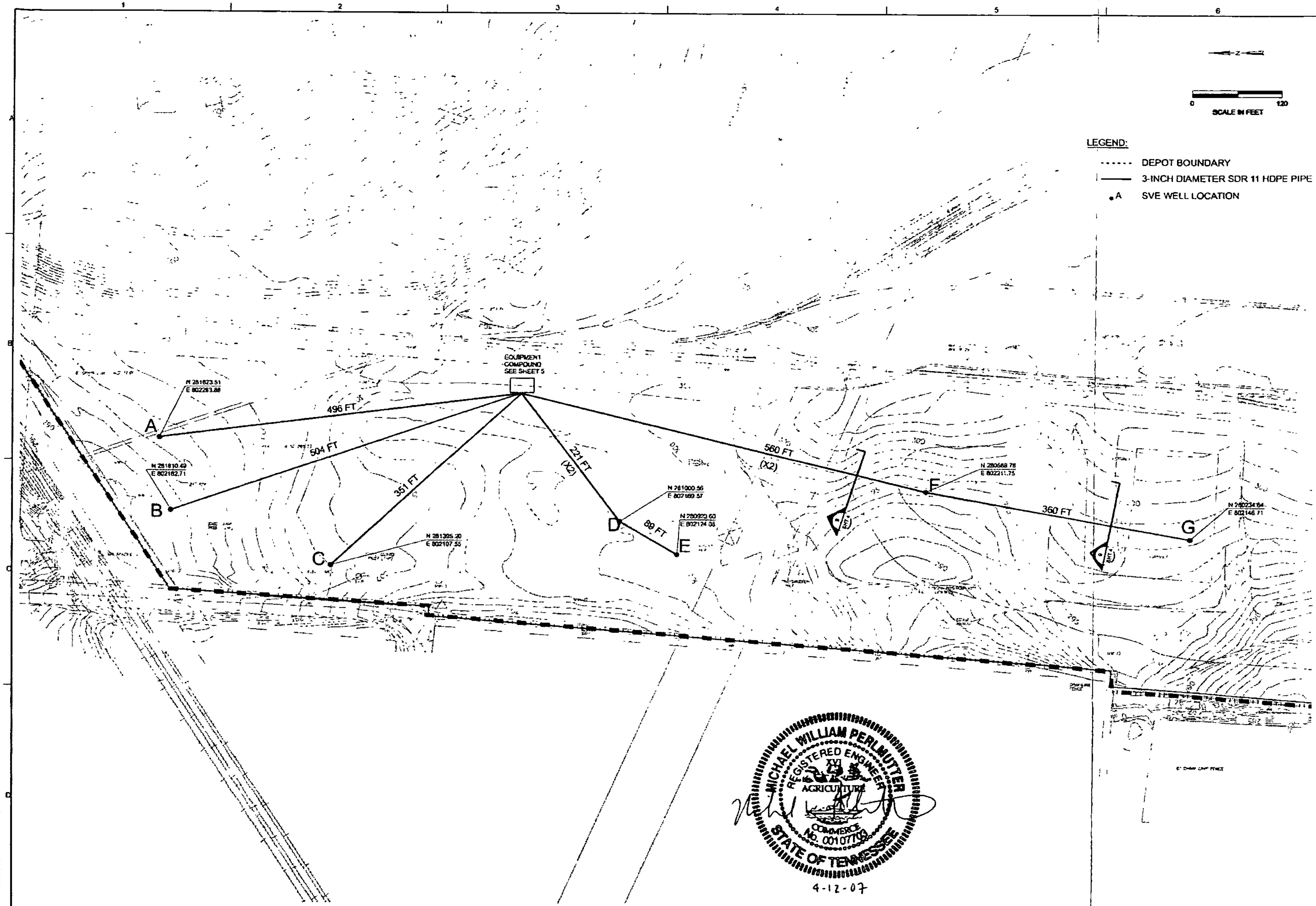
GENERAL
SITE MAP

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

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

USER: EGRIGGS TAB: DLAYOUT
ATL/PROJ/148071 DDMT/SARD 2006
FILENAME: SHEET 2 SITE MAP.DWG PLOT DATE: 7-Jul-06 PLOT TIME: 1:10:40 PM

8891175



CH2MHILL

FLUVIAL SANDS SVE
SVE SYSTEM LAYOUT

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

NO.	DATE	REVISION	BY	APVD

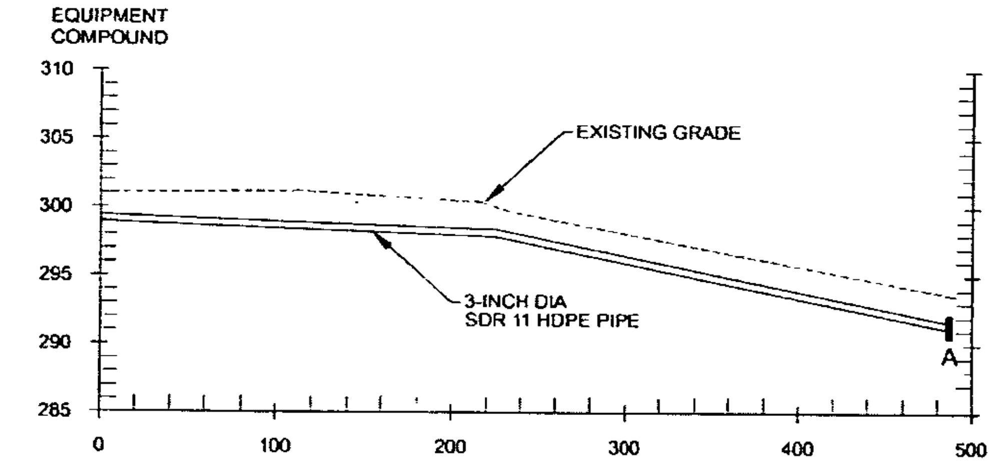
DSGN	DR	CHK	APVD
M. PERLMUTTER	E. GRIGGS	M. STRONG	D. NELSON

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

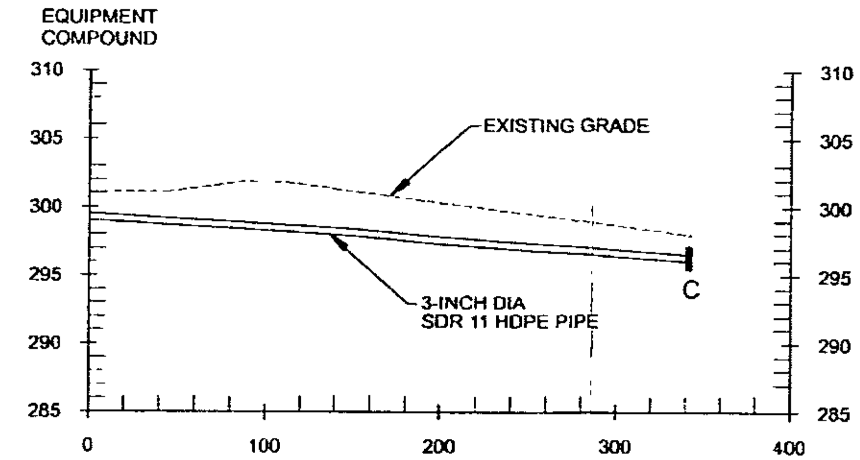
DATE	SEPTEMBER, 2006
PROJ	177556
DWG	F-1
SHEET	3

USER: EGRIGGS TAB: DLAYOUT
ATL/PROJ/148071 DDMT/Cap Addendum.DWG
FILENAME: SVE SYSTEM LAYOUT.DWG PLOT DATE: 7-Jul-06 PLOT TIME: 1:10:40 PM

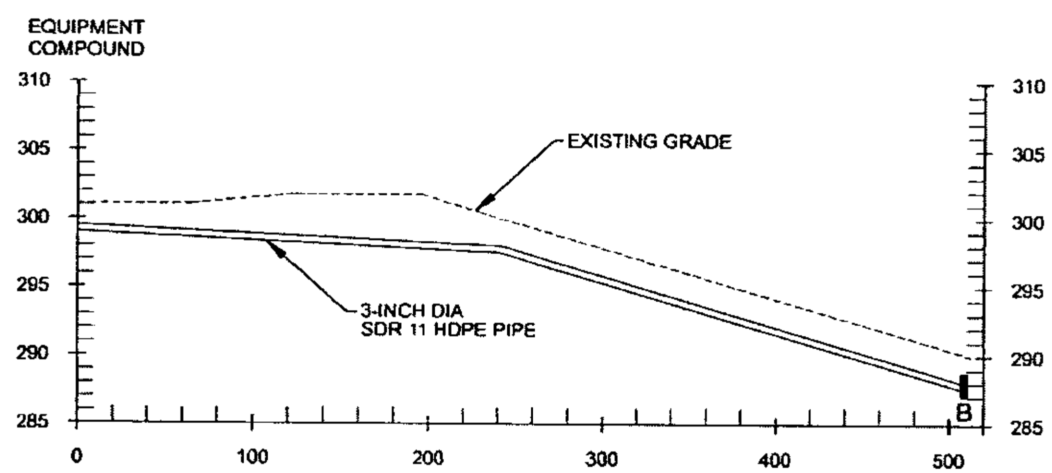
8891176



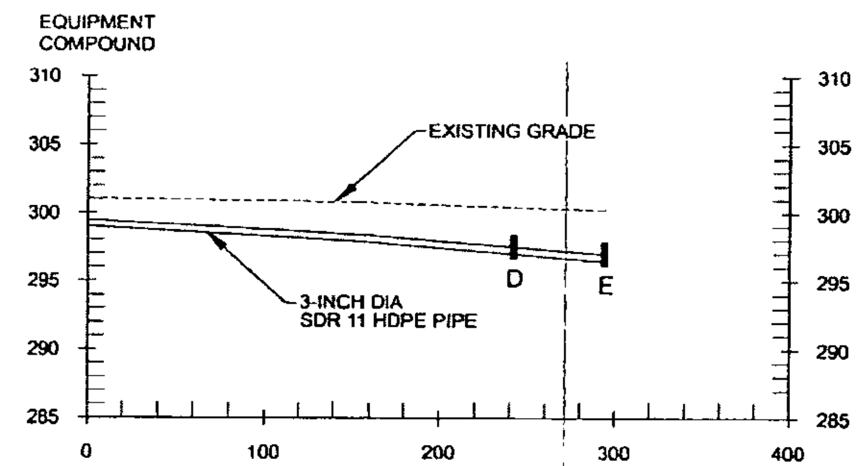
EQUIPMENT COMPOUND TO SVE WELL A



EQUIPMENT COMPOUND TO SVE WELL C



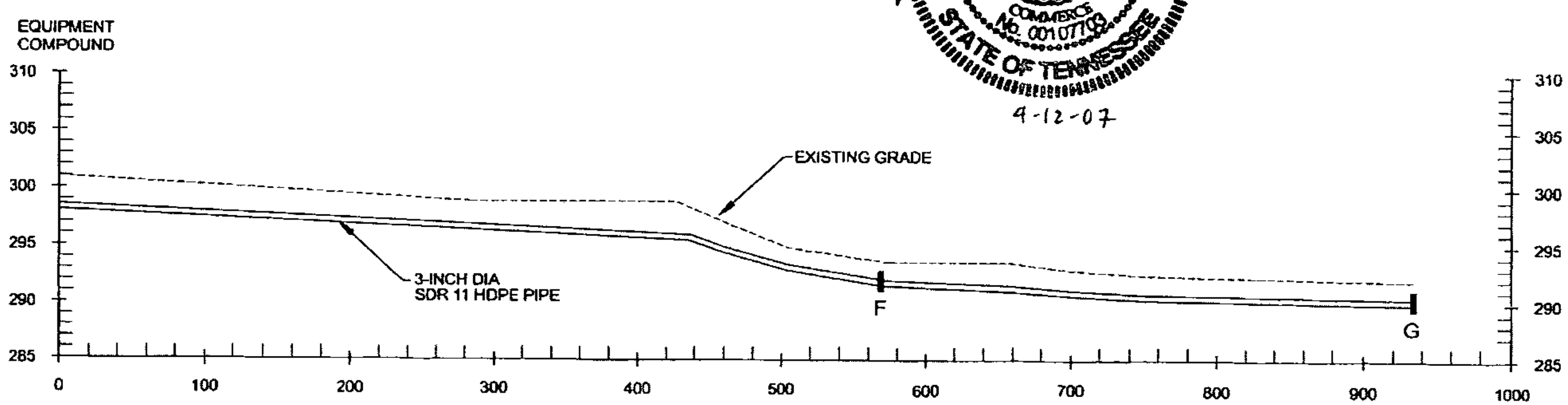
EQUIPMENT COMPOUND TO SVE WELL B



EQUIPMENT COMPOUND TO SVE WELL D AND E

MICHAEL WILLIAM PERLMUTTER
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No. 00107709
STATE OF TENNESSEE

4-12-07



EQUIPMENT COMPOUND TO SVE WELL F AND G

NOTES.

1. CROSS-SECTIONS REPRESENT FINAL PIPING LOCATION. CONVEYANCE PIPING TO BE PLACED ABOVE GRADE DURING OPERATION OF LOESS DEPOSITS THERMAL-ENHANCED SVE.
2. HDPE PIPE TO BE MINIMUM 2 - FEET BELOW EXISTING GRADE FOLLOWING DECOMMISIONING OF LOESS DEPOSITS THERMAL-ENHANCED SVE SYSTEM.
3. MAINTAIN 0.5% SLOPE TO SVE WELLS TO PROMOTE CONDENSATE RETURN.

NO	DATE	REVISION	BY	APVD

DSGN M. PERLMUTTER | DR C. GRIGGS | CHK M. STRONG | APVD D. NILSON

REUSE OF DOCUMENTS: THIS DOCUMENT AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF CH2M HILL AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CH2M HILL.

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

FLUVIAL SANDS SVE
CONVEYANCE PIPING CROSS
SECTIONS

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

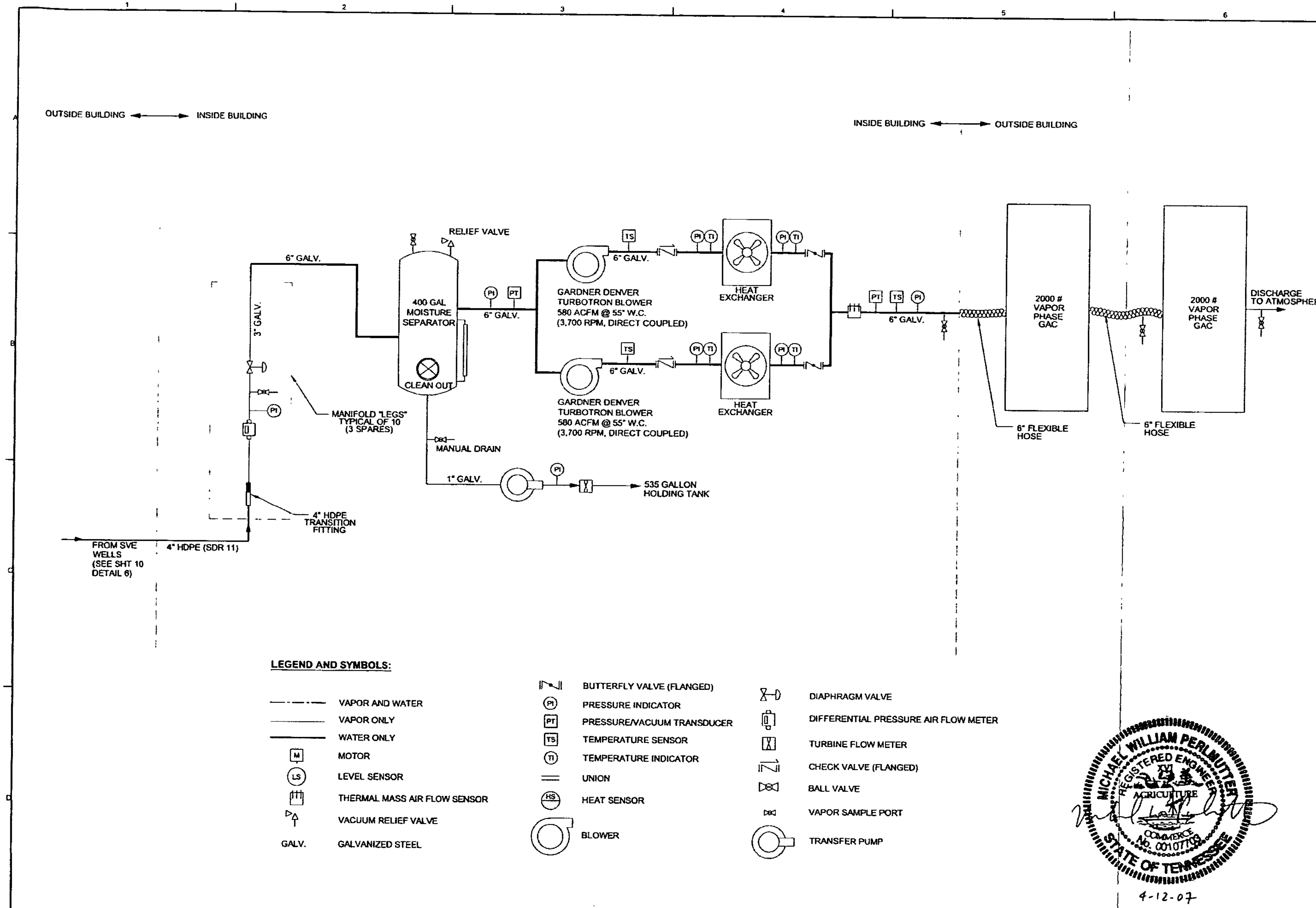
DATE	SEPTEMBER, 2006
PROJ	177556
DWG	F-2
SHEET	4

USER: EGRIGGS TAB: LAYOUT1

ATL/PROJ/148071 DDMT/SARD 2006

FILENAME: SHEET 4 CONVEYANCE PIPING X-SECTIONS.DWG PLOT DATE: 7-Jul-08 PLOT TIME: 1:10:40 PM

8891177



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

4-12-07

CH2MHILL

FLUVIAL SANDS SVE
PROCESS FLOW DIAGRAM

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

NO	DATE	REVISION	BY	APVD

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

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

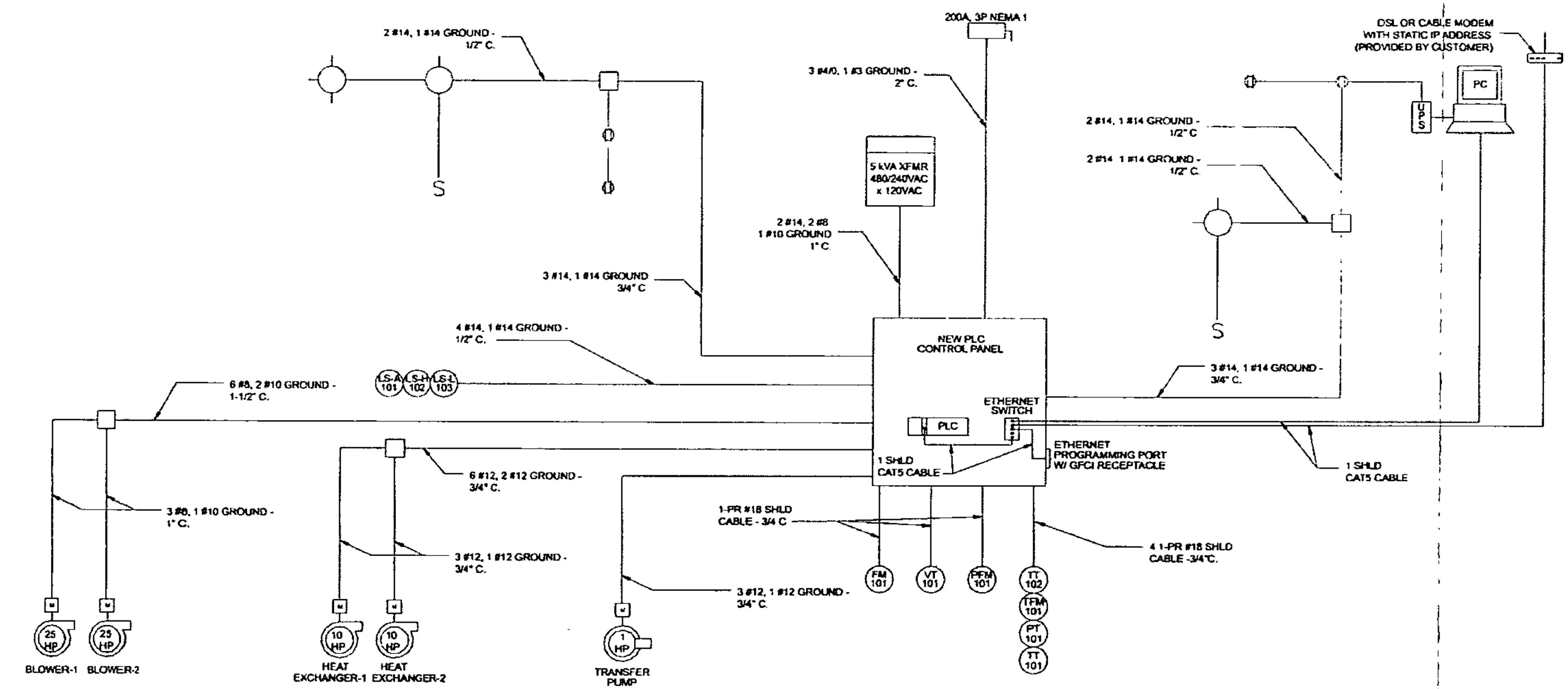
DATE	MARCH 2007
PROJ	177556
DWG	F-3
SHEET	5

USER: GHARTLEY TAB: LAYOUT1

ATL/PROJ/148071 DDMT/SARD 2006

FILENAME: SHEET_5_P_ROCESS_FLOW_DIA.DWG PLOT DATE: 19-Feb-07 PLOT TIME: 4:58:00 PM

8891178



PROCESS EQUIPMENT LEGEND

- MOTOR
- BLOWER
- TRANSFER PUMP
- LIGHT FIXTURE
- DUPLEX RECEPTACLE
- INSTRUMENT FIELD MOUNTED
- DISCONNECT SWITCH
- SWITCH - 1P

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

4-12-07

PROCESS ABBREVIATIONS

FM — FLOW METER
LS-H — LEVEL SWITCH - HIGH LEVEL
LS-H — LEVEL SWITCH - HIGH LEVEL
LS-L — LEVEL SWITCH - LOW LEVEL
PT — PRESSURE TRANSDUCER
TFM — THERMAL FLOW METER
TT — TEMPERATURE TRANSDUCER
VT — VACUUM TRANSDUCER

NO.	DATE	REVISION	BY	APVD

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

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

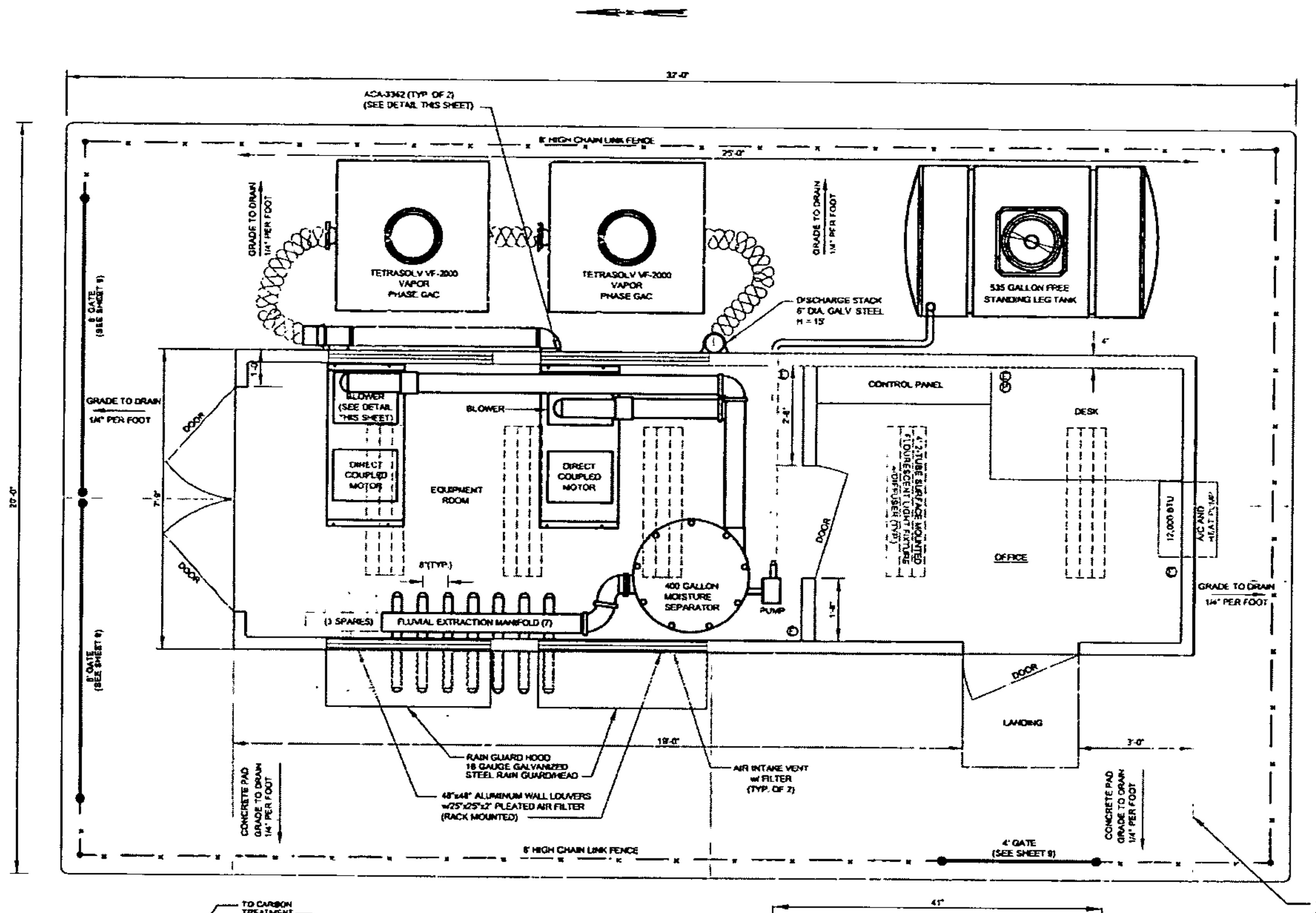
FLUVIAL SANDS SVE
PROCESS AND
INSTRUMENTATION DIAGRAM

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

DATE SEPTEMBER, 2006
PROJ 177556
DWG F-4
SHEET 6

USER: EGRIGGS TAB: LAYOUT1
ATL/PROJ/148071 DDMT/SARD 2006
FILENAME: SHEET 6 (PROCESS & INSTRUMENT).DWG
PLOT DATE: 7-Sep-06
PLOT TIME: 3.31.01 PM

8891179



BUILDING SPECIFICATIONS

1 PERIMETER FRAME. Perimeter tubular 2" x 6" frame members (13 ga.) with structural steel "C" channel 2" x 8" set perpendicular to and inletted into side tubular members. Channel is utilized as forklift slots for handling. All frame parts are coated with a corrosive resistant (black in color) paint. Anchor bldg. to concrete foundation per manufacturer's recommendation.

2. METAL WEATHER SHIELD. Galvanized steel construction. The shield covers the entire floor assembly and is located between frame and underside of floor joists.

3 FLOOR JOISTS: joists are nominal 2 x 4 steel joists spaced in a lateral configuration, 12" O.C.

4 FLOOR INSULATION Fiberglass batt-type insulation between floor joists is R-11 and entirely fills any and all voids.

5 FLOOR COVERING: 3/16" smooth steel floor (painted black).

6 WALL STUDS Studs are 3 ½" 20 ga. Galvanized steel studs, spaced 16" O.C. Top and bottom runners are 3 ½" x 18 ga.

7 WALL INSULATION: Fiberglass batt-type insulation between studs is R-11 and entirely fills any and all voids.

8. INTERIOR WALL COVERING 5/16" thick gypsum board with laminated vinyl covering is fastened to the inside of the studs with screws and gypsum adhesive; material has a class "A" flame spread rating. 4" vinyl base cove is applied at the base. Sound loss for this unit will be approximately 20 decibels from outside to inside.

9 EXTERIOR WALL SHEATHING: Under steel siding structural sheathing is secured to entire exterior, per manufacturer's recommendations. Sheathing is 1/8" foil laminated on both sides.

10 ROOF FRAMING Rafters are nominal 4" 16 ga. galvanized steel spaced in lateral configuration 12" O.C.

11 INTERIOR CEILING Ceiling material is 1/2" gypsum with a white stucco pre-finish, fastened securely to roof rafters with screws. Material has a class "A" flame spread rating.

12 ROOF INSULATION: Fiberglass batt-type insulation between roof rafters is R-11 and entirely fills any and all voids.

13 EXTERIOR ROOF SHEATHING: The top side of the rafter has 16 ga. Smooth steel sheathing fastened securely to roof rafters. Covered completely with a minimum 4 mil. polyvinyl vapor barrier.

14 ROOF COVERING. 30 ga. galvanized steel construction. Roof metal covers entire roof assembly.

15 EXTERIOR SIDING: Galvanized steel siding is 29 ga. pre-finished (on both sides) commercial type with appropriate top and bottom trim fastened securely to studs. Seven standard colors are available. 20-year guarantee.

16. EXTERIOR DOORS Doors are a steel door with steel jamb. Jambs will have ball bearing hinges. Door will have a tempered ½ lite and a heavy duty closer.

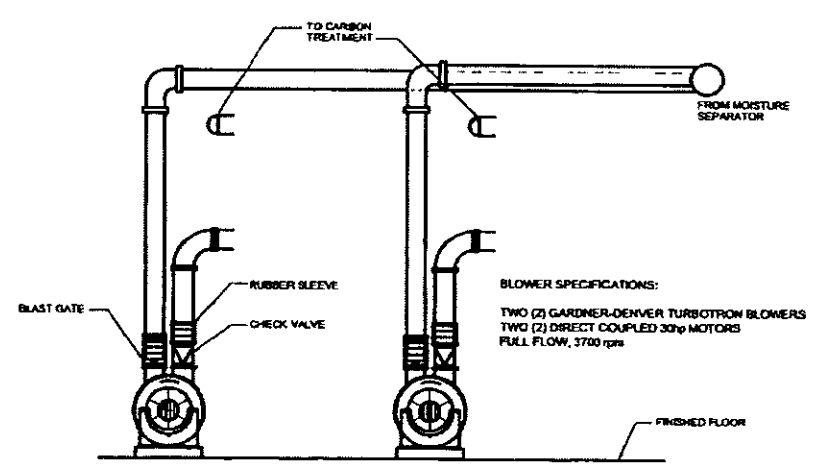
17. FULL DEPTH FORK POCKETS All sizes 2 1/2" x6" structural "C" channel (3 1/2" x 7" opening).

18. INTERIOR LIGHT FIXTURES All light fixtures are 4' - 0" (four foot) twin tube with an acrylic wrap-around type diffuser cover.

19. INTERIOR CEILING HEIGHT. The dimension from the finished floor surface to the finished ceiling surface is 8'-0"

20. ELECTRIC SERVICE PANEL: Prewire service entrance panel is equipped with a 100-amp main breaker, a 15-amp breaker (for lights), a 20-amp breaker (for receptacles), and any additional breakers necessary. Entrance conduit is through the exterior wall for ease of hook-up. All electric components U.L. listed and wired to National Electrical Code. Standard service is 240/120v, single phase, 60 cycle.

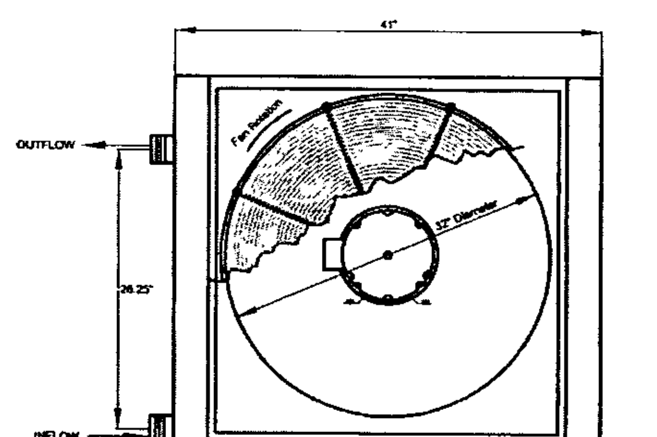
21 HVAC. One thru the wall G.E. 12,000 BTU air conditioner



BLOWER SPECIFICATIONS:

TWO (2) GARDNER-DENVER TURBOTRON BLOWERS
TWO (2) DIRECT COUPLED 30hp MOTORS
FULL FLOW, 3700 rpm

BLOWER DETAIL
N.T.S.



ACA - 3362
American Industrial Heat
Transfer, Inc.

AFTERCOOLER DETAIL
N.T.S.

LEGEND

- ⓔ ELECTRICAL OUTLET
- ⓟ PHONE JACK

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

4-12-07

CH2MHILL

FLUVIAL SANDS SVE
EQUIPMENT COMPOUND

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

NO.	DATE	REVISION	BY	APVD

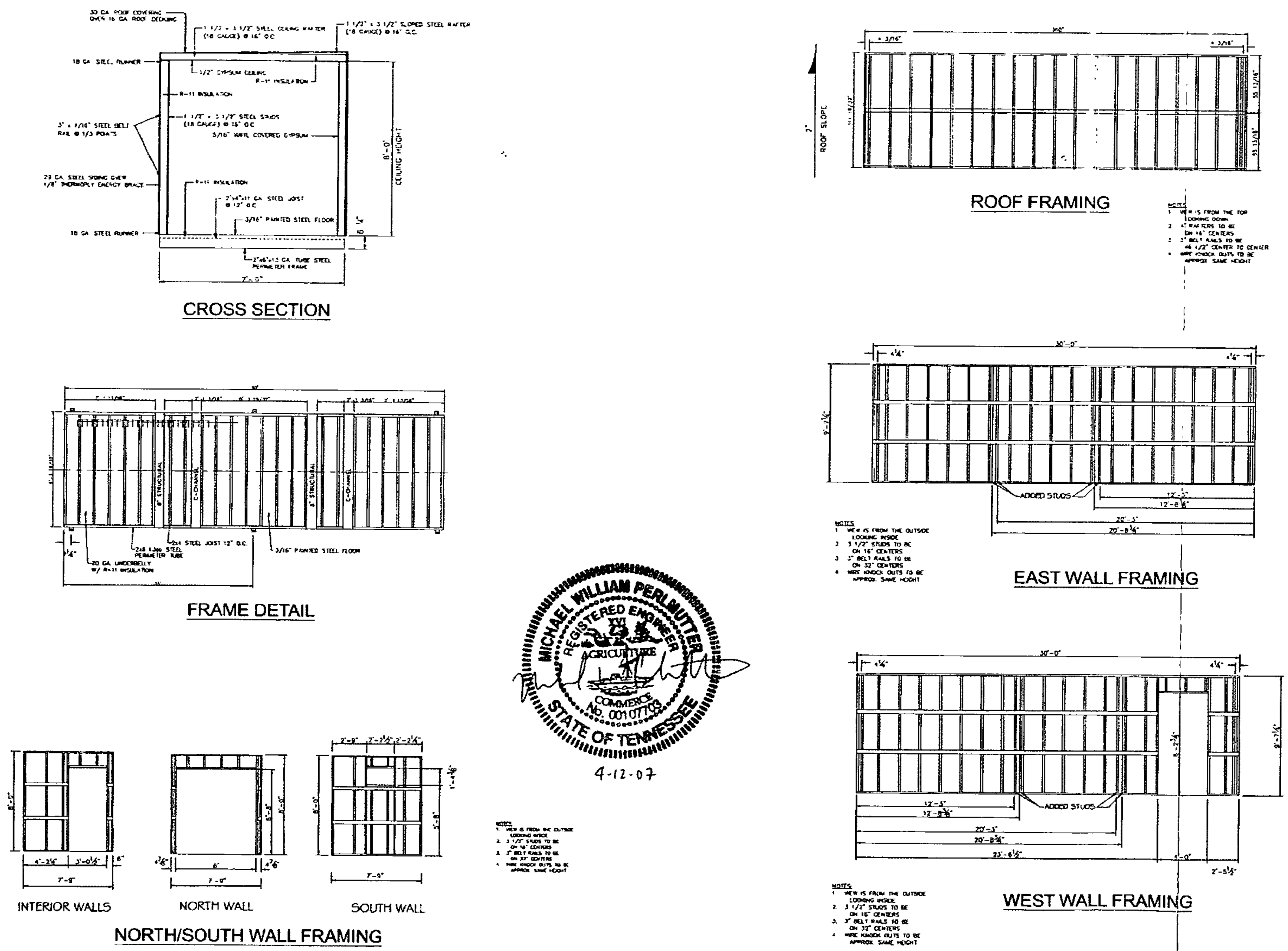
DSGN	DR	CHK	APVD
M. PERLMUTTER	G. HARTLEY	M. STRONG	D. NELSON

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

DATE	MARCH 2007
PROJ	177556
DWG	F-5
SHEET	7

ATL/PROJ/148071 DDMT/SARD 2006
FILENAME: SHEET 7 (EQUIPMENT COMPOUND).DWG PLOT DATE: 19-Feb-07 PLOT TIME: 4:59:17 PM
USER: GHARTLEY TAB: LAYOUT1

8891180



CH2MHILL	FLUVIAL SANDS SVE BUILDING DETAILS
MEMPHIS DEPOT DUNN FIELD SOURCE AREAS REMEDIAL DESIGN MEMPHIS, TN	

NO.	DATE	REVISION	BY	APVD

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

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

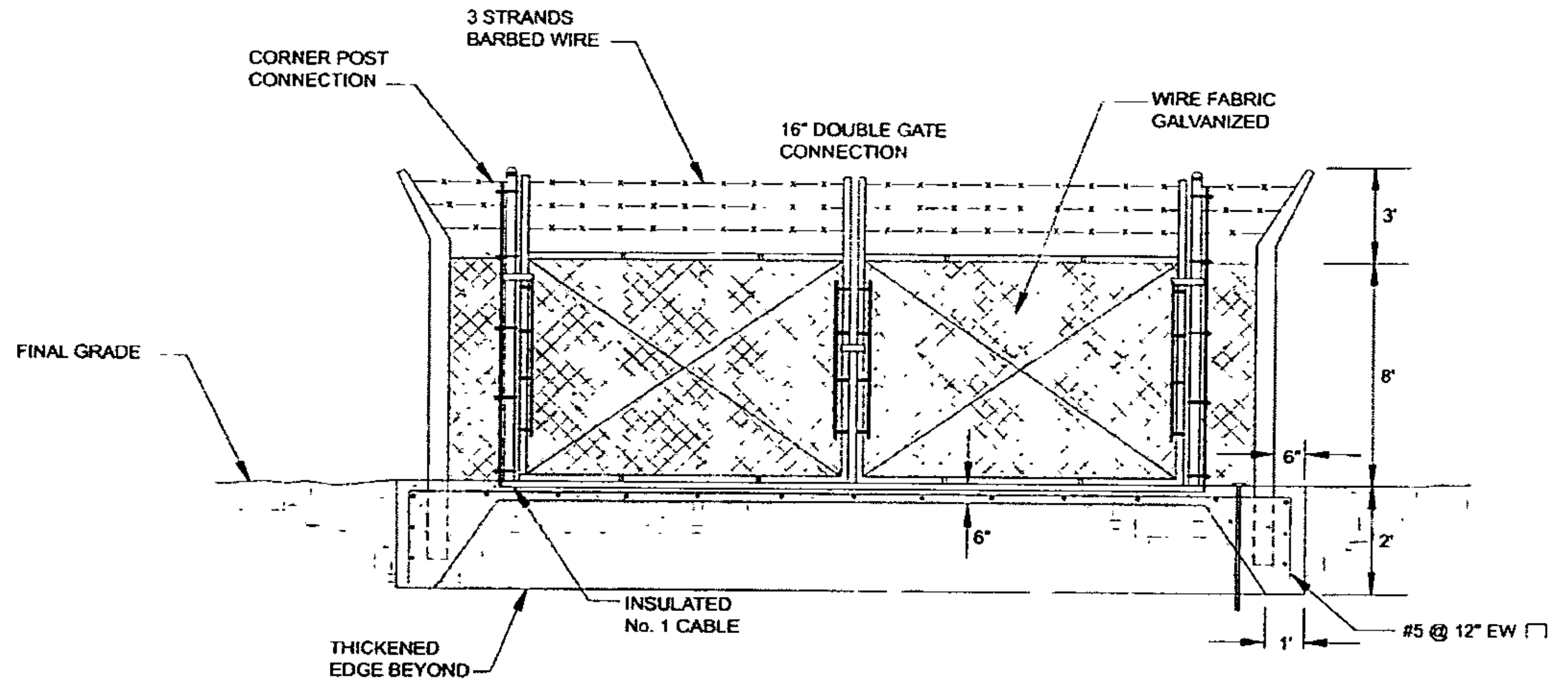
DATE	SEPTEMBER, 2006
PROJ	177556
DWG	F-6
SHEET	8

USER: EGRIGGS TAB: LAYOUT1

ATL/PROJ/148071 DDMT/SARD 2006

FILENAME: SHEET 8 (BUILDING DETAILS).DWG PLOT DATE: 7-Jul-08 PLOT TIME: 1:10:40 PM

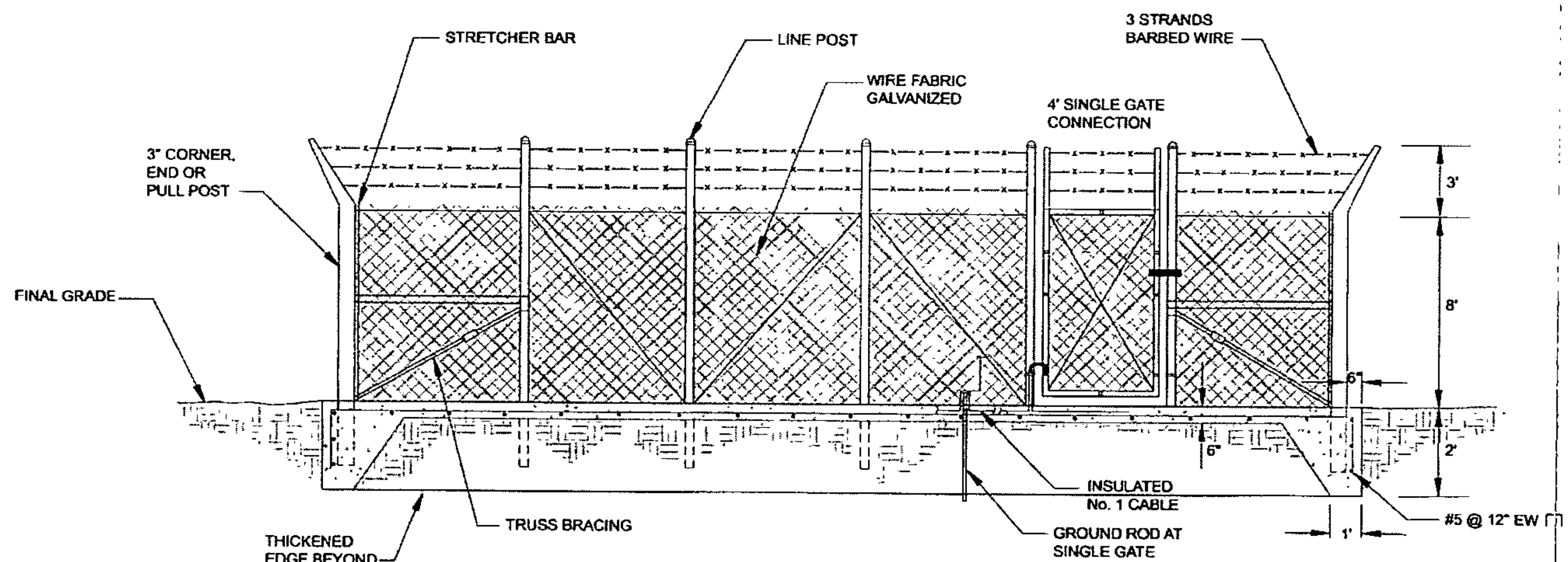
8891181



DOUBLE GATE DETAIL

NO SCALE

NOTES:
WHEN ANCHORAGE OF EQUIPMENT TO PAD IS REQUIRED, USE CONCRETE ANCHORS SPECIFIED



CHAIN LINK FENCE & CONCRETE PAD DETAIL

NO SCALE

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

4-12-07

NO.	DATE	REVISION	BY	APVD

DSGN M. PERLMUTTER | DR G. HARTLEY | CHK H. STRONG | APVD D. NELSON

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

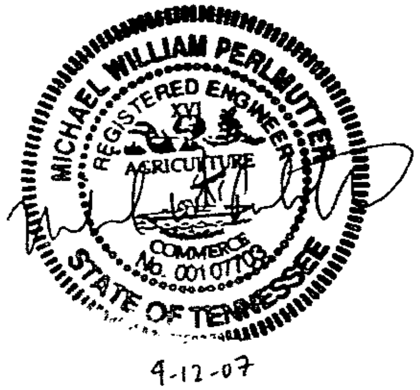
FLUVIAL SANDS SVE
FENCE DETAIL

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

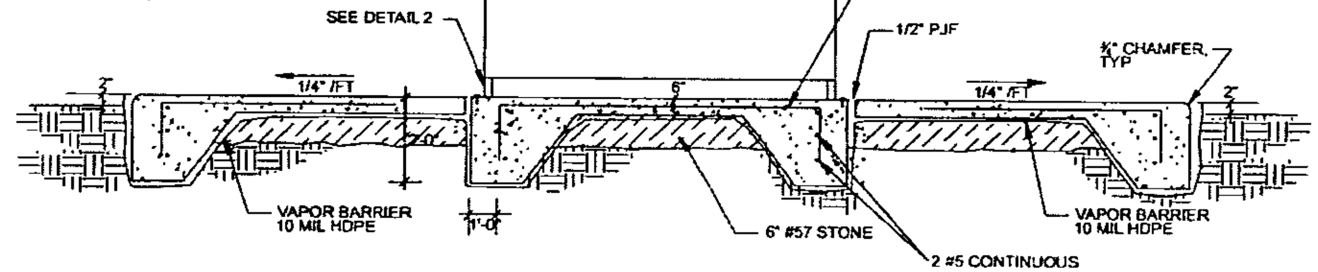
DATE	SEPTEMBER, 2006
PROJ	177556
DWG	F-7
SHEET	9

USER: EGRIGGS TAB: DLAYOUT
ATL/PROJ/148071 DDMT/SARD 2006
FILENAME: SHEET 9 (FENCE DETAIL).DWG PLOT DATE: 7-Jul-06 PLOT TIME: 1:10:40 PM

