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FINAL FEASIBILITY STUDY ADDENDUM OPERABLE UNIT 4 (OU4) NTC ORLANDO FL
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TETRA TECH

Comprehensive **L**ong-term **E**nvironmental **A**ction **N**avy

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Feasibility Study Addendum
for
Operable Unit 4

Naval Training Center Orlando
Orlando, Florida

Contract Task Order 0143

August 2012

BRAC Program Management Office Southeast
4130 Faber Place Drive, Suite 202
North Charleston, South Carolina 29405

TETRA TECH

Rev. 1
08/23/12

FEASIBILITY STUDY ADDENDUM
FOR
OPERABLE UNIT 4

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:

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PROFESSIONAL GEOLOGIST CERTIFICATION

I hereby certify that this document, *Draft Feasibility Study Addendum for Operable Unit 4*, was prepared under my direct supervision in accordance with acceptable standards of geological practice.

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ACRONYMS AND ABBREVIATIONS

μg/kg	Micrograms per kilogram
μg/L	Micrograms per liter
ABB-ES	ABB Environmental Services, Inc.
amsl	Above mean sea level
ARAR	Applicable or relevant and appropriate requirements
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CCI	CH2MHILL Constructors, Inc.
CMT	Continuous multi-channel tubing
COC	Chemicals of concern
COPC	Chemicals of potential concern
CSM	Conceptual site model
CTE	Central tendency risk estimate
CTL	Cleanup Target Level
CVOC	Chlorinated volatile organic compound
DCE	Dichloroethene
DNAPL	Dense non-aqueous phase liquid
DPT	Direct push technology
DRMO	Defense Reutilization and Marketing Office
EISB	Enhanced In Situ Bioremediation
EOS	Emulsified oil substrate
ERD	Enhanced reductive dechlorination
FDEP	Florida Department of Environmental Protection
FFI	Focused Field Investigation
FFS	Focused Feasibility Study
FOSET	Finding of Suitability for Early Transfer
FS	Feasibility Study
GCTL	Groundwater Cleanup Target Level
HI	Hazard Index
HLA	Harding Lawson Associates
HRC	Hydrogen release compound
IRA	Interim Remedial Action
ISCO	In situ chemical oxidation
LHC	Lower Hawthorn clay
LUC	Land Use Control
MIP	Membrane interface probe
MNA	Monitored natural attenuation
NAVFAC SE	Naval Facilities Engineering Command Southeast
ND	Non-detect

ACRONYMS AND ABBREVIATIONS (Continued)

NTC	Naval Training Center
ORP	Oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
O&M	Operation and Maintenance
PAH	Polynuclear aromatic hydrocarbon
PCE	Tetrachloroethene
PPE	Personal protective equipment
PRG	Preliminary remediation goal
RAB	Restoration Advisory Board
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objective
RI	Remedial Investigation
ROD	Record of Decision
RME	Reasonable Maximum Exposure
RW	Recovery well
SA	Study Area
SCTL	Soil Cleanup Target Level
SZA	Shallow Zone A
SZB	Shallow Zone B
TBC	To Be Considered
TCE	Trichloroethylene
TOR	Time of Remediation
TPOC	Temporary point of compliance
UHC	Upper Hawthorn Clay
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VC	Vinyl chloride
VOC	Volatile organic compound
WBZ	Water-bearing zone

1.0 INTRODUCTION

Tetra Tech has been contracted by the Department of the Navy, Naval Facilities Engineering Command Southeast (NAVFAC SE) to prepare an addendum for the Feasibility Study (FS) for Operable Unit (OU) 4 at Naval Training Center (NTC), Orlando, Florida. OU 4 is located within Area C of the NTC, Orlando and includes Study Areas (SAs) 12, 13, and 14. The location of NTC Area C in the Orlando area is shown in Figure 1-1. The site vicinity of Area C and the location of OU 4 within Area C are depicted in Figure 1-2.

This OU 4 FS Addendum presents new information to augment the previous FS Report for OU 4 (HLA, 2001b). Specifically, this FS Addendum presents new remedial alternatives and provides the alternative analysis for the new alternatives. The Navy has taken this action as a result of the following sequence of events:

- The Proposed Plan for OU 4 selected FS Alternative V-3 to address chlorinated volatile organic compounds (CVOC) contamination in the surficial aquifer zone (NAVFAC, 2001). This alternative included chemical oxidation for plume source areas and enhanced biodegradation for dissolved plume areas.

- Alternative V-3 was implemented in 2003. The in situ chemical oxidation (ISCO) component of Alternative V-3 consisted of a groundwater injection/extraction and recirculation system to apply potassium permanganate to the surficial aquifer to achieve destruction of CVOC contaminants. After approximately eight months of system operation, including modifications to the system components and operating procedures, it was determined that injection/recirculation of a chemical oxidant could not be effectively conducted in the surficial aquifer materials.

- Additional site investigation phases conducted between 2004 and 2006 determined that a deeper zone of groundwater lying within the upper Hawthorn Group of sediments, directly beneath the surficial aquifer, had been impacted by CVOCs (CCI, 2005a; Tetra Tech, 2009). This zone of groundwater contamination had not been identified in the previous Remedial Investigation (RI) or evaluated in the previous FS.

- In 2007, an interim remedial action (IRA) was conducted that consisted of injecting a biostimulant to enhance biodegradation (i.e., reductive dechlorination) of the CVOC plume in the surficial aquifer. Groundwater monitoring following the injection of emulsified oil substrate (EOS®) demonstrated that this technology was successful in reducing the concentrations of CVOCs in the source areas of the site (CCI, 2009a).

Based on the above sequence of events, it was recognized that new remedial alternatives were required to guide the selection of effective and comprehensive remedial actions for OU 4. The previous FS (HLA, 2001b) presented two sets of alternatives based on two types of groundwater contamination that were identified in the surficial aquifer at OU 4. Alternatives V-1 through V-7 addressed the CVOCs plume in the surficial aquifer; alternatives A-1 through A-4 addressed a separate plume area containing antimony in groundwater. This FS Addendum addresses only new alternatives for CVOC contamination in the surficial aquifer and in the Hawthorn water bearing zone (WBZ) groundwater that underlies the surficial aquifer at OU 4. An important component of this addendum to the FS is that the new alternatives build upon the on-going EOS® IRA biostimulation activities that have been proven successful at OU 4. Thus, the new alternatives presented in this FS Addendum are consistent with the current IRA efforts at OU 4. The alternatives considered for antimony do not require any modifications and are unchanged, and will not be further addressed in this addendum.

The new alternatives presented herein have been subjected to detailed analysis against the nine standard criteria defined by the United States Environmental Protection Agency (USEPA) in Guidance for Conducting Remedial Investigations and Feasibility Studies under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (USEPA, 1988). A comparative analysis has been performed for the new alternatives according to the CERCLA requirements. Because this document is an addendum to the previous FS Report (HLA, 2001b), several components included in the original FS are not repeated in this document. Furthermore, all technology components of the new alternatives presented in this addendum were identified in the previous FS. Identification and screening of remedial technologies, CERCLA requirements for detailed evaluation of remedial alternatives, and the analysis of applicable or relevant and appropriate requirements (ARARs) were previously presented in the FS (HLA, 2001b) and are not repeated. However, for completeness and to ensure compliance with any new regulations or standards introduced since preparation of the original FS, ARARs for the new alternatives are identified in this addendum.

This addendum also includes a brief summary of the past events that occurred during the remedial investigation, a review and summary of IRAs, pertinent information from more recent site investigations, and presentation of the current conceptual site model (CSM).

1.1 SITE DESCRIPTION

OU 4 consists of a composite of SA 12 [Defense Reutilization and Marketing Office (DRMO) Warehouses and Salvage Yard], SA 13 (former base laundry and dry cleaning facility), and SA 14 (DRMO Storage Area). The eastern and southern portions of the site have been developed, include existing or legacy facilities formerly operated by the Navy, and are relatively flat, with ground elevations ranging from 113 to 110 feet above mean sea level (amsl). Immediately west of former Building 1100, the site is mostly vegetated as the ground slopes gently downward to the shoreline of Lake Druid at an elevation of approximately 100 feet amsl (see Figure 1-2). Lake Druid consists of a roughly circular body of water approximately 16.5 acres in size with a maximum depth of approximately 14 feet near its center.