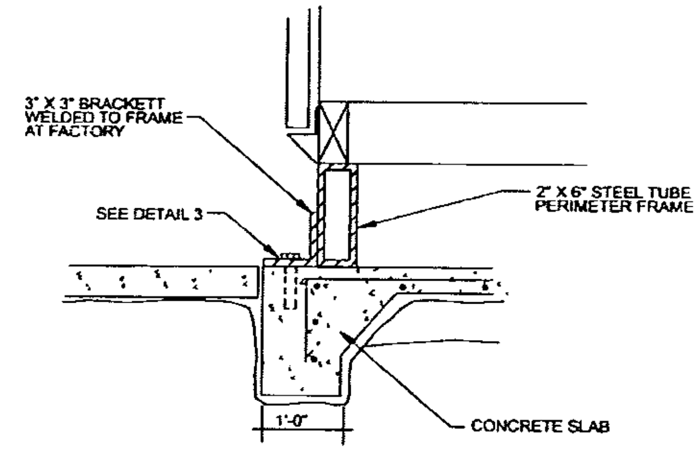
8891182



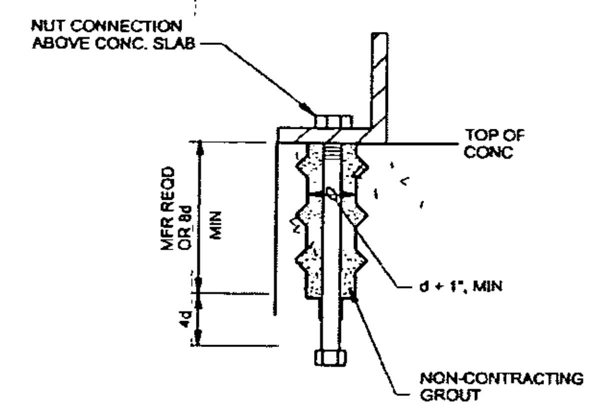
4-12-07



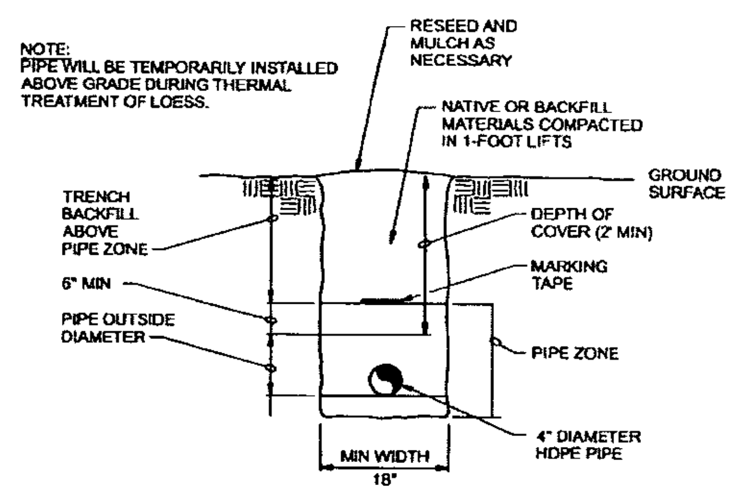
① BUILDING FOUNDATION DETAIL
NTS



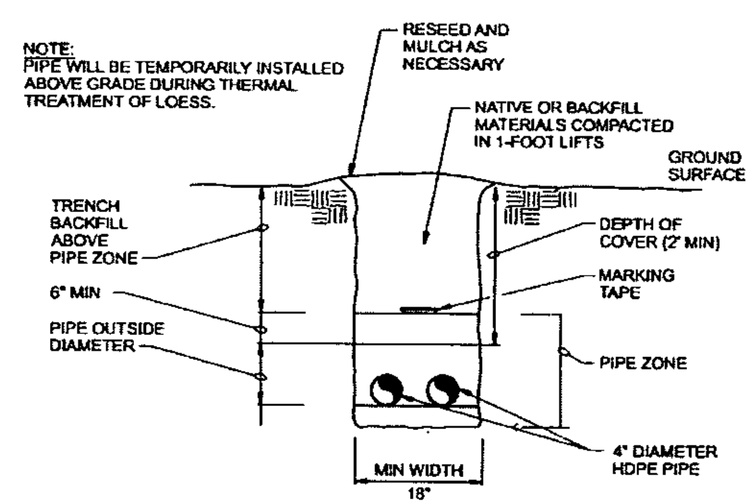
② ATTACHMENT DETAIL
NTS



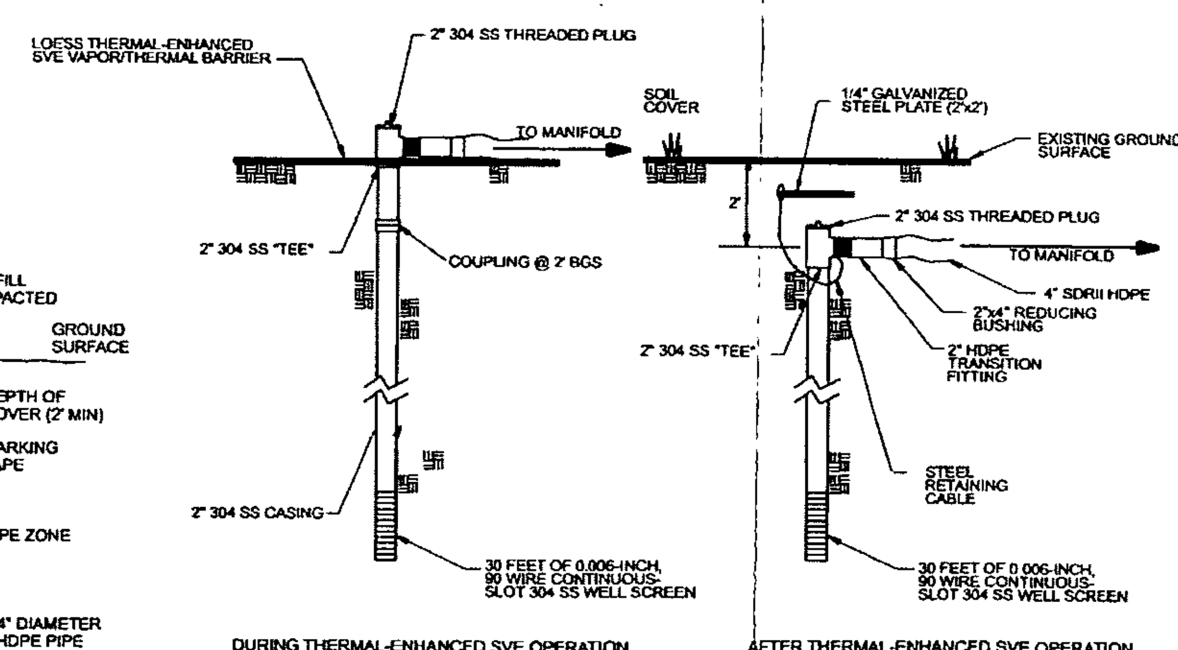
③ ANCHOR BOLT DETAIL
NTS



④ SINGLE PIPE SECTION
NTS



⑤ DOUBLE PIPE SECTION
NTS



⑥ SVE WELL HEAD DETAIL
NTS

NO	DATE	REVISION	BY	APVD

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

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

FLUVIAL SANDS SVE
DETAILS

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

DATE	MARCH, 2007
PROJ	177556
DWG	F-8
SHEET	10

USER: EGRIGGS TAB: LAYOUT1

ATL/PROJ/148071 DDMT/SARD 2006

FILENAME: SHEET 10 (DETAILS).DWG PLOT DATE: 11-Dec-06 PLOT TIME: 10:33:41 AM

ATTACHMENT A

Cut Sheets

8891184

TurboTron® Full Flow and Half Flow Regenerative Blowers/Vacuum Pumps

TurboTron

Regenerative Blowers/ Vacuum Pumps

FULL FLOW SERIES

- Airflow to 900 cfm
- Pressure to 13 psig
- Vacuum to 14 "Hg

HALF FLOW SERIES

- Airflow to 450 cfm
- Pressure to 13 psig
- Vacuum to 14 "Hg

Gardner Denver patented Full Flow and Half Flow TurboTron® blowers/vacuum pumps are specifically designed to provide continuous flow, pulse-free air, with the versatility to perform in numerous air applications. Its unique capabilities make TurboTron the choice in applications from wastewater treatment aeration and pneumatic conveying to chemical tank agitation and vacuum cleaning. Typical industries for the TurboTron include foundries, plating, plastics, pharmaceutical, pulp and paper and printing. Application assistance is available by contacting your local TurboTron Representative.

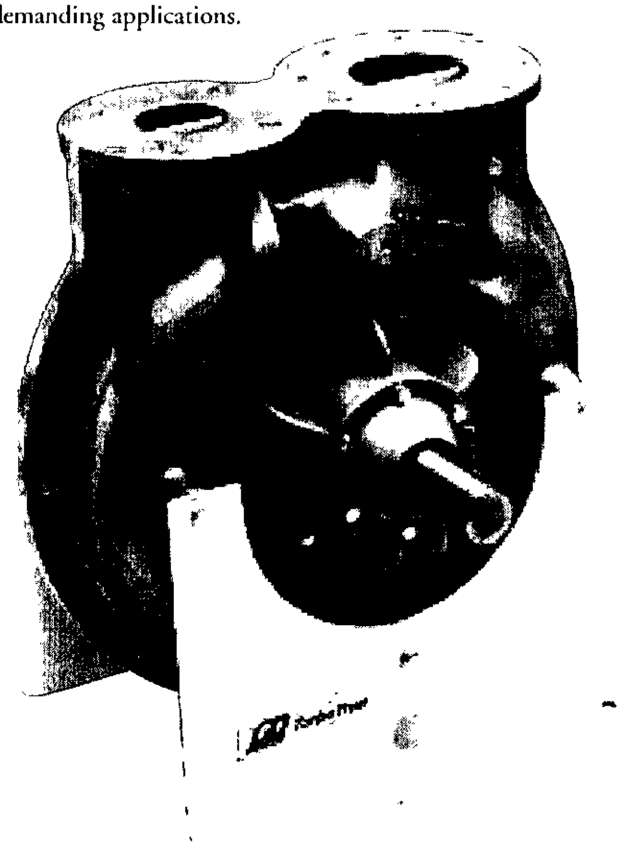
KEY FEATURES:

POWERFUL – Installed as a blower or vacuum pump, the TurboTron features a revolutionary impeller design, achieving multistage compression with a single impeller. This unique design represents the best efficiency in the industry. TurboTron delivers quiet, clean, smooth, pulse-free air with pressures to 13 psig and vacuum to 14 "Hg.

QUIET AND PULSE FREE – Noise and vibration are reduced. Even without an accoustical cover, the typical free field noise level is only 82 dBA at three feet, one meter.

TROUBLE-FREE – TurboTron is virtually maintenance free. There is only one moving part and no timing gears. The high tensile strength aluminum composite housing is corrosion resistant. Non-binding Teflon® is used in close tolerance areas. Bearings require only occasional greasing and shaft seals are non-contacting and non-wearing.

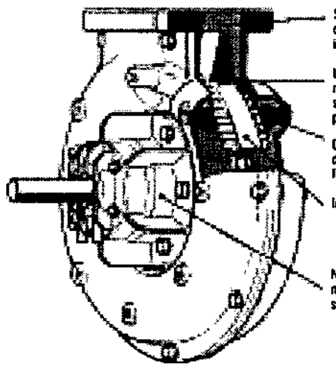
VALUE – TurboTron's revolutionary design, proven dependability and power make this blower/vacuum producer the best investment for the most demanding applications.

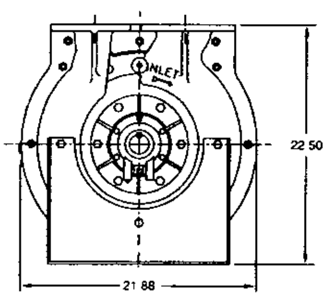


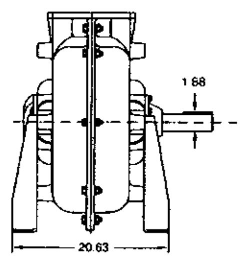
8891185

TurboTron® Full and Half Flow Performance and Dimensional Data

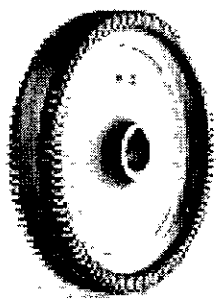
REVOLUTIONARY DESIGN







FULL FLOW

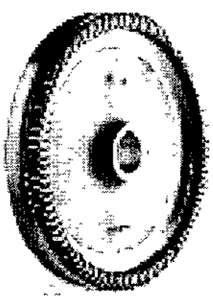


Full Flow Impeller

RPM		PRESSURE (psig) 2	3	4	5	6	7	8	9	10	11	12	13
2000	SCFM	262	211	164	120								
	HP	5.1	7.1	9.1	11.1								
2800	SCFM	458	415	374	333	295	257	221					
	HP	9.0	11 7	14.3	17 0	19.7	22.5	25.2					
3700	SCFM	668	629	591	555	520	486	454	423	393	364		
	HP	15.3	18.9	22.4	22.8	29.3	32.9	36.6	40.4	44 1	47 6		
4500	SCFM	858	817	780	745	713	682	653	626	600	575	552	529
	HP	22.8	27.4	31.7	35.9	40.1	44 3	48.6	52 9	57.3	61 6	66.0	70 2

RPM		VACUUM ("Hg) 3	4	5	6	7	8	9	10	11	12	13	14
2000	ICFM	258	217	179	143	109	77						
	HP	3 8	4 8	5.8	6.8	7.7	8.7						
2800	ICFM	428	393	352	312	274	235	199	163	128			
	HP	7 0	8 0	9 3	10.5	11.7	13.0	14 2	15.6	16.9			
3700	ICFM	630	583	536	490	446	402	359	318	278	239		
	HP	10 8	12 8	14.5	16.1	17.7	19.2	20.7	22.4	24 1	25.8		
4500	ICFM	810	757	702	648	,596	546	498	452	407	364	323	283
	HP	15 7	18 0	20.3	22 3	24.2	26.0	27.8	29.5	31.3	33.2	35 0	36.7

HALF FLOW



Half Flow Impeller

RPM		PRESSURE (psig) 2	3	4	5	6	7	8	9	10	11	12	13
2000	SCFM	131	105	82	60								
	HP	2 8	3.9	5.0	6.1								
2800	SCFM	229	208	187	167	147	129	111					
	HP	5 0	6.4	7.9	9.3	10.8	12.3	13.9					
3700	SCFM	334	314	295	277	260	243	227	211	196	182		
	HP	8 4	10.4	12.3	14.2	16.1	18.1	20.1	22.2	24.3	26.2		
4500	SCFM	429	409	390	373	356	341	327	313	300	288	276	265
	HP	12.5	15.1	17.4	19 7	22.0	24.3	26.7	29.1	31.5	33 9	36.3	38 6

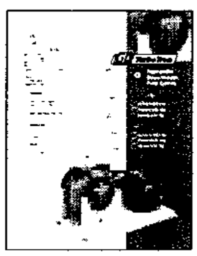
RPM		VACUUM ("Hg) 3	4	5	6	7	8	9	10	11	12	13	14
2000	ICFM	129	109	90	71	55	39						
	HP	2.1	2.6	3 2	3 7	4 2	4.8						
2800	ICFM	214	197	176	156	134	118	99	81	64			
	HP	3.9	4 4	5.1	5.8	6.4	7 1	7.8	8.6	9.3			
3700	ICFM	315	291	268	245	223	201	180	159	139	119		
	HP	5.9	7 0	8.0	8.9	9.7	10 6	11.4	12 3	13 2	14.2		
4500	ICFM	405	378	351	324	298	273	249	226	203	182	161	141
	HP	8 6	9 9	11.2	12.3	13 3	14 3	15 3	16.2	17 2	18.2	19 2	20 2

Performance data for air at standard conditions Sea level 14 7 PSIA, 29 92 "Hg, 68°F inlet temperature, 36% relative humidity

Contact Your TurboTron Representative

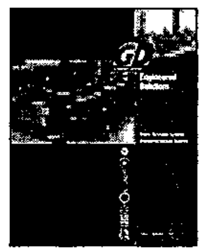
Other Gardner Denver Brochures Available

TurboPak A Blower/ Vacuum Pump System



Water & Wastewater Treatment Solutions

Engineered Solutions



For additional information, contact your local representative or

Gardner Denver Blower Division
100 Gardner Park, Peachtree City, GA 30269
Toll Free 800-543-7736 ext 414
Phone 770-632-5000 • Fax 770-486-5629
E-mail: blowersmktg@gardnerdenver.com
Visit our web site: www.gardnerdenver.com
For Parts Information, Contact:
Gardner Denver Blower Division Customer Service
Toll Free 800-982-3009
Phone 770-632-5000 • Fax 770-486-5629

Bulletin GDL-212 04012.5M Specifications subject to change without notice.

ERDCO®

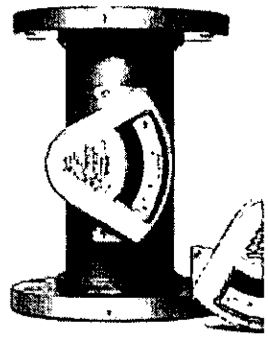
See-Flo®
indicators for transparent fluids

Armor-Flo™
general purpose meters

Turbo-Flo™
insertion flowmeters

Applications List

3200 See-Flo® Indicator



See-Flo® meters indicate flow rate and permit visual inspection of water, air or other transparent fluids. For general purpose industrial service, See-Flo® meters handle a wide range of process fluids in vertical or horizontal piping runs.

The wedge shape of the meter housing makes See-Flo® practically self-cleaning. Where periodic maintenance might be necessary, the tempered glass window is easily removed and replaced. Because of its large internal cavities this product will not plug up like the old glass tube "rotameters".

Each flowmeter is calibrated to be direct reading for the liquid or gas opera conditions that you specify. Scales with special engineering units and dual measure are available.

Series	Description	Applications	Functions	Features	Materials	Pressure Limits	Tempe Limits
3200	Flow Indicator	Transparent Liquids or gases	Direct reading flow rate Observe fluid condition	Lowest cost meter No power required Calibrated for application conditions	Aluminum, brass or 316 sst	200 psig	400°F 400°F ra requires viton o-r

Back to See-Flo® Selection Guide

ERDCO Engineering Corporation

800.553.0550 toll-free in US and Canada
Telephone: 847.328.0550
Fax: 847.328.3535
721 Custer Avenue

8891187

Evanston, IL 60202 USA

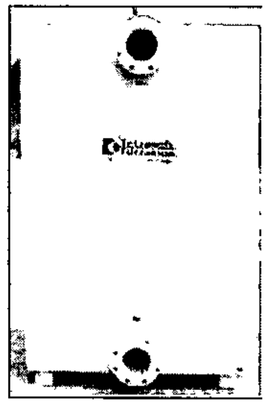
e-mail: info@erdco.com

8891183

Tetrasolv Filtration

Catalog

VF SERIES FILTERS
MODEL VF-2000

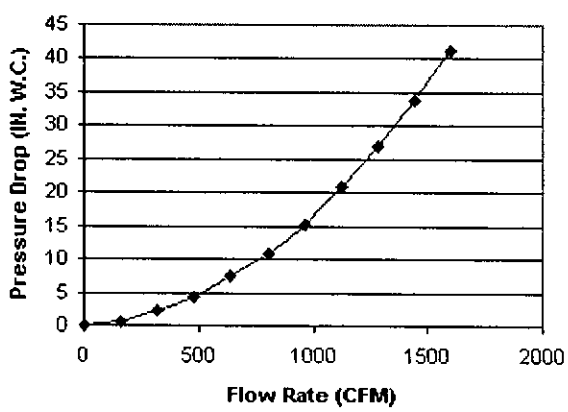


The VF-2000 filter is a media filter vessel designed to treat vapor streams where pressure drop is a strong concern. While the typical design application is a activated carbon adsorbtion unit, the filter can easily accommodate many medias. The sturdy construction makes these filter vessels ideal for long term treatment units. Some applications include:

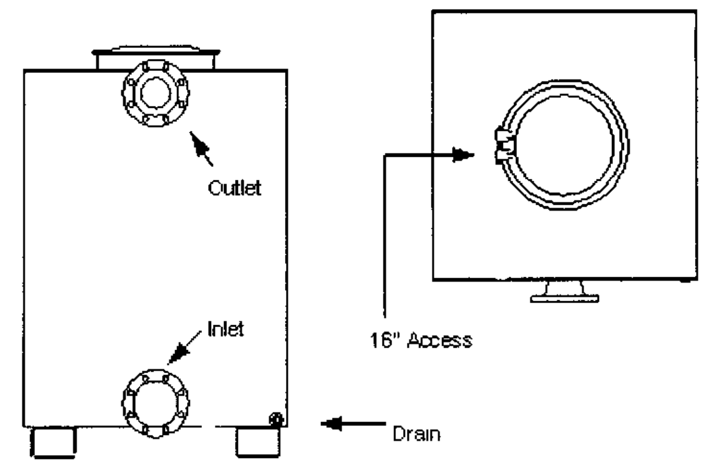
- Soil Vapor Extraction Treatment
- Air Stripper Off Gas Treatment
- Odor Removal System
- Storage Tank Purge Vapor Treatment
- Pilot Study
- Industrial Process Treatment

PRESSURE DROP GRAPH

*(As Filled 4*10 GAC)*



8891189



VF-2000 SPECIFICATIONS			
Overall Height	6'8"	Vessel/Internal Piping Materials	Polypropylene
Footprint	4' x 4'	Internal Coating	Polyamide (2-Part) Epoxy Resin
Inlet / Outlet (150# FLNG)	6"	External Coating	Epoxy Mastic (Light Grey)
Drain / Vent (FNPT)	1/2"	Maximum Pressure / Temp	3 PSIG / 250° F
GAC Fill (lbs)	2000	Cross Sectional Bed Area	16 FT^2
Shipping / Operational Weight (lbs)	2,650/3,200	Bed Depth/Volume	4.5 FT / 71 FT^3

Our Company | News | Catalog | Services | RFQs | Contact

Tetrasolv Filtration, Inc. • 1200 East 26th Street • Anderson, Indiana 46016 • USA
Toll Free: 800-441-4034 Telephone: 765-643-3941 • Fax: 765-643-3949
www.tetrasolv com • info@tetrasolv com

Draft Statement of Work
Loess Deposits Thermal-Enhanced SVE
Memphis Depot Dunn Field
Memphis, TN

1.0 Introduction

This draft Statement of Work (SOW) is for the loess deposits thermal-enhanced soil vapor extraction (SVE) system at Memphis Depot Dunn Field and has been prepared for the U.S. Army Corps of Engineers (USACE) - Huntsville Center as part of Task Order 6 under Contract Number DACA87-02-D-0006. This draft SOW is part of the Dunn Field Source Areas Remedial Design (RD) in anticipation of the Remedial Action Work Plan (RAWP) that will be developed by the Remedial Action Contractor (RAC) for the Source Areas groundwater remediation effort. The details on performance and monitoring requirements for execution of the work provided in this draft SOW will be incorporated as part of the Contract prepared by the RAC.

The Dunn Field Source Areas RD and this draft SOW has been submitted to satisfy the requirements outlined by the Base Realignment and Closure (BRAC) Act, as well as requirements set forth by the BRAC Cleanup Team (BCT) for the Memphis Depot. The BCT is composed of representatives of the Defense Logistics Agency (DLA), Tennessee Department of Environment and Conservation (TDEC), and the EPA. The lead agency for site activities at the Depot is the DLA. The regulatory oversight agencies are EPA Region 4 and TDEC.

This remedial action (RA) will include the use of thermal-enhanced SVE (electrical resistance heating [ERH] or in situ thermal desorption [ISTD]) to treat 1.3 acres of Dunn Field from 5 to 30 feet below ground surface (bgs). Sheets 11 and 12 show the layout of the treatment areas. Figure 2-3a shows the typical Dunn Field geologic cross section. Figure 5-3 indicates the removal efficiency objectives for the thermal-enhanced SVE system.

Regardless of the method, the ground surface will be covered with an insulated vapor barrier, which will be used to: (1) provide a seal to atmosphere and enhance SVE performance in the loess, as demonstrated during the SVE pilot tests, (2) provide thermal insulation and prevent contaminants from condensing near the land surface, and (3) prevent surface water infiltration, which could lead to undesirable cooling of the treatment zone.

2.0 Site Background

The Memphis Depot is located in southeastern Memphis, Tennessee (see Figure 2-1). It originated as a military facility in the early 1940s. Its initial mission and function was to provide stock control, materiel storage, and maintenance services for the U.S. Army (Memphis Depot Caretaker Division, 2003). In 1995, the Depot was placed on the list of DoD facilities to be closed under BRAC. Storage and distribution of materiel for all U.S. military services and some civil agencies continued until the Depot closed in September 1997.

The Depot is located approximately 5 miles east of the Mississippi River and just northeast of Interstate 240. The property consists of approximately 642 acres and includes two components: (1) the MI, which includes open storage areas, warehouses, military family housing, and outdoor recreational areas; and (2) Dunn Field, which includes former bulk mineral (bauxite and fluorspar) storage and waste disposal areas.

Dunn Field, which consists of approximately 64 acres of undeveloped land, is 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) (see Figure 2-2). Approximately two-thirds of Dunn Field is covered with grass, and the remaining area is covered with crushed rock and paved surfaces.

All of Dunn Field is currently zoned as Light Industrial (I-L). However, the approximately 20-acre Northeast Open Area[1] was identified in the final Dunn Field ROD as future public open space for recreational purposes (CH2M HILL, 2004a).

2.1 Geology

The impacted vadose zone at Dunn Field consists of two distinct geological units: (1) a shallow, relatively low-permeability loess, and (2) a deep, relatively high-permeability alluvium (fluvial sands). The loess, a semi-cohesive eolian deposit composed of silt, silty clay, silty fine sand, and mixtures thereof, extends from the ground surface to a depth of about 30 feet (ft) below ground surface (bgs). Underlying the loess are several feet of sandy clay, followed by 30 to 75 ft of the fluvial sands, silt, and gravel.

The upper 10 ft of the fluvial deposits represent a transition zone between the silt-dominated loess and the sand and gravel of the fluvial aquifer. Underneath the western boundary of Dunn Field, the lower portion of the fluvial deposits, which is comprised of sand, sandy gravel, and gravelly sand, is about 40 ft thick. The sand is generally bright orange to dark red and ranges from poorly-graded to well-graded, fine- to coarse-grained, and very well-sorted to poorly sorted quartz grains. The unit transitions downward into poorly graded, tan to brownish yellow sandy gravel, with chert being the primary gravel constituent. The gravel ranges from small pebbles (1/2 inch) up to small cobbles (average diameter of 4 inches). Interbedded within the sand and gravel are clay lenses that range from thin laminations to layers up to 1 foot thick.

A clay unit of variable thickness is present at the bottom of the fluvial aquifer as the formation transitions to the Jackson Formation/Upper Claiborne Group. The unit is an orange, stiff to dense, silty clay with gray mottling that ranges from 5 to 8 ft thick. The unit directly overlies the gray, stiff, dense, silty clay of the Jackson Formation/Upper Claiborne Group. The two clay layers are distinguished by their different colors and the presence of slightly less silt in the clay of the Jackson Formation (ranging from 20 to 25 percent). Additional site geology details are presented in the following documents:

[1] For purposes of completing the RI and FS, Dunn Field was divided into three separate areas: Northeast Open Area, Disposal Area, and Stockpile Area

- *Dunn Field RI Report* (CH2M HILL, 2002)
- *Report of Offsite Design-Related Investigation* (MACTEC, 2005b)
- *Results of the Memphis Depot – Dunn Field Remedial Design Investigation* (RDI) (CH2M HILL, 2006a)

2.2 Nature and Extent of Contamination in Subsurface Soil

Subsurface soil samples were collected during the Dunn Field RI. Concentrations of chlorinated volatile organic compounds (CVOCs) in subsurface soil samples collected in 1999 showed significant levels of the following: 1,1,2,2-tetrachloroethane (PCA); 1,2-dichloroethane (DCA); carbon tetrachloride (CT); chloroform; methylene chloride; tetrachloroethene (PCE); trichloroethene (TCE); and vinyl chloride. The highest level of TCE detected in 1999 was 460 milligrams per kilogram (mg/kg).

Based on analysis of the 1999 data and on detection of possible dense non-aqueous phase liquid (DNAPL) in groundwater immediately west of the Disposal Area, CH2M HILL conducted further soil sampling in October 2000 to delineate potential SAs. As part of this effort, 15 soil borings were installed in the Disposal Area; CVOCs were detected in soil samples at concentrations up to 22.6 mg/kg (1,1,2,2-trichloroethane [TCA]).

A passive soil gas survey was conducted at Dunn Field in August 1998 (Phase 1) and October 1998 (Phase 2). Phase 1 focused on the Disposal Area and Phase 2 expanded the soil gas sampling grid to the east and north to further delineate soil gas identified in Phase 1. The goal of this survey was to provide screening information on the potential sources of volatile organic compound (VOC) contamination of groundwater at Dunn Field. A total of 538 Gore-Sorber modules were installed (302 in Phase 1 and 236 in Phase 2). A complete discussion of the investigation findings is provided in the Dunn Field RI Report.

A soil gas investigation was also conducted by Parsons Engineering Science, Inc. (Parsons) in October 2000. Parsons collected soil gas samples using a SimulProbeTM. This work was reported in the Remedial Process Optimization (RPO) Phase II Evaluation Report, Defense Depot Memphis, Tennessee (Parsons, 2001). The Parsons report contains a summary of the laboratory analytical results for the soil gas samples collected at Dunn Field.

A pre-RD investigation was conducted in 2003 to supplement existing chemical and physical data on 17 former disposal sites on Dunn Field (*Disposal Sites Final Remedial Design Rev. 1*, CH2M HILL, 2004). Land surveying, geophysical surveying, and trench excavation was conducted at Dunn Field to define the location and dimensions of each disposal site as compared to existing information on each site, evaluate the chemical and physical characteristics of materials present within the Priority Level A and B disposal sites along with the surrounding soil media, and develop estimates of the physical condition and quantity of potentially hazardous materials present in each Priority Level A and B disposal site. Uncovered buried objects, including a few crushed 55-gallon drums, were removed during the investigation.

Additional soil samples were collected as part of the RDI for Dunn Field to delineate CVOC contamination to a depth of approximately 30 ft (within the loess deposits only). As part of this effort, a membrane interface probe (MIP) investigation was conducted to characterize the magnitude and extent of elevated CVOCs in the loess by using the semi-quantitative electron capture detector (ECD). Soil samples were collected from select MIP locations for laboratory analysis to correlate the data sets and adequately delineate the areas with CVOCs concentrations below the MIP detection limit but above the established Dunn Field remediation goals (RGs). More than 160 locations were investigated with the MIP and more than 80 soil samples were collected during the RDI. Soil sampling results (including key results from previous soil investigations) and MIP responses are summarized on Figures 2-10a, 2-10b, 2-10c, and 2-10d.

Based on SVE treatability study results, the RDI results, and the estimated time to achieve cleanup goals using conventional SVE, it was concluded that conventional SVE would not likely be able to achieve the ROD RG in a reasonable timeframe (5 years). As such, thermal-enhanced SVE was selected as the remedy for the loess.

3.0 Scope of Work

The RAC requires Subcontractor assistance to design, install, construct, operate, and monitor the loess deposits thermal-enhanced SVE system at Dunn Field. This section provides the technical approach for the onsite activities included in the SOW. The subcontractor shall furnish all labor, equipment, materials, lower-tier Subcontractors, supplies, and all else necessary to completely perform the scope of work identified herein. All work shall be completed in compliance with current federal, state, and local regulations and in accordance with standard industry practice.

The proposal submitted in response to this solicitation shall include the following information:

- A comprehensive technical and management approach, including site specific concerns, to accomplish the work.
- A proposed schedule for completing the work.
- The anticipated personnel and equipment required to complete the work.
- A statement of any exceptions or assumptions that have been taken to this SOW.
- Other information as required by this RFP.

The Bidder shall carefully examine the site and make all inspections necessary in order to determine the full extent of the work required to make the completed work conform to the bid requirements. The Bidder shall satisfy himself as to the nature and location of the work, conditions, the conformation and condition of the existing ground surface, and the character of equipment and facilities needed for the prosecution of the work. The Bidder shall satisfy himself as to the character, quality, and quantity of surface and subsurface materials or obstacles to be encountered. Any inaccuracies or discrepancies between the actual field conditions and the bid documents must be brought to the RAC's attention in order to clarify the exact nature of the work included in the bid requirements.

Per the bid form, the bid shall be provided as follows:

1. Cost to design system (with technical approach and contingencies).
2. Cost to install, construct, operate, and monitor system per design to achieve remedial goals (RGs).
3. Cost to extend operation on a monthly basis to increase mass removal or achieve RGs if confirmation soil sample results indicate additional treatment time is required beyond the contracted operational period.

3.1 Work Required

The Subcontractor shall perform all work and provide all labor, materials, equipment, and supplies to perform and complete the work described herein. Specific actions, including primary (P) and secondary (S) responsibilities of the project team, are detailed in **Table 1**. The Subcontractor should comply with federal, state, and local laws, statutes, and ordinances relating to the execution of the work. This requirement includes, but is not limited to, applicable regulations for minimum wage rates, nondiscrimination in the employment of labor, protection of public and employee safety and health, environmental protection, the protection of natural resources, fire protection, burning and non-burning requirements, permits, fees, waste management, and similar subjects.

Upon receiving written authorization to proceed, the Subcontractor shall conduct the following tasks:

Design

- Review the Memphis Depot Dunn Field Source Areas Final Remedial Design (CH2M HILL, 2007) and any relevant background documents.
- Conduct a site visit to observe conditions, review utility mapping, etc., review the surrounding community, and attend one Memphis Depot team meeting in Memphis to discuss details and issues associated with the final design and system implementation.
- Participate in team teleconferences related to design, implementation and operation of a thermal-enhanced SVE system in support of the Dunn Field Source Areas RA. For estimation purposes it is envisioned that three teleconferences would occur prior to system implementation and two after system operation is completed.
- Consultation with the BCT regarding planning, final design, implementation and evaluation of the thermal-enhanced SVE system.
- Complete the design of the thermal-enhanced SVE system and provide its final layout.
- Finalize system process flow diagram and update of the major equipment listing,
- Finalize cost estimate to fully implement and complete the thermal-enhanced SVE process at Dunn Field according to project responsibilities defined in **Table 1**.

Installation, Construction, Operation, and Monitoring

- Procure materials, services and mobilize for system construction.
- Operate the thermal-enhanced SVE system in accordance with the responsibilities outlined in **Table 1** and the performance objectives presented below.
- Participate in teleconferences to update the team on system operation and performance. For estimation purposes it is envisioned that brief teleconferences would be held twice per month to update the BCT on system performance and progress. To facilitate and streamline team discussion, a standing call agenda will be created. Call frequency will likely be altered following system start-up to best suit the needs and schedules of the project team.
- Prepare and electronically distribute a biweekly summary of system operation to the BCT.
- Collaborate with RAC to design the confirmation soil sampling protocol during the planned cool-down phase to evaluate whether RGs have been achieved. Participate in subsequent teleconference(s) to assess need to continue treatment.
- Upon thermal-enhanced SVE system completion, demobilize equipment, personnel and return site to its original pre-test conditions.
- Prepare a final report summarizing system performance and remedy results.

3.2 Remedial Action Objectives and Remediation Goals

Remedial action objectives (RAOs) are medium-specific goals that the RA is expected to meet to protect human health and the environment and to comply with the Applicable or Relevant and Appropriate Requirements (ARARs) established in the final Dunn Field ROD. The following RAOs were developed for subsurface soil impacted by CVOCs at the Disposal Area:

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

Based on the risk assessment findings and the chemicals of concern (COCs) developed, RGs were established for affected media at Dunn Field. As presented in the final Dunn Field ROD (CH2M HILL, 2004a), the RGs for CVOCs in soil, soil vapor, and groundwater at Dunn Field are summarized in **Table 2.**

Performance Metric

The objective of the thermal-enhanced SVE system is to achieve RGs for CVOCs in soil, soil vapor, and groundwater at Dunn Field. The system should be designed and operated accordingly. However, rather than guaranteeing performance, the Subcontractor is encouraged to optimize the thermal treatment system to minimize costs and maximize mass removal with the ultimate objective of achieving RGs.

Therefore, based on the Subcontractor's final design, the Subcontractor will be required to sustain the design temperature (for example, 95°C or higher) at a minimum number of horizontal and vertical monitoring points (for example, one location per 500 cubic yards of soil) for an agreed upon number of days (for example, 80 days). At the end of the contracted operational period the RAC may request the Subcontractor to continue operating the thermal-enhanced SVE system at the contracted monthly rate (see SOW Section 4).

The Subcontractor will also be required to demonstrate that hydraulic and pneumatic control is maintained throughout the operation period to ensure that the contaminants that are mobilized are also captured.

3.3 Mobilization and Cleanup

The Subcontractor will perform all work necessary to move personnel and equipment in and out, set up and remove drill rigs and other equipment, and clean up and restore the sites to their original condition prior to the onset of construction activities. The Subcontractor should avoid contaminating the project area. Waste oil, rubbish, and other similar materials will not be dumped on the ground. If needed, the RAC will provide a secure area to store construction equipment while not in use.

3.4 Decontamination

Onsite activities will require decontamination of personnel, construction equipment, and sampling equipment. Decontamination methods shall be developed in the Subcontractor SSHASP in accordance with Section 4 of the November 2001, EPA Science and Ecosystem Services Division *Environmental Investigation Standard Operating Procedures and Quality Assurance Manual* (EISOPQAM).

3.5 Waste Management

Soil Cuttings, Drilling Fluids, and Well Development Water

The Subcontractor will be responsible for obtaining containers (55-gallon drums or roll-off containers) to manage soil cuttings, and drilling fluids at the site and the equipment decontamination pad. Decontamination water, well development water, and purge water will also be collected in the provided containers. Each container must be labeled with a unique identifier, contents, date, and source of waste, including borehole or well number.

Fluids collected at the decontamination pad shall be transferred using a Subcontractor supplied sump pump into the provided drums or containers; soil that accumulates on the decontamination pad while decontaminating equipment shall be also removed and placed in the provided drum(s). Decontamination fluids and recovered soils will not be mixed together.

Personal Protective Equipment and General Debris

Used PPE and solid wastes such as packaging materials and other non-hazardous waste resulting from system construction or operations, should be placed in a trash bag and disposed in any RAC dumpster that is utilized for trash collection (not cardboard, white paper, or metal shavings).

Thermal-Enhanced SVE System Waste Streams

Operation of the thermal-enhanced SVE system may create up to three unique waste streams: vapor, water and recovered solvents. Management of these materials is the responsibility of the Subcontractor; disposal will be handled by the RAC. During system operation, water generated in the system will be treated by the Subcontractor and discharged to the City of Memphis POTW through the existing IRA groundwater recovery system. It will be the responsibility of the Subcontractor to comply with regulations or procedures regarding discharge to the POTW as regulated by the City of Memphis Public Works Department.

Vapor extracted from the subsurface will be discharged directly to the atmosphere following treatment. The RAC will obtain all necessary air discharge permits from applicable federal, state and local regulatory bodies.

If applicable, solvent reclaimed from extracted vapor will be collected in 55-gallon steel drums provided by the RAC. During system operation, any drum accumulating or containing recovered solvent will be stored with secondary containment provisions. When full, solvent drums will be transported offsite for disposal by the Subcontractor. Drums containing recovered solvent must be labeled with a unique identifier, contents, date, and source of waste; drums must be sealed prior to transport and when they are not in use.

3.6 Site Restoration and Demobilization

All disturbed areas will be seeded, fertilized, and mulched to minimize erosion. The areas will be graded smooth and uniform with the surrounding areas. Large stone, debris, and materials will be removed and, if necessary, disposed of offsite. The grass mix will be installed per the specifications throughout the course of the project, since the sites are widespread and will be completed at various times. Fencing will also be installed around the perimeter of the remediation site to limit unauthorized access.

During demobilization, temporary facilities, utilities, and equipment will be removed from the site. Any debris or solid waste material remaining from the closure activities will be removed and properly disposed of. Cleanup and demobilization activities will not be considered complete until final approval is issued by the DLA.

3.7 Health and Safety

All field personnel performing system construction or operation activities will have completed and be current in the following training prior to site entry.

- OSHA40-Hour HAZWOPER Training
- Annual Medical Monitoring

Proof of completion of training and certification will be collected prior to the commencement of work activities and maintained on file.

A kick-off health and safety meeting will be conducted by the RAC SSC prior to initiation of field work and daily tailgate health and safety meetings will be conducted thereafter at the beginning of each work day. At a minimum, Level D Personal Protective Equipment (safety goggles, hard hat, safety shoes, tyvek or cotton coveralls, and gloves) will be worn during construction and operation activities. Task specific PPE will be provided by the Subcontractor in accordance with the SSHASP developed for system construction and operation. If health and safety conditions in the field exceed the current level of protection, the SSC may either upgrade PPE or suspend work until hazardous conditions have dissipated, or may implement an engineered solution.

3.8 Required Submittals

Site-Specific Health and Safety Plan

The Subcontractor SSHASP will include a detailed description of work with equipment, materials, and personnel identified to perform Subcontractor's scope of work. In addition, the SSHASP will include an inventory of chemicals that will be used onsite, along with MSDSs for each. The SSHASP shall specify chemical handling procedures and required PPE for each task involving potential chemical exposure during the Subcontractor's work. The SSHASP will be consistent, and the Subcontractor shall comply, with the requirements and guidelines of:

- Occupational Safety and Health Administration (OSHA) Standards and Regulations contained in Title 29, Code of Federal Regulations, Parts 1910 and 1926 (29 CFR 1910 and 1926), including amendments as stated in Federal Regulations March 6, 1989: 9294-9336 Final Rule, 29 CRF 1910.120 "Hazardous Waste Operations and Emergency Response";
- United States Environmental Protection Agency (USEPA) Standard Operating Guidelines Revised November 1984;
- NIOSH/OSHA/USCG/EPA Occupational Safety and Health Guidance Manual for Hazardous Site Activities, October 1985, NIOSH Publication No. 85-115; and
- Threshold Limit Values for Chemical Substances in the Work Environment adopted by American Conference of Governmental Industrial Hygienists (ACGIH), 1997 or most recent version
- If the Subcontractor does not have its own drilling safety procedures manual, the National Drilling Federation *Drilling Safety Guide, 1991* must be followed.

Implementation Plan

The Subcontractor shall develop a site-specific "Implementation Plan" as described hereinafter, explaining its complete approach to completing the work. The implementation plan at a minimum will include the following information:

- Project organization
- Lines of communication
- Resources (e.g., personnel, materials, equipment, etc.)
- Project schedule
- Detailed description of the remediation system and proposed construction approaches
- Experimental procedures including any proposed laboratory analysis.
- Mobilization
- Site preparation

8891199

- Sampling and Analysis Plan
- Erosion and Sedimentation Control Plan
- Demobilization
- Site restoration
- Quality Assurance

Operations and Maintenance Plan

A detailed operations and maintenance (O&M) plan for the thermal-enhanced SVE system will be developed. The material presented in the plan is intended to be a general description of the O&M requirements of the thermal-enhanced SVE system. The plan will consist of the following information:

- System startup and shutdown procedures
- Emergency shutdown and communication procedures
- Vapor and groundwater recovery system operating and waste management procedures
- Process monitoring and data collection
- Equipment inspection procedures
- Project team contacts list and projected staffing
- Projected operating schedules and duration
- Contingency measures
- System specific health and safety information

3.9 Deliverables

System Progress Updates

During operation of the thermal-enhanced SVE system, the Subcontractor will prepare and electronically distribute a biweekly summary of system operation to the project team. In general, process data contained in this deliverable should provide a high level summary of system operation that could easily be used to update site regulators or other interested parties on system progress. Information envisioned in this deliverable includes: heating progress, system or process sampling, contaminant recovery, the volume and nature of wastes disposed, and system uptime/downtime. Upset conditions and corresponding actions or requirements to minimize should also be reported.

Final Report

Upon completion of treatment, the Subcontractor will furnish a draft report within 45 days to the RAC. The draft report shall include, but not be limited to, the results, analytical evaluation, and interpretation of system operation. The draft report will include a written synopsis of the work, the basis for supporting computations and a summary of system operations. Supporting process monitoring data will be supplied in electronic database format. Results will be presented in an organized, neat, concise manner; text and figures will be completed on use 8½" by 11" or 11" by 17" paper only. The draft report will be delivered to the Memphis Depot BCT team electronically in native file form. Supplemental information pertinent to the construction and operation of the thermal-enhanced SVE system, which may include but is not limited to construction logs, Quality Assurance/Quality Control inspections, boring logs, system drawings, equipment specifications, process monitoring records, operations logs, and system photographs will also be provided in electronic format. A master table summarizing file name, format, contents and general organization will be provided for all electronic information delivered.

Comments to the draft report will be provided by the RAC to the Subcontractor within 21 business days. The final report will be submitted within 10 working days following receipt of RAC comments on the draft report. Five bound copies, one unbound copy, and three electronic copies in Adobe Acrobat PDF format of the final report will be submitted to the RAC. The final electronic copy of the document and all supplemental system information (compiled for the draft deliverable) will be supplied to the project team using CD/DVD media.

4.0 Project Schedule

Subcontractor shall provide whatever resources necessary to complete the SOW within the timeframe presented in the final project schedule developed for the project. Work is limited to daylight hours with work on the weekends acceptable as needed.

The Subcontractor is requested to state in the proposal the estimated duration of performing the various major tasks required to complete Subcontractor's work, including all submittals, and the total estimated duration of performing the total project. This information shall be provided in the form of a project schedule indicating all tasks to complete the work, long lead time items, and indicating the sequence of work.

Project submittals are not schedule driven and may be submitted at any reasonable time following Subcontractor notice to proceed. However, to avoid possible implementation/ operations delays, project submittals (SSHASP, implementation plan, and O&M plan) identified in this SOW must be provided within 21 days of RAC concurrence of the final thermal-enhanced SVE system design. The deliverable date for the final summary reports including analytical and interpretive data will be determined subsequent to completion of the thermal-enhanced SVE system evaluation. Upon project completion, the Subcontractor will provide the draft final and final report in accordance with the durations outlined in Section 3 Deliverables.

Period of Performance

The period of performance has been initially set for October 7, 2007 through November 10, 2008. However, to achieve RAOs, the period of performance may be modified as a function of the following:

- Long-term CVOC mass removal trends
- Subsurface temperatures
- Soil confirmation sampling results
- Operational costs

These variables would be evaluated with the RAC to asses the need for additional heating time to achieve RGs in the loess deposits. The soil remedy evaluation process may be facilitated with the use of the *U.S. Army Corps of Engineers Soil Vapor Extraction Performance Checklist* (Attachment A of the PSVP), *Development of Recommendations and Methods to Support Assessment of Soil Venting Performance and Closure* (EPA, 2001), *Guidance on Soil Vapor*

Extraction Optimization (AFCEE, 2001) (Attachment B of the PSVP includes the STOP Decision Tree), or other relevant SVE performance monitoring guidance.

Tables

TABLE 1
Task Responsibility Matrix – Thermal-Enhanced SVE System
Memphis Depot Dunn Field Source Areas

Task	RAC	Thermal	Notes
Site Evaluation/Proposal			
Data collection/assembly	P	S	
Preliminary design	S	P	
Site inspection	P	P	
Cost estimate	S	P	
Design and plans			
Work Plan/Final design	P	P	
O&M Plan	S	P	Will also include sampling and analysis for system and site. RAC will provide site specific sampling procedures to Subcontractor.
SSHASP	P	S	Project will be conducted under overall RAC SSHASP, however, Subcontractor will need to prepare their own SSHASP for company equipment/ operations (technology specific).
SAP and QAP	P		QAP developed for Dunn Field site will be adopted
Schedule	P	S	
Shop drawings		P	
Permitting			
Grading	P		
Erosion control/SWPPP	P		
Building/construction	P		
Well/drilling	P		RAC lead with TDEC
Discharge	P		RAC lead with TDEC
Air emission	P		RAC lead with TDEC
Procurement			
Breakout lists of all materials/ equipment		P	
SOWs for Subcontracted work	P	P	RAC and thermal Subcontractor will each develop and supply SOW to their own subcontractors.
Quotes and searches		P	
Ordering		P	

8891203

8891204

TABLE 1
Task Responsibility Matrix – Thermal-Enhanced SVE System
Memphis Depot Dunn Field Source Areas

Task	RAC	Thermal	Notes
Follow-up		P	
Shipping		P	
Site preparation & mobilization prep			
Housing for staff		P	
Transportation for staff		P	
Establish vendor list for local supplies		P	
Survey	P		
Utility locate	P		
Mark well and boring locations	P		RAC will perform task under thermal Subcontractor direction
Fencing and gates	P		Only a temp exclusion zone is required (i.e. construction barricade, flagging, etc).
Office, equipment, and supplies	P		
Space for labor work scheduling	P		
Toilets	P		
Dumpster	P		
Power and water hookup	P		
Staging area	P		Staging areas are available at project site
Site preparation & mobilization prep			
Decontamination area	P		
90-day area	P		RAC will manage storage of containerized cuttings and process waste
PPE	P	P	RAC and thermal subcontractor will each provide PPE to their own employees
Emergency procedures	P	P	
Health and safety	P	S	
Drilling and well installation			
Drilling	S	P	Subcontractor will contract and oversee installation of subsurface thermal remediation equipment (heaters/electrodes, recovery points, instrumentation strings, etc.).