Former Building 1100 included the laundry and dry-cleaning facility and the building site is the primary focus for OU 4 and this FS Addendum (see Figure 1-2). Building 1100 was constructed in 1943 and dry-cleaning operations began in 1958, or possibly earlier. Wastewater from the laundry machines was discharged to the sanitary sewer through "badly deteriorated drainage trenches" in the floor (ABB-ES, 1996). The floor trenches discharged to a single pipe connected to a settling and surge tank. Due to the large volume of water generated from the laundry process, a 30,000-gallon surge tank was installed on the west side of the building in the mid-1960s. Waste filters from the dry-cleaning machines were also generated at the facility. Dry cleaning chemical tetrachloroethene (PCE) was separated from the water and filters by heating the assemblies in a pressure cooker known as the "Filter Cooker" located in the northern portion of the building. Operations ceased in the fall of 1994 and all laundry equipment (both conventional water-based and dry cleaning) was subsequently removed from the building. The building was demolished in 2004.

A series of environmental investigations conducted at OU 4 identified the presence of CVOC contamination in soil and groundwater originating from the laundry. The primary groundwater contaminants at OU 4 are PCE, trichloroethylene (TCE), cis-1,2-dichloroethene (DCE), and vinyl chloride (VC). The types of chemicals present and the location of highest levels of contamination indicate that the former dry cleaning operations, specifically floor drains in the building, were the primary source of the contamination release. Figure 1-3 shows the OU 4 site features and identifies the locations of wells installed at various depths in the surficial aquifer and the underlying Hawthorn WBZ.

1.2 ENVIRONMENTAL SETTING

The aquifer system underlying the Orlando area consists of, in order of increasing depth, the surficial aquifer, the intermediate aquifer, and the Floridan aquifer. The surficial aquifer system is an unconfined sand aquifer that extends from the water table to the top of the Hawthorn Group, and may be locally divided by discontinuous beds or lenses of silty clay. The intermediate aquifer (Hawthorn Group) underlies the surficial aquifer and consists of small lenses of permeable material, such as limestone, shell, or sand, within the clayey sediments of the Hawthorn Group. The more permeable lenses are usually discontinuous in both vertical and horizontal extent and typically do not have sufficient yields to justify their use as a potable groundwater source. The Floridan aquifer which underlies the Hawthorn Group is the principal artesian aquifer in Orange County. It includes all or parts of the Avon Park and

Lake City Limestones, the Ocala Group limestones, and the typical basal limestone of the Hawthorn Group. The general groundwater flow direction in the Floridan aquifer is to the east (USGS, 2004).

The surficial aquifer at OU 4 extends from ground surface to approximately 70 feet below ground surface (bgs) and is primarily composed of unconsolidated, poorly sorted, medium dense to dense fine-grained quartz sand with varying amounts of silt and clay. The surficial aquifer is an unconfined aquifer and is locally recharged by rainfall. The water table ranges in depth from 2 to 12 feet bgs.

Contained within the surficial aquifer at OU 4 is a cemented layer located approximately 15 to 20 feet bgs with a varying thickness that averages about 5 feet. Though acting as an aquitard, this hard layer does not act as a hydraulic or chemical barrier. Groundwater flow in the surficial aquifer is predominantly horizontal and flows westerly toward Lake Druid. There is, however, a downward component of flow due to a site-wide downward hydraulic gradient across the surficial aquifer. Therefore, the entire thickness of the surficial aquifer (from the water table to the top of the Hawthorn Group) is susceptible to the potential transport of contaminants. For identifying contamination within the aquifer, the surficial aquifer was divided into three depth zones during the investigation; shallow zone (0 to 20 feet bgs), intermediate zone (20 feet to 40 feet bgs) and deep zone (approximately 40 feet to the top of Hawthorn