TABLE 1
Task Responsibility Matrix – Thermal-Enhanced SVE System
Memphis Depot Dunn Field Source Areas

Task	RAC	Thermal	Notes
Oversight	S	P	
Baseline sampling	P		
Materials for installation		P	Subcontractor provides specialized construction materials
Waste handling	P	P	Contracted driller(s) will containerize all wastes. RAC will dispose of containerized drill cuttings.
Construction, Treatment Areas			
Install heaters/electrodes		P	
Install recovery well-heads		P	
Install pumps		P	
Piping network		P	
Cables and electrical		P	
Monitoring cables/wires		P	
Thermocouples		P	
Post-installation well-field survey	P		
Construction, Process			
Miscellaneous instrumentation	P		TBD - the location, operation interface, and coordination of installation with Subcontractor will be determined by RAC if additional instrumentation or monitoring equipment is implemented.
Secondary containment pad		P	
Lighting etc.		P	
Power system	S	P	Subcontractor to supply specifics (voltage, phase, amperage) of system utility requirements to RAC
Heat exchangers and knockouts		P	
Vapor treatment system		P	
Water treatment system		P	
Utility connections, power	P		RAC will provide service drop and local disconnect to thermal system specifications
Utility connect, water	P		RAC will provide non-potable water (as needed)
Sewer connection	P		RAC will provide service to discharge treated water generated by thermal system operation.
Waste water management	P		RAC will provide service to discharge treated water generated by thermal system operation.

8891205

8891206

TABLE 1
Task Responsibility Matrix – Thermal-Enhanced SVE System
Memphis Depot Dunn Field Source Areas

Task	RAC	Thermal	Notes
Sampling point install + labeling	P	S	RAC lead. Subcontractor to identify process sample locations
Testing, commissioning			
Monitoring system tests		P	
Finalize data recording sheets and procedures	S	P	
Training, on-site			
Operators		P	
Data collection/assembly	P	P	
Communication		P	
Reporting		P	
Emergency procedures		P	
Health and Safety	S	P	
Operation			
Client interface	P		
Operate well-field		P	
Power system		P	
Heat exchangers and knockouts		P	
Vapor treatment system		P	
Water treatment system		P	
Data collection	P	P	
Sampling and analysis	P		RAC will perform sampling and analysis to document system performance.
Mass and energy balance calculations		P	
Data reduction + presentation	P	P	
Utility arrangement and payment	P		RAC will supply treatment process utilities (power, water. sewer). Subcontractor to provide detailed record of system consumption and discharge.
Rental of miscellaneous		P	

TABLE 1
Task Responsibility Matrix – Thermal-Enhanced SVE System
Memphis Depot Dunn Field Source Areas

Task	RAC	Thermal	Notes
equipment			
Reports and client meetings	P	S	
Waste disposal	P		RAC will dispose of containerized wastes. Subcontractor and their contractors must containerize all system wastes (excluding treated water).
Operation			
PPE	P	P	RAC and Subcontractor will each provide PPE to their own employees
Health and safety monitoring	P	S	Subcontractor will provide health and safety monitoring in accordance with the technology specific SSHASP developed for operation of their thermal system equipment If required, RAC will supplement health and safety monitoring per requirements defined in the site SSHASP.
Interim soil sampling	P		
Analytical and data management	P		
Demobilization			
Well-field disassembly		P	
Well abandonment	P		Will be performed by RAC following equipment removal
Power system		P	
Heat exchangers and knockouts		P	
Vapor treatment system		P	
Water treatment system		P	
Remove containment pads		P	
Site restoration	P		
Rental returns	P	P	
Remove fence + gates		P	
Waste disposal	P		
Shipping of residual equipment		P	
Reporting/closing			
Client interface	P		
Data reduction and presentation	P	S	

8891207

8891208

TABLE 1
Task Responsibility Matrix – Thermal-Enhanced SVE System
Memphis Depot Dunn Field Source Areas

Task	RAC	Thermal	Notes
Final report	P	S	
Meetings and negotiations	P	S	
Publications	P	S	
Contract closure	P		

(P) Primary responsibility
(S) Secondary responsibility
(NA) Not Applicable

TABLE 2
Summary of Remediation Goals for CVOCs in Soil, Soil Vapor, and Groundwater at Dunn Field
Memphis Depot Dunn Field Remedial Design

Parameter	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)
	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:

µg/L = micrograms per liter

HI = Hazard Index

MCL = Maximum Contaminant Level

mg/kg = milligrams per kilogram

ppbv = parts per billion per volume

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

* 1,1-dichloroethene has recently been reclassified by U.S. Environmental Protection Agency (EPA) as a non-carcinogen; however, existing MCL is based on previous assumption that it is a carcinogen. EPA is likely to revise this MCL.

** For trichloroethene, a slope factor of 0.02 (mg/kg-day)E-01 from the range of 0.02 to 0.4 (mg/kg-day)E-01.

*** Soil vapor concentration is in equilibrium with the calculated soil screening level (SSL).

8891209

8891210

Figures

8891211

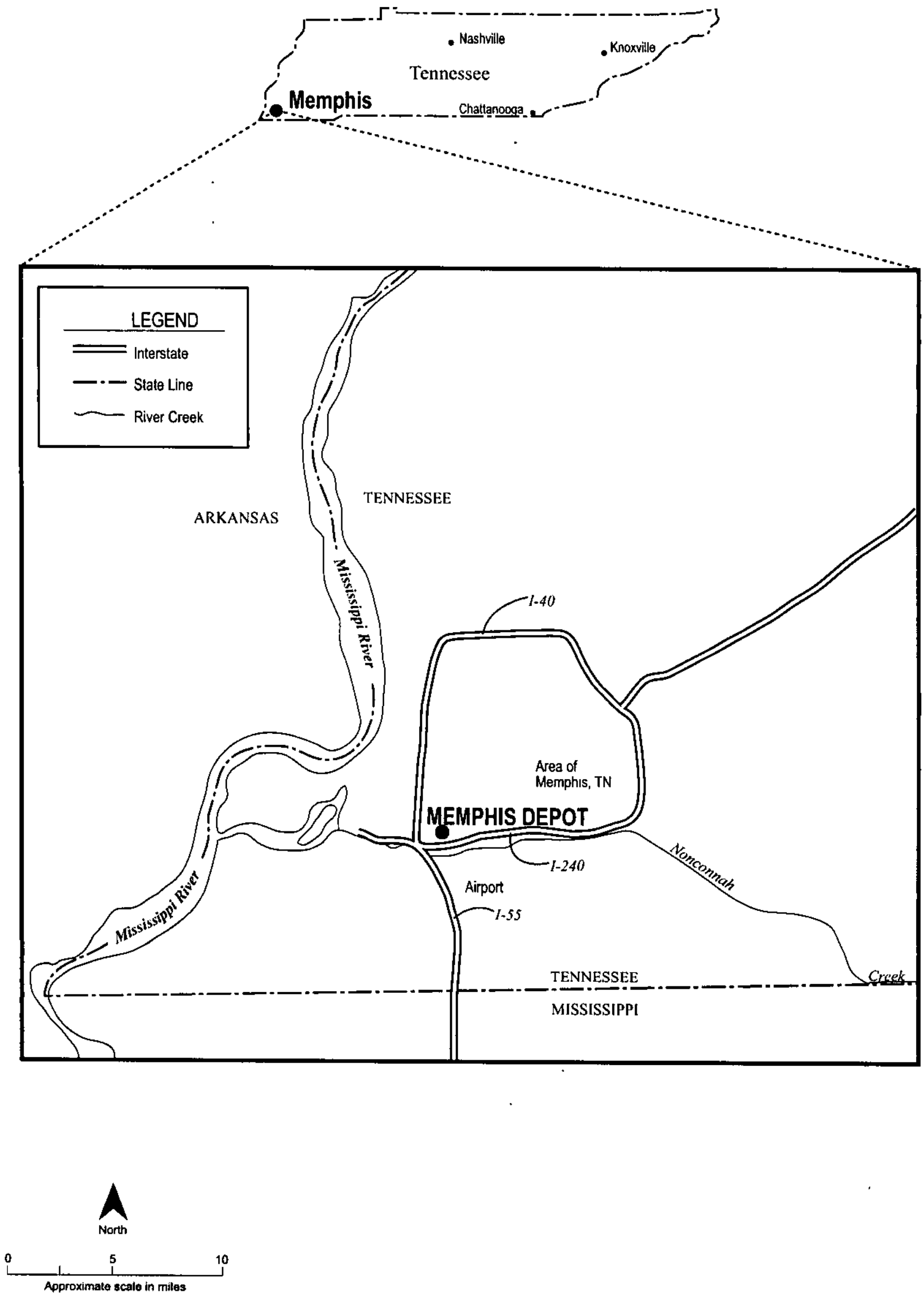


FIGURE 2-1
Memphis Depot Location In The Memphis Metropolitan Area
Memphis Depot Dunn Field Remedial Design

CH2MHILL

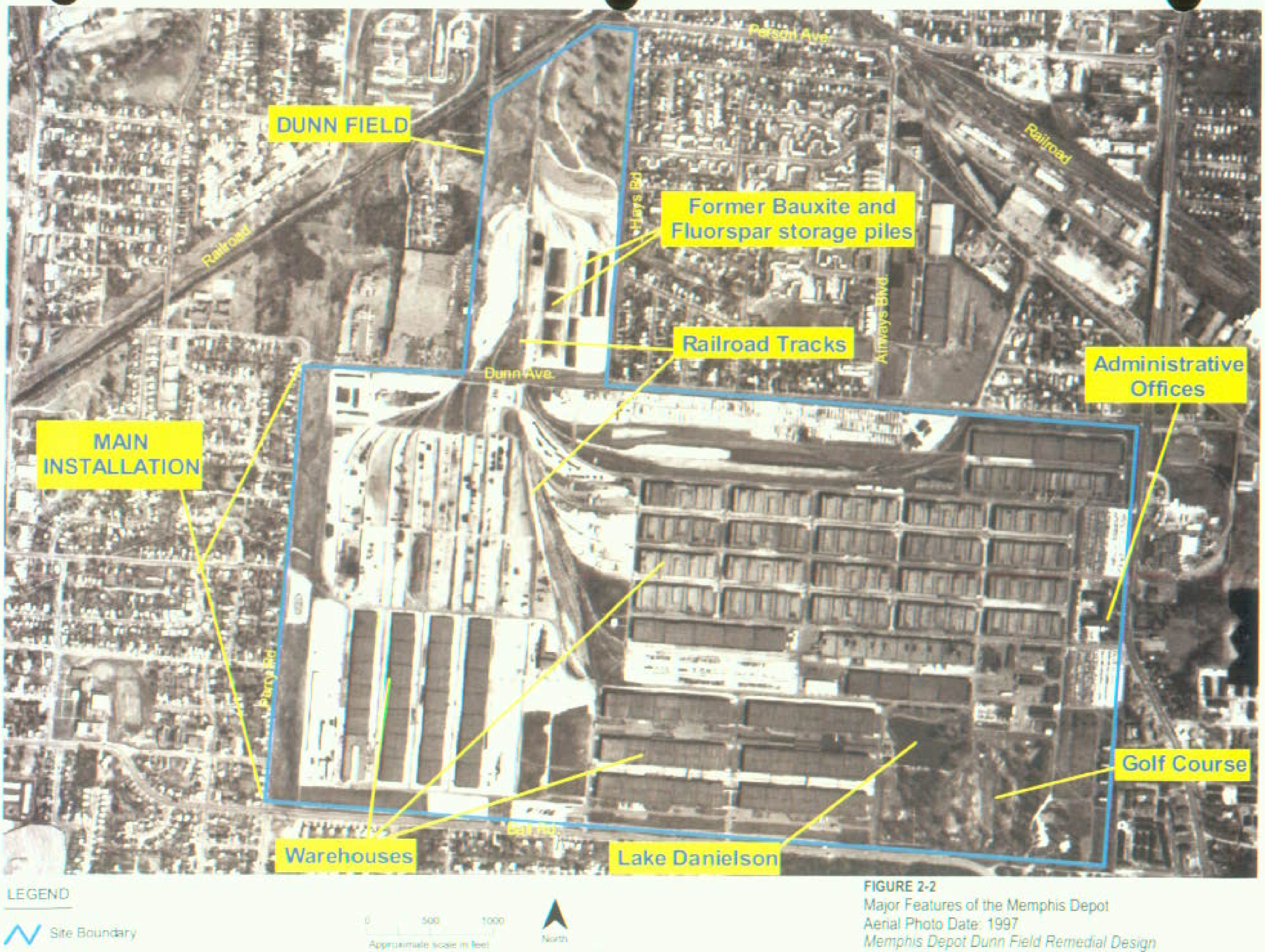


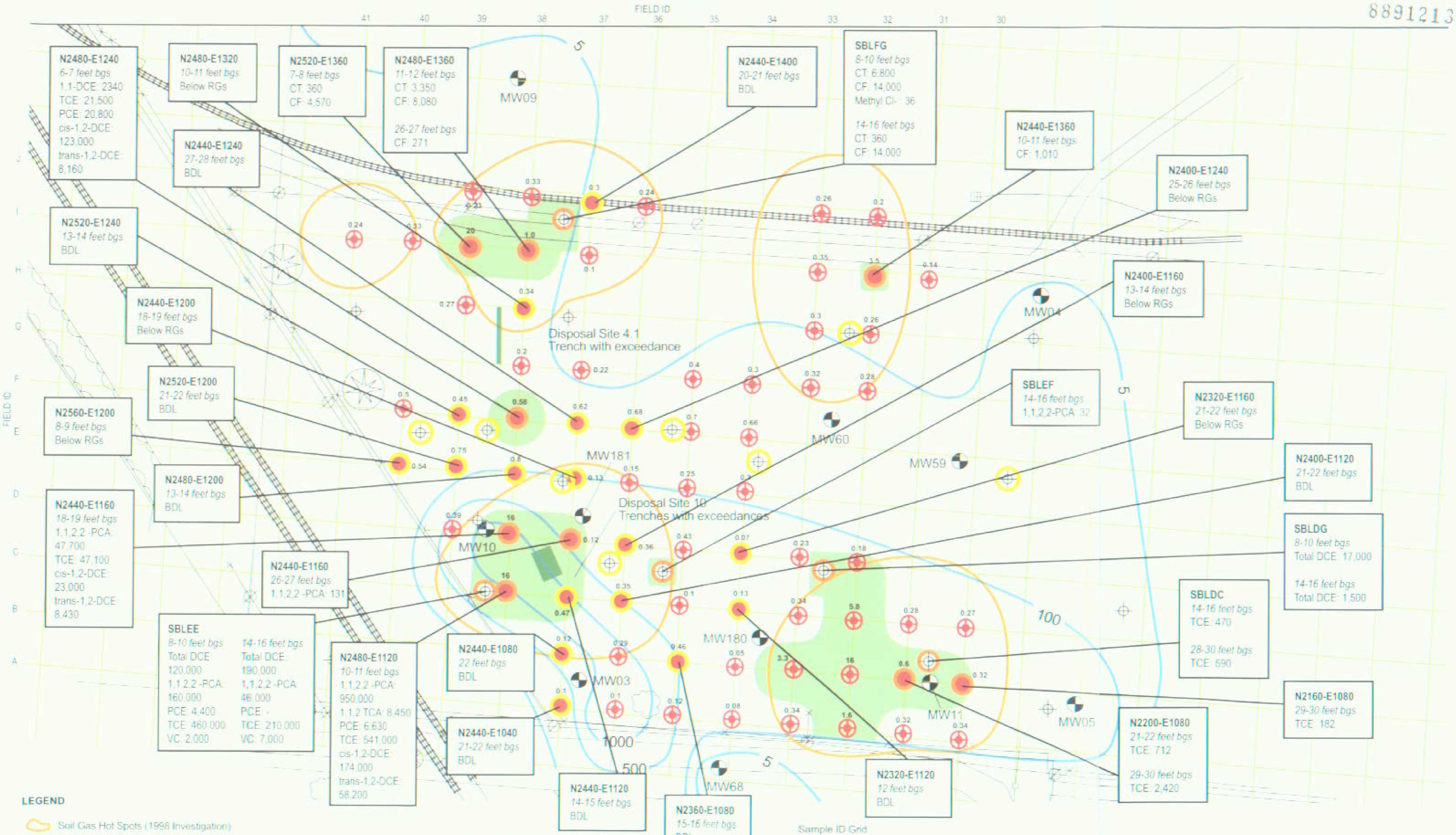
FIGURE 2-2
Major Features of the Memphis Depot
Aerial Photo Date: 1997
Memphis Depot Dunn Field Remedial Design

CH2MHILL

ES082006008ATL Memphis 102.a

8891212

8891213



LEGEND

- Soil Gas Hot Spots (1998 Investigation)
- Soil Boring Location (1999 Investigation)
- Source Area Soil Boring Location (2000 Investigation)
- Monitoring Well Location
- 100 — Groundwater Total CVOC Contours (µg/L) (November 2005)
- Estimated Extent of Areas Requiring Remedial Action
- Completed MIP Location
- MIP and Soil Sample Location
- 0.32 Maximum ECD Response
- bgs Below Ground Surface
- BDL Below Detection Limits
- RG Remedial Goals
- Below RGs
- Above RGs

NOTE
1) Shaded areas based on MIP and soil sample data.
2) Soil concentrations in µg/kg

FIGURE 2-10a
Total VOC Extent in Loess Deposits - Treatment Area 1
Memphis Depot Dunn Field Remedial Design

CH2MHILL

889121

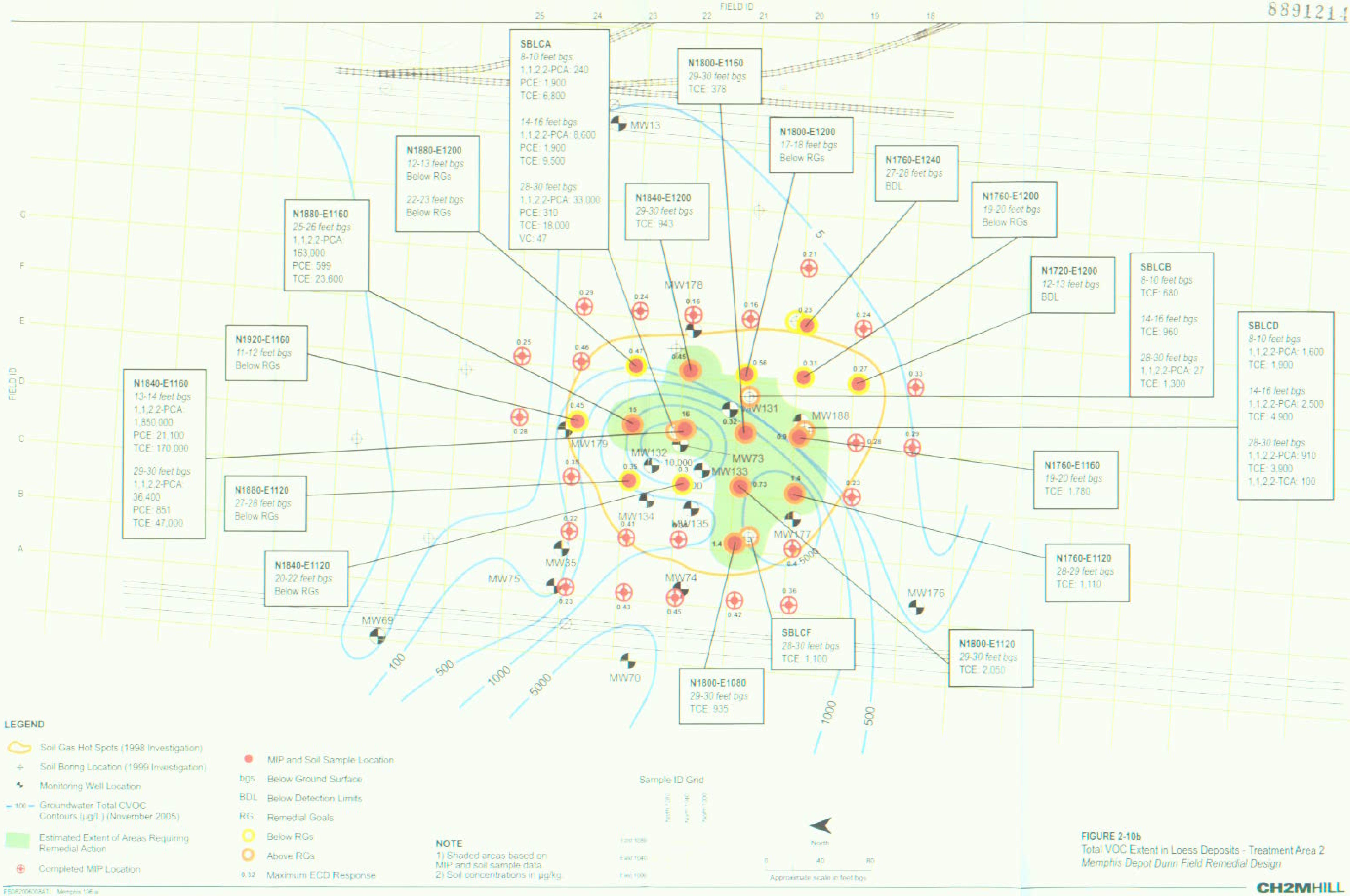
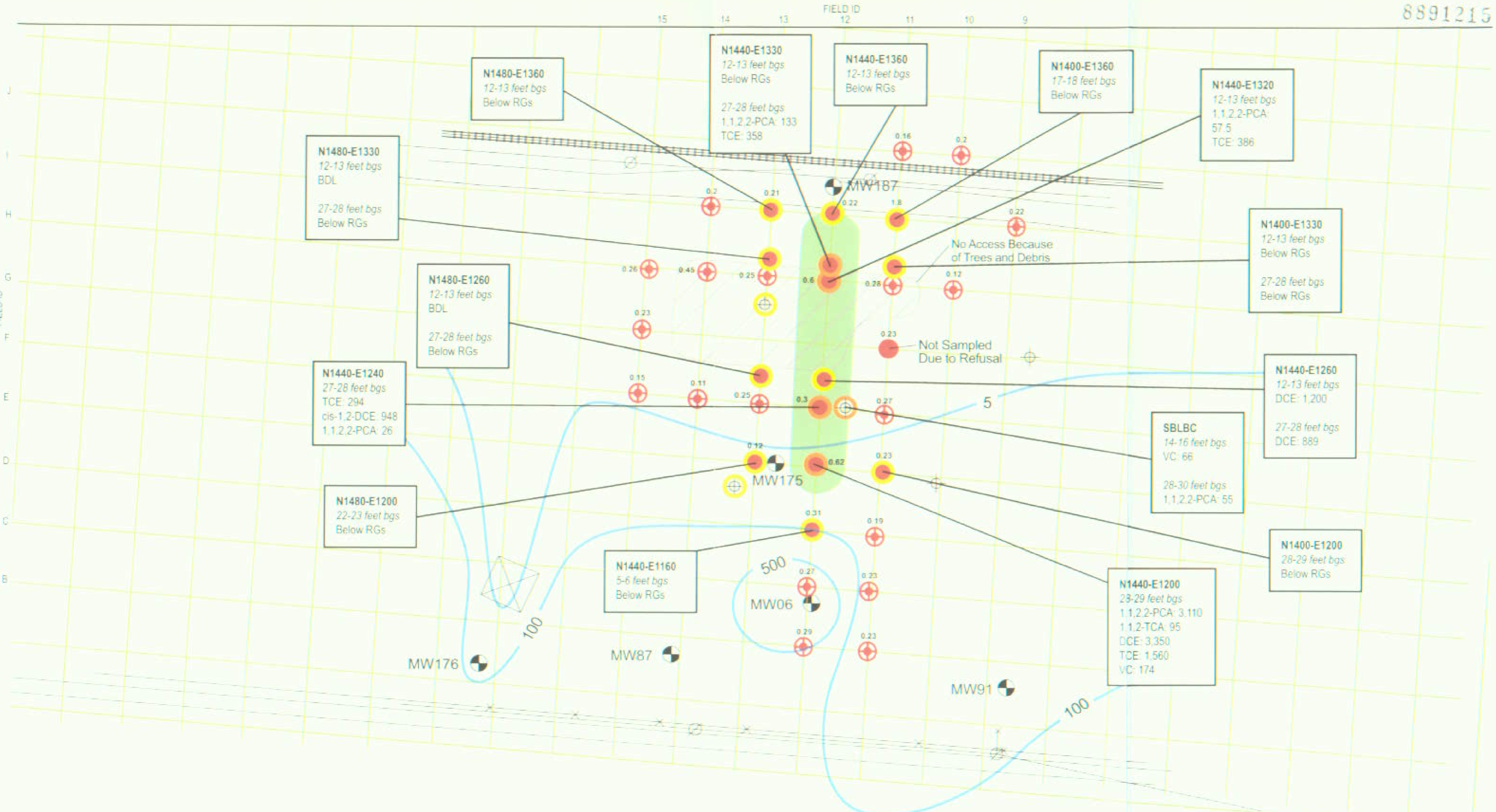


FIGURE 2-10b
Total VOC Extent in Loess Deposits - Treatment Area 2
Memphis Depot Dunn Field Remedial Design

CH2MHILL

8891215



LEGEND

- Soil Gas Hot Spots (1998 Investigation)
- Soil Boring Location (1999 Investigation)
- Source Area Soil Boring Location (2000 Investigation)
- Monitoring Well Location
- 100 — Groundwater Total CVOC Contours (µg/L) (November 2005)
- Estimated Extent of Areas Requiring Remedial Action
- Completed MIP Location
- MIP and Soil Sample Location
- 0.32 Maximum ECD Response
- bgs Below Ground Surface
- BDL Below Detection Limits
- RG Remedial Goals
- Below RGs
- Above RGs

NOTE
1) Shaded areas based on MIP and soil sample data
2) Soil concentrations in µg/kg

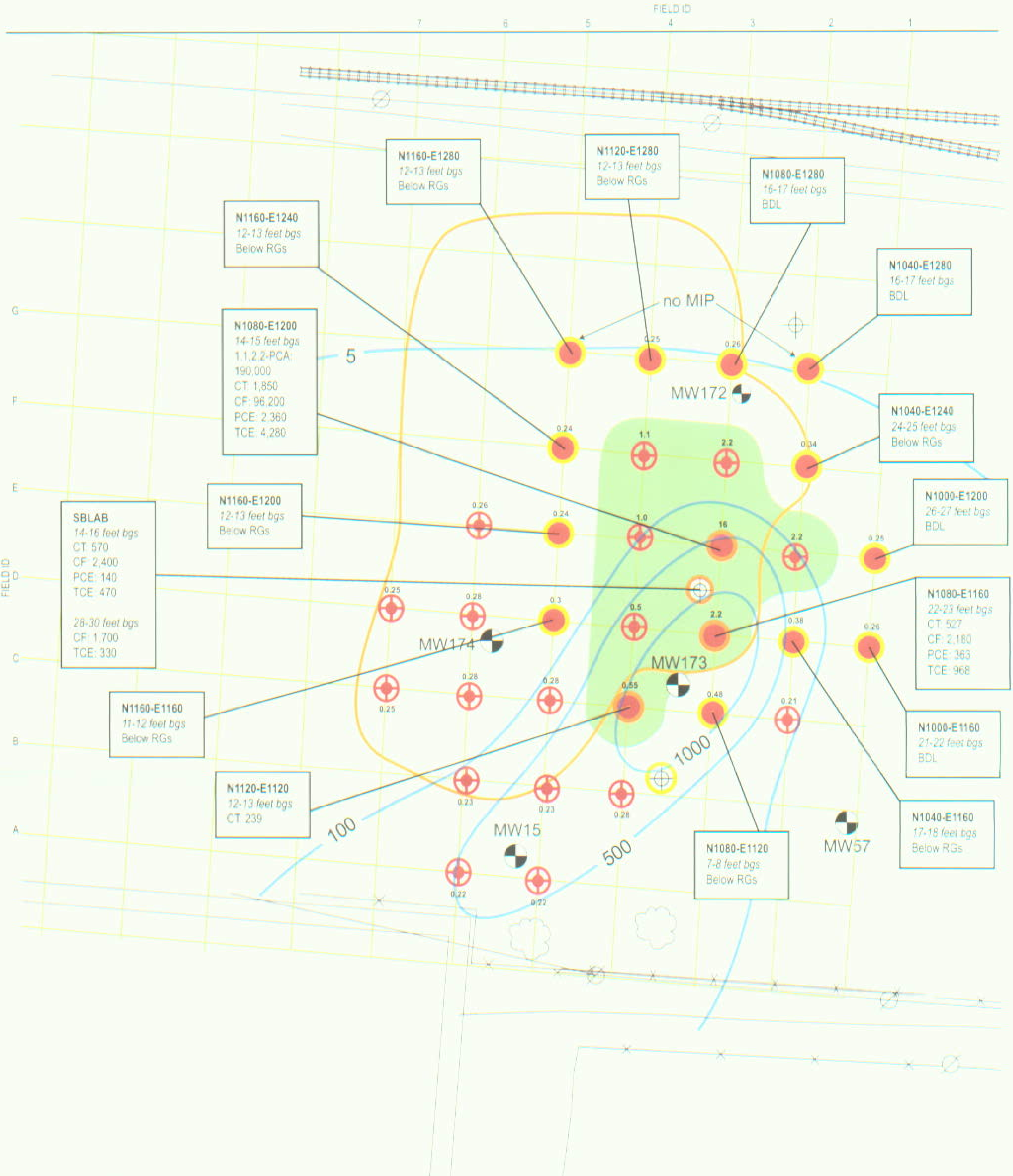
Sample ID Grid

North

0 40 80
Approximate scale in feet bgs bgs

FIGURE 2-10c
Total VOC Extent in Loess Deposits - Treatment Area 3
Memphis Depot Dunn Field Remedial Design

CH2MHILL



LEGEND

- Soil Gas Hot Spots (1998 Investigation)
- Soil Boring Location (1999 Investigation)
- Source Area Soil Boring Location (2000 Investigation)
- Monitoring Well Location
- 100 — Groundwater Total CVOC Contours (µg/L) (November 2005)
- Estimated Extent of Areas Requiring Remedial Action
- Completed MIP Location
- MIP and Soil Sample Location
- bgs Below Ground Surface
- BDL Below Detection Limits
- RG Remedial Goals
- Below RGs
- Above RGs
- 0.32 Maximum ECD Response

Sample ID Grid

North 1080 | North 1040 | North 1000

East 1080
East 1040
East 1000

NOTE
1) Shaded areas based on MIP and soil sample data.
2) Soil concentrations in µg/kg.

North

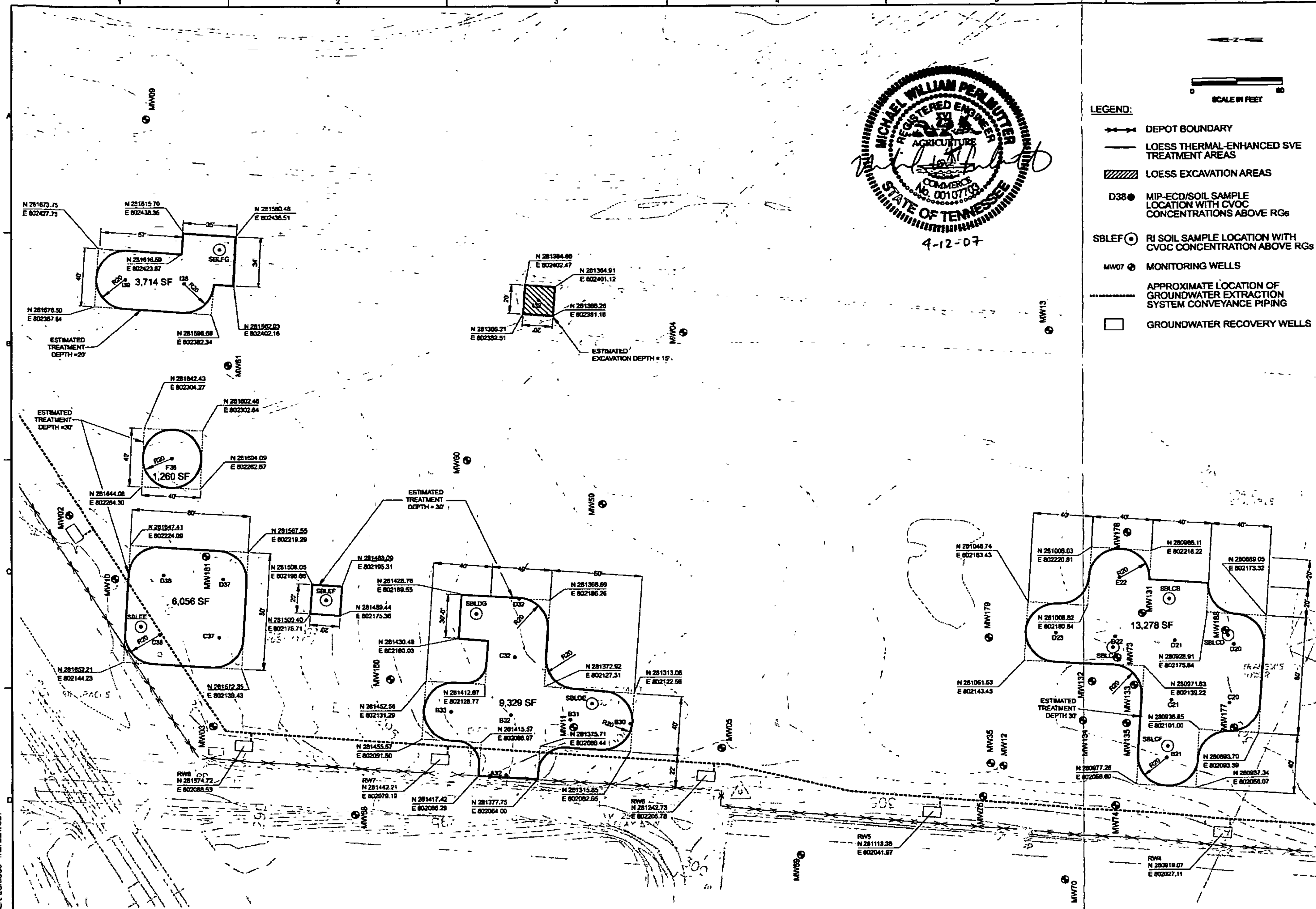
0 40 80
Approximate scale in feet bgs bgs

FIGURE 2-10d
Total VOC Extent in Loess Deposits - Treatment Area 4
Memphis Depot Dunn Field Remedial Design

ES082006006ATL Memphis 104.ai

CH2MHILL

8891217



CH2MHILL

NORTH LOESS TREATMENT AREAS

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

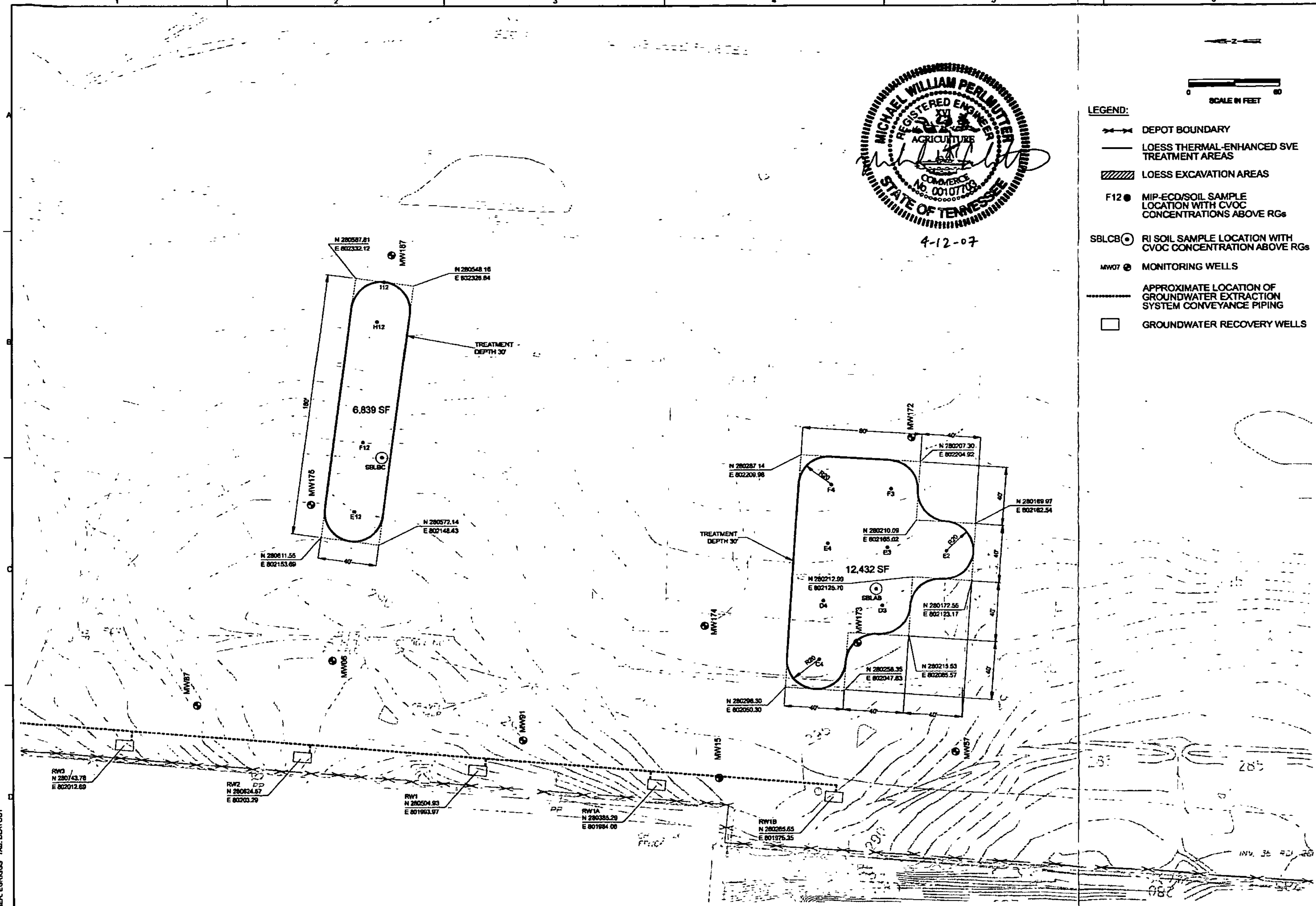
NO.	DATE	REVISION	BY	APVD
DSGN	M. PERLMUTTER	DR E. GRIGGS	CHK M. STRONG	APVD D. NELSON

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.

DATE	MARCH, 2007
PROJ	177556
DWG	L-1
SHEET	11

USER: EGRIGGS TAB: DLAYOUT
ATL/PROJ/148071 DDMT/SARD 2006/SARD/NEW FOLDER/SHEET 11 LOESS 1.DWG
FILENAME: SVE SYSTEM LAYOUT.DWG PLOT DATE: 6-Mar-07 PLOT TIME: 5:06:19 PM

8891218



CH2MHILL	
MEMPHIS DEPOT DUNN FIELD SOURCE AREAS REMEDIAL DESIGN MEMPHIS, TN	SOUTH LOESS TREATMENT AREAS
DSGN	M. PERLMUTTER
DR	E. GRIGGS
CHK	M. STRONG
APVD	D. NELSON
VERIFY SCALE	BAR IS ONE INCH ON ORIGINAL DRAWING.
DATE	MARCH, 2007
PROJ	177556
DWG	L-2
SHEET	12

FILENAME: SVE SYSTEM LAYOUT.DWG PLOT DATE: 6-Mar-07 PLOT TIME: 5:07:36 PM

ATL/PROJ/148071 DDMT/SARD 2006/SARD/NEW FOLDER.SHEET 12 LOESS 2DWG

USER: EGRIGGS TAB: DLAYOUT

LEGEND

- Monitoring Well Location
- 100 — Groundwater Total CVOC Contours (µg/L) (November 2005)
- Exceedance of Site-Specific Screening Levels To Be Protective Of Groundwater (CVOCS)

Required Treatment Efficiencies (%)

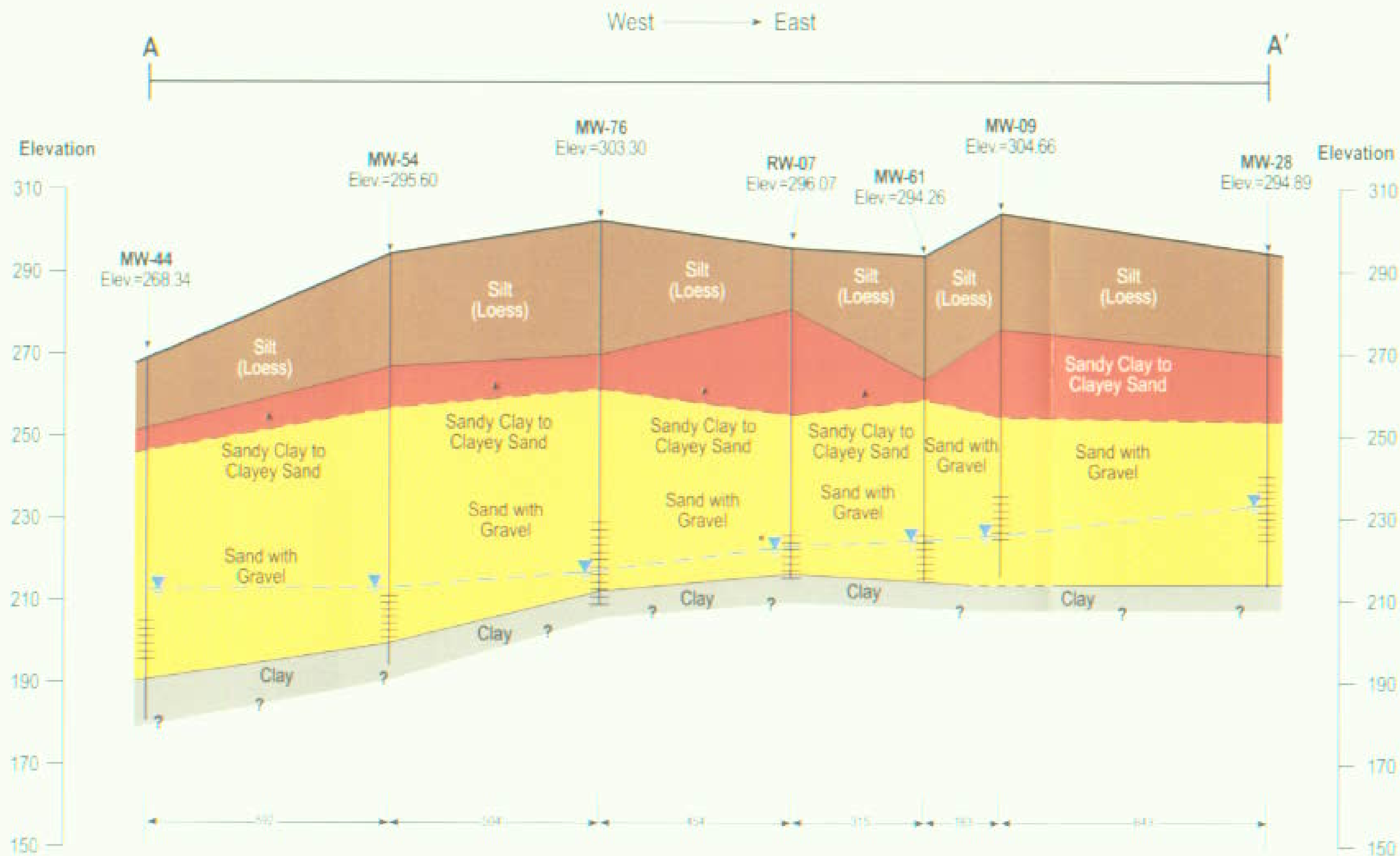
- 99.9999
- 99.999
- 99.99
- 99.9
- 99
- 95
- 90 and below

NOTE
Shaded areas based on resultant MIP and soil sample data

FIGURE 5-3
Required Loess Deposits Treatment Efficiences
Memphis Depot Dunn Field Remedial Design

CH2MHILL

8891220



SCALE

Vertical Scale 1" = 40'
Horizontal Scale 1" = 400'

LEGEND

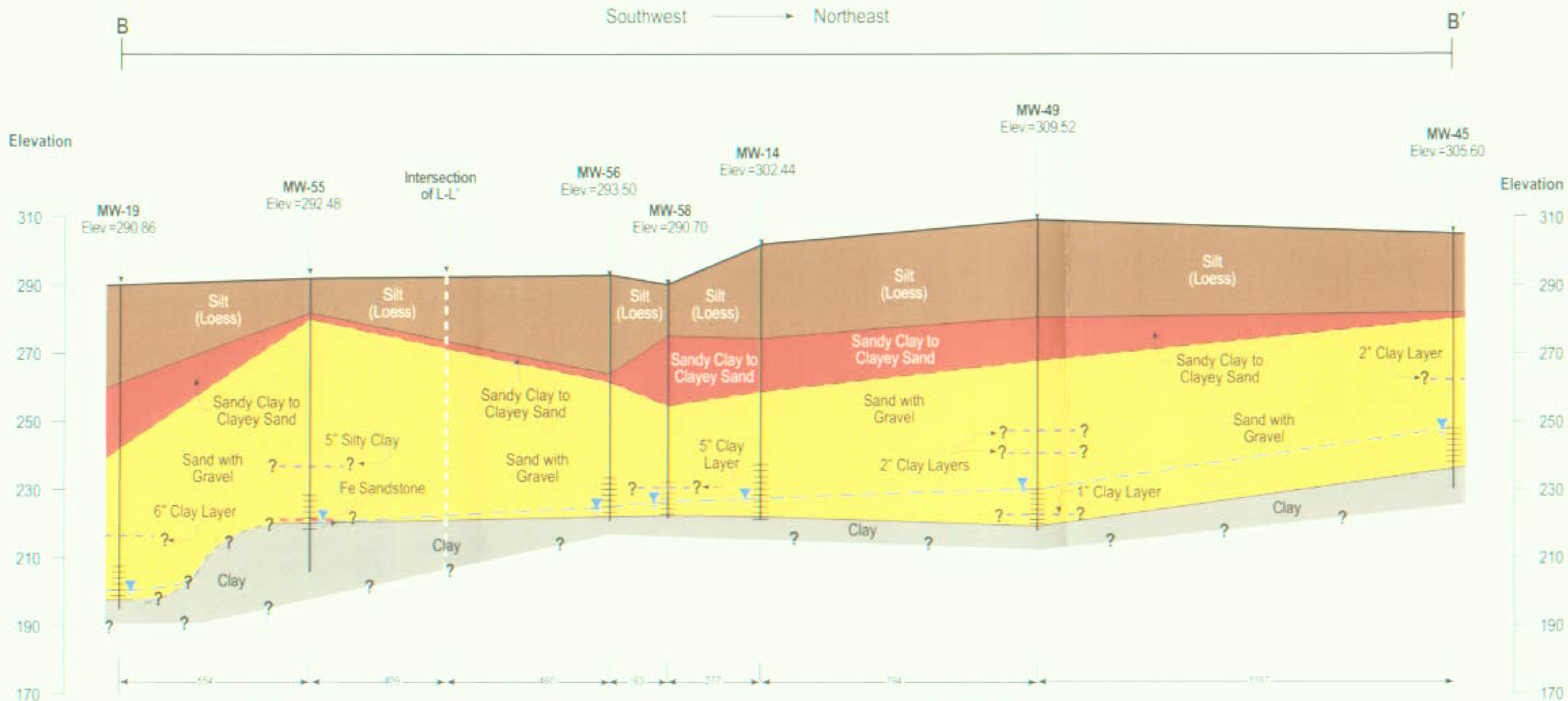
Well Screen Interval
Measured Groundwater Elevation
Interpreted Geologic Contact
Transitional Geologic Contact
Inferred Geologic Contact
Loess Consists of Silt and Clay Deposits

Note: All water levels from 01/10/2001 gauging event except where noted.
* RW-07 was not operating on 01/10/2001.

FIGURE 2-8a
Lithologic Cross-Section A - A'
Memphis Depot Dunn Field RI Report

CH2MHILL

Rev. 1



SCALE

Vertical Scale 1" = 40'
Horizontal Scale 1" = 400'

LEGEND

- Well Screen Interval
- Measured Groundwater Elevation
- Interpreted Geologic Contact
- Transitional Geologic Contact
- Inferred Geologic Contact

Loess Consists of Silt and Clay Deposits

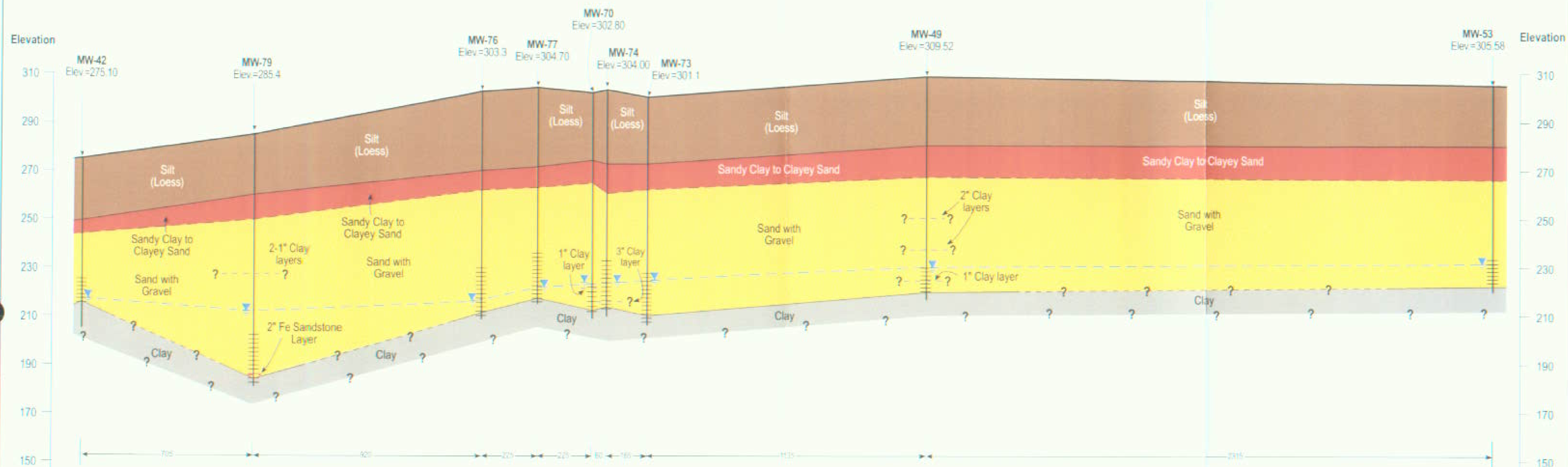
Note: All water levels from 01/10/2001 gauging event, except where noted.

FIGURE 2-8b
Lithologic Cross-Section B - B'
Memphis Depot Dunn Field RI Report

Rev. 1

CH2MHILL

8891222



LEGEND

- Well Screen Interval
- Measured Groundwater Elevation
- Interpreted Geologic Contact
- Transitional Geologic Contact
- ? Inferred Geologic Contact

Loess Consists of Silt and Clay Deposits

Note: All water levels from 01/10/2001 gauging event, except where noted. RW-04 not operating on 01/10/2001

SCALE

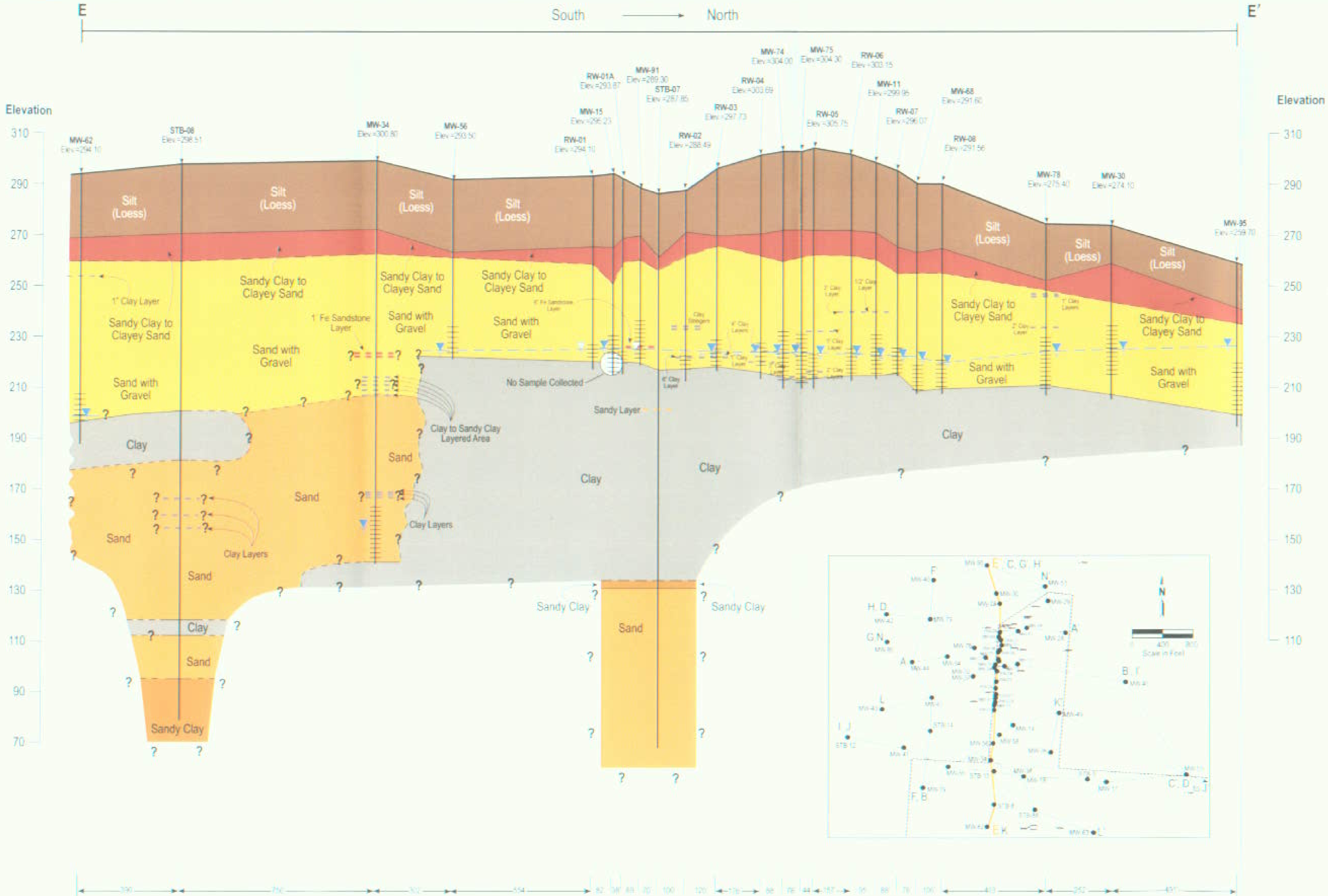
Vertical Scale 1" = 40'
Horizontal Scale 1" = 400'

Rev. 1

FIGURE 2-8d
Lithologic Cross-Section D - D'
Memphis Depot Dunn Field RI Report

CH2MHILL

8891223



SCALE

Vertical Scale 1" = 40'
Horizontal Scale 1" = 400'

LEGEND

Well Screen Interval
Measured Groundwater Elevation
Interpreted Geologic Contact
Transitional Geologic Contact
Inferred Geologic Contact
Loess Consists of Silt and Clay Deposits

Note: All water levels from 01/10/2001 gauging event except where noted.
RW-08 was in operation and RW-01, RW-1A, RW-1B, RW-02, and RW-07 were not operating on 01/10/2001.

Rev. 1

FIGURE 2-8e
Lithologic Cross-Section E - E'
Memphis Depot Dunn Field RI Report

CH2MHILL

Draft Statement of Work
ZVI Injection into the Fluvial Aquifer
Memphis Depot Dunn Field
Memphis, TN

1.0 Introduction

This draft Statement of Work (SOW) is for the injection of zero-valent iron (ZVI) into the fluvial aquifer beneath Memphis Depot Dunn Field and has been prepared for the U.S. Army Corps of Engineers (USACE) - Huntsville Center as part of Task Order 6 under Contract Number DACA87-02-D-0006. This draft SOW is part of the Dunn Field Source Areas Remedial Design (RD) in anticipation of the Remedial Action Work Plan (RAWP) that will be developed by the Remedial Action Contractor (RAC) for the Source Areas groundwater remediation effort. The details on performance and monitoring requirements for execution of the work provided in this draft SOW will be incorporated as part of the Contract prepared by the RAC.

The Dunn Field Source Areas RD and this draft SOW has been submitted to satisfy the requirements outlined by the Base Realignment and Closure (BRAC) Act, as well as requirements set forth by the BRAC Cleanup Team (BCT) for the Memphis Depot. The BCT is composed of representatives of the Defense Logistics Agency (DLA), Tennessee Department of Environment and Conservation (TDEC), and the EPA. The lead agency for site activities at the Depot is the DLA. The regulatory oversight agencies are EPA Region 4 and TDEC.

This remedial action (RA) will consist of the injection of ZVI at 44 injection locations on Dunn Field. Based on an average saturated thickness of 12.5 ft over the entire targeted area, approximately 270 2-foot thick injection intervals and nearly 350,000 pounds of ZVI will be required to complete the 44 injection borings. Sheets 13 and 14 show the layout of the ZVI injections. Figures 2-8a, b, d, and e show typical Dunn Field geologic cross sections.

2.0 Site Background

The Memphis Depot is located in southeastern Memphis, Tennessee (see Figure 2-1). It originated as a military facility in the early 1940s. Its initial mission and function was to provide stock control, materiel storage, and maintenance services for the U.S. Army (Memphis Depot Caretaker Division, 2003). In 1995, the Depot was placed on the list of DoD facilities to be closed under BRAC. Storage and distribution of materiel for all U.S. military services and some civil agencies continued until the Depot closed in September 1997.

The Depot is located approximately 5 miles east of the Mississippi River and just northeast of Interstate 240. The property consists of approximately 642 acres and includes two components: (1) the MI, which includes open storage areas, warehouses, military family housing, and outdoor recreational areas; and (2) Dunn Field, which includes former bulk mineral (bauxite and fluorspar) storage and waste disposal areas.

8891225

Dunn Field, which consists of approximately 64 acres of undeveloped land, is 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) (see Figure 2-2). Approximately two-thirds of Dunn Field is covered with grass, and the remaining area is covered with crushed rock and paved surfaces.

All of Dunn Field is currently zoned as Light Industrial (I-L). However, the approximately 20-acre Northeast Open Area[1] was identified in the final Dunn Field ROD as future public open space for recreational purposes (CH2M HILL, 2004a).

2.1 Geology

The impacted vadose zone at Dunn Field consists of two distinct geological units: (1) a shallow, relatively low-permeability loess, and (2) a deep, relatively high-permeability alluvium (fluvial sands). The loess, a semi-cohesive eolian deposit composed of silt, silty clay, silty fine sand, and mixtures thereof, extends from the ground surface to a depth of about 30 feet (ft) below ground surface (bgs). Underlying the loess are several feet of sandy clay, followed by 30 to 75 ft of the fluvial sands, silt, and gravel.

The upper 10 ft of the fluvial deposits represent a transition zone between the silt-dominated loess and the sand and gravel of the fluvial aquifer. Underneath the western boundary of Dunn Field, the lower portion of the fluvial deposits, which is comprised of sand, sandy gravel, and gravelly sand, is about 40 ft thick. The sand is generally bright orange to dark red and ranges from poorly-graded to well-graded, fine- to coarse-grained, and very well-sorted to poorly sorted quartz grains. The unit transitions downward into poorly graded, tan to brownish yellow sandy gravel, with chert being the primary gravel constituent. The gravel ranges from small pebbles (1/2 inch) up to small cobbles (average diameter of 4 inches). Interbedded within the sand and gravel are clay lenses that range from thin laminations to layers up to 1 foot thick.

A clay unit of variable thickness is present at the bottom of the fluvial aquifer as the formation transitions to the Jackson Formation/Upper Claiborne Group. The unit is an orange, stiff to dense, silty clay with gray mottling that ranges from 5 to 8 ft thick. The unit directly overlies the gray, stiff, dense, silty clay of the Jackson Formation/Upper Claiborne Group. The two clay layers are distinguished by their different colors and the presence of slightly less silt in the clay of the Jackson Formation (ranging from 20 to 25 percent). Additional site geology details are presented in the following documents:

- *Dunn Field RI Report* (CH2M HILL, 2002)
- *Report of Offsite Design-Related Investigation* (MACTEC, 2005b)
- *Results of the Memphis Depot – Dunn Field Remedial Design Investigation* (RDI) (CH2M HILL, 2006a)

[1] For purposes of completing the RI and FS, Dunn Field was divided into three separate areas: Northeast Open Area, Disposal Area, and Stockpile Area.

2.2 Hydrogeology

Groundwater occurs within a predominantly medium- to fine-grained sand geological unit referred to as the fluvial aquifer. Recharge to the unconfined fluvial aquifer is primarily from the infiltration of rainfall. Continuous cores obtained from borings at Dunn Field indicate perched groundwater exists seasonally in the loess. However, these perched water zones are limited in areal extent and cannot serve as a water supply.

The base of the fluvial aquifer is the uppermost clay in the Jackson Formation/Upper Claiborne Group. The saturated thickness of the fluvial aquifer is variable across Dunn Field and is controlled by the configuration of the basal clay. Depth to water is approximately 75 ft bgs. Maximum saturated thickness ranges between 10 and 30 ft above the clay. In general, the groundwater in the fluvial aquifer flows west, which is also the direction of the local dip of the clay confining unit. The potentiometric surface for the fluvial aquifer is shown on Figure 2-3. In addition, a series of isopleths were developed from the geologic and hydrogeologic data to aid in the design effort:

- Estimated thickness of the loess deposits (see Figure 2-4)
- Estimated elevation of the loess-fluvial interface (see Figure 2-5)
- Saturated thickness of the fluvial aquifer (see Figure 2-6)
- Estimated elevation of the top of the uppermost clay layer in the Jackson Formation/Upper Claiborne Unit (see Figure 2-7)

Aquifer tests conducted at Dunn Field indicate the average hydraulic conductivity for the fluvial aquifer is 7.8×10^{-3} centimeters per second (cm/sec). The groundwater velocity in the fluvial aquifer beneath Dunn Field is estimated to range from 0.13 feet per day (ft/day) to 1.7 ft/day based on a hydraulic gradient that ranges from 0.0017 foot per foot (ft/ft) to 0.023 ft/ft along the western boundary of Dunn Field and an effective porosity of 0.3. Additional site hydrogeology details are presented in the *Dunn Field RI Report* (CH2M HILL, 2002).

3.0 Scope of Work

This section provides the technical approach for the onsite activities included in the SOW. The subcontractor shall furnish all labor, equipment, materials, lower-tier Subcontractors, supplies, and all else necessary to completely perform the scope of work identified herein. The Subcontractor should comply with federal, state, and local laws, statutes, and ordinances relating to the execution of the work. This requirement includes, but is not limited to, applicable regulations for minimum wage rates, nondiscrimination in the employment of labor, protection of public and employee safety and health, environmental protection, the protection of natural resources, fire protection, burning and non-burning requirements, permits, fees, waste management, and similar subjects.

3.1 Technical Approach

ZVI injection will occur after the thermal-enhanced SVE system has been decommissioned and the fluvial sands SVE system is installed and operating successfully.

The ZVI injection boring locations were selected based on the chemical analyses of groundwater samples collected since January 1996, as well as the results of the ZVI treatability study, EISR, and RDI. The TAs and injection boring layout are shown on Figure 6-3 and Sheets 13 and 14 in Attachment A. Using 35-ft spacing, 44 ZVI injection locations are currently planned for the source area groundwater remedy. The current design is based on the 1,000 µg/L total CVOC isoconcentration contour presented on Figure 2-11i.

Treatment Area	ZVI Locations
1	18
2	19
3	0
4	7
Total	**44**

The final ZVI injection layout will be determined based on groundwater sampling events conducted before, during, and after the loess thermal-enhanced SVE system has been implemented. The scope of the groundwater remedy could be re-evaluated as the loess deposits and fluvial sands CVOC mass is reduced and the groundwater CVOC concentrations respond accordingly. The RAC will adjust the number of ZVI injection locations if the plume geometry changes (increase or decrease in area) between the approval of the RD and implementation of the groundwater remedy.

As discussed above, before the thermal-enhanced SVE system is installed, the existing PVC MWs within the thermal treatment areas will be abandoned and replaced with stainless steel MWs. These new MWs, along with the other existing wells designated in the PSVP for effectiveness monitoring, will be sampled prior to the start of the soil remedies. Groundwater sampling will be conducted again during operation of the thermal-enhanced SVE system (between 3 to 9 months after startup) and then 2 more times after system is stopped (no less frequently than quarterly). The data from these events will be used to conduct a trend analysis using the Mann-Kendall test. If a decreasing trend is observed in all wells specified in each area (see below), then additional sampling events will be conducted (for no more than another year) before ZVI is finally injected. Otherwise, ZVI injection will occur immediately. The MWs for each treatment area that will be used in the trend analysis are:

- **TA1:** MW-10 and MW-3
- **TA2:** MW-73, MW-74, MW-132, MW-134, MW-135, and MW-177
- **TA4:** MW-173

The final injection locations will be surveyed and inspected to identify potential access issues, such as utility interference and buildings or structures that may be impacted. Some injection locations may have to be changed to avoid impacts to utilities, buildings, traffic, or other site features. The total adjustment of any injection location will typically be less than 15 ft in any direction. If greater adjustments are needed, the injection location will be moved to a portion of the targeted TA with higher CVOC concentrations and/or downgradient whenever possible. Using this protocol, the total mass of chemical injected in each TA will be maintained.

Due to the non-uniform distribution of ZVI, some localized areas within the targeted TAs may not be directly treated with the proposed layout. Such areas are expected to be treated over time by groundwater advection through areas containing emplaced iron. Although not planned at this time, additional injections may be considered based on the results of post-injection monitoring.

ZVI injections will be completed using pneumatic fracturing and atomized injection methods. The subcontractor will use rotasonic drilling methods to advance the soil borings and inject powdered ZVI.

Mobilization and Site Setup

The Subcontractor will perform all work necessary to move personnel and equipment in and out, set up and remove drill rigs and other equipment, and clean up and restore the sites to their original condition prior to the onset of construction activities. The Subcontractor should avoid contaminating the project area. Waste oil, rubbish, and other similar materials will not be dumped on the ground. If needed, (RAC) will provide a secure area to store construction equipment while not in use.

Before remedy implementation, site controls such as access barricades, flagging, fencing, and signs, will be installed or upgraded to control unauthorized access to the site. The various work areas for site activities, such as boring locations, stockpiles, and haul roads, will be clearly marked and flagged. Markers from previous underground utility surveys will be upgraded and protected. Any utilities found in the work areas will be flagged and work options will be planned to address these areas without damaging the facilities.

Materials Handling and Staging Areas

The ZVI will be the same as or equivalent to the material used during the ZVI treatability study[2]. It is expected that the ZVI powder will be shipped to Dunn Field in Super Sacks® or similar containers, which will be stored in a designated material handling area until needed for mixing and injection. Empty Super Sacks® will be disposed as non-hazardous waste. Potable water for ZVI mixing will be supplied directly from nearby hydrant(s). The ZVI will be sampled and analyzed to ensure that the material is free of contaminants. Upon delivery to the site, the ZVI will be sampled and analyzed to ensure that the material is free of contaminants and meets manufacture specifications. QA samples will be collected from 5 percent of the ZVI super-sacks and analyzed by an independent, third-party-certified laboratory to evaluate conformity with the manufacturer specifications[3].

Nitrogen gas will be delivered directly to the injection locations in tube trailers obtained from a local supplier. The trailers, which are similar to those used during the ZVI treatability study, are approximately 42 ft long and contain approximately 100,000 to 144,000 standard cubic feet (scf) of nitrogen.

Mass of Injected ZVI

Assuming an iron-to-soil mass ratio of a 0.5 percent for each injection point and soil density of approximately 100 pounds per cubic foot, approximately 600 to 650 pounds of ZVI will be

---

[2] The H-200 is a proprietary high reactivity, food-grade zero-valent iron powder that is directly reduced from iron ores. As a result of its production process, the H-200 contains internal porosities, which greatly increase its surface area and, therefore, reactivity. Carbon molecules and other inclusions found within its structural matrix (not as a separate phase) have been theorized to further enhance its reactivity, exceeding that of similar sized cast iron powder.

[3] From http://www hepure com/zero_valent_iron_product_information.html

required to treat each 1-ft thick, 20-ft radius interval. The estimated saturated thickness (based on historical data) and required ZVI quantities at each injection location in all four TAs are detailed in Table 6-3. Based on an average saturated thickness of 13 ft over the entire targeted area, approximately 288 2-ft thick injection intervals and nearly 360,000 pounds of ZVI will be required to complete the 44 injection borings.

Monitoring During Injections

In addition to the quantity of iron applied at each injection location, the following system operational parameters will be monitored and collected:

- Nitrogen gas flow rate,
- ZVI and water slurry composition,
- ZVI and water slurry injection flow rate,
- Injection interval,
- Down-hole injection initiation and maintenance pressures,
- Injection pressure influence at surrounding monitoring points, and
- Ground surface heave adjacent to, and in the vicinity of, the injection point.

Because Contractor and Subcontractor representatives will be present concurrently onsite during all field activities, discussions of results and performance demonstration will be held immediately following collection of the monitoring data. Corrective action, if required for compliance, will be the consensus decision between the Contractor and the Subcontractor. Final reporting of demonstration of compliance with or deviation from the performance and monitoring requirements will be based upon detailed review of results and agreement between the Contractor and Subcontractor. The Subcontractor will be notified immediately by the Contractor upon identification of non-compliant work. Results will be reviewed and decisions will be made as soon as practicable to avoid significant interference with the implementation schedule.

3.2 Performance Metrics

1. Achieving Design ZVI Loading: The Subcontractor will deliver the minimum specified ZVI load into uniformly spaced injection borings/intervals into each treatment zone as defined in **Table 1**.

   During the injection process, the Subcontractor will monitor the injection duration and the injected slurry volume. Because the iron power is typically injected as a batch with a known iron concentration, the Subcontractor will be able to record the exact quantity of iron powder injected into each interval by measuring the initial and final volume of slurry in the storage vessel for each injection cycle.

   The goal of the ZVI injection strategy is twofold:

   - Distribute the ZVI as uniformly as possible throughout the entire treatment zone.
   - Reduce CVOC concentrations in the source areas.

   If the design ZVI mass cannot be injected at one or more of the fracture intervals, surplus mass will be injected into an overlying interval up to 150% of the targeted mass. A replacement injection boring (less than 15 feet away) will be required under the following circumstances:

- Less than 75% of the design ZVI mass for the entire location is injected.
- More than 2 consecutive injection intervals receive less than 25% of the design ZVI mass.

Injection pressures will be observed to ensure proper operation of the system and iron powder dispersion into the formation. The Subcontractor will keep record of these and other operational parameters during the field activities.

2. Achieving Radius of Influence: The Subcontractor anticipates that their injection process will achieve a minimum radius of influence (ROI) of 20 feet in the Fluvial Aquifer using the liquid atomized injection [LAI] process. As a result, the Contractor has utilized this information to budget their field effort. As specified in the Scope of Services, failure to achieve the specified ROI and subsequent incomplete ZVI delivery will result in additional injections. Subcontractor's costs (Subcontractor-provided equipment and labor) for the additional injection will be performed at their sole expense. Contractor will be responsible for costs of additional chemicals, oversight, and other Contractor-supplied support equipment.

   The ZVI injection process will be intermittently calibrated through the use of soil confirmation borings after every eight ZVI injections are completed. The soil borings will be advanced to the injection interval to confirm that the ZVI is adequately distributed based on the design ROI assumptions. Soil samples would be collected from the injection zone to detect the presence of ZVI powder through both visual and laboratory analysis (EPA Method SW846 6010B) and to review the effect of the injections on the surrounding matrix. The spacing of subsequent injection borings would be modified accordingly.

   During injection of the ZVI slurry, the Subcontractor field personnel will maintain sufficient gas flow to effectively atomize the liquid during emplacement within the subsurface. However, subsurface anomalies may cause day lighting of the injected slurry, which if determined by the Contractor to create a potential safety condition, then the gas flow and pressure will be reduced accordingly.

   While pressure monitoring at adjacent wells and ground surface heave will be used as a qualitative indicator of ROI, it will not be used for compliance with the performance specification since ZVI delivery is the primary goal. The Subcontractor will provide and set up equipment to monitor and record the wellhead pressures from nearby monitoring wells. The selection of the monitoring locations will be the combined effort of the Contractor and Subcontractor and will be within a reasonable distance and not to exceed thirty feet from the injection boring. The Subcontractor will measure pressure in the chosen monitoring wells using pressure gauges and maximum drag-arm indicators. During the injection process, the Subcontractor will seal all surrounding monitoring well casings to the atmosphere using removable caps or packers. The well seals will be equipped with vent valves so that pressure build-up may be alleviated slowly prior to the Contractor regaining well access for water level monitoring.

3. Demonstration of Fracturing:

   Subcontractor will apply pneumatic fracturing consistent with the procedures and methods, one skilled in the art of fracturing, and applicable to the depth and type of geology described in the Final Scope of Services.

The Subcontractor will provide the Contractor a pressure-time history curve (electronic datalog record of pressure versus time) for each injection interval. An independent fracturing injection step will be applied prior to emplacement of the ZVI slurry injection at each interval within the Fluvial Aquifer. A pressure-time history curve will be reviewed to determine the extent of fracturing that occurred within the formation. The Subcontractor and Contractor will immediately review and interpret the available data, including the down-hole pressure-time history curve, pressure influence at surrounding monitoring wells, and the presence of ground surface heave to determine if fracturing occurred prior to moving to the next injection interval.

If fracturing cannot be achieved due to unforeseen site conditions, the Contractor and Subcontractor shall discuss alternative procedures and agree upon a corrective action prior to continuing work.

4. <u>Avoidance/Minimizing of Groundwater and/or ZVI Slurry Surfacing/Day Lighting:</u> primary goal of this work is to prevent human health and safety incidents. To this end, the Subcontractor is required to perform the work in a manner that minimizes day lighting of groundwater and slurry. If daylighting should occur that creates an immediate health and safety concern, the Subcontractor shall respond appropriately and if necessary immediately cease injection operations and provide containment and removal/neutralization of the surface spill. In the case of the excessive occurrence of day lighting, the Contractor and Subcontractor shall discuss alternative procedures and agree upon a corrective action prior to continuing work, including modification of performance objectives if necessary.

<u>Limit of Subcontractor's Liability</u>

The Subcontractor is not responsible for failure of the material to reach all areas of the target treatment zone due to differing site conditions that were not documented in the Final Scope of Services. Such conditions include, but are not limited to, inherent geologic anomalies and any natural structure which can adversely affect the ROI of the injection process and detrimentally impact the distribution of the injected materials.

3.2 Final Report

Upon completion of treatment, the Subcontractor will furnish a draft report within 45 days to the RAC. The draft report shall include, but not be limited to, the results, analytical evaluation, and interpretation of system operation. The draft report will include a written synopsis of the work, the basis for supporting computations and a summary of system operations. Supporting process monitoring data will be supplied in electronic database format. Results will be presented in an organized, neat, concise manner; text and figures will be completed on use 8½" by 11" or 11" by 17" paper only. The draft report will be delivered to the Memphis Depot BCT team electronically in native file form. A master table summarizing file name, format, contents and general organization will be provided for all electronic information delivered.

Comments to the draft report will be provided by the RAC to the Subcontractor within 21 business days. The final report will be submitted within 10 working days following receipt of RAC comments on the draft report. Five bound copies, one unbound copy, and three electronic copies in Adobe Acrobat PDF format of the final report will be submitted to the

RAC. The final electronic copy of the document and all supplemental system information (compiled for the draft deliverable) will be supplied to the project team using CD/DVD media.

4.0 Project Schedule

Subcontractor shall provide whatever resources necessary to complete the SOW within the timeframe presented in the final project schedule developed for the project. Work is limited to daylight hours with work on the weekends acceptable as needed.

The Subcontractor is requested to state in the proposal the estimated duration of performing the various major tasks required to complete Subcontractor's work, including all submittals, and the total estimated duration of performing the total project. This information shall be provided in the form of a project schedule indicating all tasks to complete the work, long lead time items, and indicating the sequence of work.

It is currently anticipated that mobilization will occur on April 20, 2007.

Tables

8891234

TABLE 1
ZVI Injection Boring Summary
Memphis Depot Dunn Field Source Areas

Boring Number	Northing	Easting	Targeted Depth (ft bgs)	Number of 2-foot Injection Intervals	ZVI per 2-foot Injection Intervals (lb)	Total Iron (lb)
Treatment Area 1						
1			64-77	7	1,167	8,168
2			64-77	7	1,167	8,168
3			65-78	7	1,167	8,168
4			66-78	6	1,257	7,540
5			66-78	6	1,257	7,540
6			66-78	6	1,257	7,540
7			66-78	6	1,257	7,540
8			66-78	6	1,257	7,540
9			64-78	7	1,257	8,796
10			65-79	7	1,257	8,796
11			65-79	7	1,257	8,796
12			66-78	6	1,257	7,540
13			64-78	7	1,257	8,796
14			65-79	7	1,257	8,796
15			65-79	7	1,257	8,796
16			71-83	6	1,257	7,540
17			72-82	5	1,257	6,283
18			72-82	5	1,257	6,283
TA1 Subtotal				**115**		**142,628**
Treatment Area 2						
19			89	8	1,257	10,053
20			89	8	1,257	10,053
21			89	8	1,257	10,053
22			89	8	1,257	10,053
23			89	8	1,257	10,053
24			89	8	1,257	10,053
25			89	8	1,257	10,053
26			88	8	1,178	9,425
27			88	8	1,178	9,425
28			88	8	1,178	9,425
29			88	8	1,178	9,425
30			88	8	1,178	9,425
31			88	8	1,178	9,425
32			88	8	1,178	9,425
33			88	8	1,178	9,425
34			88	8	1,178	9,425

8891235

TABLE 1
ZVI Injection Boring Summary
Memphis Depot Dunn Field Source Areas

Boring Number	Northing	Easting	Targeted Depth (ft bgs)	Number of 2-foot Injection Intervals	ZVI per 2-foot Injection Intervals (lb)	Total Iron (lb)
35			88	8	1,178	9,425
36			88	8	1,178	9,425
37			88	8	1,178	9,425
TA2 Subtotal				**136**		**183,469**
Treatment Area 4						
38			77	4	1,257	5,027
39			77	4	1,257	5,027
40			77	4	1,257	5,027
41			77	4	1,257	5,027
42			77	4	1,257	5,027
43			76	4	1,257	5,027
44			76	4	1,257	5,027
TA 4 Subtotal				**28**		**35,186**
Total						
Total				**279**		**361,283**

Figures

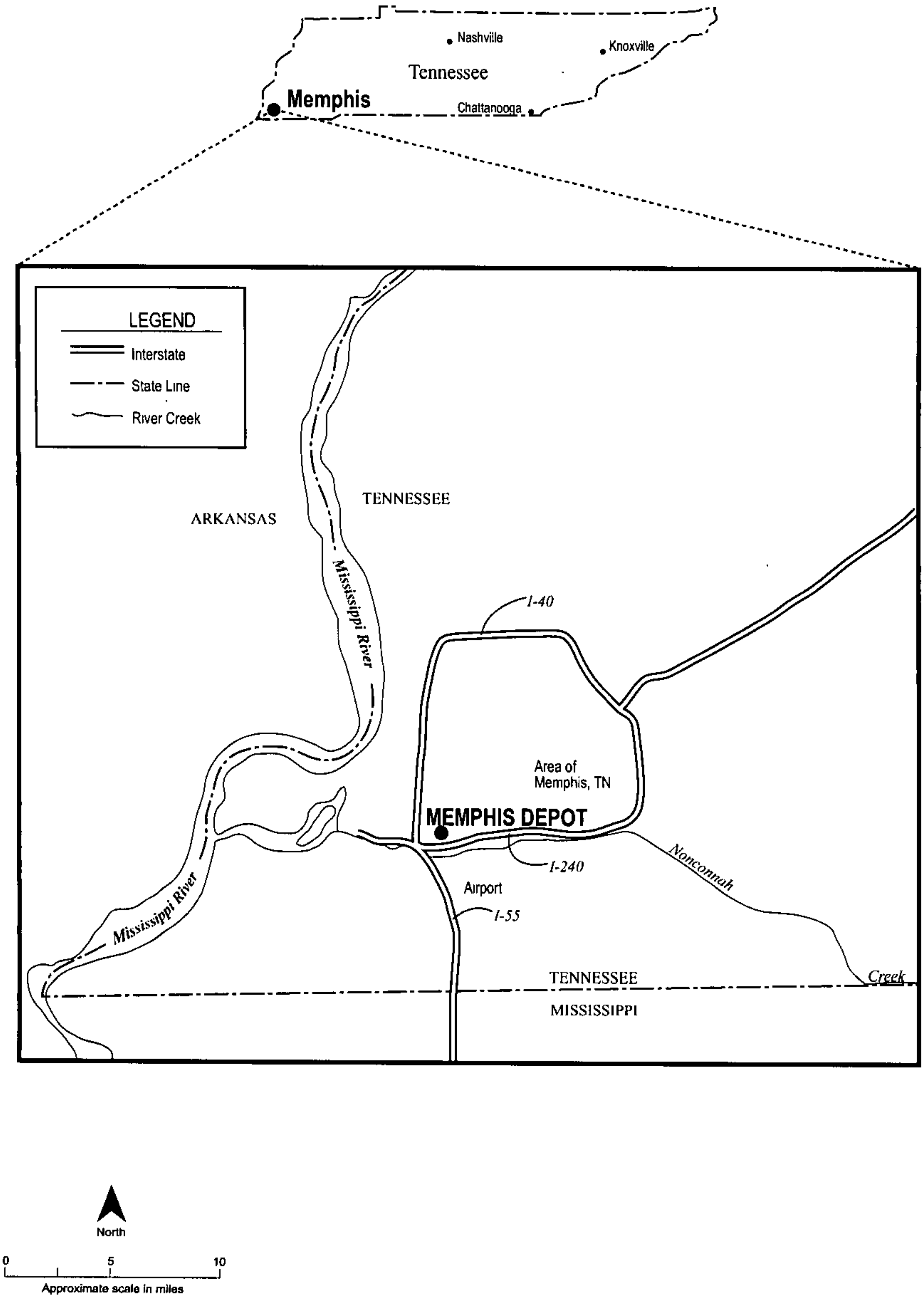
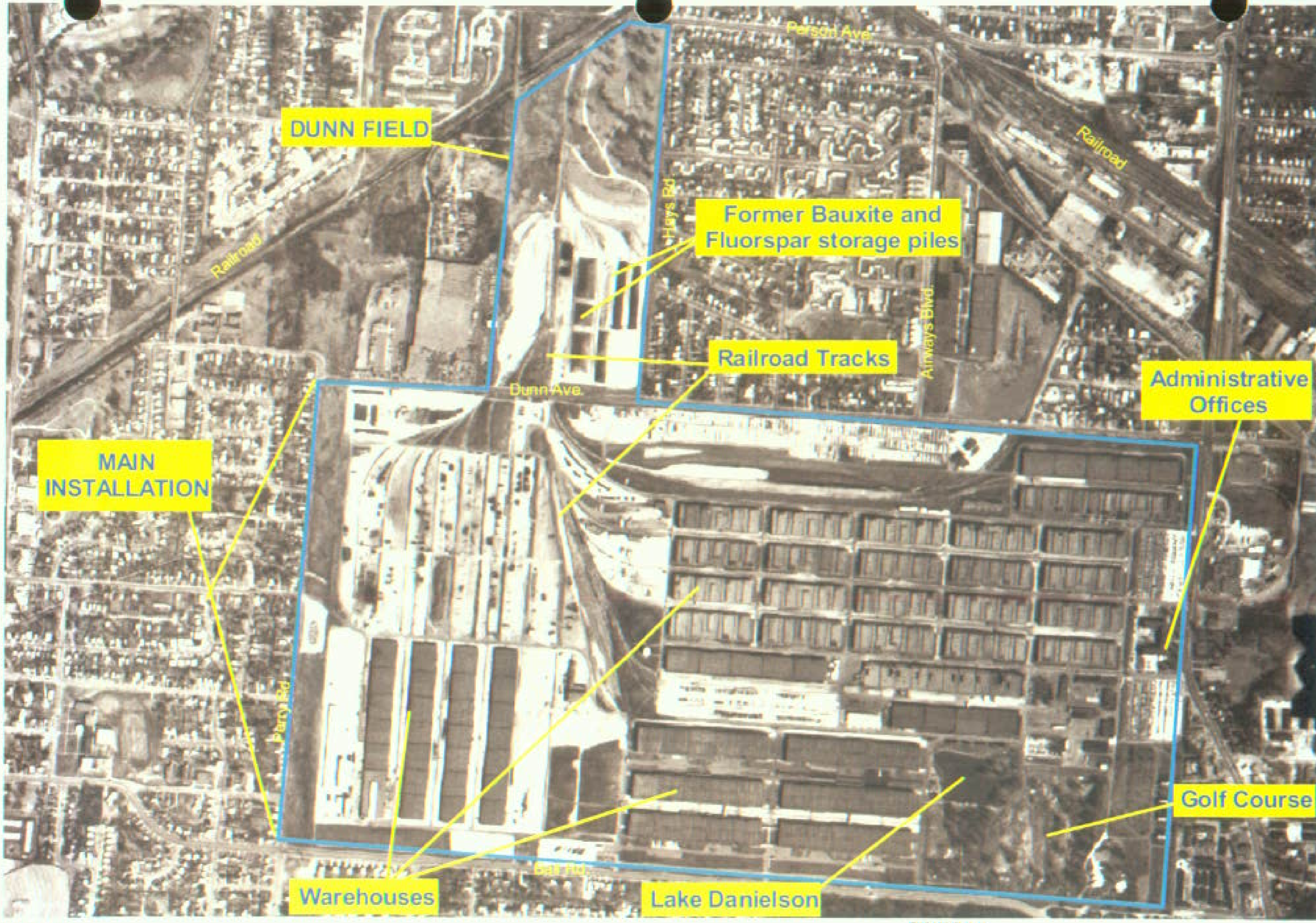


FIGURE 2-1
Memphis Depot Location In The Memphis Metropolitan Area
Memphis Depot Dunn Field Remedial Design



8891233

FIGURE 2-2
Major Features of the Memphis Depot
Aerial Photo Date: 1997
Memphis Depot Dunn Field Remedial Design

CH2MHILL

ES082006008ATL Memphis 102 #

8891239

- ■RW03 RECOVERY WELL SCREENED IN THE FLUVIAL AQUIFER
- ●MW73 MONITORING WELL SCREENED IN THE FLUVIAL AQUIFER
- ●STB7 SOIL TEST BORING
- ●MW144 NEW OFFSITE DESIGN-RELATED WELL LOCATION
- ◇MW37 MONITORING WELL SCREENED IN THE INTERMEDIATE AQUIFER
- ▲MW67 MONITORING WELL SCREENED IN THE MEMPHIS AQUIFER
- ○ ABANDONED WELL
- —210— POTENTIOMETRIC SURFACE OF FLUVIAL AQUIFER (FEET MSL) DECEMBER 2004

NOTE: (1) CONTOUR INTERVAL INCREASED FROM 1 FOOT TO 10 FEET NEAR MW169

(2) THE GROUND WATER ELEVATIONS OF THE RECOVERY WELLS, AND THE MONITORING WELLS SCREENED IN THE INTERMEDIATE AND MEMPHIS AQUIFERS WERE NOT USED IN CONTOURING

(3) THE DECEMBER 2004 DATA AT MW77 AND MW126 ARE CONSIDERED TO BE SUSPECT, AND WERE NOT USED IN CONTOURING. ESTIMATED ELEVATION VALUES OF 222.65 AND 235.00 RESPECTIVELY, (CONSISTENT WITH HISTORICAL VALUES) WERE USED

(4) ADDITIONAL MONITORING WELLS IN THE DUNN FIELD AREA NOT USED IN CONTOURING INCLUDED

(A) MW02 – SCREENED IN PROBABLE PERCHED ZONE

(B) MW05 – DRY

(C) MW14, MW28, MW29, MW49, MW56, MW84, MW130 – NOT IN CLOSE PROXIMITY TO AREA OF INTEREST

(D) MW57, MW95 – GROUNDWATER LEVELS INCONSISTENT WITH PREVIOUS READINGS

(E) MW131–MW135 – CLUSTERED WELLS NEAR OTHER WELLS; DATA NOT NEEDED

(F) MW158A – CLUSTER WELL SCREENED IN SHALLOW PORTION OF FLUVIAL AQUIFER

(G) MW166, MW166A – NOT ACCESSIBLE

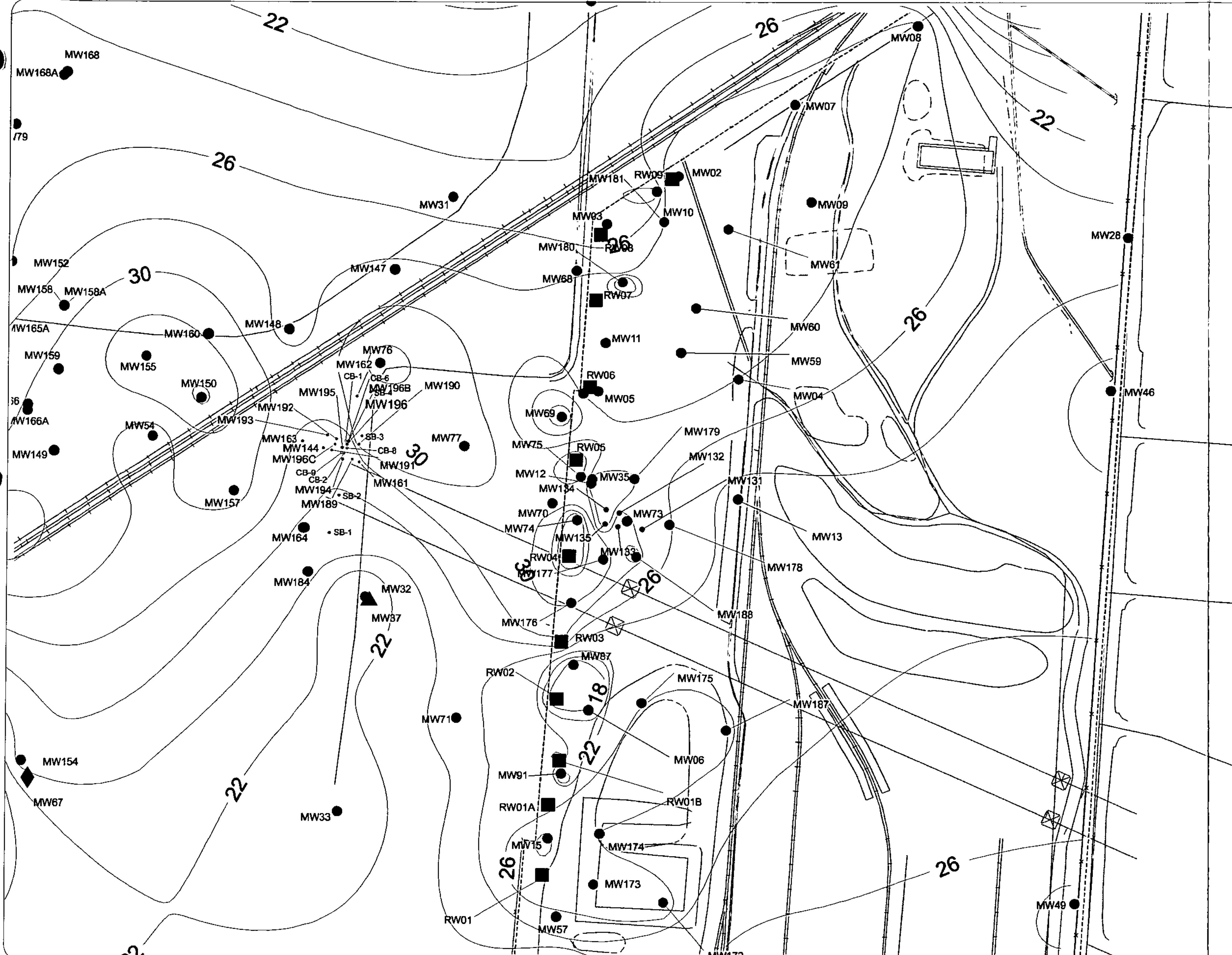
SCALE IN FEET 0 400 800

FIGURE 2-3
Potentiometric Surface
Map of the Fluvial Aquifer,
March 1, 2006
MEMPHIS DEPOT DUNN FIELD REMEDIAL DESIGN

CH2MHILL

ATL/PROJ/148071 DDMT/PRD 2006

09-Jan-2007



LEGEND

- ■ RW03 RECOVERY WELL
- ● MW53 FLUVIAL AQUIFER MONITORING WELL
- ▲ MW43 INTERMEDIATE AQUIFER MONITORING WELL
- ● PZ06 PIEZOMETER
- ◆ MW67 MEMPHIS AQUIFER MONITORING WELL
- ● SB SOIL BORING
- ------ MEMPHIS DEPOT BOUNDARY
- —215— THICKNESS OF LOESS DEPOSITS

NOTE:

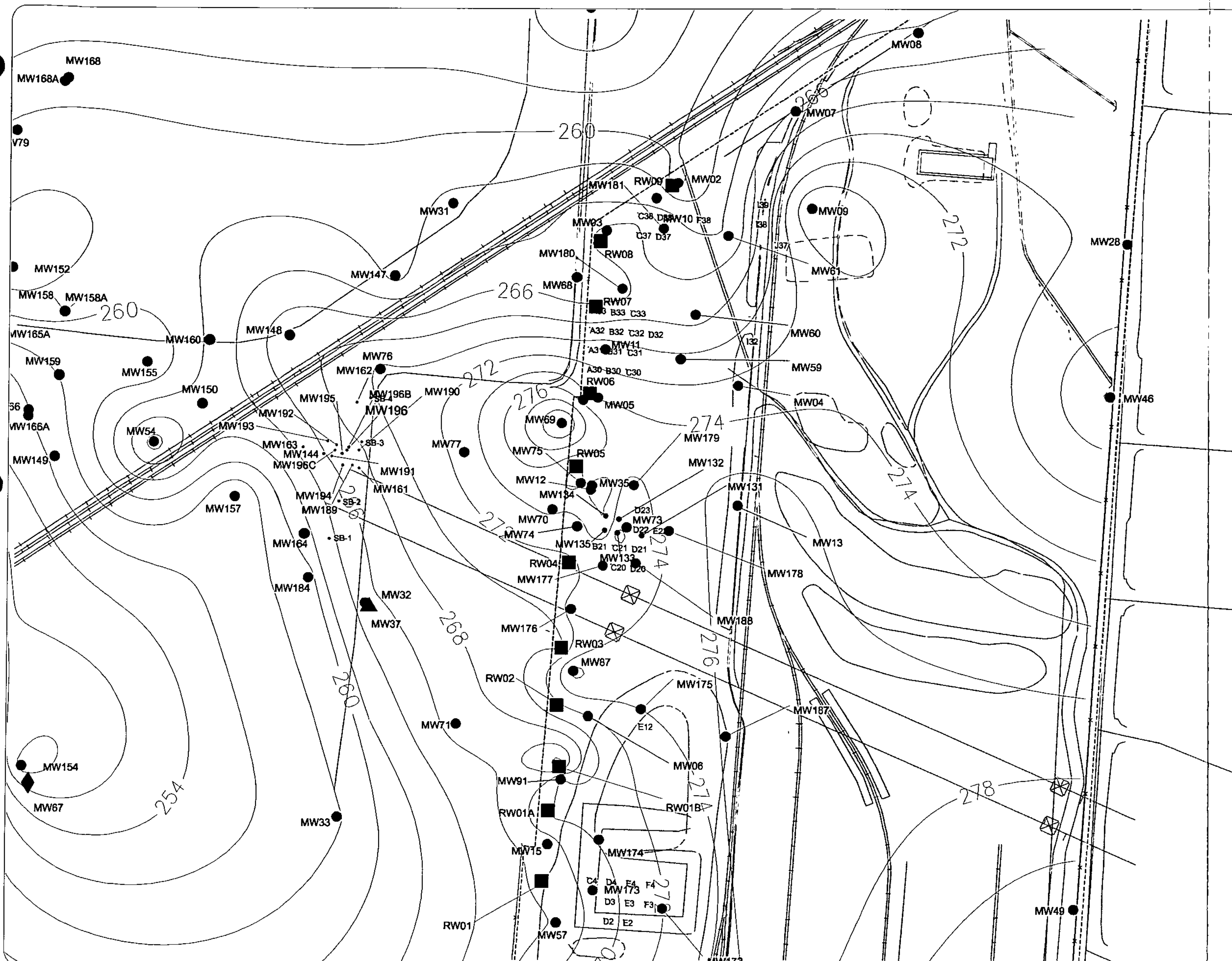
— ELEVATION CONTOURS IN INTERVALS OF 2 FOOT

FIGURE 2-4
ESTIMATED THICKNESS OF LOESS DEPOSITS
MARCH 2006
MEMPHIS DEPOT, DUNN FIELD

CH2MHILL

ATL/PROJ/148071/DDMT/DUNNFIELD RD_2003/FIGURE_4 (03-23-05) 09-JAN-2007

8891241



LEGEND

■ RW03	RECOVERY WELL
• MW53	FLUVIAL AQUIFER MONITORING WELL
▲ MW43	INTERMEDIATE AQUIFER MONITORING WELL
• PZ06	PIEZOMETER
◆ MW67	MEMPHIS AQUIFER MONITORING WELL
• SB	SOIL BORING
------	MEMPHIS DEPOT BOUNDARY
—215—	TOP OF FLUVIAL DEPOSITS (FEET MSL)

0 50 100

1" = 200'

N

NOTE:

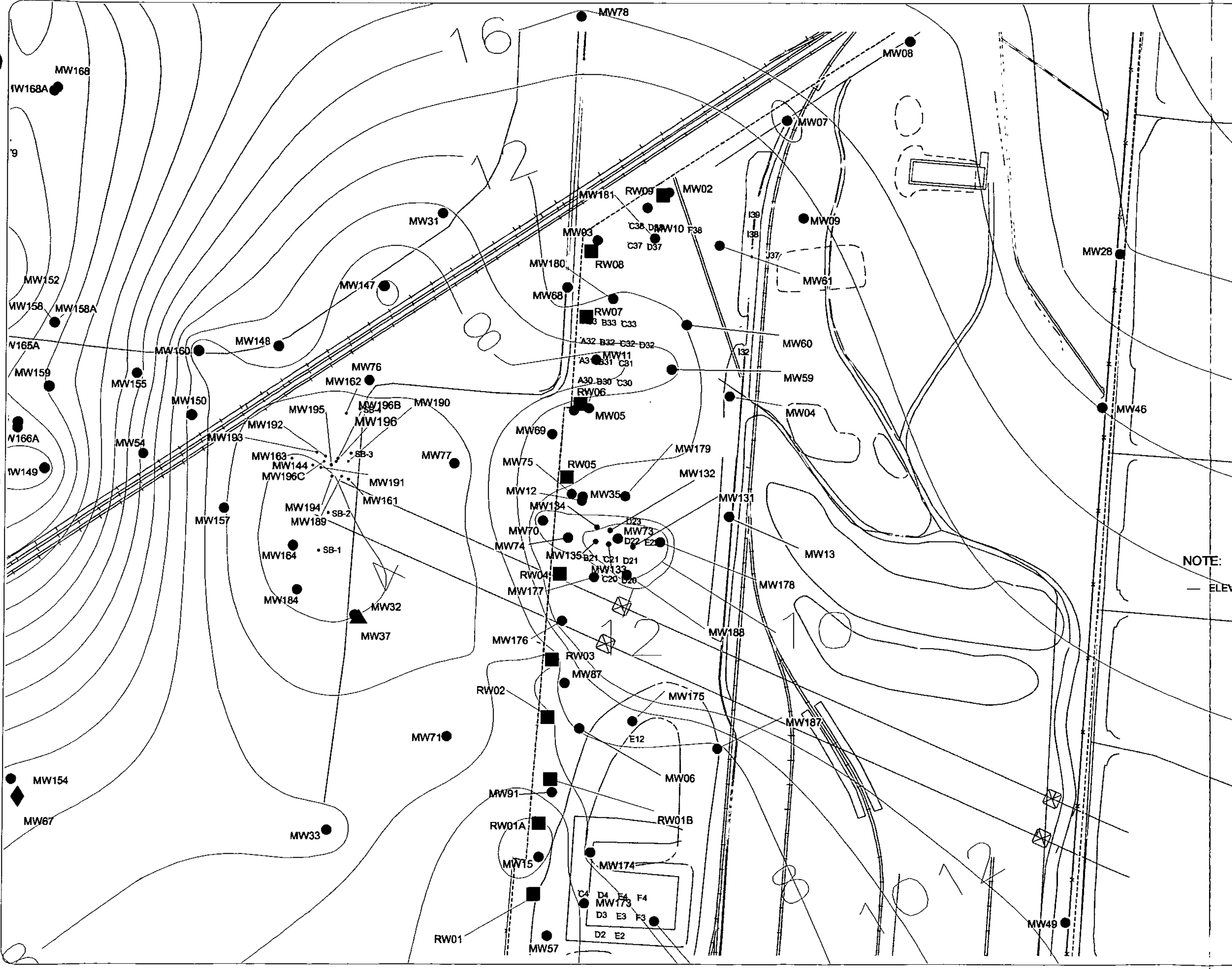
— ELEVATION CONTOURS IN INTERVALS OF 2 FOOT.

FIGURE 2-5
ESTIMATED INTERFACE BETWEEN LOESS DEPOSITS AND FLUVIAL SANDS MARCH 2006

MEMPHIS DEPOT, DUNN FIELD

CH2MHILL

ATL/PROJ/148071/DDMT/DUNNFIELD RD_2003/FIGURE_2 (03-23-05) 09-JAN-2007



N

0 100 200
SCALE IN FEET

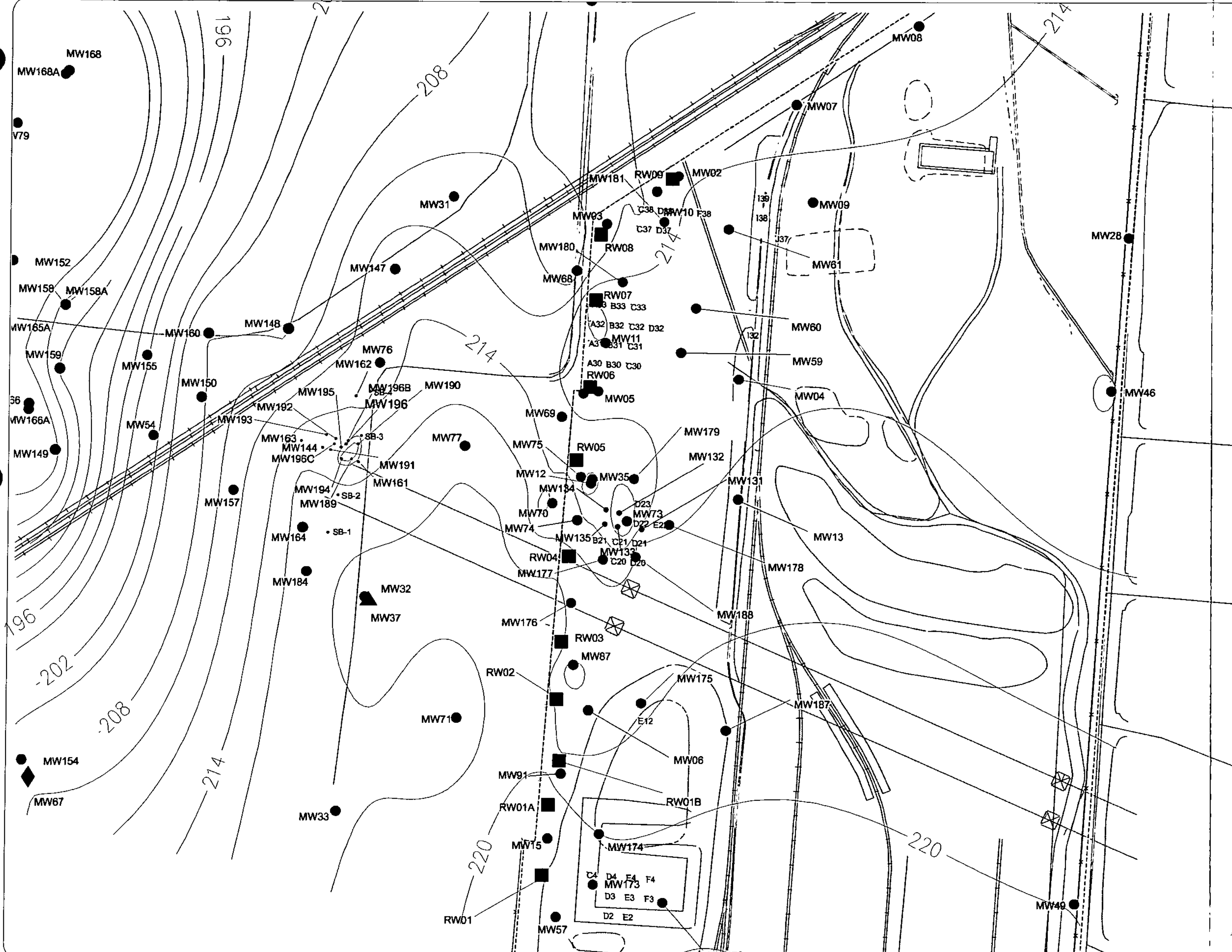
LEGEND

- ■ RW03 RECOVERY WELL
- ● MW53 FLUVIAL AQUIFER MONITORING WELL
- ▲ MW43 INTERMEDIATE AQUIFER MONITORING WELL
- ● PZ06 PIEZOMETER
- ◆ MW67 MEMPHIS AQUIFER MONITORING WELL
- ● SB SOIL BORING
- ------ MEMPHIS DEPOT BOUNDARY
- —215— SATURATED THICKNESS (FEET MSL)

FIGURE 2-6
SATURATED THICKNESS
OF THE FLUVIAL AQUIFER
MARCH 2006
MEMPHIS DEPOT, DUNN FIELD

CH2MHILL

8891243



N

0 50 100

1" = 200'

LEGEND

- ■ RW03 RECOVERY WELL
- ● MW53 FLUVIAL AQUIFER MONITORING WELL
- ▲ MW43 INTERMEDIATE AQUIFER MONITORING WELL
- ● PZ06 PIEZOMETER
- ◆ MW67 MEMPHIS AQUIFER MONITORING WELL
- ● SB SOIL BORING
- ------ MEMPHIS DEPOT BOUNDARY
- —215— TOP OF CLAY (FEET MSL)

NOTE:

— ELEVATION CONTOURS IN INTERVALS OF 2 FOOT.

FIGURE 2-7
ESTIMATED ELEVATION OF THETOP OF UPPERMOST CLAY IN THE JACKSON FORMATION/UPPER CLAIBORNE UNIT
MEMPHIS DEPOT, DUNN FIELD

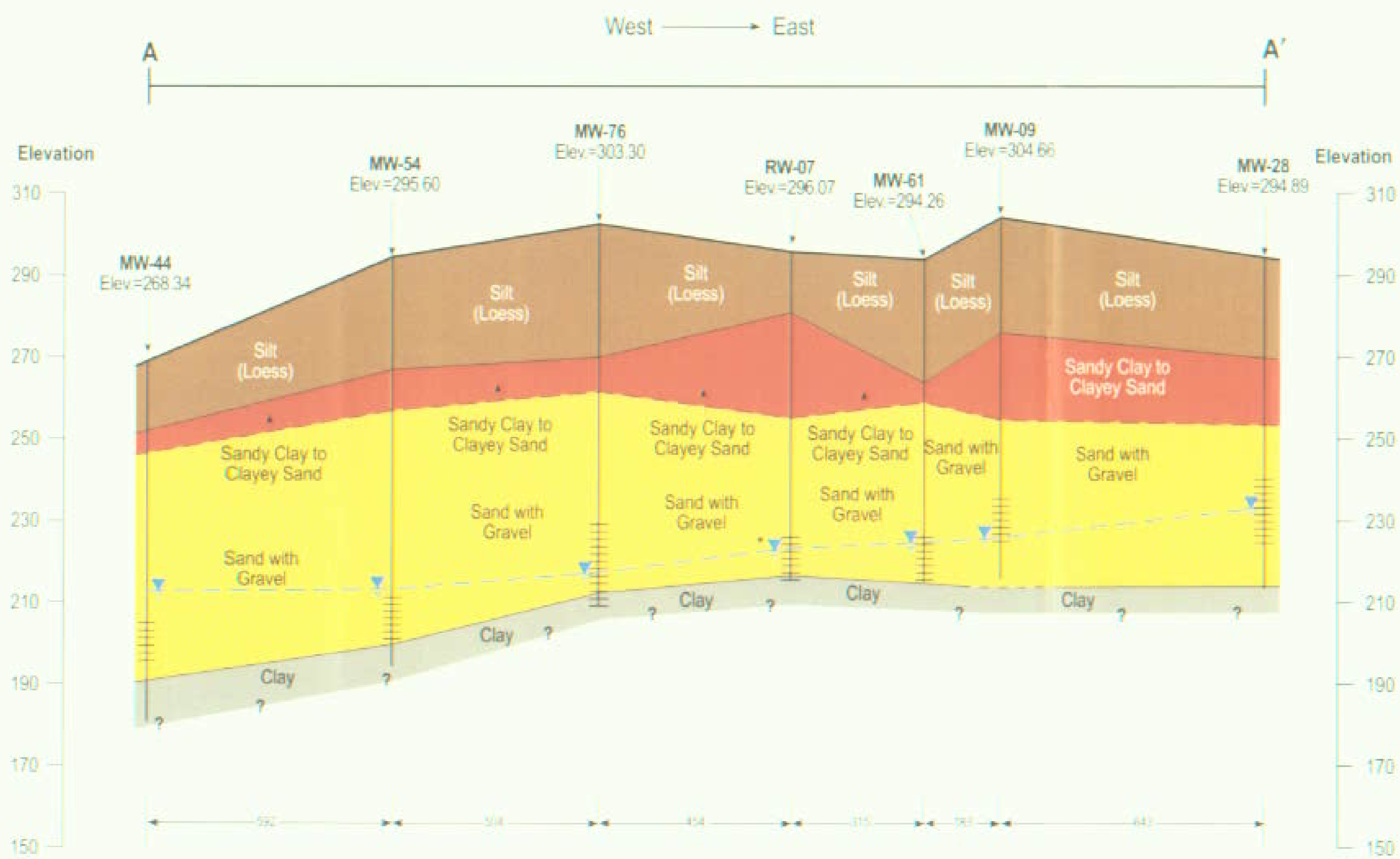
CH2MHILL

ATL/PROJ/148071/DDMT/DUNNFIELD RD_2003/FIGURE_3 (03-23-05) 09-JAN-2007

FIGURE 6-4
ZVI Injection Location Layout
Memphis Depot Dunn Field Remedial Design

CH2MHILL

8891245



SCALE

Vertical Scale 1" = 40'
Horizontal Scale 1" = 400'

LEGEND

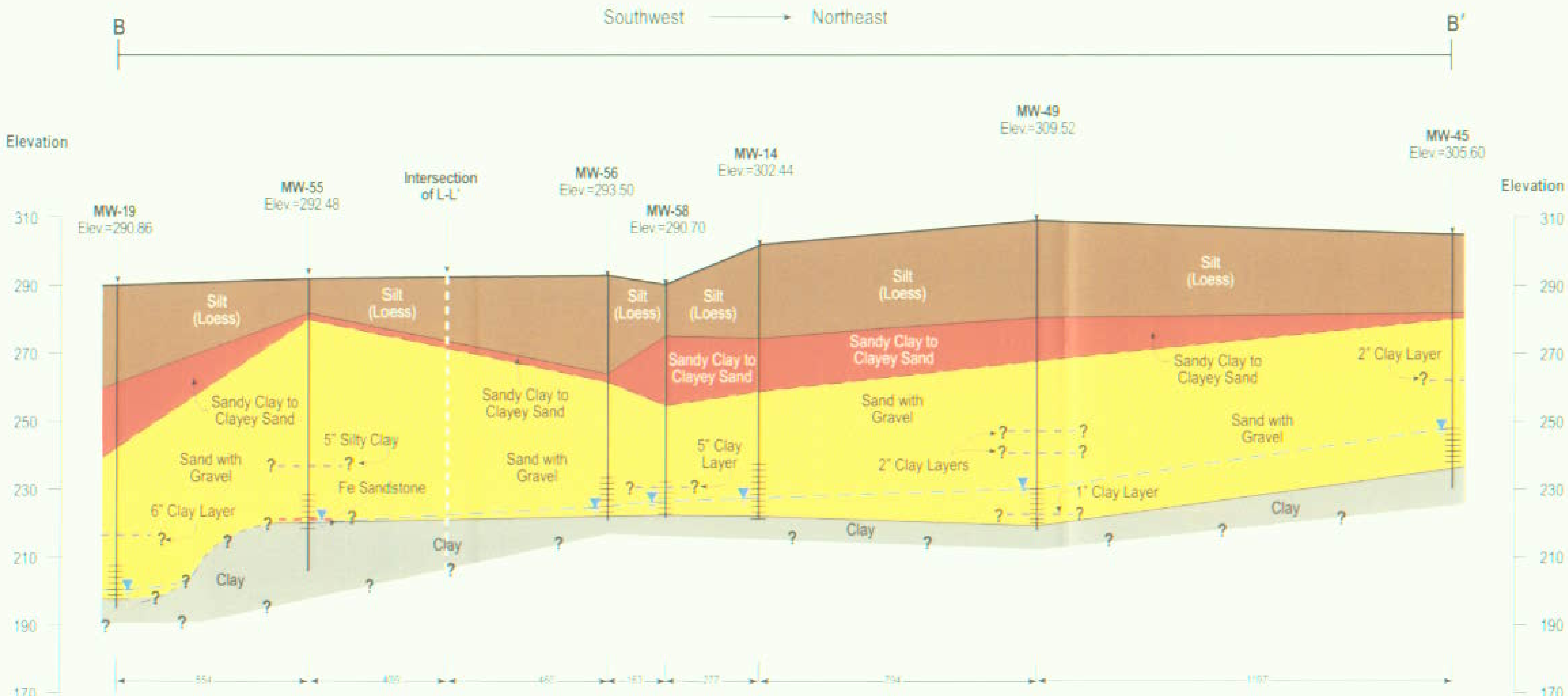
Well Screen Interval
Measured Groundwater Elevation
Interpreted Geologic Contact
Transitional Geologic Contact
? Inferred Geologic Contact
Loess Consists of Silt and Clay Deposits

Note: All water levels from 01/10/2001 gauging event except where noted.
* RW-07 was not operating on 01/10/2001

FIGURE 2-8a
Lithologic Cross-Section A - A'
Memphis Depot Dunn Field RI Report

CH2MHILL

Rev. 1



SCALE

Vertical Scale 1" = 40'
Horizontal Scale 1" = 400'

LEGEND

- Well Screen Interval
- Measured Groundwater Elevation
- Interpreted Geologic Contact
- Transitional Geologic Contact
- Inferred Geologic Contact

Loess Consists of Silt and Clay Deposits

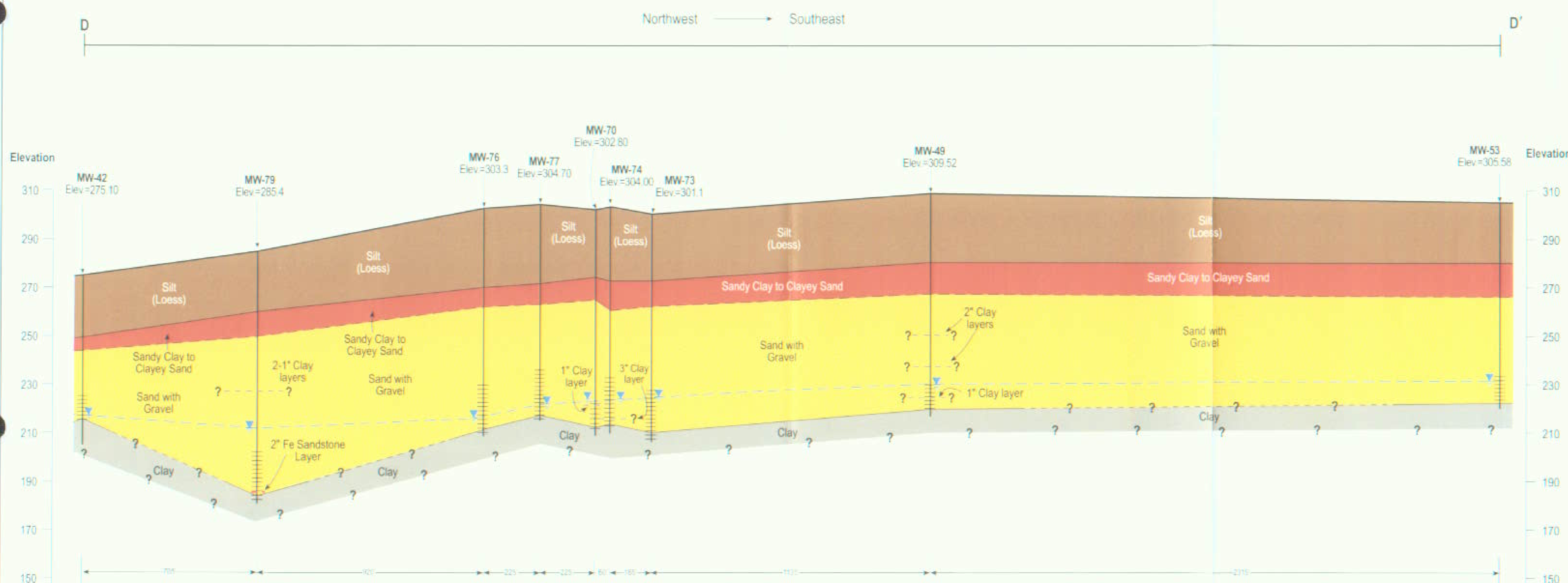
Note: All water levels from 01/10/2001 gauging event except where noted.

FIGURE 2-8b
Lithologic Cross-Section B - B'
Memphis Depot Dunn Field RI Report

Rev. 1

CH2MHILL

8891247



LEGEND

- Well Screen Interval
- Measured Groundwater Elevation
- Interpreted Geologic Contact
- Transitional Geologic Contact
- Inferred Geologic Contact

Loess Consists of Silt and Clay Deposits

Note: All water levels from 01/10/2001 gauging event except where noted. RW-04 not operating on 01/10/2001.

SCALE

Vertical Scale	1" = 40'
Horizontal Scale	1" = 400'

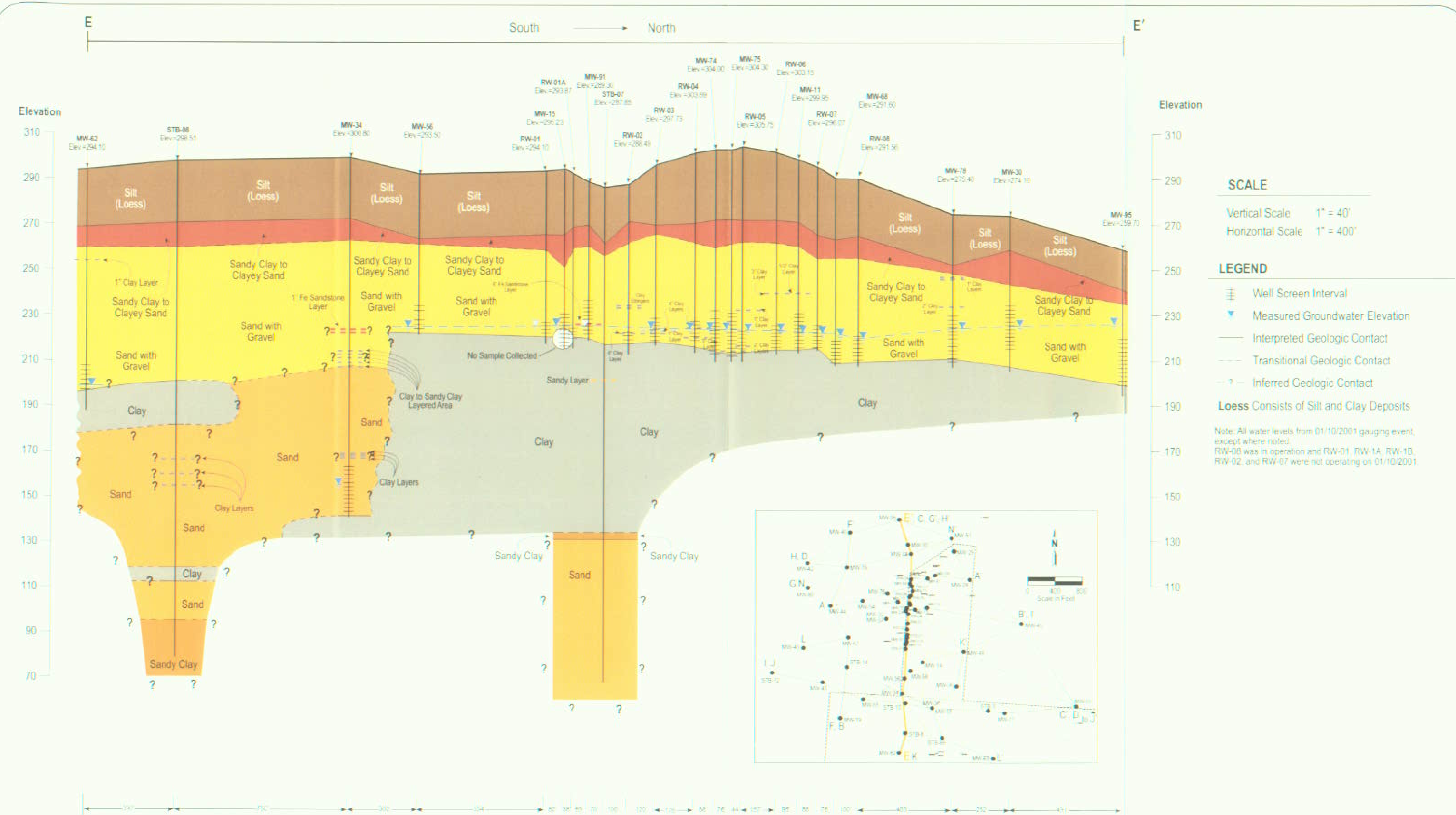
Rev. 1

FIGURE 2-8d
Lithologic Cross-Section D - D'
Memphis Depot Dunn Field RI Report

CH2MHILL

E032002012ATL Memphis Depot 110 FHR

8891243

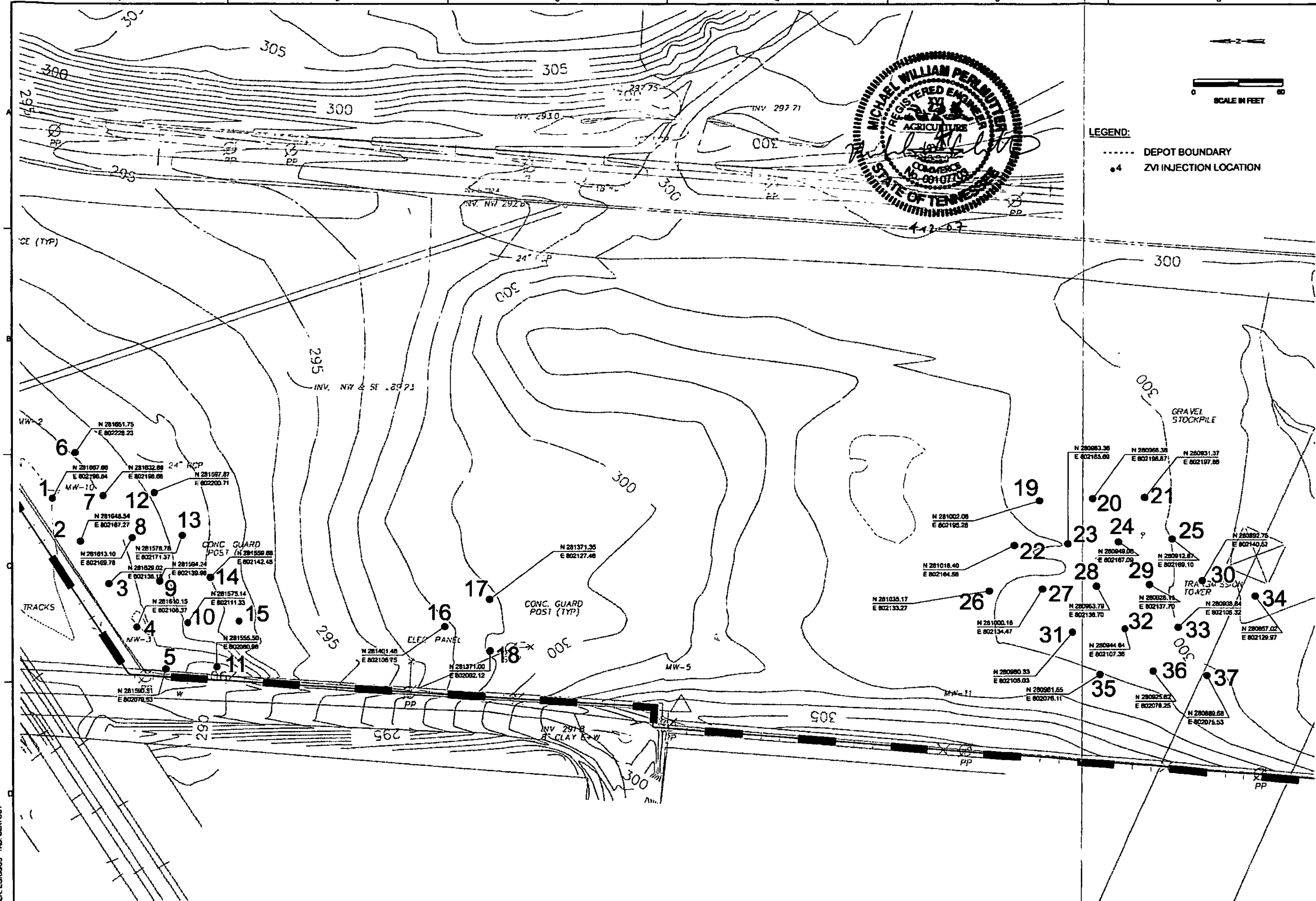


Rev. 1

FIGURE 2-8e
Lithologic Cross-Section E - E'
Memphis Depot Dunn Field RI Report

CH2MHILL

8891249



CH2MHILL

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

GROUNDWATER
NORTH ZVI INJECTION LOCATIONS

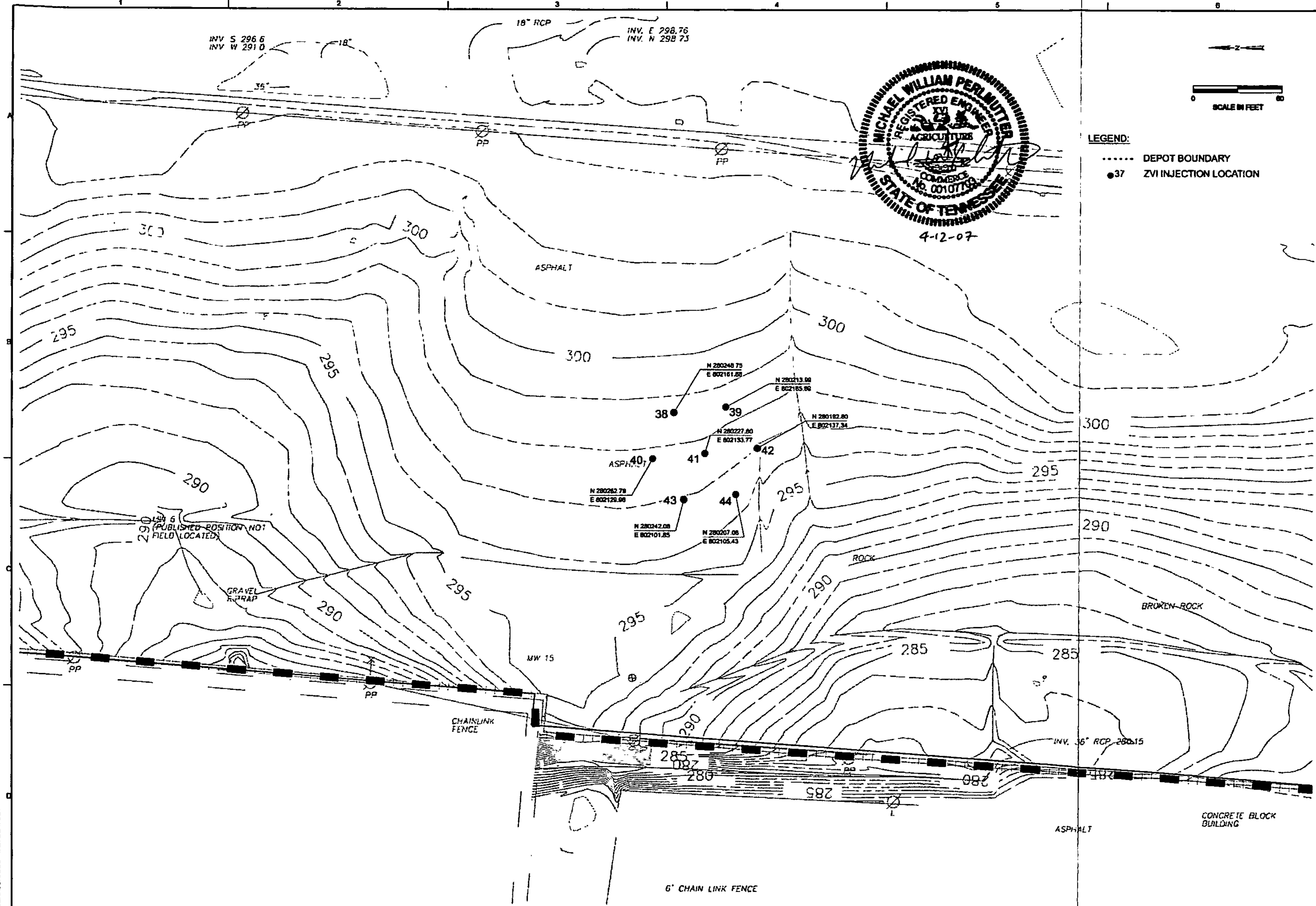
NO.	DATE	REVISION	BY	APVD

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

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.

DATE	SEPTEMBER, 2006
PROJ	177556
DWG	GW-1
SHEET	13

USER: EGRIGGS TAB: GLAYOUT
ATL/PROJ/148071 DDMT/SARD 2006.DWG
FILENAME: SVE SYSTEM LAYOUT.DWG
PLOT DATE: 7-Jul-06
PLOT TIME: 1:10:40 PM



NO.	DATE	REVISION	BY	APVD

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

MEMPHIS DEPOT DUNN FIELD
SOURCE AREAS
REMEDIAL DESIGN
MEMPHIS, TN

CH2MHILL

GROUNDWATER
SOUTH ZVI INJECTION LOCATIONS

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

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

ATL/PROJ/148071 DDMT/SARD 2006.DWG
FILENAME: SVE SYSTEM LAYOUT.DWG
PLOT DATE: 7-Jul-06
PLOT TIME: 1:10:40 PM
USER: EGRIGGS TAB: DLAYOUT

APPENDIX F

Industrial Wastewater Discharge Agreement

8891252

DEFENSE LOGISTICS AGENCY

DEFENSE DEPOT SUSQUEHANNA PENNSYLVANIA
OL, MEMPHIS
2163 AIRWAYS BOULEVARD
MEMPHIS, TENNESSEE 38114

IN REPLY REFER TO DDSP-D

May 31, 2002

MEMORANDUM FOR Al-Chokhachi (City of Memphis Division of Public Works)

SUBJECT: Dunn Field Recovery Well System

As a follow-up to our conversation of Tuesday, May 21, 2002, I am providing additional information to your office on the Dunn Field Recovery System. The City of Memphis granted a permit to the former Memphis Depot to discharge groundwater pumped from under Dunn Field directly into the City's sewer system. The groundwater is pumped into a manhole at the intersection of Person Ave. and Hays Road. It was agreed that treatment of the water would not be required prior to discharge into the City system. Therefore, the groundwater is pumped directly into the City's sewer system without treatment.

In March of 2001, the system on Dunn Field was expanded from seven wells to eleven wells. The four additional wells were placed in areas determined to have the highest concentrations of contaminants. The concentration of chloroform has risen during recent samplings to around 50 ug/L, which exceeds the permit limits of 20 ug/L monthly average and 40 ug/L one time maximum. Additionally, the concentration of Cis 1,2-DCE has occasionally been above the monthly average of 50 ug/L, but has not exceeded the one time maximum of 100 ug/L.

The discharge rate from Dunn Field into the City sewer system is approximately 50 gpm or 72,000 gallons per day, which is then mixed with and diluted by the flows going to the treatment plant. It is requested that a revision to the permit be made to allow concentrations of chloroform and Cis 1,2-DCE , respectively as follows:

Chloroform: 100ug/L monthly average // 200ug/L one - time maximum

Cis 1, 2 – Dichloroethene: 80 ug/L monthly average
100 ug/L one - time maximum

We are committed to meeting all requirements, as necessary and we look forward to working with you and the Division of Public Works. For more information, please contact me at (901) 544-0617.

Sincerely,

CLYDE E. HUNT, JR
Remedial Program Manager

8891253

City of Memphis
TENNESSEE

DR. WILLIE W. HERENTON - Mayor
RICK MASSON - Chief Administrative Officer
DIVISION OF PUBLIC WORKS
JERRY R. COLLINS JR. - Director
Maynard C. Stiles Wastewater Treatment Plant

Tuesday, June 04, 2002

Mr. Clyde Hunt
Project Manager
Memphis Depot Caretaker
2163 Airways Boulevard
Memphis, Tennessee 38114

RE: Revised Industrial Wastewater Discharge Agreement Permit No. S-NN3-097
Memphis Depot Caretaker @ 2163 Airways Blvd., Memphis, Tennessee

Dear Mr. Hunt:

Please find enclosed the revised sections (D.3) of Memphis Depot Caretaker 's Industrial Wastewater Discharge Agreement for your review. This revision is to include new limits for Chloroform and Cis 1,2-Dichloroethne.

If you should have any questions, please feel free to contact me at (901) 353-2392.

Sincerely,

Akil AL-Chokhachi
Environmental Engineer

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097

MEMPHIS DEPO

D.3 Priority Pollutants and other substances that may be present in the wastewater discharge

(See Appendix A for complete listing.)

PAGE 1 OF 2 Ground Water with a flow of 561,600 gallons / day

Parameter	PPN	Class	Daily Average (Monthly Average) Maximum Level mg/l	lbs/day	Instantaneous (One Day) Maximum Level mg/l	lbs/day
1,1,1-trichloroethane	11	Volat	0.010	0.047	0.020	0.094
1,1,2,2-tetrachloroethane	15	Volat	0.500	2.342	1.000	4.684
1,1,2-trichloroethane	14	Volat	0.050	0.234	0.100	0.468
1,1-dichloroethene		Volta	0.050	0.234	0.100	0.468
Aluminum		Metal	1.000	4.684	2.000	9.367
Arsenic	115	Metal	0.040	0.187	0.100	0.468
Bis (2-ethylhexyl) Phthalate	66	Semiv	0.010	0.047	0.020	0.094
Cadmium (total)	118	Metal	0.010	0.047	0.020	0.094
Carbon Tetrachloride (tetrachlor-)	6	Volat	0.020	0.094	0.040	0.187
Chloroform (trichloromethane)	23	Volat	0.100	0.468	0.200	0.937
Chromium (total)	119	Metal	0.200	0.937	0.400	1.873
Cis-1,2-dichloroethene		Volat	0.080	0.375	0.100	0.468
Copper (total)	120	Metal	0.200	0.937	0.400	1.873
Di-n-butyl Phthalate	68	Semiv	0.030	0.141	0.060	0.281
Iron		Metal	10.000	46.837	20.000	93.675
Lead (total)	122	Metal	0.150	0.703	0.300	1.405
Mercury	123	Metal	0.001	0.005	0.002	0.009
Methylene Chloride (dichlorometh-)	44	Volat	0.010	0.047	0.020	0.094
Naphthalene	55	Semiv	0.010	0.047	0.020	0.094
Nickel (total)	124	Metal	0.100	0.468	0.300	1.405
Phenol	65	Semiv	0.010	0.047	0.020	0.094
Tetrachloroethylene (perc- & Tet-)	85	Semiv	0.060	0.281	0.120	0.562
Toluene	86	Volat	0.020	0.094	0.040	0.187
Trans-1,2-dichloroethene		Volat	0.050	0.234	0.100	0.468
Trichloroethylene (trichloroethe-)	87	Volat	0.400	1.873	0.800	3.747

8891255

City of Memphis
TENNESSEE

DR. WILLIE W. HERENTON - Mayor
RICK MASSON - Chief Administrative Officer
DIVISION OF PUBLIC WORKS
JERRY R COLLINS JR. - Director
Maynard C. Stiles Wastewater Treatment Plant

Wednesday, May 07, 2003

Mr. John DeBack
BRAC Environmental coordinator
DDSP-D (Memphis)
2163 Airways Boulevard Building 144
Memphis, Tennessee 38114

RE: Renewal Industrial Wastewater Discharge Agreement Permit No. S-NN3-097
DDSP-D (Memphis) @ 2163 Airways Blvd., Memphis, Tennessee

Dear Mr. DeBack:

Please find enclosed singed and approved copy the revised/renewed DDSP-D (Memphis) 's Industrial Wastewater Discharge Agreement for your record keeping.

If you should have any questions, please feel free to contact me at (901) 353-2392.

Sincerely,

Akil AL-Chokhachi
Environmental Engineer

8891256

ORIGINAL

S-NN3-097

DDSP-D MEMPHIS

City of Memphis

Division of Public Works

Industrial Wastewater Discharge Agreement

made by and between the
City of Memphis
and
D D S P- D (Memphis)
on
May 01, 2003

Approved by: [signature]
Jerry Collins, Director
Public Works

8891257

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097

DDSP-D MEMPHIS

» » » Intent and Purpose « « «

The City of Memphis in enacting the revised Sewer Use Ordinance deemed it necessary to identify certain significant contributors to the municipal sewer system and regulate the significant contributors on the discharge quantity and characteristics which would be permitted to be discharged into the municipal wastewater system. The basis for the values shown in the following sections are primarily to comply with the State of Tennessee and the Environmental Protection Agency regulations and to preserve the integrity of the publicly owned treatment works.

The agreement serves as a firm understanding between the user and the City for a specified period of time not to exceed five (5) years. The parameters which have been identified in this document reflect the best estimate of the user as to the characteristics of his discharge and will remain in effect until modified by amendments to the discharge agreement. The allowable levels for each parameter are determined by limitations imposed by the Sewer Use Ordinance and for compounds, not specifically limited by the Sewer Use Ordinance or EPA Categorical limitations, the best professional judgement of the City staff engineers and chemists. Primary in the determination is the protection of the integrity of the publicly owned treatment works. Accordingly, tables of guidance for criteria influent levels for specific incompatible wastes have been developed and are part of the Sewer Use Ordinance.

Willful failure of an industrial user to report significant changes in operations which affect wastewater constituents and characteristics can result in the revoking of his discharge agreement. If a public sewer becomes obstructed or damaged because of any substances improperly discharged into it, D D S P- D (Memphis) if responsible for such discharge shall be billed and shall pay for all the expenses incurred by the City in cleaning out, repairing, or rebuilding the sewer.

According to Section 33-173 of the Sewer Use Ordinance, violations of the Discharge Agreement and the Sewer Use Ordinance requirements may result in civil penalties up to ten thousand dollars ($10,000) for each day during which the acts or omission continues or occurs.

Each industrial user discharging compounds regulated by the pretreatment program or other programs identified by the Environmental Protection Agency (EPA) must also pretreat to the point as required by the EPA. In addition to this, the State of Tennessee has identified certain allowable levels for incompatibles entering a publicly owned treatment works. The pretreatment values set by the City are listed in Table 1 and Table 2, Section 33-104 of the Sewer Use Ordinance.

Wastewater discharge agreements are issued to a specific user for a specific operation. A wastewater discharge agreement shall not be reassigned or transferred or sold to a new owner, new user different premises, or a new or changed operation which will significantly affect wastewater characteristics, Section 33-85 of the Sewer Use Ordinance.

The industrial user shall comply with the record-keeping requirements outlined in the general pretreatment Standards in part 403.12 (o) of the Federal Regulations and Section 33-83(f) of the Sewer Use ordinance.

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

»»» Intent and Purpose «««

According to Section 33-110 of the Sewer Use Ordinance, the Industrial User shall notify the Control Authority immediately in the event of spill, bypass, upset and slug or accidental discharges, including any discharges that would violate a prohibition under Section 33-103, with procedures for the follow-up written notification within five days. The Control Authority will evaluate the Industrial User every two years or as needed for slug discharge control plan, if not required then, the Industrial User shall submit a signed statement stating that there is no potential nor any need for developing such a plan. However, if required then the Control Authority will attach a copy of the plan to this Agreement.

Whereas, Chapter 33 of the Code of Ordinances of the City of Memphis requires that "dischargers to the municipal wastewater treatment facilities designated by the approving authority as requiring agreements shall not discharge to the system without said agreement"; and

Whereas, D D S P- D (Memphis) located at 2163 Airways Blvd, Bldg 144 desires to discharge to the Memphis sewer system; and

Whereas, D D S P- D (Memphis) agrees to comply with all requirements specified in Chapter 33 of the Code of Ordinances and any revision thereof.

Now therefore, D D S P- D (Memphis) is granted the right to discharge the wastewater of such characteristics and volume as described in this wastewater discharge permit into the City of Memphis sewer system from May 01, 2003 to April 30, 2008.

Signed by:

Rodney Thomas

City of Memphis

Authorized Industrial User Representative:

JOHN P. DE BACK

DOD BRAC ENVIRONMENTAL COORDINATOR

John P DeBack

D D S P- D (Memphis)

8891259

City Of Memphis
Industrial Wastewater Discharge Agreement

S	-	N	N	3	-	097
DDSP-D MEMPHIS						

Start Date	Expiration Date
May 01, 2003	April 30, 2008

A.1 Corporate Name: D D S P- D (Memphis)
Corporate Address: 2163 Airways Blvd, Bldg 144
Memphis TN 38114

A.2 Company Name: D D S P- D (Memphis)
Mailing Address: 2163 Airways Blvd, Bldg 144
Memphis TN 38114

A.3 Facility Name: D D S P- D (Memphis)
Facility Address: 2163 Airways Blvd, Bldg 144
Memphis TN 38114

A.4 Contact Official: John De Back
Title: B R A C Environmental Coordinator
Phone: (901) 544-0622

A.5 Signing Official: John De Back
Title: B R A C Environmental Coordinator
Signee Address: 2163 Airways Blvd, Bldg 144
Memphis TN 38114

A.6 I certify that the information contained in this industrial wastewater discharge agreement consisting of twenty two pages (and any appendices) is familiar to me and to the best of my knowledge and belief, such information is true, complete and correct.

John D De Back May 01, 2003

Authorized Industrial User Representative: Signature/Date

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097

DDSP-D MEMPHIS

SECTION B - FACILITY OPERATIONAL CHARACTERISTICS

B.1 Description of manufacturing or service activities

The operation to be permitted is a ground water recovery system located in an open area, Dunn Field, adjacent to the northern perimeter of the DDMT main installation. The DDMT facility is currently being closed with the intent of transferring much of the facility to private ownership. Manufacturing of goods does not occur in the Dunn Field portion of the facility.

*Note: The ground water (GW) recovery and discharge system will operate on a continual basis once the system is completely operational. The federal government will operate and maintain the system.

B.2 Standard Industrial Classification(s)

a. 9711 b. c. d. e. f.

B.3 Weekly days of operation are 7 days/Week (GW)

B.4 The hours of operation and the number of employees per shift.

Shift	Times: Start	Times: Stop	Number of Employees: Weekday	Saturday	Sunday
Day	8:00 am	5:00 pm	1		
Evening					
Night					

B.5 Is production operation subject to seasonal variation? No

If so, complete the following:

a. Seasonal maximum wastewater discharged into the municipal sewer system is ______ gallons/day, during the months of ______

b. Seasonal minimum wastewater discharged into the municipal sewer system is ______ gallons/day, during the months of ______

8891261

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

B.6 Description of other operational schedule characteristics / scheduled shutdown

No operational variations are currently planned. The pumping rate may be altered based on the hydraulic capacity of the city sewer collection system, if required.

This discharge agreement application is for the following groundwater recovery system:

* One 40 - gpm wells
* One 50 - gpm wells
* Five 60 - gpm wells

This seven well groundwater recovery system will result in a total estimated discharge flow of 390 gpm (0.562 mgd) .

Requests for permits for additional wells beyond the seven identified may be submitted in the future, if required. The ground water design currently requires up to seventeen total wells to be installed in up to two phases.

B.7 Description of operational variables and frequency of occurrances which may result in unusual discharges

Fluctuations in the discharge of the system may occur due to changes in ground water conditions. The discharges described in Section B.6 are expected to be maximum discharges.

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

B.8 Raw Materials

Type	Quantity	Units
N / A		

8891263

City of Memphis
TENNESSEE

DR. WILLIE W. HERENTON - Mayor
RICK MASSON - Chief Administrative Officer
DIVISION OF PUBLIC WORKS
JERRY R COLLINS JR. - Director
Maynard C. Stiles Wastewater Treatment Plant

Wednesday, May 07, 2003

Mr. John DeBack
BRAC Environmental coordinator
DDSP-D (Memphis)
2163 Airways Boulevard Building 144
Memphis, Tennessee 38114

RE: Renewal Industrial Wastewater Discharge Agreement Permit No. S-NN3-097
DDSP-D (Memphis) @ 2163 Airways Blvd., Memphis, Tennessee

Dear Mr. DeBack:

Please find enclosed singed and approved copy the revised/renewed DDSP-D (Memphis) 's Industrial Wastewater Discharge Agreement for your record keeping.

If you should have any questions, please feel free to contact me at (901) 353-2392.

Sincerely,

Akil AL-Chokhachi
Environmental Engineer

8891264

ORIGINAL

S-NN3-097

DDSP-D MEMPHIS

City of Memphis

Division of Public Works

Industrial Wastewater Discharge Agreement

made by and between the

City of Memphis

and

D D S P- D (Memphis)

on

May 01, 2003

Approved by: Jerry Collins, Director
Public Works

8891265

S-NN3-097
DDSP-D MEMPHIS

City Of Memphis
Industrial Wastewater Discharge Agreement

» » » Intent and Purpose « « «

The City of Memphis in enacting the revised Sewer Use Ordinance deemed it necessary to identify certain significant contributors to the municipal sewer system and regulate the significant contributors on the discharge quantity and characteristics which would be permitted to be discharged into the municipal wastewater system. The basis for the values shown in the following sections are primarily to comply with the State of Tennessee and the Environmental Protection Agency regulations and to preserve the integrity of the publicly owned treatment works.

The agreement serves as a firm understanding between the user and the City for a specified period of time not to exceed five (5) years. The parameters which have been identified in this document reflect the best estimate of the user as to the characteristics of his discharge and will remain in effect until modified by amendments to the discharge agreement. The allowable levels for each parameter are determined by limitations imposed by the Sewer Use Ordinance and for compounds, not specifically limited by the Sewer Use Ordinance or EPA Categorical limitations, the best professional judgement of the City staff engineers and chemists. Primary in the determination is the protection of the integrity of the publicly owned treatment works. Accordingly, tables of guidance for criteria influent levels for specific incompatible wastes have been developed and are part of the Sewer Use Ordinance.

Willful failure of an industrial user to report significant changes in operations which affect wastewater constituents and characteristics can result in the revoking of his discharge agreement. If a public sewer becomes obstructed or damaged because of any substances improperly discharged into it, D D S P- D (Memphis) if responsible for such discharge shall be billed and shall pay for all the expenses incurred by the City in cleaning out, repairing, or rebuilding the sewer.

According to Section 33-173 of the Sewer Use Ordinance, violations of the Discharge Agreement and the Sewer Use Ordinance requirements may result in civil penalties up to ten thousand dollars ($10,000) for each day during which the acts or omission continues or occurs.

Each industrial user discharging compounds regulated by the pretreatment program or other programs identified by the Environmental Protection Agency (EPA) must also pretreat to the point as required by the EPA. In addition to this, the State of Tennessee has identified certain allowable levels for incompatibles entering a publicly owned treatment works. The pretreatment values set by the City are listed in Table 1 and Table 2, Section 33-104 of the Sewer Use Ordinance.

Wastewater discharge agreements are issued to a specific user for a specific operation. A wastewater discharge agreement shall not be reassigned or transferred or sold to a new owner, new user different premises, or a new or changed operation which will significantly affect wastewater characteristics, Section 33-85 of the Sewer Use Ordinance.

The industrial user shall comply with the record-keeping requirements outlined in the general pretreatment Standards in part 403.12 (o) of the Federal Regulations and Section 33-83(f) of the Sewer Use ordinance.

8891266

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

»»» Intent and Purpose «««

According to Section 33-110 of the Sewer Use Ordinance, the Industrial User shall notify the Control Authority immediately in the event of spill, bypass, upset and slug or accidental discharges, including any discharges that would violate a prohibition under Section 33-103, with procedures for the follow-up written notification within five days. The Control Authority will evaluate the Industrial User every two years or as needed for slug discharge control plan, if not required then, the Industrial User shall submit a signed statement stating that there is no potential nor any need for developing such a plan. However, if required then the Control Authority will attach a copy of the plan to this Agreement.

Whereas, Chapter 33 of the Code of Ordinances of the City of Memphis requires that "dischargers to the municipal wastewater treatment facilities designated by the approving authority as requiring agreements shall not discharge to the system without said agreement"; and

Whereas, D D S P- D (Memphis) located at 2163 Airways Blvd, Bldg 144 desires to discharge to the Memphis sewer system; and

Whereas, D D S P- D (Memphis) agrees to comply with all requirements specified in Chapter 33 of the Code of Ordinances and any revision thereof.

Now therefore, D D S P- D (Memphis) is granted the right to discharge the wastewater of such characteristics and volume as described in this wastewater discharge permit into the City of Memphis sewer system from May 01, 2003 to April 30, 2008.

Signed by:

Rodney Thomas

City of Memphis

Authorized Industrial User Representative:

JOHN P. DEBACK

DOD BRAC ENVIRONMENTAL COORDINATOR

John P. DeBack

D D S P- D (Memphis)

8891267

City Of Memphis
Industrial Wastewater Discharge Agreement

S	-	N	N	3	-	097

DDSP-D MEMPHIS

Start Date	Expiration Date
May 01, 2003	April 30, 2008

A.1	Corporate Name	D D S P- D (Memphis)		
	Corporate Address	2163 Airways Blvd, Bldg 144		
		Memphis	TN	38114
A.2	Company Name	D D S P- D (Memphis)		
	Mailing Address	2163 Airways Blvd, Bldg 144		
		Memphis	TN	38114
A.3	Facility Name	D D S P- D (Memphis)		
	Facility Address	2163 Airways Blvd, Bldg 144		
		Memphis	TN	38114
A.4	Contact Official	John De Back		
	Title	B R A C Environmental Coordinator		
	Phone	(901) 544-0622		
A.5	Signing Official	John De Back		
	Title	B R A C Environmental Coordinator		
	Signee Address	2163 Airways Blvd, Bldg 144		
		Memphis	TN	38114

A.6 I certify that the information contained in this industrial wastewater discharge agreement consisting of twenty two pages (and any appendices) is familiar to me and to the best of my knowledge and belief, such information is true, complete and correct.

John De Back May 01, 2003

Authorized Industrial User Representative. Signature/Date

8891268

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

SECTION B - FACILITY OPERATIONAL CHARACTERISTICS

B.1 Description of manufacturing or service activities

The operation to be permitted is a ground water recovery system located in an open area, Dunn Field, adjacent to the northern perimeter of the DDMT main installation. The DDMT facility is currently being closed with the intent of transferring much of the facility to private ownership. Manufacturing of goods does not occur in the Dunn Field portion of the facility.

*Note: The ground water (GW) recovery and discharge system will operate on a continual basis once the system is completely operational. The federal government will operate and maintain the system.

B.2 Standard Industrial Classification(s)

a. 9711 b. c. d. e. f.

B.3 Weekly days of operation are 7 days/Week (GW)

B.4 The hours of operation and the number of employees per shift.

Shift	Times: Start	Times: Stop	Number of Employees: Weekday	Saturday	Sunday
Day	8:00 am	5:00 pm	1		
Evening					
Night					

B.5 Is production operation subject to seasonal variation? No

If so, complete the following:

a. Seasonal maximum wastewater discharged into the municipal sewer system is ______ gallons/day, during the months of ______

b. Seasonal minimum wastewater discharged into the municipal sewer system is ______ gallons/day, during the months of ______

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097

DDSP-D MEMPHIS

B.8 Raw Materials

Type	Quantity	Units
N / A		

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097

DDSP-D MEMPHIS

B.9 Catalysts, Intermediates

Type	Quantity	Units
N / A		

8891271

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

B.9 Catalysts, Intermediates

Type	Quantity	Units
N / A		

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

B.10 Principal Products

Type	Quantity	Units
No Manufacturing Activities		

8891273

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

B.11 Byproducts and Waste Products

Type	Quantity	Units
None		

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097

DDSP-D MEMPHIS

B.12 Components of Non-contact Cooling Water

Type	Quantity	Units
N / A		

8891275

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

B.13 The person (or position) on the plant site who shall be contacted for emergency situations during plant operating hours.

Name	John De Back
Title	B R A C Environmental Coordinator
Phone	(901)-544-0622

B.14 The person(s) who shall be contacted at any time during emergency situations.

Name	Phone
John De Back - B R A C Environ. Coordinator	(901)-544-0622

B.15 Description of spill prevention controls and counter measure plans / accidental and slug discharges

A spill of any material or contaminated stormwater run-off as a result of an excavation of hazardous materials or any wastewater other than recovered groundwater shall not be discharged into the sanitary sewer without a written approval from the City of Memphis.

8891276

City Of Memphis Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

B.6 Description of other operational schedule characteristics / scheduled shutdown

No operational variations are currently planned. The pumping rate may be altered based on the hydraulic capacity of the city sewer collection system, if required.

This discharge agreement application is for the following groundwater recovery system:

* One 40 - gpm wells
* One 50 - gpm wells
* Five 60 - gpm wells

This seven well groundwater recovery system will result in a total estimated discharge flow of 390 gpm (0.562 mgd) .

Requests for permits for additional wells beyond the seven identified may be submitted in the future, if required. The ground water design currently requires up to seventeen total wells to be installed in up to two phases.

B.7 Description of operational variables and frequency of occurrances which may result in unusual discharges

Fluctuations in the discharge of the system may occur due to changes in ground water conditions. The discharges described in Section B.6 are expected to be maximum discharges.

8891277

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

SECTION C - WATER USAGE CHARACTERISTICS

C.1 MLG&W Account number(s)

124708000

C.4 f. & C.5 a. - Recovered ground water only

C.2 MLG&W Billing address (if different from A.3)

C.3 Annual water usage by source:

From	Million Gallons Per Year
a. Public water supply	
b. Private well	
c. Surface stream	

C.4 Daily average water consumption:

In	Gallons Per Day
a. Process (industrial)	
b. Non-contact cooling	
c. Boiler Feed	
d. Product	
e. Domestic/Sanitary	
f. Other	561,600

C.5 Daily average water discharge:

To	Gallons Per Day
a. Wastewater sewer	561,600
b. Storm drain	
c. Waste hauler	
d. Evaporative loss	
e. Product	

8891278

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

SECTION D - WASTEWATER CHARACTERISTICS

PAGE 1 OF 2 Ground Water with a flow of 561,600gallons / day

D.1 Analysis of wastewater discharged into the municipal sewer system

Parameter	Daily Average (Monthly Average) Maximum Level mg/l	Daily Average (Monthly Average) Maximum Level lbs/day	Instantaneous (One Day) Maximum Level mg/l	Instantaneous (One Day) Maximum Level lbs/day
Biochemical Oxygen Demand (BOD_5)	250.000	1,170.936	400.000	1,873.498
Total Suspended Solids	300.000	1,405.123	500.000	2,341.872
Total Solids				
Oil & Grease (Hydrocarbons)				
Oil & Grease (Total)	10 000	46.837	10.000	46.837
Ammonia Nitrogen (NH_3 - N)				
Total Kjeldahl Nitrogen (TKN)				

	Pounds
Alkalinity (Pounds of 100% sulfuric acid per day. See Attachment)	
Acidity (Pounds of 100% sodium hydroxide per day. See Attachment)	

	Minimum	Maximum
Maximum Temperature (Degrees Fahrenheit)		
pH Range (Standard Units) (See Attachment)	5.5	10.0

D.2 Description of wastewater sampling location. Method of sample collection see attachment.

Sampling point is at the final discharge prior to the City Sanitary Sewer.

No Priority Pollutants or other substances listed in Appendix A are being discharged into the sanitary sewer.

Note: Blank = parameters not quantified.

8891279

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097

DDSP-D MEMPHIS

D.3 Priority Pollutants and other substances that may be present in the wastewater discharge

(See Appendix A for complete listing)

PAGE 1 OF 2 Ground Water with a flow of 561,600 gallons / day

Parameter	PPN	Class	Daily Average (Monthly Average) Maximum Level mg/l	lbs/day	Instantaneous (One Day) Maximum Level mg/l	lbs/day
1,1,1-trichloroethane	11	Volat	0.010	0.047	0.020	0.094
1,1,2,2-tetrachloroethane	15	Volat	0.500	2.342	1.000	4.684
1,1,2-trichloroethane	14	Volat	0.050	0.234	0.100	0.468
1,1-dichloroethene		Volta	0.050	0.234	0.100	0.468
Aluminum		Metal	1.000	4.684	2 000	9.367
Arsenic	115	Metal	0.040	0.187	0.100	0.468
Bis (2-ethylhexyl) Phthalate	66	Semiv	0.010	0.047	0.020	0.094
Cadmium (total)	118	Metal	0.010	0.047	0 020	0.094
Carbon Tetrachloride (tetrachlor-)	6	Volat	0.020	0 094	0.040	0.187
Chloroform (trichloromethane)	23	Volat	0.100	0.468	0.200	0.937
Chromium (total)	119	Metal	0.200	0.937	0.400	1.873
Cis-1,2-dichloroethene		Volat	0.080	0.375	0.100	0.468
Copper (total)	120	Metal	0.200	0.937	0.400	1.873
Di-n-butyl Phthalate	68	Semiv	0.030	0.141	0.060	0.281
Iron		Metal	10.000	46.837	20.000	93.675
Lead (total)	122	Metal	0.150	0.703	0.300	1.405
Mercury	123	Metal	0.001	0.005	0.002	0.009
Methylene Chloride (dichlorometh-)	44	Volat	0.010	0.047	0.020	0.094
Naphthalene	55	Semiv	0.010	0.047	0.020	0.094
Nickel (total)	124	Metal	0.100	0.468	0.300	1.405
Phenol	65	Semiv	0.010	0.047	0.020	0.094
Tetrachloroethylene (perc- & Tet-)	85	Semiv	0.060	0 281	0.120	0.562
Toluene	86	Volat	0.020	0.094	0.040	0.187
Trans-1,2-dichloroethene		Volat	0.050	0.234	0.100	0 468
Trichloroethylene (trichloroethe-)	87	Volat	0 400	1.873	0.800	3.747

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

SECTION D - WASTEWATER CHARACTERISTICS

PAGE 2 OF 2 Ground Water with a flow of 561,600 gallons / day

D.1 Analysis of wastewater discharged into the municipal sewer system

Parameter	Daily Average (Monthly Average) Maximum Level mg/l	Daily Average (Monthly Average) Maximum Level lbs/day	Instantaneous (One Day) Maximum Level mg/l	Instantaneous (One Day) Maximum Level lbs/day
Biochemical Oxygen Demand (BOD_5)				
Total Suspended Solids				
Total Solids				
Oil & Grease (Hydrocarbons)				
Oil & Grease (Total)				
Ammonia Nitrogen (NH_3 - N)				
Total Kjeldahl Nitrogen (TKN)				

	Pounds
Alkalinity (Pounds of 100% sulfuric acid per day. See Attachment)	
Acidity (Pounds of 100% sodium hydroxide per day See Attachment)	

	Minimum	Maximum
Maximum Temperature (Degrees Fahrenheit)		
pH Range (Standard Units) (See Attachment)		

D.2 Description of wastewater sampling location. Method of sample collection see attachment

This page is inserted due to additional space required for priority pollutants (Page 13-2).

8891281

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

D.3 Priority Pollutants and other substances that may be present in the wastewater discharge

(See Appendix A for complete listing.)

PAGE 2 OF 2 Ground Water with a flow of 561,600 gallons / day

Parameter	PPN	Class	Daily Average (Monthly Average) Maximum Level mg/l	Daily Average (Monthly Average) Maximum Level lbs/day	Instantaneous (One Day) Maximum Level mg/l	Instantaneous (One Day) Maximum Level lbs/day
Zinc (total)	128	Metal	0.300	1.405	1.000	4.684

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

D.4 The person or laboratory responsible for wastewater sampling and analysis

The name of the laboratory will be provided once a contract is in place, the groundwater recovery system (described in B . 6) is installed, and sampling begins.

D.5 Type and description of wastewater metering and sampling facilities

A continuous direct reading meter, flow totalizer, and sampling tap will be provided just prior to the discharge pipe leaving DDMT property.

D.6 Any batch wastewater discharges? No

If yes, describe type, volume, strength and time of discharges

8891283

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

D.7 Is wastewater treated prior to discharge into the municipal sewer system? No

If yes, complete the following:

a. Description of unit processes used and wastewater quality before and after treatment

b. Description of production characteristics and any persistent or normal operational problems which may affect treatment system operations

c. Description of quality testing or process control methodology which shall ensure acceptable treatment levels

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097

DDSP-D MEMPHIS

SECTION E - SEWER FLOW PLAN, SITE PLAN AND PROCESS SCHEMATICS

E.1 The area of plant site in acres 64.11

E.2 Sewer flow plan or list of outlets, size and flow

PART 1 OF 3

The proposed layout of the groundwater recovery wells and piping system are shown on the figure provided in Attachment 2. Groundwater from the recovery wells will be combined into a common pipeline, conveyed and discharged (i.e., single discharge) into the sewer manhole located at Rozelle Street on the South side of Cane Creek (as shown on the Attachment 2 figure).

Initially, the groundwater discharge rates will be approximately 830 gpm. Each well will be brought on line by discharging flow from an 8-hour period into a holding tank. The groundwater in the holding tank will be analyzed to confirm concentrations are below the proposed discharge limits, prior to discharge to the sewer system.

8891285

City Of Memphis
Industrial Wastewater Discharge Agreement

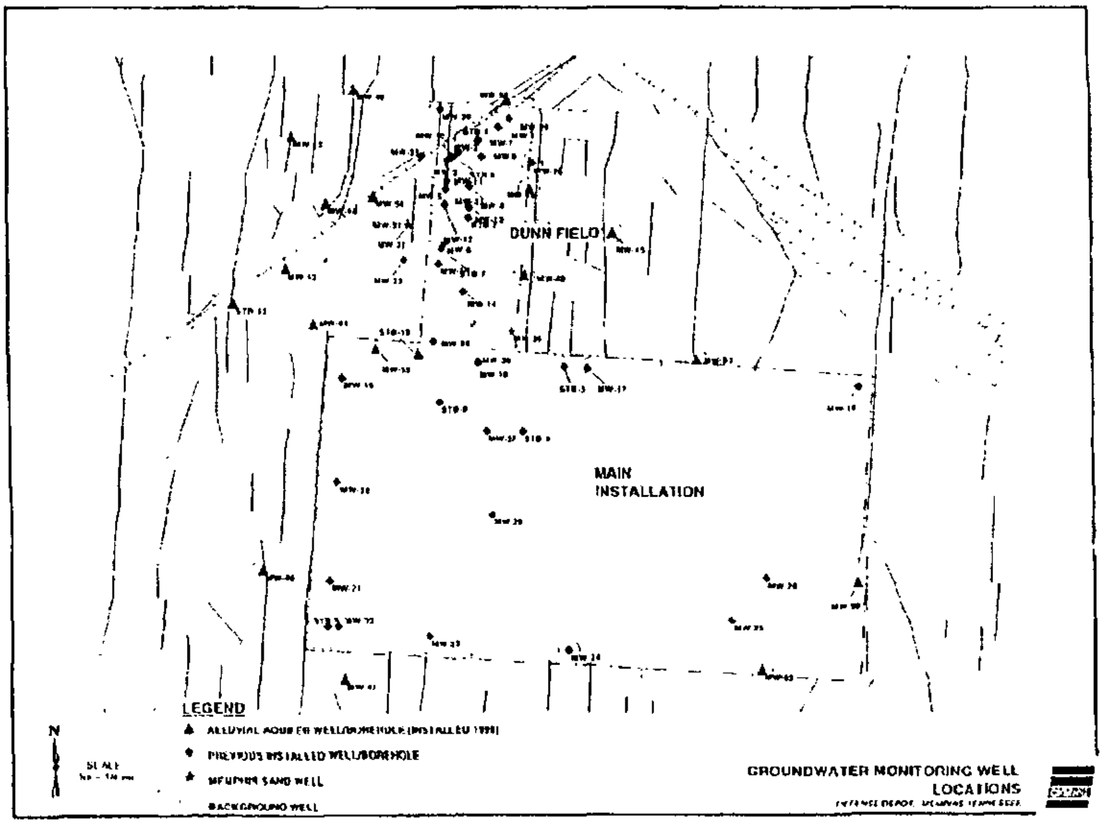
S-NN3-097
DDSP-D MEMPHIS

SECTION E - SEWER FLOW PLAN, SITE PLAN AND PROCESS SCHEMATICS

E.1 The area of plant site in acres 64.11

E.2 Sewer flow plan or list of outlets, size and flow

PART 2 OF 3



8891286

City Of Memphis
Industrial Wastewater Discharge Agreement

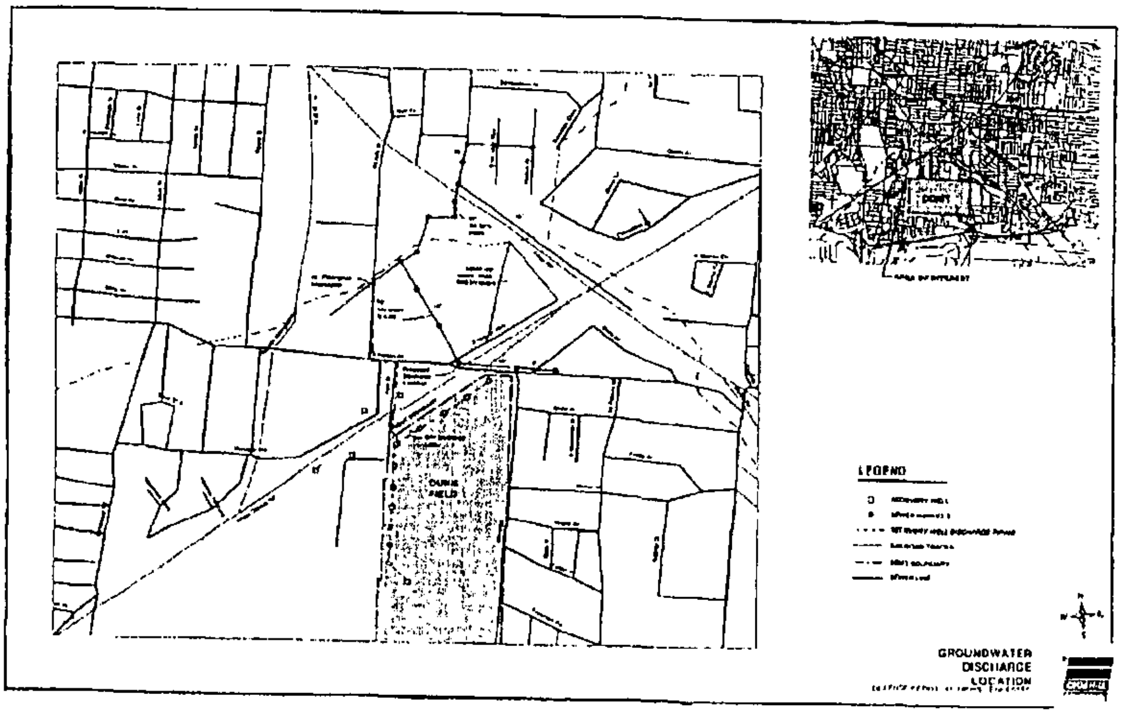
S-NN3-097
DDSP-D MEMPHIS

SECTION E - SEWER FLOW PLAN, SITE PLAN AND PROCESS SCHEMATICS

E.1 The area of plant site in acres 64.11

E.2 Sewer flow plan or list of outlets, size and flow

PART 3 OF 3



8891287

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

E.3 Plan indicating major structures and locations of hazardous materials and certain sewer appurtenances

PART 1 OF 1

See attached plan.

8891288

City Of Memphis
Industrial Wastewater Discharge
Agreement

S-NN3-097
DDSP-D MEMPHIS

E.4 Flow diagram of materials or processes

PART 1 OF 1

N/A

8891289

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

E.5 Diagram and description of areas with quantified acreage where storm waters (run-off) are discharged into the municipal sewer system

Storm water total acreage | 0.00 |

PART 1 OF 1

No storm water is being discharged into the sanitary sewer.

City Of Memphis Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

SECTION F - SELF-MONITORING SCHEDULE PART 1 OF 1

F.1 The self monitoring requirements to be performed and/or reported to the City of Memphis. All monitoring records should be kept on file for a minimum of 3 years.

According to Section 33-83 of the Sewer Use Ordinance, if sampling performed by an Industrial User indicates a violation, the User shall notify the Control Authority within 24 hours of becoming aware of the violation. The User shall repeat the sampling and analysis and submit the results of the repeated analysis to the City within 30 days after becoming aware of the violation or sooner if so directed by the City Authorized representatives.

If any pollutant is monitored more frequently than required, using EPA approved methods, the results of this monitoring shall be included in the report.

A. SELF-MONITORING REQUIREMENT:

1) Continuous flow monitoring of the final discharge (Groundwater).

2) One (1) grab sample shall be collected semi-annually in May and November with analyses for:

pH
VOCs (SW846 Method 8240)
SVOCs (SW846 Method 8270)
TAL Metals (EPA 200 Series)

B. REPORTING REQUIREMENT:

1. Monthly reports include the total volume dishcarged be sent by the 10th of each month.

2. Semi-annual Reports detailing all analyses of samples collected shall be submitted in June & December.

The above reports shall be submitted to:

Mr. Akil AL-Chokhachi
City of Memphis
2303 North Second Street
Memphis, Tennessee 38127-7500

The Monthly volumes discharged shall be sent to :

Sewer Fee Billing Department
Room 622, City Hall
125 Mid-America Mall
Memphis, TN 38103

A spill of any material or contaminated stormwater run-off as a result of an excavation of hazardous materials or any wastewater other than recovered groundwater shall not be discharged into the sanitary sewer without a written approval from the City ofMemphis.

8891291

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

SECTION G - COMPLIANCE SCHEDULE PART 1 OF 1

G.1 The compliance schedule as required to meet categorical pretreatment standards and other requirements required by the City of Memphis pretreatment program.

None required

City Of Memphis Industrial Wastewater Discharge Agreement

S-NN3-097
DDSP-D MEMPHIS

SECTION H - HAZARDOUS MATERIALS PART 1 OF 1

H.1 All hazardous, toxic, noxious or malodorous materials used, produced or formed as by product or waste.

NOT APPLICABLE FOR DDMT INSTALLATION

DUNN FIELD:

Historically, Dunn Field was used as a burial area on DDMT. The individual burial sites within Dunn Field have the following suspected buried contaminants:

- thiodiglycol
- arsenic
- chloroform
- ammonia hydroxide
- acetic acid
- ammonia salts
- metals
- orthotoluidine dihydrochloride
- VOCs
- SVOCs
- methyl bromide
- nitric acid PAHS
- trichloroacetic acid
- sulphuric acid
- hydrochloric acid
- lead
- pesticides

8891293

City Of Memphis
Industrial Wastewater Discharge Agreement

S-NN3-097
ODSP-D MEMPHIS

SECTION I - ATTACHMENTS

PART 1 OF 1

I.1 Summary of Attachments

Appendix A, B, C, & D
Sewer Use Ordinance Table 1 & 2

Sara 312 Tier Two Emergency and Hazardous Chemical Inventory

APPENDIX G

Plan for Mothballing of Interim Remedial Action Groundwater Recovery System

8891295

Defense Distribution Center (Memphis)
Dunn Field

Source Area Remedial Design

Plan for Mothballing of Interim Remedial Action Groundwater Recovery System

Rev. 0

PREPARED FOR

U.S. Army Engineering and Support Center, Huntsville
4820 University Square
Huntsville, AL 35816

April 2005

PREPARED BY

CH2M HILL
115 Perimeter Center Place NE, Suite 700
Atlanta, GA 30346

Contents

Attachments

1.0 Introduction and Purpose

This plan for mothballing of the Interim Remedial Action (IRA) Groundwater Recovery System (hereafter referred to as the Mothballing Plan) is component of the Memphis Depot Dunn Field Source Areas Remedial Design (RD) and has been prepared for the U.S. Army Corps of Engineers (USACE) - Huntsville Center as part of Task Order 6 under contract number DACA87-02-D-0006. This document outlines the systematic approach for mothballing the existing groundwater recovery system (GWRS) in accordance with the *Final Memphis Depot Dunn Field Record of Decision* (ROD) (CH2M HILL, 2004).

The purpose of this Mothballing Plan is to identify the primary components of the GWRS and provide guidance for their deactivation and long-term preservation (as required) during the implementation and operation of the source areas RA. The primary GWRS components include the following:

Component	Mothballing Plan Section
Electrical (including telephone)	2.1
Control building	2.2
Wellhead assembly	2.3
Submersible pumps	2.4
Wellhead enclosure	2.5
Electrical control panel enclosure	2.6
Transfer pipes	2.7
Sampling and flow monitoring station	2.8
Publicly-Owned Treatment Works (POTW) connection	2.9
Revised *Industrial Wastewater Discharge Permit*	2.10

1.1 Background - Interim Remedial Action

An interim ROD was signed in April 1996, with the objectives of hydraulic containment to: (1) prevent further contaminant plume migration; and (2) reduce contaminant mass in groundwater. The GWRS, 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 due to an increased understanding of the extent of groundwater contamination, as gained during the Remedial Investigation (RI).

From system startup in 1998 through January 2005, the GWRS has pumped nearly 200 million gallons of groundwater from the fluvial aquifer, which is discharged to the City of Memphis publicly owned treatment works (POTW). Through November 30, 2004, approximately 600 pounds of CVOCs have been removed (MACTEC, 2005), which includes approximately 235 pounds of trichloroethene (TCE)[1]. Despite the contaminant mass removal, the Five-Year Review for Dunn Field (CH2M HILL, 2003a) concluded that the

[1] Average concentrations during entire operation period 140 µg/L TCE and 360 µg/L total CVOCs

extraction system does not provide adequate control over groundwater flow and the westward spread of COCs in the fluvial aquifer. As a result, contaminant levels have been increasing in downgradient (offsite) monitoring wells.

1.2 Groundwater Remedy and Implementation of Mothballing

As summarized in the final Dunn Field ROD (CH2M HILL, 2004), the selected groundwater remedy for Dunn Field is: (1) zero-valent iron (ZVI) injection in onsite source areas with concurrent installation and operation a soil vapor extraction (SVE) system in the loess and fluvial deposits and (2) institutional controls.

After the ZVI injections have been completed, the GWRS will be deactivated in accordance with this Mothballing Plan. Because of its potential use for facilitating aquifer remediation, the GWRS will not be dismantled until remedial goals in groundwater and soil have been achieved onsite.

2.0 Mothballing Approach

Based on safety and logistical considerations, the system components should be deactivated as sequenced in this section. Construction drawings for the year 2000 GWRS update are included as Attachment A. Photographs from the Memphis Dunn Field Five-Year Review (CH2M HILL, 2003) are included in Attachment B.

2.1 Electrical System

The GWRS electrical system should be deactivated as follows:

1. Shut system down at control building (CB).
2. De-energize and secure the electrical power at the power drop for the GWRS.
3. Disconnect all wellhead assembly electrical power leads and components and wrap/cover/insulate against weathering. Alert Memphis, Light, Gas, and Water that power service is no longer required.
4. De-energize and secure the telephone connection for the system modem. Alert phone company (Bell South) that phone service is no longer required.
5. Place a weather-resistant label (or signage, if necessary) in a visible location near the power drop that indicates the site name and owner, company representative name, company field representative name, contact number(s), and date and time of the power disconnection. Provide a statement not to alter the disconnected power drop without owner authorization.

Because the source areas remedy includes subsurface components (for example, drilling and shallow trenching), the buried power lines should be surveyed and then marked with flexible, high visibility exterior pipe markers every 50 feet between identified above-ground portions of the buried power lines (for example, the two aboveground, exterior electrical panel boxes on the southern exterior wall of the CB).

2.2 Control Building

After the electrical system has been deactivated, perform the following tasks to mothball the CB.

Control Building Power

Confirm that all CB electrical power leads and components, including the two exterior electrical panel boxes on its southern exterior wall, are permanently unplugged, disconnected, and de-energized.

Exterior Electrical Panel Boxes

Inspect the interior and exterior of the two electrical panel boxes. Note evidence of wear or deterioration due to weather exposure. Make repairs as needed. Secure and lock the two electrical panel doors with weather resistant locks. Place a weather-resistant label on both electrical panel boxes listing the site name and owner, company representative name, company field representative name, contact number(s), and date and time of the power disconnection. Provide a statement not to access the electrical panel boxes without owner authorization.

Control Building

Inspect the CB structure, base, enclosure door seals, and wire mesh backing to the louvers. Note evidence of wear or deterioration due to weather exposure. Inspect interior of CB in preparation for storing the submersible pumps (Section 2.4) and flow totalizer (section 2.6). Make repairs as needed. Secure and lock CB doors with weather resistant locks. Place a weather-resistant label on the CB door listing the site name and owner, company representative name, company field representative name, contact number(s), and date and time of the power disconnection. Provide a statement not to access the CB without owner authorization.

2.3 Wellhead Assembly

After the electrical system and CB has been deactivated, confirm all electrical power leads and components are permanently unplugged or disconnected, and de-energized.

Before the submersible pumps can be removed from the recovery wells, the 1.5-, 2-, 3-, 6- and 8-inch diameter transfer pipes must be systematically drained to return the extracted groundwater to the subsurface. The transfer pipes will be drained in segments based on recovery well elevations, which are shown on Sheet C-2 in Attachment A. The recovery wells are grouped as follows:

Recovery Wells (High to Low Elevation) and Estimated Transfer Pipe Volume (gal)

Segment	1	Volume	2	Volume	3	Volume	4	Volume	Total
1	RW-1B	5							5
2	RW-1A	5	RW-1	20					25
3	RW-4	205	RW-3	260	RW-2	45			510
4	RW-5	50	RW-6	260	RW-7	265	RW-8	325	900
5	RW-9	1,475							1,475
Total									**2,915**

Beginning with the topographically highest well in a segment, open valves and remove, disengage, or bypass[2] check valves at the selected recovery well to allow groundwater in the transfer pipes to drain into the recovery well. Wellhead assembly is shown on Sheet M-1 in Attachment A and Attachment B (photographs). Estimated groundwater volumes are summarized above. After the groundwater finishes draining into the first recovery well, repeat the drainage process for the next recovery well and progress down the segment. After all of the groundwater has drained down the wells, complete the following tasks at each wellhead assembly:

[2] If the check valve is part of the pump and can't be accessed at the wellhead assembly.

1. Disassemble each wellhead assembly to permit access to each sanitary well seal (Sheet M-1).
2. Remove and decontaminate the dedicated water level sensor at each recovery well (see photograph of wellhead assembly in Attachment B). Secure and store the water level sensor inside the weather-resistant wellhead enclosure.
3. Remove the sanitary well seal and the submersible pump (see Section 2.5).
4. Reinstall and secure the sanitary well seal and associated wellhead assembly piping as it was prior to submersible pump removal. If this is not possible, seal all openings with a cap, threaded plug, blind flange, or by closing a valve to prevent passive venting into the wellhead enclosure. All pipe openings that are not sealed should be plugged to prevent biological hosting.

2.4 Submersible Pump

After the sanitary well seal has been removed, the submersible pump can be removed from each recovery well. As shown on Sheet M-1 in Attachment A, the submersible pumps are supported by 1- to 1.5-inch diameter 304 Schedule 40 drop pipes (see Table A on Sheet M-1). Because the wellhead assemblies are in wellhead enclosures, the drop pipes (and submersible pumps) will have to be gradually raised and cut at the surface. The process may be accelerated by temporarily removing the wellhead enclosure. If the GWRS is reactivated, the severed drop pipes will have to be replaced.

Remove all wire rope, tubing, and electrical connections at the closest mechanical connection to the submersible pump. Purge any groundwater, disassemble, and decontaminate the pump. Ensure the pump is free of all moisture before reassembling. Store the pump in a weather-resistant container; a field constructed PVC tube is sufficient. Place a weather-resistant label on the pump container listing the site name and owner, company representative name, company field representative name, contact number(s), and date and time of pump removal. Provide a statement not to remove from the wellhead enclosure or use the pump without owner authorization.

2.5 Well Head Enclosure

After the submersible pump has been removed and secured, inspect the wellhead enclosure structure, base, and door seals for weather-related integrity. Make repairs as needed. Inspect and replace the wire mesh backing to the louvers on the wellhead enclosure doors (as necessary). Secure and lock wellhead enclosure doors with weather resistant locks.

Place a weather-resistant label on the exterior of the wellhead enclosure door listing the site name and owner, company representative name, company field representative name, contact number(s), and date and time of system mothballing. Provide a statement not to access the wellhead enclosure or use the pump without owner authorization.

2.6 Electrical Control Panel Enclosures

After the electrical system and CB has been deactivated, confirm all electrical power leads and components are permanently unplugged or disconnected, and de-energized. Inspect the circuit breaker, power supply, submersible pump motor starter, wire pass-through, field panel, well level probe termination and the ground bus, as well as the enclosures for these components for mothballing integrity.

Confirm that the component enclosures, internal to the electrical control panel enclosure (ECPC), are weather-resistant and have an approved custody seal after final inspection. Inspect the ECPC structure, base and enclosure door seals for weather-related integrity. Make repairs as needed.

Secure and lock ECPC doors with weather-resistant locks. Place a weather-resistant label on the ECPC door listing site name and owner, company representative name, company field representative name, contact number(s), and date and time of mothballing. Provide a statement not to access the ECPC without owner authorization.

2.7 Transfer Pipes

No mothballing activities are anticipated for the buried groundwater transfer pipes. As performed in previous steps, most of the transfer pipes will be drained of groundwater. Unless the lines are dewatered by pumping at the surface during the mothballing process, the transfer pipe segment between RW-1 and RW-2 will contain groundwater indefinitely; however, the 2-inch diameter pipe segment is only 100 feet long with a volume of 15 gallons. Note that a section of the transfer pipes may be used to discharge condensate from the SVE system to the POTW.

The as-built drawings (Attachment A) indicate that the transfer pipes are at least four feet below ground surface. This depth is adequate for long-term mothballed status. Because the source areas remedy includes subsurface components (for example, drilling and shallow trenching), the transfer pipes should be surveyed and then marked with flexible high visibility exterior pipe markers every 50 feet between known identifiable above-ground portions of the discharge line (for example, the sampling and flow monitoring station).

2.8 Sampling and Flow Monitoring Station

The sampling and flow monitoring station (SFMS) is an aboveground component of the GWRS transfer pipe that must be purged of groundwater before it can be mothballed. To ease SFMS mothballing, the groundwater (approximately 1,200 gallons) contained in the transfer pipes from around proposed RW-12 to the publicly owned treatment works (POTW) connection (Sheet E-1 in Attachment A) should be dewatered by tapping into the transfer pipe and pumping at the surface.

The final groundwater volume on the totalizer should be noted. The totalizer should be disconnected, evacuated, dried (internally and externally), stored in a weather-resistant container (for example, a field-constructed PVC tube), and placed inside the CB. The totalizer container should have a weather-resistant label listing the site name and owner, company representative name, company field representative name, contact number(s), date and time of storage, and final volume. Provide a statement to not remove the totalizer from its container or CB without owner authorization.

Finally, all SFMS connections, including sample ports, should be capped, blind flanged, or plugged to any prevent passive venting and biological hosting.

2.9 Publicly Owned Treatment Works Connection

The optional[3] POTW connection should be mothballed as follows:

1. Close valve.
2. Secure cover with a weather-resistant lock.
3. Place a weather-resistant label on the POTW connection cover (or signage as appropriate) listing the site name and owner, company representative name, company field representative name, contact number(s), date and time of mothballing, and final groundwater volume. Provide a caution statement not to access the POTW connection without owner authorization.

2.10 Revised Industrial Wastewater Discharge Permit

A revised *Industrial Wastewater Discharge Agreement* (Permit No. S-NN3-097) should be submitted to the City of Memphis Division of Public Works and Memphis Depot Caretaker upon GWRS shutdown. The revised permit should indicate that groundwater discharge from the GWRS will be suspended indefinitely.

[3] Because condensate will be generated during the operation of the SVE system, the POTW connection may remain active

3.0 Annual Inspections

Annual GWRS inspections should be conducted to minimize deterioration during the long-term system shutdown. The inspections should focus on wear and tear due to natural and human (vandalism) elements. At a minimum, the following GWRS components should be inspected annually:

Inspection Component	General Tasks
Control building	Inspect the structure, base, enclosure door seals, wire mesh backing to the louvers, and interior and exterior of the two electrical panel boxes. Note evidence of wear or deterioration due to weather exposure.
	Make repairs and replace the lock as needed.
	Inventory submersible pumps and flow totalizer.
Wellhead enclosure	Inspect the structure, base, and door seals, and wire mesh backing to the louvers on the wellhead enclosure doors.
	Make repairs and replace locks as needed.
Electrical control panel enclosure	Inspect the custody seal, circuit breaker, power supply, submersible pump motor starter, wire pass-through, field panel, well level probe termination and the ground bus, as well as the enclosures for these components.
	Make repairs and replace locks as needed.
POTW connection	Replace lock as needed.

4.0 References

CH2M HILL. 2003. *Dunn Field Five-Year Review.* January 2003.

CH2M HILL. 2004. *Final Memphis Depot Dunn Field Record of Decision.* Prepared for the U.S. Army Engineering and Support Center, Huntsville, Alabama. March 2004.

8891306

ATTACHMENT A

Updated Groundwater Interim Remedial Action Construction Drawings

8891307

US Army Corps of Engineer's
Huntsville Division

UPDATED GROUNDWATER INTERIM REMEDIAL ACTION

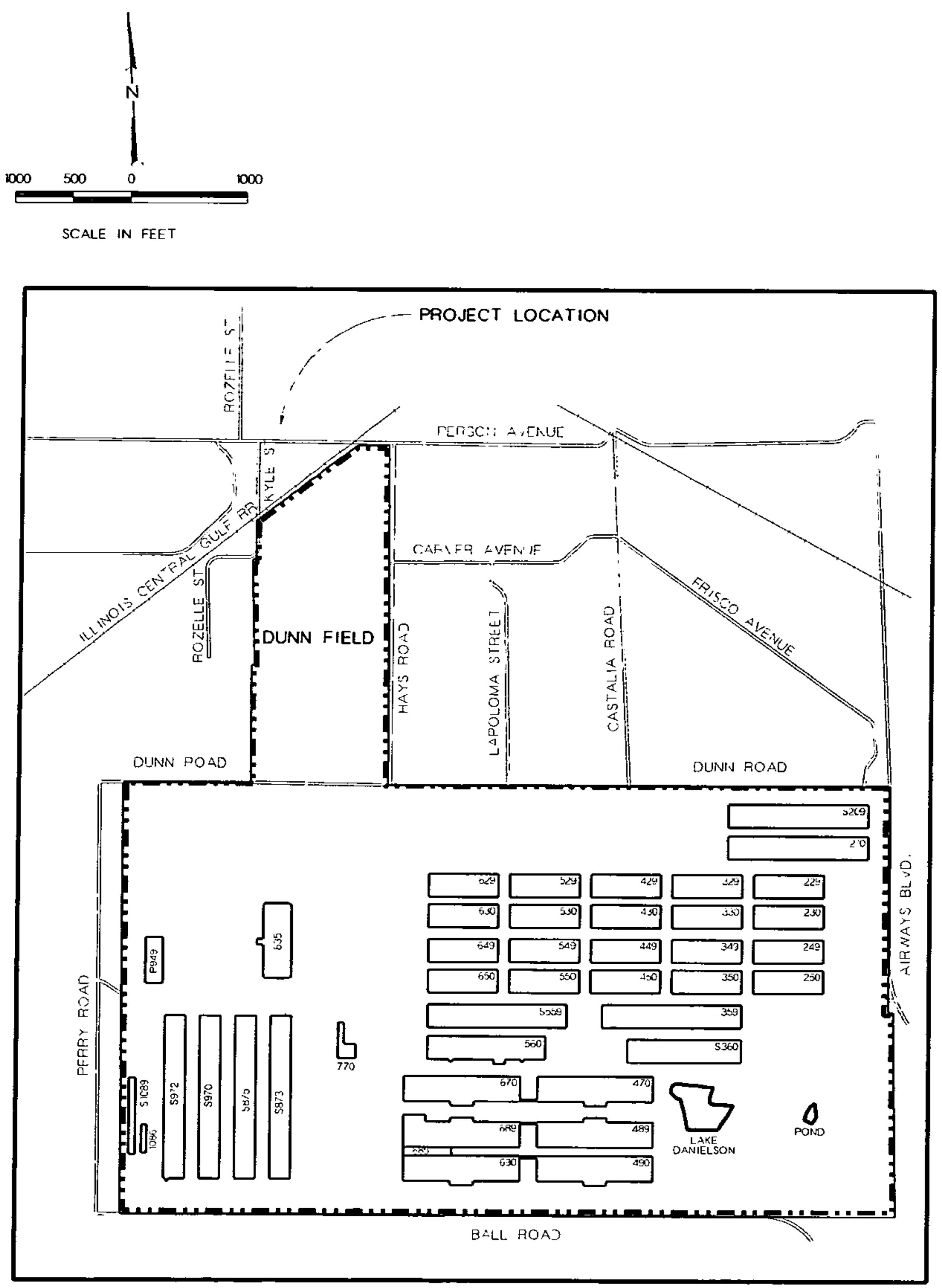
FINAL DESIGN

DEFENSE DEPOT
MEMPHIS, TENNESSEE

UPDATED GROUNDWATER
INTERIM REMEDIAL ACTION
DEFENSE DEPOT
MEMPHIS, TENNESSEE

COVER SHEET

8891308



LEGEND

DEFENSE DEPOT BOUNDARY

LOCATION AND VICINITY MAP

NTS

DRAWING INDEX

SHEET NO.	DESCRIPTION
0	COVER SHEET
G-1	LOCATION AND VICINITY MAP AND DRAWING INDEX
G-2	ABBREVIATIONS
G-3	GENERAL AND CIVIL LEGENDS
G-4	PROCESS MECHANICAL LEGEND
G-5	ELECTRICAL LEGEND
G-6	I&C LEGEND
C-1	SOUTH SITE PLAN
C-2	PIPELINE PLAN AND PROFILE
C-3	SITE LAYOUT AND GRADING FOR RECOVERY WELLS 1, 1A, 1B & 2
M-1	TYPICAL RECOVERY WELL LAYOUT AND MECHANICAL DETAILS
E-1	ELECTRICAL SITE PLAN - NORTH
E-2	ELECTRICAL SITE PLAN - SOUTH
E-3	ELECTRICAL ONE LINE DIAGRAM
E-4	TYPICAL WELL PLAN, CONTROL DIAGRAM AND PANEL ELEMENTARY
E-5	STANDARD DETAILS
I-1	PROCESS AND INSTRUMENTATION DIAGRAM
I-2	CONTROL AND PANEL DIAGRAMS
I-3	INSTRUMENTATION DETAILS

SYMBOL	ZONE	SYMBOL	ZONE	DATE	BY
		REVISIONS		REVISIONS	

DESIGN		DRAWING		FINAL CHECK
MADE	CHKD	DR	CHKD	
RD	TI	RD	TI	RB

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DATE: JANUARY 2000

CH2M HILL
ATLANTA, GEORGIA

U. S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS MOBILE ALABAMA

U. S. ARMY CORPS OF ENGINEERS HUNTSVILLE ALABAMA

UPDATED GROUNDWATER INTERIM REMEDIAL ACTION

LOCATION AND VICINITY MAP AND DRAWING INDEX

DEFENSE DEPOT MEMPHIS TENNESSEE

SIZE D | INVITATION NO. | FILE NO. | SHEET G-1

SCALE: NONE | FILE: 491p2g01.dgn | SHEET 1 OF 18

491p2g01.dgn 18-JAN-2000 10:27:40

AB	ANCHOR BOLT
ABDN	ABANDON
AC	ASBESTOS CEMENT
ACI	AMERICAN CONCRETE INSTITUTE
ACST	ACOUSTICAL
ACU	AIR CONDITIONING CONDENSING UNIT
AD	AREA DRAIN
ADD (ADD'TL)	ADDITIONAL
ADJ	ADJUSTABLE
AFF	ABOVE FINISHED FLOOR
AFG	ANNEALED FLOAT GLASS
AG	ABOVE GROUND
AGGR	AGGREGATE
AHR	ANCHOR
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AL (ALUM)	ALUMINUM
ALTN (ALT)	ALTERNATE
ANCH	ANCHOR
ANDZ	ANODIZE
APVD	APPROVED
APPROX	APPROXIMATE
∟	ANGLE
ARCH	ARCHITECTURAL
ARD	ACID RESISTANT DRAIN
ARV	ACID RESISTANT VENT
AS	AIR SUPPLY
@	AT
AUTO	AUTOMATIC
AUX	AUXILIARY
B/	BOTTOM OF
B	BELL
BAL	BALANCED
BC	BEGINNING OF CURVE
BD	BUTTERFLY DAMPER, BOARD
BF	BLIND FLANGE
BFF	BELOW FINISHED FLOOR
BFV	BUTTERFLY VALVE
B	BASELINE
BLDG	BUILDING
BLK	BLOCK
BM	BENCHMARK, BEAM
BOC	BACK OF CURB
BOP	BOTTOM OF PIPE
BOT (BOTT)	BOTTOM
BRG	BEARING
BV	BALL VALVE
BVC	BEGINNING OF VERTICAL CURVE
C-C	CENTER TO CENTER
CAB	CABINET
CB	CATCH BASIN
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CHAN, C	CHANNEL (BEAM)
CHEM	CHEMICAL
CI	CAST IRON
CIP	CAST IRON PIPE
CISP	CAST IRON SOIL PIPE
CJ	CONSTRUCTION JOINT
℄, CL	CENTERLINE
CLDIP	CEMENT LINED DUCTILE IRON PIPE
CLG	CEILING
CLO	CLOSET
CLR	CLEAR
CSP	CORRUGATED STEEL PIPE
CMU	CONCRETE MASONRY UNIT
CO	CLEAN OUT
COL	COLUMN
CONC	CONCRETE
CONDTN	CONDITIONED
CONN	CONNECTION
CONT	CONTINUOUS, CONTINUATION
CONTR	CONTRACTOR
COORD	COORDINATE
COP	COPPER
CPLG	COUPLING
CPRSR	COMPRESSOR
CPVC	CHLORINATED PVC
CRS	COLD ROLLED STEEL
CS	CUP SINK
CST	CARBON STEEL
CT	CERAMIC TILE
CTR	CENTER
CTR'D	CENTERED
CTSK	COUNTERSINK
CU	CUBIC
CUH	COPPER TUBING, HARD DRAWN
CU FT	CUBIC FOOT
CU IN	CUBIC INCH
CU YD	CUBIC YARD
CV	CHECK VALVE
D	DISCHARGE
D, DR	DRAIN
DAF	DISSOLVED AIR FLOTATION
DBA	DEFORMED BAR ANCHOR
DBL	DOUBLE
DEG	DEGREE
DET	DETAIL
DF	DOUGLAS FIR
DF	DRINKING FOUNTAIN
DI	DROP INLET
DI	DUCTILE IRON
DIA, Ø	DIAMETER
DIAG	DIAGONAL
DIP	DUCTILE IRON PIPE
DIR	DIRECTION
DISCH	DISCHARGE
DS	DOWNSPOUT
DW	DISHWASHER, DEIONIZED WATER
DWG	DRAWING
DWN	DOWN
°C	DEGREE CELSIUS
Δ	DELTA
E	EAST
EA	EACH
EC	END OF CURVE
ECC	ECCENTRIC
EF	EACH FACE
EF	EXHAUST FAN
EJ	EXPANSION JOINT
EL (ELEV)	ELEVATION
ELB	ELBOW
ELC	ELECTRICAL LOAD CENTER
ELEC	ELECTRIC, ELECTRICAL
ENGR	ENGINEER
EP	EDGE OF PAVING
EQL (SP)	EQUAL, EQUALLY SPACED
EQPT (EQUIP)	EQUIPMENT
EQ SP	EQUALLY SPACED
ER	END OF RETURN
EVC	END OF VERTICAL CURVE
EW	EACH WAY
EXH	EXHAUST
EXP	EXPANSION
EXP	EXPOSED
EXP AB	EXPANSION ANCHOR BOLT
EXP JT	EXPANSION JOINT
EXST, (EXIST)	EXISTING
EXT	EXTERIOR
F	FUEL
FC	FLEXIBLE COUPLING
FCA	FLANGED COUPLING ADAPTER
FCO	FLOOR CLEANOUT
FCTY	FACTORY
FD	FLOOR DRAIN
FDN	FOUNDATION
FEXT	FIRE EXTINGUISHER
FF	FINISHED FLOOR
FG	FINISH GRADE
FH	FULL HEIGHT
FHY	FIRE HYDRANT
FIG	FIGURE
FL (FLR)	FLOOR
FL	FLOW LINE
FLEX	FLEXIBLE
FLG	FLANGE
FLH	FLAT HEAD
FLTR	FILTER
FM	FORCE MAIN
FNSH, FIN	FINISH
FOC	FACE OF CURB
FRP	FIBERGLASS REINFORCED PLASTIC
FSHS	FOLDING SHOWER SEAT
FT	FOOT OR FEET
FTG	FOOTING
FU	FIXTURE UNIT
°F	DEGREE FAHRENHEIT
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GB	GRAB BAR
GC	GROOVED COUPLING
GL	GLASS
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GRTG	GRATING
GSP	GALVANIZED STEEL PIPE
GV	GATE VALVE
GVL	GRAVEL
GWB	GYPSUM WALL BOARD
GYP	GYPSUM
HAS	HEADED ANCHOR STUD
HB	HOSE BIBB
HC	HOLLOW CORE
HD	HUB DRAIN
HDR	HEADER
HDW	HARDWARE
HGL	HYDRAULIC GRADE LINE
HGT	HEIGHT
HK	HOOK
HM	HOLLOW METAL, HOIST MONORAIL
HORIZ	HORIZONTAL
HOW	HIGHEST OBSERVED WATER
HP	HORSEPOWER
HPT	HIGH POINT
HR	HOSE RACK
HV	HOSE VALVE
HVAC	HEATING, VENTILATING, AND AIR CONDITIONING
I	AIR INJECTION
ID	INSIDE DIAMETER
IF	INSIDE FACE
IG	INSULATING GLASS
IN	INCH
INJS	INJECTIONS
INSTM	INSTRUMENTATION
INSUL	INSULATION
IE	INVERT ELEVATION
IRRIG	IRRIGATION
ITG	INSULATED TEMPERED GLASS
JAN	JANITOR
JCT	JUNCTION
JT	JOINT
KIP	THOUSAND POUNDS
KSK	KITCHEN SINK
KW	KILOWATT
L	LENGTH
LAB	LABORATORY
LAM	LAMINATE
LAT	LATITUDE
LAV	LAVATORY
LB	POUND
LB/CU FT	POUNDS PER CUBIC FOOT
LF	LINEAR FEET
LG	LONG
LHR	LEFT HAND REVERSE
LH	LEFT HAND
LLH	LONG LEG HORIZONTAL
LLV	LONG LEG VERTICAL
LNTL	LINTEL
LONG	LONGITUDINAL
LR	LONG RADIUS
LS	LABORATORY SINK
LWL	LOW WATER LEVEL
M & BH	MOP & BROOM HOLDER
MAS	MASONRY
MATL	MATERIAL
MAX	MAXIMUM
MB	MACHINE BOLT
MCC	MOTOR CONTROL CENTER
MDP	MAIN DISTRIBUTION PANEL
MECH	MECHANICAL
MET	METAL
MFD	MANUFACTURED
MFR	MANUFACTURER
MGD	MILLION GALLONS PER DAY
MH	MANHOLE
MHW	MEAN HIGH WATER
MIN	MINIMUM
MIR	MIRROR
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MLW	MEAN LOW WATER
MP	METAL PANEL
MPU	MULTIPURPOSE UNIT
MTL	MEAN TIDE LEVEL
MTS	MILL TYPE STEEL PIPE
MW	MONITORING WELL
MWS	MAXIMUM WATER SURFACE
N	NORTH
N/A	NOT APPLICABLE
NAD	NORTH AMERICAN DATUM
ND	NAPKIN DISPOSAL
NGS STA	NATIONAL GEODETIC SURVEY STATION
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NIC	NOT IN CONTRACT
NO	NUMBER
NP	NON - PROTECTED
NPT	NATIONAL PIPE THREADS
NTS	NOT TO SCALE
O TO O	OUT TO OUT
OC	ON CENTER
OD	OUTSIDE DIAMETER
OF	OUTSIDE FACE
OHP	OVERHEAD POWER LINES
OP	OPAQUE PANEL
OPH	OPPOSITE HAND
OPP	OPPOSITE
OPER	OPERATOR
OPNG	OPENING
OSD	OPEN SITE DRAIN
OV	OVERFLOW
P	PILASTER, PIPE
PC	POINT OF CURVATURE
PE	EFFLUENT
PED	PEDESTAL
PEP	POLYETHYLENE PIPE
PERF	PERFORATED
PI	POINT OF INTERSECTION
PJF	PREMOLDED JOINT FILLER
PL	PLATE (STEEL)
PLF	POUNDS PER LINEAR FOOT
⅊	PROPERTY LINE
PLAS	PLASTIC
PLYWD	PLYWOOD
PNL	PANEL
PO	PUSH ON JOINT
PPL	POLYPROPYLENE LINED
PRCST	PRECAST
PREFAB	PREFABRICATED
PRESS	PRESSURE
PRM	PERMANENT REFERENCE MARKER
PRI	PRIMARY
PROJ	PROJECTION
PROP	PROPERTY
PS	POLYCARBONATE SHEET
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH, GAUGE
PT	PRESSURE TREATED, POINT OF TANGENCY
PTD	PAPER TOWEL DISPENSER
PV	PLUG VALVE
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PVMT	PAVEMENT
PVT	POINT OF VERTICAL TANGENCY
QT	QUARRY TILE
R	RISER
R, (RAD)	RADIUS
RC	REINFORCED CONCRETE
RCP	REINFORCED CONCRETE PIPE
RD	
RD	ROOF DRAIN
RDCR	REDUCER
RDL	RADIAL
RDW	REDWOOD
REF	REFER OR REFERENCE
REF	REFRIGERATOR
REFR	REFRIGERATE, REFRIGERANT
REINF	REINFORCED, REINFORCING, REINFORCE
REQD	REQUIRED
RF	RAISED FACE
RG	REFLECTIVE GLASS
RH	RODHOLE
RH	RIGHT HAND
RHR	RIGHT HAND REVERSE
RL	RAIN LEADER
RLS	RUBBER LINED STEEL
RM	ROOM
RO	REVERSE OSMOSIS
RST	REINFORCING STEEL
RPM	REVOLUTION PER MINUTE
RTN	RETURN
RTNG	RETAINING
R/W	RIGHT-OF-WAY
RW	RECOVERY WELL
S	SANITARY SEWER
S	I-BEAM
S	SLOPE
S	SOUTH
SATC	SUSPENDED ACOUSTICAL TILE CEILING
SBC	STANDARD BUILDING CODE
SC	SHOWER CURTAIN
SC	SOLID CORE
SCR	SHOWER CURTAIN ROD
SCFM	STANDARD CUBIC FEET PER MINUTE
SCH	SCHEDULE
SD	SOAP DISPENSER
SDWK	SIDEWALK
SEC	SECONDARY
SECT	SECTION
SED	SEDIMENTATION
SEW	SEWAGE
SF	SQUARE FEET
SG	LAMINATED SAFTEY GLASS
SGT	STRUCTURAL GLAZED TILE
SGWB	SUSPENDED GYPSUM WALLBOARD
SH, (SHT)	SHEET
SH	SHOWER
SHA	SURFACE HARDENING AGENT
SHS	SOLIDS HANDLING SYSTEM
SIM	SIMILAR
SK	SINK
SLV	SLEEVE
SOLN	SOLUTION
SP	SPACE OR SPACES
SPEC, SPECS	SPECIFICATIONS
SPLY	SUPPLY
SQ	SQUARE
SQ FT	SQUARE FOOT, FEET
SQ IN	SQUARE INCH
SR	SHORT RADIUS
SS	STORM SEWER
SS, SST	STAINLESS STEEL
SSH	SAFETY SHOWER
SSK	SERVICE SINK
STA	STATION
STD	STANDARD
STIF	STIFFENER
STIRR	STIRRUP
STL	STEEL
STR	STRAIGHT
STRL	STRUCTURAL
STRUCT	STRUCTURE
SW	STORM WATER
SUSP	SUSPENDED
SYMM	SYMMETRICAL
T/	TOP OF
T, TAN	TANGENT
TB	TOWEL BAR
TBG	TUBING
T & G	TOP AND BOTTOM
TC	TOP OF CURB /
T & C	TONGUE AND GROOVE
TDH	TOTAL DYNAMIC HEAD
TECH	TECHNICAL
TEL	TELEPHONE
TEMP	TEMPORARY
TF	TOP FACE
TFG	TEMPERED FLOAT GLASS
THD	THREAD
THK	THICKNESS
TL	TEFLON LINED PIPE
TLOG	TOP OF LANDING
TOC	TOP OF CONCRETE
TP	TURNING POINT
TPD	TOILET PAPER DISPENSER
TRANS	TRANSFORMER
TRANSV	TRANSVERSE
TRD	TREAD
TS	TUBE STEEL
TSL	TOP OF SLAB
TST	TOP OF STEEL
TW, TOW	TOP OF WALL
TYP	TYPICAL
UNO	UNLESS NOTED OTHERWISE
UBC	UNIFORM BUILDING CODE
UG	UNDERGROUND
V	VACUUM
VE	VENT
VB	VAPOR BARRIER
VC	VERTICAL CURVE
VC	VITRIFIED CLAY PIPE
VDOT	VIRGINIA DEPARTMENT OF TRANSPORTATION
VERT	VERTICAL
VPC	POINT OF VERTICAL CURVATURE
VT	VINYL TILE
VTR	VENT THROUGH ROOF
W	WEST
WA	SUMP WATER
W/	WITH
WC	WATER CLOSET
WD	WOOD
WG	WIRE GLASS
WO	WINDOW OPENING
WP	WATER PROOF
WP	WORK POINT
WH	WATER HEATER
WR	WASTE RECEPTACLE
WS	WATERSTOP
WS	WATER SURFACE
WS	WELDED STEEL
WTP	WATER TREATMENT PLANT
WTR	WATER
WWTP	WASTEWATER TREATMENT PLANT
WU	WALL URINAL
YDS	YARDS

NOTES

1. SEE ELECTRICAL AND INSTRUMENTATION DRAWINGS FOR RESPECTIVE ABBREVIATIONS
2. CONTACT THE CONTRACTING OFFICER FOR ABBREVIATIONS NOT LISTED
3. THIS IS A STANDARD LEGEND SHEET. THEREFORE, SOME SYMBOLS OR ABBREVIATIONS MAY APPEAR ON THIS SHEET AND NOT ON THE PLANS

SYMBOL	ZONE	REVISIONS	DATE	BY

DESIGN MADE	DESIGN CHKD	DRAWING DR	DRAWING CHKD	FINAL CHECK
RD	TI	RD	TI	RB

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 — 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DATE JANUARY 2000

CH2M HILL
ATLANTA, GEORGIA

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS MOBILE, ALABAMA
U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE, ALABAMA

UPDATED GROUNDWATER INTERIM REMEDIAL ACTION

ABBREVIATIONS

DEFENSE DEPOT MEMPHIS TENNESSEE

SIZE D | INVITATION NO | FILE NO. | SHEET G-2
SCALE: NONE | FILE 491p2g02.dgn | SHEET 2 OF 18

0491g102 div 18-JAN-2000 10:27:48

8891309

8891310

GENERAL NOTES:

1. FACILITIES ARE SHOWN HEAVY LINED. SCREENING IS USED IN ORDER TO CLARIFY DRAWINGS. FOR EXAMPLE, STRUCTURES ARE SCREENED ON ELECTRICAL DRAWINGS TO HIGH-LITE CONDUITS AND EQUIPMENT
2. REPETITIVE FEATURES ARE NOT DRAWN IN THEIR ENTIRETY AND SHALL BE COMPLETELY PROVIDED AS IF DRAWN IN FULL
3. LINE OF EXISTING GRADES, AS SHOWN ON THE STRUCTURE SECTIONS ARE APPROXIMATE. THEY ARE AT THE STRUCTURE FACE, OR ON THE SECTION END EXCEPT AS NOTED.
4. VERIFY ALL ROUGH-IN DIMENSIONS FOR EQUIPMENT PROVIDED IN THIS CONTRACT, OR BY OTHERS.
5. REFER TO MECHANICAL, ELECTRICAL AND OTHER CATEGORIES OF DRAWINGS FOR ADDITIONAL NOTES.

CIVIL LEGEND

POWER POLE
SERVICE POLE
LIGHT POLE
TELEPHONE POLE
POWER-TEL POLE
GUY POLE
GUY ANCHOR
ST STORM MANHOLE
TELEPHONE MANHOLE
E ELECTRICAL MANHOLE
SA SANITARY MANHOLE
FIRE HYDRANT
WATER VALVE
WATER RISER
PROP. LINE / R.O.W
EDGE OF PAVEMENT (ASPHALT)
EDGE OF CONCRETE
EDGE OF GRAVEL DRIVE (G)
EDGE OF DIRT DRIVE (D)
ROCK
A ASPHALT
LR LIMEROCK
TEMPORARY BENCHMARK (Nail or Nail and Disc)
CATCH BASIN
HARDWOOD TREE
PINE TREE
WATER METER
SEWER CLEANOUT
SANITARY VALVE
GAS VALVE
TRAFFIC POLE
FENCE

RAILROAD SPUR
EXISTING CONTOURS
281 280 PROPOSED CONTOURS
280 00 SPOT ELEVATIONS
MW-11 MONITORING WELLS
RW-10 RECOVERY WELLS

NOTES:
1) ALL PROPERTY LINES AND RIGHT-OF-WAYS ARE APPROXIMATE, THEY ARE DETERMINED FROM SHELBY COUNTY TAX MAPS AND SHOULD BE VERIFIED IN THE FIELD
2) COORDINATE SYSTEM IS BASED ON PUBLISHED XYZ COORDINATES ON SELECTED MONITOR WELLS

DETAIL REFERENCING

7 — DETAIL IDENTIFICATION NUMBER
6 12 — SHEET NUMBER ON WHICH DETAIL OF THE CONDITION IS DRAWN
9 — SHEET NUMBER ON WHICH CONDITION IS SHOWN
10 — ADDITIONAL SHEET NUMBERS ON WHICH CONDITION IS SHOWN

SYMBOL	ZONE		SYMBOL	ZONE		DATE	BY
REVISIONS				REVISIONS			

DESIGN		DRAWING		FINAL CHECK
MADE	CHKD	DR	CHKD	
RD	CM	RD	GM	RB

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DATE: JANUARY 2000

CH2M HILL
ATLANTA, GEORGIA

U. S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS MOBILE, ALABAMA
U S ARMY CORPS OF ENGINEERS HUNTSVILLE, ALABAMA

UPDATED GROUNDWATER INTERIM REMEDIAL ACTION
GENERAL AND CIVIL LEGENDS
DEFENSE DEPOT MEMPHIS TENNESSEE

SIZE D | INVITATION NO | FILE NO | SHEET G-3
SCALE: NONE | FILE: 491p2g03.dgn | SHEET 3 OF 18

0491g03.div 18-JAN-2000 10 28 18

8891311

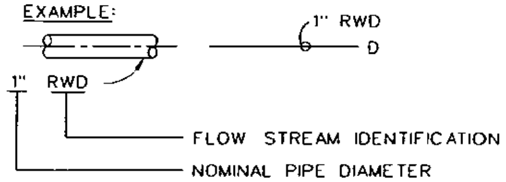
MECHANICAL LEGEND AND NOTES

GENERAL PIPING NOTES

1. SIZE OF FITTINGS SHOWN ON PLANS SHALL CORRESPOND TO ADJACENT STRAIGHT RUN OF PIPE, UNLESS OTHERWISE INDICATED. TYPE OF JOINT AND FITTING MATERIAL SHALL BE THE SAME AS SHOWN FOR ADJACENT STRAIGHT RUN OF PIPE.
2. ALL JOINTS SHALL BE WATERTIGHT.
3. NUMBER AND LOCATION OF UNIONS SHOWN ON PLANS IS ONLY APPROXIMATE. PROVIDE ALL UNIONS NECESSARY TO FACILITATE CONVENIENT REMOVAL OF VALVES AND MECHANICAL EQUIPMENT
4. WHERE A FLANGED COUPLING ADAPTER IS SHOWN, A STANDARD FLANGE SHALL BE JOINED TO THE COUPLING ADAPTER
5. SEE PIPING SPECIFICATIONS FOR PIPING AND JOINT MATERIALS & TYPES.
6. SYMBOLS SHOWN HERE FOR SINGLE LINE FITTINGS ARE GENERIC ONLY. REFER TO PIPING SPECIFICATIONS FOR SPECIFIC END CONNECTIONS FOR SINGLE LINE PIPE AND FITTINGS.
7. UNLESS OTHERWISE INDICATED, EXISTING PIPING AND EQUIPMENT IS SHOWN LIGHT-LINED AND/OR SCREENED AND IS NOTED AS EXISTING. NEW PIPING AND EQUIPMENT IS SHOWN HEAVY-LINED.

PIPING DESIGNATION

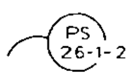
EXAMPLE:



MISCELLANEOUS PIPING SYMBOLS

FLEXIBLE (ELASTOMER) PIPE CONNECTION

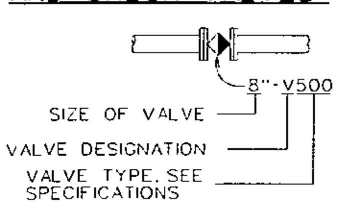
GAUGE WITH COCK



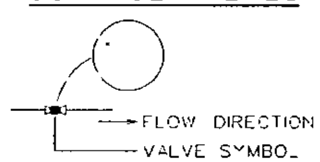
TYPICAL INSTRUMENT SYMBOL (SEE I&C LEGEND)

VALVE DESIGNATIONS

MANUAL VALVES AND CHECK VALVES

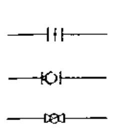


CONTROL VALVES



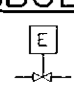
- BUBBLE WITH XV OR XCV DESIGNATION SHOWN ON P&ID WHERE X - PROCESS VARIABLE

VALVE SYMBOLS



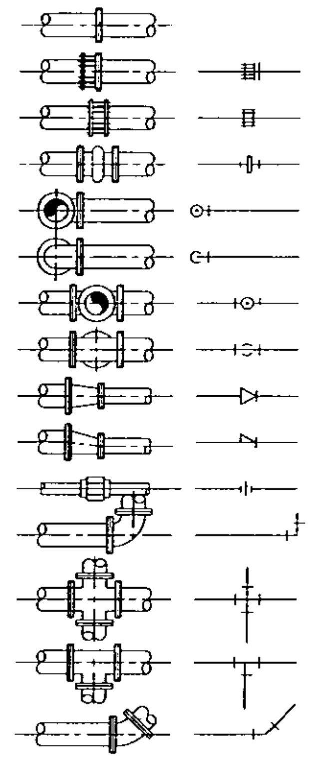
ACTUATOR SYMBOLS

ELECTRICAL MOTORIZED



PIPE AND FITTING SYMBOLS

DOUBLE LINE SINGLE LINE



NOTE

THIS IS A STANDARD LEGEND SHEET. SOME SYMBOLS OR ABBREVIATIONS MAY APPEAR ON THIS SHEET AND NOT BE UTILIZED ON THIS PROJECT.

SYMBOL	ZONE		SYMBOL	ZONE		DATE	BY
		REVISIONS				REVISIONS	

DESIGN		DRAWING		FINAL CHECK
MADE	CHKD	DR	CHKD	
RD	TI	RD	TI	RB

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DATE JANUARY 2000

CH2M HILL
ATLANTA, GEORGIA

U S ARMY ENGINEER DISTRICT CORPS OF ENGINEERS MOBILE, ALABAMA

U S ARMY CORPS OF ENGINEERS HUNTSVILLE ALABAMA

UPDATED GROUNDWATER INTERIM REMEDIAL ACTION

PROCESS MECHANICAL LEGEND

DEFENSE DEPOT MEMPHIS TENNESSEE

SIZE	INVITATION NO.	FILE NO.	SHEET
D			G-4
SCALE: NONE		FILE: 491p2g04.dgn	SHEET 4 OF 18

491p2g04.dgn 18-JAN-2000 10:28:42

8891312

ELECTRICAL LEGEND

SYMBOL	DESCRIPTION
	CONTROL DEVICE - FURNISHED AND INSTALLED UNDER OTHER DIVISIONS; RACEWAYS, CONDUCTORS, AND CONDUCTOR END TERMINATORS FURNISHED AND INSTALLED UNDER DIVISION 16 AS SHOWN. CONDUCTOR FINAL CONNECTIONS PROVIDED UNDER OTHER DIVISIONS.
	CONNECTION POINT TO EQUIPMENT SPECIFIED. FURNISHED AND INSTALLED UNDER OTHER DIVISIONS. RACEWAY, CONDUCTOR AND CONNECTION IN DIVISION 16 COORDINATE FINAL CONNECTION WITH EQUIPMENT SUPPLIER
(1"C,2#12,1#12G) (1"C,1-25/C TYPE 1)	INDICATES RACEWAY AND CIRCUIT CONDUCTORS FIRST NUMBER IS RACEWAY SIZE THE FOLLOWING NUMBERS ARE THE CONDUCTOR QUANTITIES,SIZES, AND TYPES
25MCC1	MAJOR ELECTRICAL COMPONENT OR DEVICE - NAME OR IDENTIFYING SYMBOL AS SHOWN.
	BRANCH CIRCUIT PANEL BOARD
UH1 5KW	UNIT HEATER NO.1 SEE SCHEDULE
TTC	TELEPHONE TERMINAL CABINET
	TERMINAL JUNCTION BOX
10	WOUND-ROTOR MOTOR, HORSEPOWER INDICATED
5	MOTOR, SQUIRREL CAGE INDUCTION - HORSEPOWER INDICATED
1/2	DC MOTOR, HORSEPOWER INDICATED
1	LUMINAIRE - SEE SCHEDULE
2	LUMINAIRE - SEE SCHEDULE
3	LUMINAIRE AND POLE - SEE SCHEDULE
4	WALL MOUNTED LUMINAIRE - SEE SCHEDULE
5	FLOOD LIGHTS - AIM IN THE DIRECTION SHOWN
	EXIT LIGHTS - SEE SCHEDULE
	EMERGENCY LIGHTING FIXTURE
So or 17 o	SMALL LETTER SUBSCRIPT AT SWITCH AND LUMINAIRE INDICATES SWITCHING. SUBSCRIPT NUMBER AT LUMINAIRE INDICATES CIRCUIT IN PANELBOARD.
5LP1-3	HOME RUN - DESTINATION SHOWN
or G	EXPOSED CONDUIT AND CONDUCTORS•
or G	CONCEALED CONDUIT AND CONDUCTORS• NOTE • ALL UNMARKED CONDUIT RUNS CONSIST OF TWO NO.12 CONDUCTORS IN CONDUIT. RUNS MARKED WITH CROSSHATCHES INDICATE NUMBER OF NO 12 CONDUCTORS CROSSHATCH WITH SUBSCRIPT "G" INDICATES GREEN GROUND WIRE SIZE CONDUIT ACCORDING TO SPECIFICATIONS AND APPLICABLE CODE.
	CROSSHATCHES WITH BAR INDICATE #10 CONDUCTOR SIZE CONDUIT ACCORDING TO SPECIFICATIONS AND APPLICABLE CODE.
	CONDUIT DOWN
	CONDUIT UP
	CONDUIT, STUBBED AND CAPPED AS SHOWN
--CE--	CONCRETE ENCASED CONDUIT DUCT BANK
--DB--	DIRECT BURIAL CABLE OR CONDUIT
S	WALL SWITCH: 2- DOUBLE POLE P- PILOT LIGHT; 3- THREE WAY K- KEY OPERATED; 4- FOUR WAY D- DIMMER; WP-WEATHERPROOF CRE-CORROSION RESISTANT

SYMBOL	DESCRIPTION
S_M	MANUAL MOTOR STARTER SWITCH
	CONVENIENCE RECEPTACLE - DUPLEX UNLESS SPECIFIED OTHERWISE WP-WEATHERPROOF C- CLOCK HANGER TL- TWIST LOCK CRE-CORROSION RESISTANT
	CONVENIENCE RECEPTACLE, PEDESTAL, DUPLEX SINGLE FACE UNLESS INDICATED OTHERWISE
	CONVENIENCE RECEPTACLE - DUPLEX, MOUNTED ABOVE COUNTER.
30	RECEPTACLE - 240V., 1Ø, AMPERAGE INDICATED
30	RECEPTACLE, SPECIAL PURPOSE - AMPERAGE AS INDICATED
	DUPLEX CONVENIENCE RECEPTACLE - FLUSH IN FLOOR
	MULTIOUTLET ASSEMBLY
	WALL CLOCK WITH CLOCK HANGER CONVENIENCE RECEPTACLE
	TELEPHONE RECEPTACLE (OUTLET BOX ONLY) FLUSH IN FLOOR
	TELEPHONE RECEPTACLE (OUTLET BOX ONLY) WITH 3/4" CONDUIT TO TELEPHONE TERMINAL CABINET (TTC)
J	GENERAL CONTROL OR WIRING DEVICE. NEMA 1 ENCLOSURE UNLESS INDICATED OTHERWISE. LETTER SYMBOLS OR ABBREVIATIONS INDICATE TYPE OF DEVICE.
C-E3A5 LV-E3A5	MANHOLE C INDICATES CONTROL LV INDICATES LOW VOLTAGE
	CONTROL STATION. NEMA 1 ENCLOSURE UNLESS INDICATED OTHERWISE. SEE DRAWING FOR TYPE.
30	NONFUSED DISCONNECT SWITCH, SIZE INDICATED. 3 POLE UNLESS INDICATED OTHERWISE, NEMA 1 ENCLOSURE, WP - WEATHERPROOF NEMA 4X)
60/40	FUSED DISCONNECT SWITCH, SIZE INDICATED (60/40, 60 - SWITCH RATING: 40 - FUSE RATING) 3 POLE UNLESS INDICATED OTHERWISE, NEMA 1 ENCLOSURE, WP - WEATHERPROOF (NEMA 4X)
2	CONTACTOR, MAGNETIC, NEMA SIZE INDICATED, NEMA 1 ENCLOSURE, UNLESS INDICATED OTHERWISE.
30	LIGHTING CONTACTOR, CURRENT RATING INDICATED, NEMA 1 ENCLOSURE UNLESS INDICATED OTHERWISE SEE CONTROL DIAGRAM FOR NUMBER OF POLES.
2	STARTER MAGNETIC NEMA SIZE INDICATED, NEMA 1 ENCLOSURE UNLESS INDICATED OTHERWISE. SEE CONTROL DIAGRAM.
2	COMBINATION (FUSE OR CIRCUIT BREAKER AS INDICATE). MAGNETIC STARTER, NEMA SIZE INDICATED, NEMA 1 ENCLOSURE UNLESS INDICATED OTHERWISE. SEE CONTROL DIAGRAM
	METERING FACILITIES
	MULTI-PARTY DESK TOP COMMUNICATIONS SYSTEM STATION WITH REMOTE AMPLIFIER
W	MULTI-PARTY WALL MOUNTED COMMUNICATIONS SYSTEM STATION WITH INTEGRAL AMPLIFIER
	CONE TYPE PAGING SPEAKER, CEILING MOUNTED
	INTERIOR PAGING TRUMPET SOUND REPRODUCER, 120° x 60° WITH REMOTE AMPLIFIER, SURFACE MOUNTED.
	OUTDOOR PAGING TRUMPET SOUND REPRODUCER, 120° x 60° WITH REMOTE AMPLIFIER, SURFACE MOUNTED.
	TERMINAL CABINET FOR COMMUNICATIONS SYSTEM
F	FIRE ALARM STATION, MANUAL
FA	FIRE ALARM STATION, AUTOMATIC, HEAT DETECTOR
F	FIRE ALARM BELL
F	FIRE ALARM HORN
FI	FIRE ALARM IONIZATION DETECTOR
	AIR DUCT IONIZATION DETECTOR
	GROUND ROD
	CONTACT - NORMALLY OPEN WITH NEMA SIZE INDICATED OR COIL IDENTIFICATION AS APPLICABLE
	CONTACT - NORMALLY CLOSED WITH NEMA SIZE INDICATED OR COIL IDENTIFICATION AS APPLICABLE

SYMBOL	DESCRIPTION
	OVERLOAD RELAY HEATER
	MAGNETIC STARTER WITH NEMA SIZE INDICATED
M	CIRCUIT BREAKER, MAGNETIC, TRIP SHOWN, 3 POLE UNLESS INDICATED OTHERWISE
400	CIRCUIT BREAKER, THERMAL MAGNETIC TRIP SHOWN, 3 POLE UNLESS INDICATED OTHERWISE.
400 400	CIRCUIT BREAKER WITH CURRENT LIMITING FUSES, TRIP AND FUSE RATING INDICATED, 3 POLE UNLESS INDICATED OTHERWISE
400 225	FUSED SWITCH, SWITCH AND FUSE CURRENT RATING INDICATED, 3 POLE UNLESS INDICATED OTHERWISE.
100	SWITCH - CURRENT RATING INDICATED, 3 POLE UNLESS INDICATED OTHERWISE
	DRAWOUT CIRCUIT BREAKER, LOW VOLTAGE
	DRAWOUT CIRCUIT BREAKER, MEDIUM VOLTAGE
	DRAWOUT FUSED SWITCH, MEDIUM VOLTAGE
	LIGHTNING ARRESTER
	FUSE
	CAPACITOR
SW 0-600V	METER WITH SWITCH - SCALE RANGE SHOWN
	GROUND
120V or 120/240V 15 KVA 1 PH	TRANSFORMER, VOLTAGES, PHASE AND RATING INDICATED AS APPLICABLE
GFR	GROUND FAULT RELAY WITH C.T.
	PUSH-BUTTON SWITCH, MOMENTARY CONTACT, NORMALLY OPEN
	PUSH-BUTTON SWITCH, MOMENTARY CONTACT, NORMALLY CLOSED
	PUSH BUTTON SWITCH, MAINTAINED CONTACTS WITH MECHANICAL INTERLOCK
	REMOTE DEVICE
H O A; 1 XOO; 2 OOX	SELECTOR SWITCH MAINTAINED CONTACT WITH CONTACT POSITION INDICATED, CHART IDENTIFIES OPERATION

CKT.	POSITION HAND	OFF	AUTO
1	X	O	O
2	O	O	X

X - CLOSED CONTACT
O - OPEN CONTACT

SYMBOL	DESCRIPTION
200/5 (3)	CURRENT TRANSFORMER, NUMBER AND RATIO INDICATED
A	INDICATING LIGHT - LETTER INDICATES COLOR A - AMBER G - GREEN B - BLUE R - RED C - CLEAR W - WHITE
A	PUSH TO TEST INDICATING LIGHT
XX	PROTECTIVE RELAY XX - 47 PHASE FAILURE/PHASE REVERSE; 50 INSTANTANEOUS; 51 TIME OVERCURRENT; 51GS GROUND FAULT/GROUND SENSOR
DCR	CONTROL RELAY, 24V DC COIL
CR	120V CONTROL RELAY

SYMBOL	DESCRIPTION
	TIME DELAY CONTACTS
	NORMALLY OPEN, TIMED OPEN
	NORMALLY OPEN, TIMED CLOSED
	NORMALLY CLOSED, TIMED OPEN
	NORMALLY CLOSED, TIMED CLOSED
DOE	DELAY UPON ENERGIZATION
DODE	DELAY UPON DE-ENERGIZATION
IC	INSTANTANOUS CLOSE
TC	TIMED CLOSE
TO	TIMED OPEN
	LIQUID LEVEL
	OPENS ON RISING LEVEL, CLOSES ON FALLING LEVEL
	CLOSES ON RISING LEVEL, OPENS ON FALLING LEVEL
	PRESSURE OR VACCUUM
	OPENS ON RISING PRESSURE, CLOSES ON FALLING PRESSURE
	CLOSES ON RISING PRESSURE, OPENS ON FALLING PRESSURE
	FLOW
	OPENS ON RISING FLOW, CLOSES ON FALLING FLOW
	CLOSES ON RISING FLOW, OPENS ON FALLING FLOW
	TEMPERATURE
	OPENS ON RISING TEMPERATURE, CLOSES ON FALLING TEMPERATURE
	CLOSES ON RISING TEMPERATURE, OPENS ON FALLING TEMPERATURE
	LIMIT SWITCH
	HELD OPEN, NORMALLY CLOSED
	NORMALLY CLOSED
	NORMALLY OPEN
	HELD CLOSED, NORMALLY OPEN
A / E-2	ONE LINE DIAGRAM CONTINUATION SYMBOL A-INTERFACE IDENTIFIER E-2-DWG NUMBER WHERE OTHER END OF CONTINUATION CAN BE FOUND
	ELECTRIC RESISTANCE HEATER
L, U, LR	LATCHING RELAY

NOTE:

THIS IS A STANDARD LEGEND SHEET. SOME SYMBOLS OR ABBREVIATIONS MAY APPEAR ON THIS SHEET AND NOT BE UTILIZED ON THIS PROJECT.

SYMBOL	ZONE	REVISIONS	SYMBOL	ZONE	REVISIONS	DATE	BY

DESIGN MADE	DESIGN CHKD	DRAWING DR	DRAWING CHKD	FINAL CHECK
RD	VT	RD	VT	RB

VERIFY SCALE: BAR IS ONE INCH ON ORIGINAL DRAWING. 0 — 1". IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DATE JANUARY 2000

CH2M HILL
ATLANTA,GEORGIA

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS MOBILE, ALABAMA | U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE, ALABAMA

UPDATED GROUNDWATER INTERIM REMEDIAL ACTION

ELECTRICAL LEGEND

DEFENSE DEPOT MEMPHIS TENNESSEE

SIZE D | INVITATION NO | FILE NO | SHEET G-5

SCALE NONE | FILE: 49b2g05.dgn | SHEET 5 OF 18

049g05.dgn 18-JAN-00 10:28:47

8891313

SYMBOLS (VALVE, GATE, ACTUATOR, PUMP, COMPRESSOR, MISCELLANEOUS)

- Z E FC — ELECTRIC ACTUATOR WITH POSITIONER (FAIL CLOSE ON LOSS OF SIGNAL)
- BALL
- SWING CHECK
- AIR/VACUUM RELEASE VALVE
- PLUG VALVE
- LEVEL (ULTRASONIC)
- LEVEL (FLOAT)
- ORIFICE PLATE
- ROTAMETER
- SUBMERSIBLE PUMP
- CENTRIFUGAL PUMP (DRY PIT)
- CENTRIFUGAL WET PIT PUMP OR TURBINE PUMP
- DIAPHRAGM SEAL
- AIR GAP
- VENT TO ATMOSPHERE
- RUPTURE DISC
- CALIBRATION TUBE
- S — SEAL WATER SET (SEE MECHANICAL STANDARD DETAILS)
- 120V — 120 VOLT, 60 HZ POWER
- INTERLOCK, SEE CONTROL DIAGRAMS
- BALL CHECK VALVE
- ELECTROMAGNETIC FLOWMETER

TAG NUMBER CONVENTIONS

TAG NAME SUMMARY

LETTER 1	LETTER 2	LETTER 3	LETTER 4
A - ANALYZER	A - ALARM	H - HIGH	H - HIGH
C		CONTROLLER	
F - FLOW	E - ELEMENT	I - INDICATOR	L - LOW
H - HAND	I - INDICATOR	L - LOW	
L - LEVEL	L - LIGHT	M - MIDDLE	
P - PRESSURE	O - TOTALIZE	T - TRANSMITTER	
O - STATUS	S - SWITCH		
T - TEMPERATURE	Y - COMPUTE		
W - WEIGHT			
Z - POSITION			

SAMPLE TAG NUMBER CONVENTION EXAMPLE

LSH 8-2-1 (3) = THREE LEVEL SWITCH HIGH DEVICES WITH TAG NUMBERS: LSH 8-2-1, LSH 8-2-2 AND LSH 8-2-3

INSTRUMENT LOCATION CONVENTION

FIELD   PANEL   INSIDE PANEL   MOTOR CONTROL CENTER

SIGNAL CONVENTIONS

- A — ANALOG
- DISCRETE
- PF — PULSE FREQUENCY
- PD — PULSE DURATION
- P — POWER
- 0—0 — COMPUTER OR PLC DATALINK
- NON-CONNECTING
- SIGNAL SPLIT (IMPLIES RELAY)
- (3) (2) PARALLEL (3 SIGNALS SHOWN)
- PNEUMATIC
- PLC DISCRETE INPUT
- PLC DISCRETE OUTPUT
- A — PLC ANALOG INPUT
- A — PLC ANALOG OUTPUT

INTERFACE SYMBOLS

1A2 — PROCESS STREAM 1A ORIGINATES ON SHEET I-1 AND TERMINATES ON SHEET I-2

POWER OPERATED 3b4 — SIGNAL 3b ORIGINATES ON SHEET I-3 AND TERMINATES ON SHEET I-4

INTERFACE TO OR FROM PROCESS EXTERNAL TO PROJECT

ABBREVIATIONS

AS - ADJUSTABLE SPEED
AVRV - AIR AND VACUUM RELEASE VALVE
CS - CONSTANT SPEED (SINGLE SPEED)
FCV - FLOW CONTROL VALVE
FP-X- - FIELD PANEL
FIC - FLOW INDICATING CONTROLLER
FT - FLOW TRANSMITTER
FV - FLOW VALVE
HS-X- [OO] - ON-OFF HANDSWITCH
HS-X- [OOR] - ON-OFF-REMOTE HANDSWITCH
HS-X- [1/2/ALT] - 1/2/ALTERNATE HANDSWITCH
M-X- - MECHANICAL EQUIPMENT
P-X- - PUMP
PSV - PRESSURE SAFETY VALVE
PDI - PRESSURE DIFFERENTAL INDICATOR
OL-X- [FS] - FAST-SLOW INDICATING LIGHT
OL-X- [ON] - ON STATUS LIGHT
SHK-X- - SPEED HAND CONTROL STATION
SY-X- [R/I] - TRANSDUCER RESISTANCE TO CURRENT

FLOW STREAM IDENTIFICATION

RWD - RECOVERY WELL DISCHARGE
PP - POLYPHOSPHATE

GENERAL NOTES

1. COMPONENTS AND PANELS SHOWN WITH A ◆ ARE TO BE PROVIDED UNDER SPECIFICATION SECTION INSTRUMENTATION AND CONTROLS.
2. COMPONENTS, EQUIPMENT, AND PANELS SHOWN WITH A DOUBLE ASTERISK (**) ARE TO BE PROVIDED AS PART OF A PACKAGE SYSTEM
3. THIS IS A STANDARD LEGEND. THEREFORE, NOT ALL OF THIS INFORMATION MAY BE USED ON THIS PROJECT
4. UNLESS OTHERWISE NOTED ALL TAG NUMBERS SHALL FOLLOW INSTRUMENT SOCIETY OF AMERICA (ISA) CONVENTIONS

SYMBOL	ZONE	REVISIONS	SYMBOL	ZONE	REVISIONS	DATE	BY

DESIGN		DRAWING		FINAL CHECK
MADE	CHKD	DR	CHKD	
RD	TI	RD	TI	RB

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 — 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DATE JANUARY 2000

CH2M HILL
ATLANTA, GEORGIA

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS MOBILE, ALABAMA
U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE, ALABAMA

UPDATED GROUNDWATER INTERIM REMEDIAL ACTION
I&C LEGEND
DEFENSE DEPOT MEMPHIS TENNESSEE

SIZE D | INVITATION NO. | FILE NO. | SHEET G-6
SCALE: NONE | FILE: 491p2g06 dgn | SHEET 6 OF 18

491p2g06 dgn 18-JAN-2000 10:29:54

8891314

SURVEY NOTES:

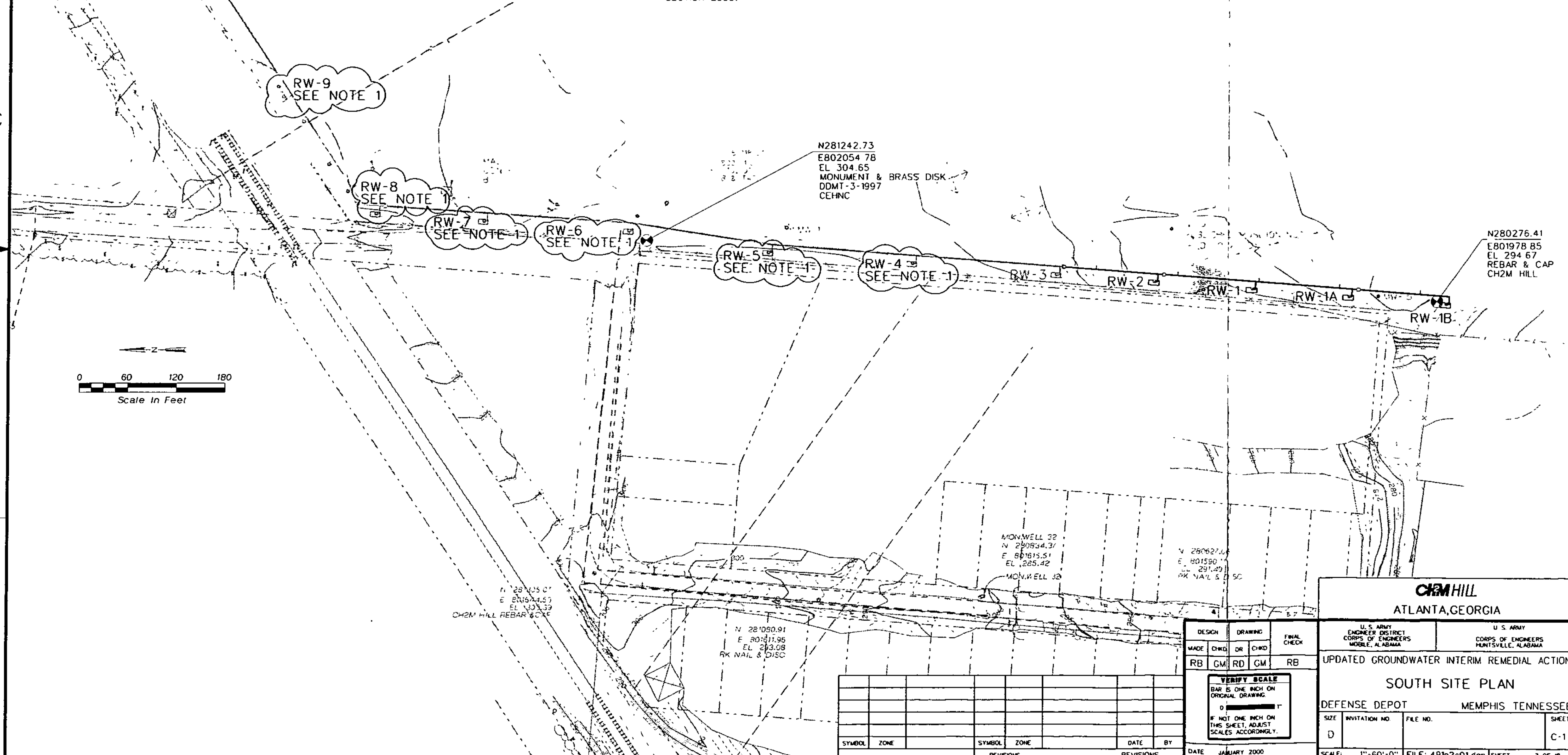
1. SURVEY PERFORMED BY CH2M HILL DATED APRIL AND JUNE, 1996, AND JANUARY, 1997.
2. ALL PROPERTY LINES AND RIGHT-OF-WAYS ARE APPROXIMATE AS DETERMINED FROM SHELBY COUNTY TAX MAPS AND SHOULD BE VERIFIED IN THE FIELD.
3. ELEVATIONS ARE BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 1988) AND ARE REFERENCED TO NCSBM A-308 1995 NEAR THE NW CORNER OF THE AIRWAYS BLVD BRIDGE OVER THE RAILROAD.
4. HORIZONTAL COORDINATES ARE BASED ON THE TENNESSEE STATE PLANE COORDINATE SYSTEM, NAD 83/93 DATUM AND IS TIED TO COE MONUMENTS T1-1E 1975, T1-1G 1975 AND T1-1H 1975, ALL LOCATED WITHIN THE DEFENSE DEPOT.

EROSION CONTROL NOTES:

1. WHERE GRADING IS PERFORMED, PROVIDE TEMPORARY SILT FENCE (ITEM 209-08) AS SHOWN ON THE TYPICAL TEMPORARY POLLUTION CONTROL STRUCTURES DRAWING EL-P-3, STATE OF TENNESSEE DEPARTMENT OF TRANSPORTATION STANDARD ROADWAY AND STRUCTURE DRAWINGS.
2. PERIMETER SILT FENCES, HAYBALE BARRIERS, AND CONSTRUCTION ENTRANCES SHALL BE IN PLACE PRIOR TO COMMENCEMENT OF SITE WORK AND SHALL REMAIN UNTIL COMPLETION OF WORK. DAMAGED ITEMS SHALL BE REPAIRED OR REPLACED IMMEDIATELY.
3. INSPECTIONS SHALL BE MADE ON A WEEKLY BASIS AND AFTER RAIN EVENTS OF 0.25 INCHES OR GREATER FOR THE ENTIRE CONSTRUCTION PERIOD. A LOG OF THE INSPECTIONS SHALL BE MAINTAINED ON SITE BY THE CONTRACTOR.
4. TEMPORARY GRASS COVER BY SEEDING OR SEEDING AND MULCHING SHALL BE PROVIDED FOR EXPOSED AREAS NOT EXPECTED TO RECEIVE FINAL COVER WITHIN 30 DAYS AND FOR STOCK PILE AREAS. TEMPORARY SEEDING AREAS SHALL BE SEEDED WITH A QUICK GROWING GRASS SPECIES IN ACCORDANCE WITH LOCAL SOIL CONSERVATION SERVICE RECOMMENDATIONS.
5. ALL AREAS DISTURBED DURING CONSTRUCTION NOT COVERED BY STRUCTURES OR CONCRETE PADS SHALL BE GRASSED AS SPECIFIED IN SECTION 2935 PERMANENT GRASS COVER SHALL BE REWORKED AND RESEEDED UNTIL ACCEPTABLE COVERAGE IS MET IN ACCORDANCE WITH SECTION 2935.

GENERAL NOTES:

1. EXISTING PUMPS AND MOTORS ON EXISTING WELLS RW-4, 5, 6, 7, 8 AND 9 TO BE REPLACED.
2. SEE DRAWING C-2 FOR LOCATION OF PIPELINE AND RECOVERY WELLS.
3. SEE DRAWING C-3 FOR SITE GRADING AT THE RECOVERY WELLS.
4. CONTOURS SHOWN WITH SHARP DIRECTIONAL CHANGES SHALL BE ROUNDED AND SMOOTHED AS A PART OF FINISHED GRADING OPERATIONS.
5. CONTOURS AND SPOT ELEVATIONS SHOWN ARE FINISHED GRADES. UNDERCUT AND/OR MAKE PROPER ALLOWANCES FOR TOPSOIL.
6. WELLS AT RW-2, 1, 1A AND 1B ARE EXISTING. WELL HEAD PIPING, PUMPS, CONCRETE PADS, AND ASSOCIATED ELECTRICAL WORK FOR THESE WELLS IS PART OF NEW CONSTRUCTION PIPING FROM THESE WELLS TO EXISTING WELL RW-3 IS ALSO PART OF NEW CONSTRUCTION.
7. WELLS RW-10, 11, 12 AND 13 ARE FUTURE WELLS.



CH2M HILL
ATLANTA, GEORGIA

U. S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS MOBILE, ALABAMA
U. S. ARMY CORPS OF ENGINEERS HUNTSVILLE, ALABAMA

UPDATED GROUNDWATER INTERIM REMEDIAL ACTION

SOUTH SITE PLAN

DEFENSE DEPOT MEMPHIS TENNESSEE

DESIGN		DRAWING		FINAL CHECK
MADE	CHKD	DR	CHKD	
RB	GM	RD	GM	RB

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DATE JANUARY 2000

SIZE	INVITATION NO	FILE NO.	SHEET
D			C-1

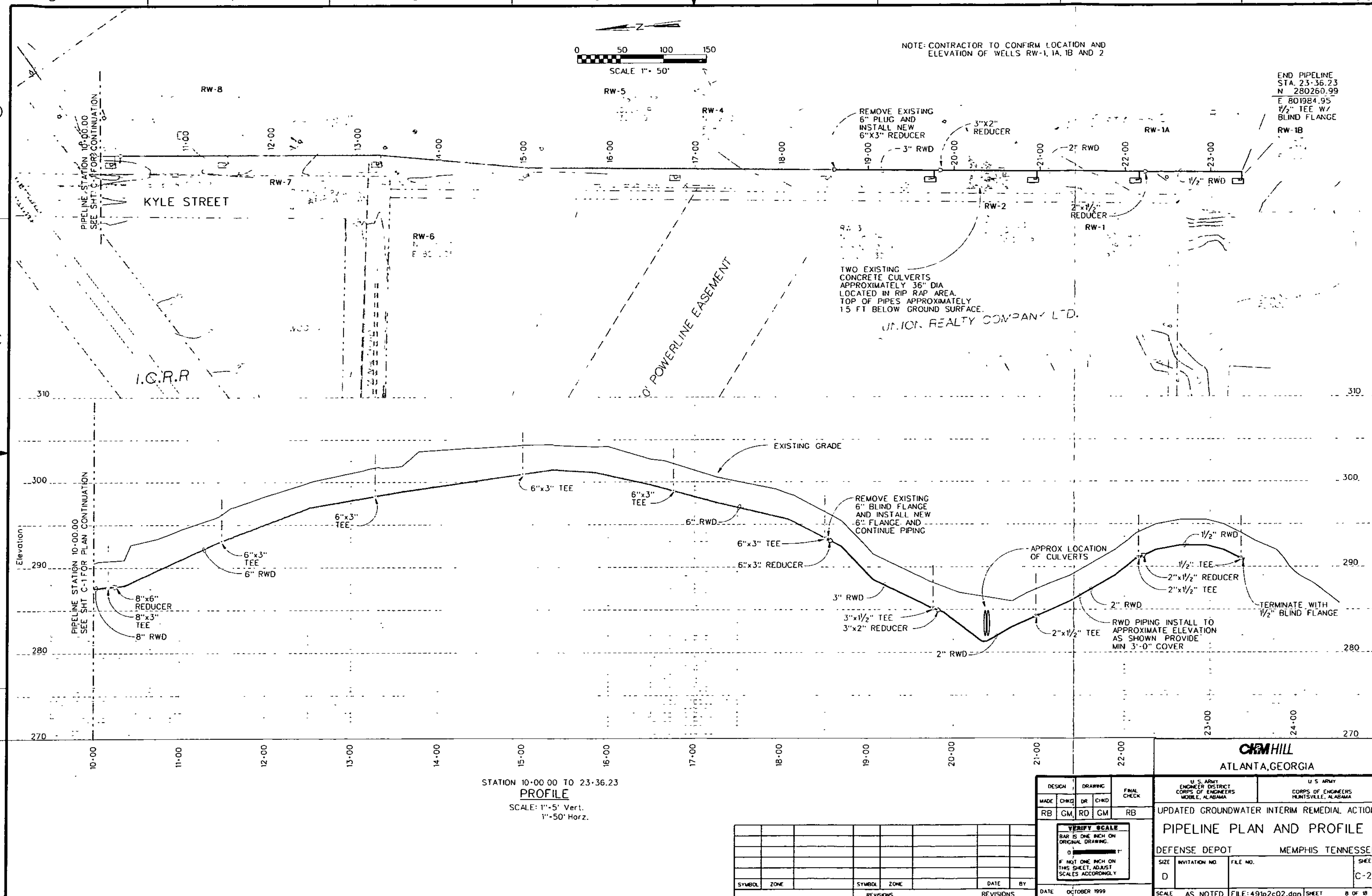
SCALE: 1"-60'-0" FILE: 491p2c01.dgn SHEET 7 OF 18

SYMBOL	ZONE	SYMBOL	ZONE	DATE	BY

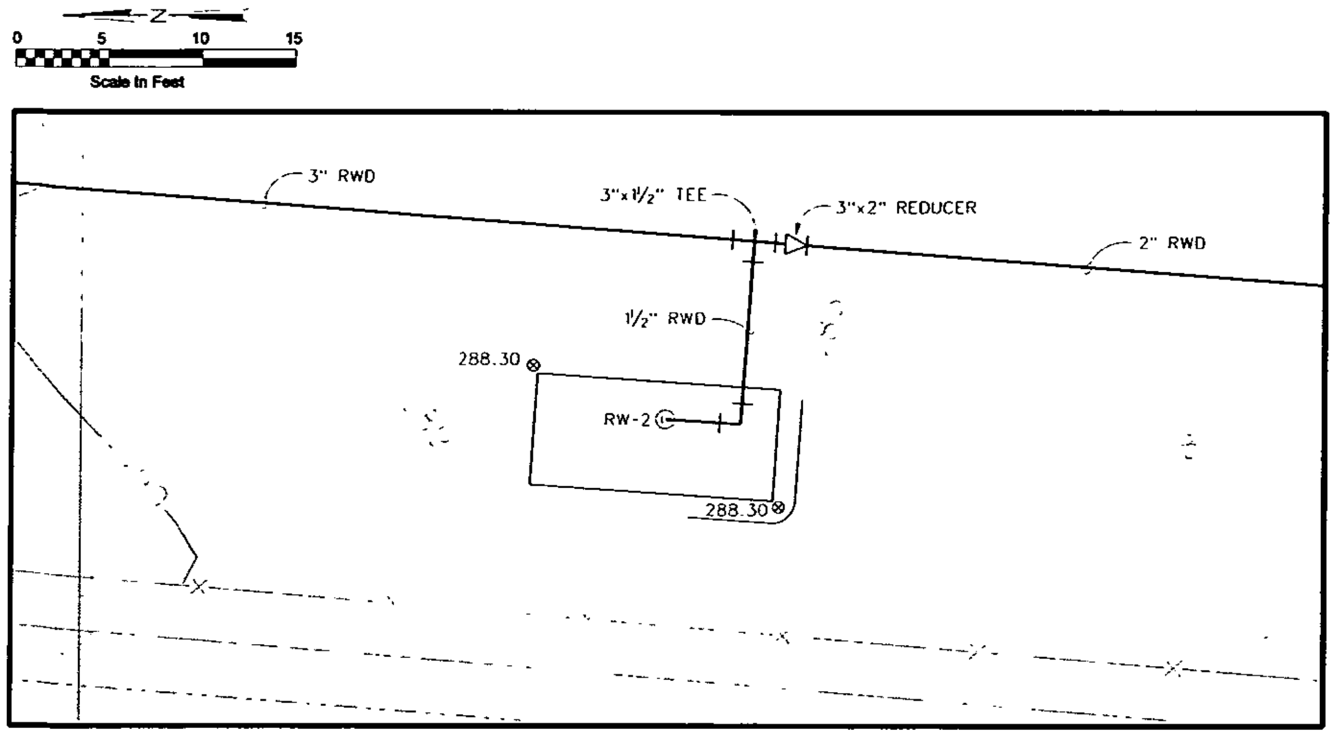
REVISIONS REVISIONS

491p2c01.dgn 18-JAN-2000 09:18:18

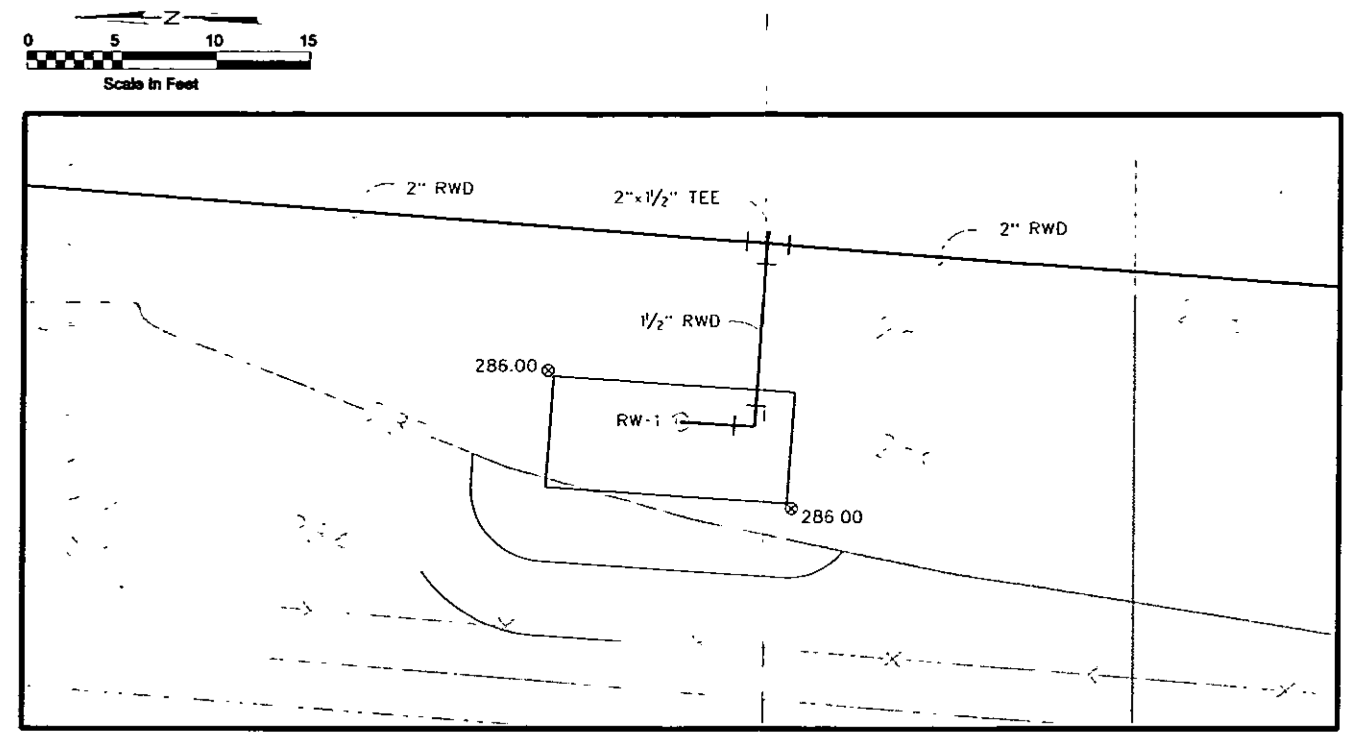
8891315


NOTE: CONTRACTOR TO CONFIRM LOCATION AND ELEVATION OF WELLS RW-1, 1A, 1B AND 2
SCALE 1" = 50'
0 50 100 150
END PIPELINE STA. 23+36.23 N 280260.99 E 801984.95 1/2" TEE W/ BLIND FLANGE
RW-8
RW-7
RW-6
RW-5
RW-4
RW-2
RW-1
RW-1A
RW-1B
KYLE STREET
I.C.R.R
POWERLINE EASEMENT
UNION REALTY COMPANY LTD.
PIPELINE STATION 10+00.00 SEE SHT C-1 FOR CONTINUATION
REMOVE EXISTING 6" PLUG AND INSTALL NEW 6"X3" REDUCER
3" RWD
3"X2" REDUCER
2" RWD
2"x1/2" REDUCER
1/2" RWD
TWO EXISTING CONCRETE CULVERTS APPROXIMATELY 36" DIA LOCATED IN RIP RAP AREA. TOP OF PIPES APPROXIMATELY 15 FT BELOW GROUND SURFACE.
EXISTING GRADE
PIPELINE STATION 10+00.00 SEE SHT C-1 FOR PLAN CONTINUATION
Elevation
310
300
290
280
270
8"x6" REDUCER
8"x3" TEE
8" RWD
6"x3" TEE
6" RWD
6"x3" TEE
6"x3" TEE
6"x3" TEE
6" RWD
6"x3" TEE
6"x3" REDUCER
REMOVE EXISTING 6" BLIND FLANGE AND INSTALL NEW 6" FLANGE AND CONTINUE PIPING
3" RWD
3"x1/2" TEE
3"x2" REDUCER
2" RWD
APPROX LOCATION OF CULVERTS
2"x1/2" TEE
2" RWD
RWD PIPING INSTALL TO APPROXIMATE ELEVATION AS SHOWN PROVIDE MIN 3'-0" COVER
1/2" RWD
1/2" TEE
2"x1/2" REDUCER
2"x1/2" TEE
TERMINATE WITH 1/2" BLIND FLANGE
10+00 11+00 12+00 13+00 14+00 15+00 16+00 17+00 18+00 19+00 20+00 21+00 22+00 23+00 24+00
STATION 10+00.00 TO 23+36.23
PROFILE
SCALE: 1"=5' Vert. 1"=50' Horz.
SYMBOL ZONE SYMBOL ZONE DATE BY
REVISIONS REVISIONS
DESIGN DRAWING FINAL CHECK
MADE CHKD DR CHKD
RB GM RD GM RB
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY
DATE OCTOBER 1999
CH2M HILL
ATLANTA, GEORGIA
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS MOBILE, ALABAMA
U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE, ALABAMA
UPDATED GROUNDWATER INTERIM REMEDIAL ACTION
PIPELINE PLAN AND PROFILE
DEFENSE DEPOT MEMPHIS TENNESSEE
SIZE D INVITATION NO. FILE NO. SHEET C-2
SCALE AS NOTED FILE: 491p2c02.dgn SHEET 8 OF 18

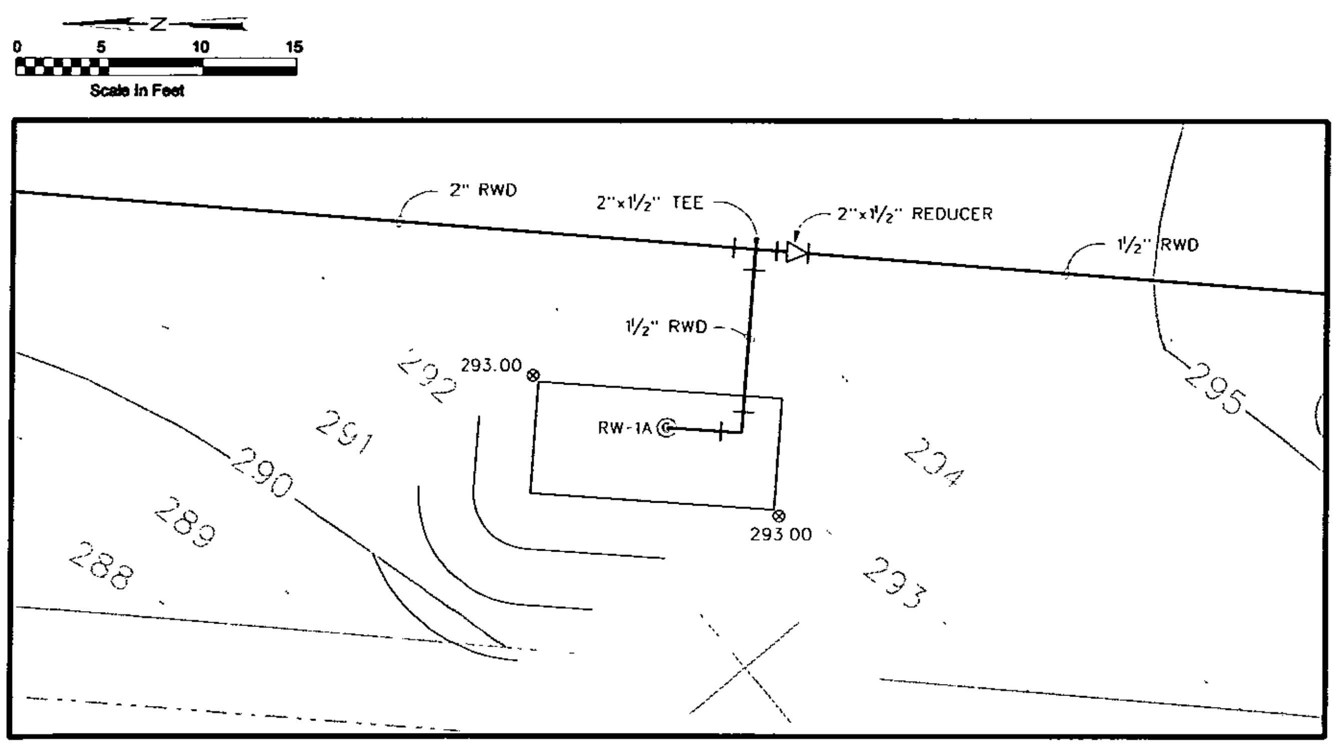
8891316



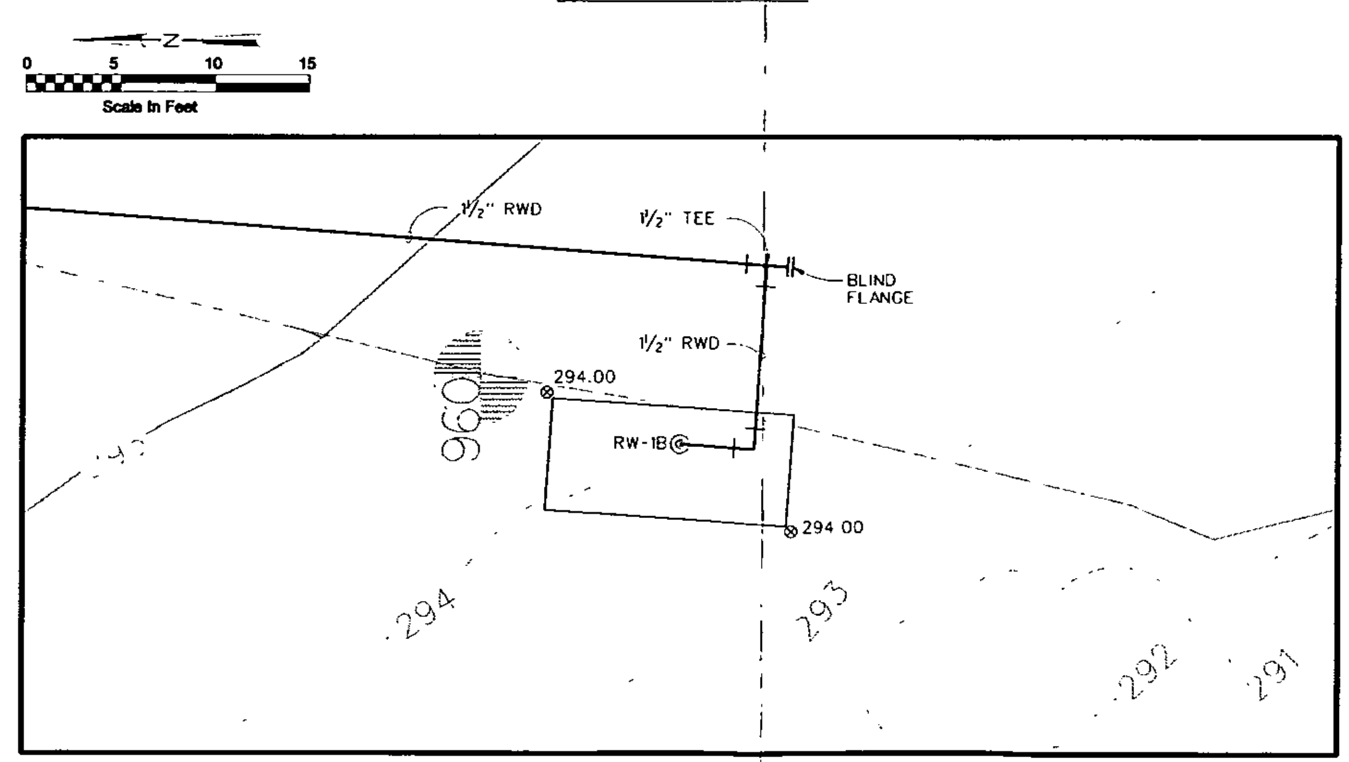
RECOVERY WELL 2



RECOVERY WELL 1



RECOVERY WELL 1A



RECOVERY WELL 1B

NOTE:
1) SEE SHEET M-1 FOR PAD ELEVATION.

SYMBOL	ZONE		SYMBOL	ZONE	DATE	BY
REVISIONS			REVISIONS			

DESIGN		DRAWING		FINAL CHECK
MADE	CHKD	DR	CHKD	
RB	GM	RD	GM	RB

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DATE JANUARY 2000

CH2M HILL
ATLANTA, GEORGIA

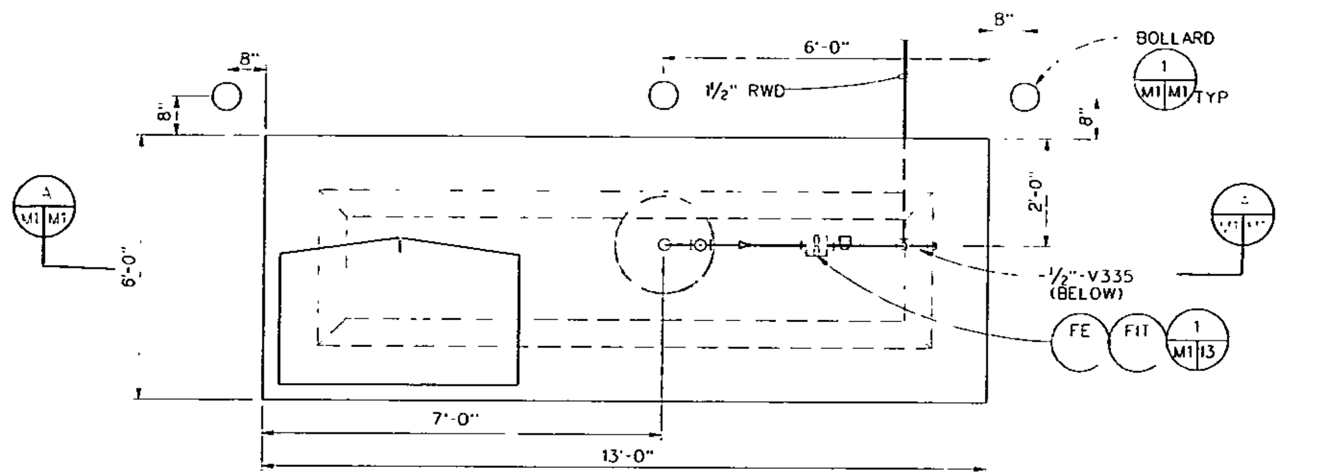
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS MOBILE, ALABAMA
U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE, ALABAMA

UPDATED GROUNDWATER INTERIM REMEDIAL ACTION
SITE LAYOUT AND GRADING FOR RECOVERY WELLS
DEFENSE DEPOT MEMPHIS TENNESSEE

SIZE	INVITATION NO.	FILE NO.	SHEET
D			C-3
SCALE: 1"=5'-0"	FILE: 491p2c03.dgn	SHEET	9 OF 18

491p2c03.dgn 18-JAN-2000 09:25:46

8891317

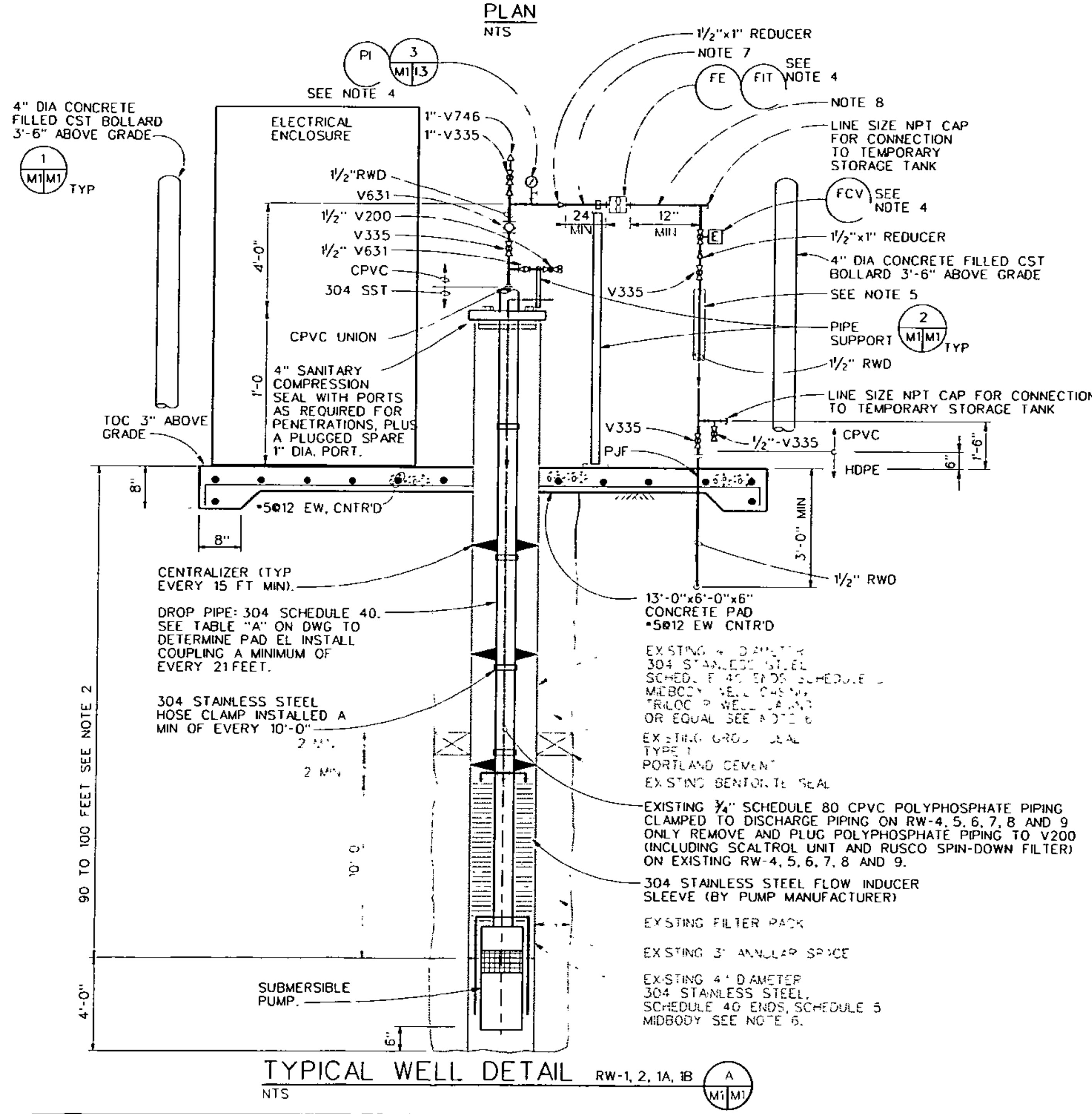


PLAN
NTS

WELL NAME	PAD ELEVATION	EXISTING DROP LEG PIPE SIZE (in)	NEW DROP LEG PIPE SIZE (in)
RW-1	EL 286.25	NONE	1
RW-1A	EL 293.25	NONE	1
RW-1B	EL 294.25	NONE	1
RW-2	EL 288.55	NONE	1
RW-4	EL 304.19	2	1
RW-5	EL 306.25	2	1
RW-6	EL 303.65	2	1¼
RW-7	EL 296 57	2	1¼*
RW-8	EL 292.06	2	½
RW-9	EL 289 76	2	½

TABLE "A"

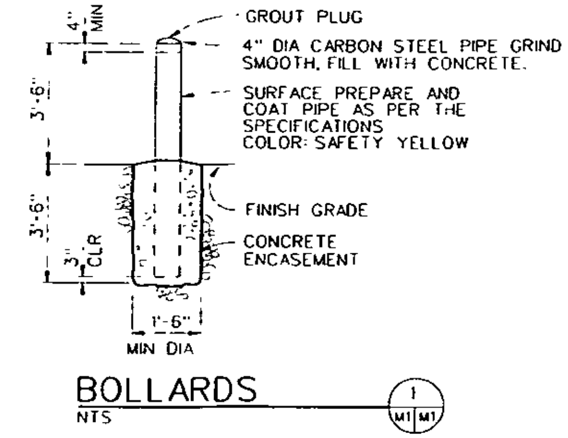
* 1" FOR ALTERNATIVE A.



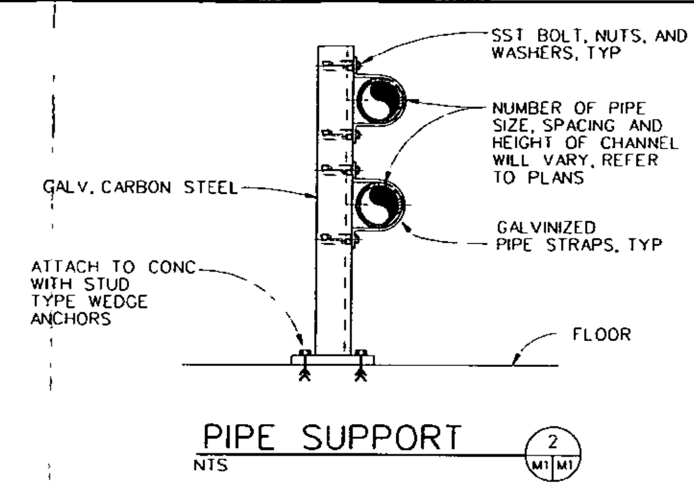
TYPICAL WELL DETAIL RW-1, 2, 1A, 1B
NTS

NOTES:

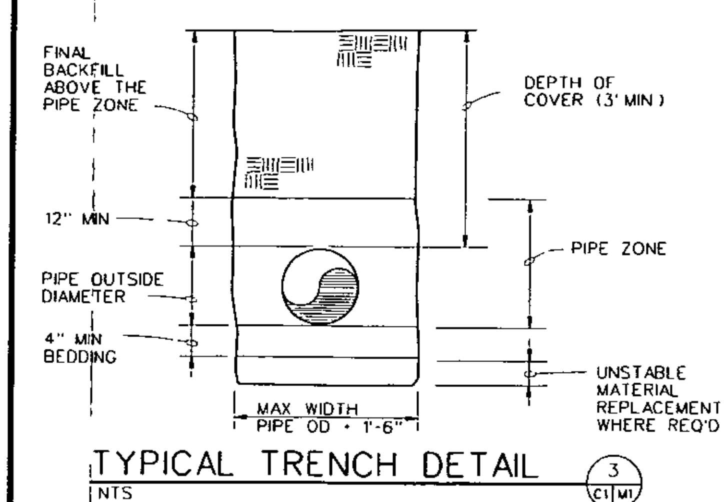
1. WELL CONSTRUCTION DETAILS TO BE FINALIZED BASED ON FIELD INVESTIGATIONS DURING INSTALLATION (WELLS INSTALLED BY OTHERS)
2. THE APPROXIMATE DEPTH OF THE CONFINING UNIT CLAY IS ESTIMATED TO BE APPROXIMATELY 90 TO 100 FEET. EXACT DEPTH WILL BE DETERMINED BY THE CONTRACTING OFFICER DURING FIELD DRILLING (WELLS INSTALLED BY OTHERS)
3. FOR WELLS RW-1, RW-1A, RW-1B AND RW-2. INSTALL PUMPS AND ALL DISCHARGE PIPING. FOR EXISTING WELLS RW-4, 6, 7, 8 AND 9 REPLACE MOTOR, PUMP, DROP LEG AND FLOW ELEMENT REPLACE FCV FOR EXISTING WELLS RW-4, 5, 6 AND 7 (REUSE EXISTING ACTUATORS), PER SPECIFICATIONS. REPLACE PUMP, MOTOR AND DROP LEG ON EXISTING WELL RW-5
4. SEE DRAWING No I-1 FOR APPROPRIATE FLOW LOOP TAG NUMBER FOR EACH WELL'S FLOW INDICATING TRANSMITTER AND PI NUMBERS.
5. ELECTRIC HEAT TRACE AND INSULATE ALL EXPOSED PIPING.
6. FOR WELLS RW-4, 5, 6, 7, 8 AND 9, DIAMETER IS 6 INCHES.
7. REPLACE EXISTING PIPING WITH 1" DIA PIPE TO REDUCER ON EXISTING WELLS RW-4, 6, 7, 8 AND 9
8. REPLACE EXISTING PIPING WITH 1" DIA PIPE TO FCV ON EXISTING WELLS RW-4, 6, 7, 8 AND 9.
9. CONTRACTOR SHALL FIELD VERIFY EXISTING PIPING CONFIGURATION AND DIMENSIONS FOR EXISTING WELLS RW-4, 5, 6, 7, 8 AND 9.



BOLLARDS
NTS



PIPE SUPPORT
NTS



TYPICAL TRENCH DETAIL
NTS

SYMBOL	ZONE		SYMBOL	ZONE		DATE	BY
REVISIONS			REVISIONS				

DESIGN		DRAWING		FINAL CHECK
MADE	CHKD	DR	CHKD	
RB	TI	RD	TI	RB

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DATE JANUARY 2000

CH2M HILL
ATLANTA, GEORGIA

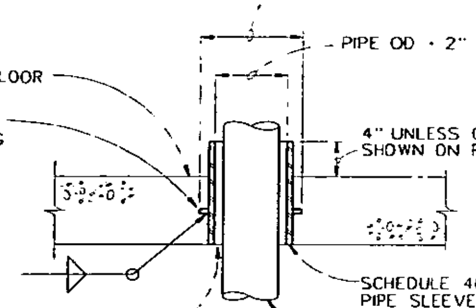
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS MOBILE, ALABAMA
U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE, ALABAMA

UPDATED GROUNDWATER INTERIM REMEDIAL ACTION
TYPICAL RECOVERY WELL LAYOUT AND MECHANICAL DETAILS
DEFENSE DEPOT MEMPHIS TENNESSEE

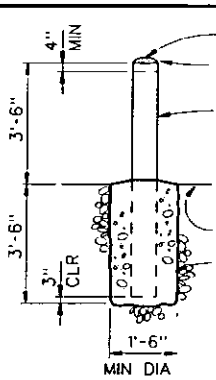
SIZE D | INVITATION NO. | FILE NO. | SHEET M-1
SCALE NONE | FILE:491p2m01.dgn | SHEET 10 OF 18

491p2m01.dgn 18-JAN-2000 09:54 05

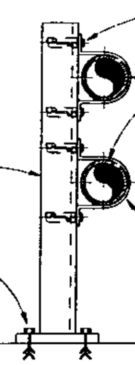
8891318



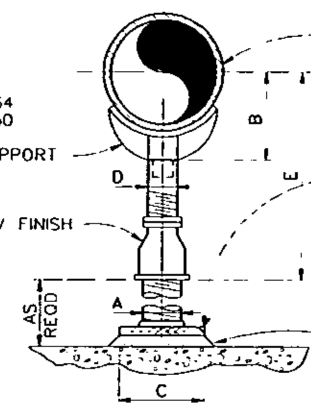
FLOOR SLEEVE (1 M2/M2)
NTS



BOLLARDS (2 M1/M2, M2)
NTS



PIPE SUPPORT (3 M1/M2)
NTS

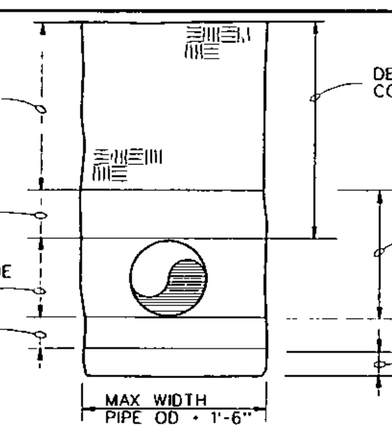


NOTES:
1. PROVIDE HALF ROUND RIGID INSULATION AND INSULATION PROTECTION SHIELD, SIMILAR TO GRINNELL FIGURE 167 OR ELCEN FIGURE 219, WHERE PIPING IS INSULATED.
2. PROVIDE NEOPRENE WAFFLE ISOLATION PAD, SIMILAR TO MASON TYPE 'W' OR KORFUND KORPAD 40, UNDER SUPPORT FOOT WHEN PIPING IS ISOLATED OR SUPPORT IS ADJACENT TO MECHANICAL EQUIPMENT

DIMENSION TABLE

PIPE SIZE	A	B	C	D	E MIN	E MAX
2-1/2"	2-1/2"	3-1/2"	7"	1-1/2"	8"	13"
3"	2-1/2"	3-3/4"	7"	1-1/2"	8-1/4"	13-1/4"
3-1/2"	2-1/2"	4"	7"	1-1/2"	8-1/2"	13-1/2"
4"	3"	4-1/4"	7-1/2"	2-1/2"	9-1/4"	14"
5"	3"	4-7/8"	7-1/2"	2-1/2"	10"	14-3/4"
6"	3"	5-1/2"	7-1/2"	2-1/2"	10-1/2"	15-1/4"
8"	3"	6-7/8"	7-1/2"	2-1/2"	11-3/4"	16-1/2"
10"	3"	8-1/2"	7-1/2"	2-1/2"	13-1/2"	18-1/4"
12"	3"	9-15/16"	7-1/2"	2-1/2"	15"	19-3/4"
14"	4"	10-15/16"	9"	3"	16-1/4"	20-3/4"
16"	4"	12-3/8"	9"	3"	17-3/4"	22-1/4"
18"	6"	13-7/8"	11"	3-1/2"	19-1/2"	24"
20"	6"	15-3/8"	11"	3-1/2"	21"	25-1/2"
24"	6"	17-15/16"	11"	4"	23-3/4"	28-1/4"
30"	6"	21-5/16"	11"	4"	27"	31-1/2"
32"	6"	22-1/2"	11"	4"	28-1/4"	32-3/4"
36"	6"	24-1/2"	11"	4"	30-1/4"	34-3/4"

PIPE SUPPORT (4 M2/M2)
NTS



TYPICAL TRENCH DETAIL (5 C1/M2)
NTS

SYMBOL	ZONE		SYMBOL	ZONE		DATE	BY
		REVISIONS				REVISIONS	

DESIGN		DRAWING		FINAL CHECK
MADE	CHKD	DR	CHKD	
RB	X	RD	X	X

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DATE JANUARY 2000

CH2M HILL
ATLANTA, GEORGIA

U. S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS MOBILE, ALABAMA
U S ARMY CORPS OF ENGINEERS HUNTSVILLE, ALABAMA

UPDATED GROUNDWATER INTERIM REMEDIAL ACTION
MECHANICAL DETAILS
DEFENSE DEPOT MEMPHIS TENNESSEE

SIZE D | INVITATION NO | FILE NO. | SHEET M-2
SCALE: NONE | FILE: X.DGN | SHEET X OF X

49192m02.dgn 18-OCT-1999 10:22:11

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE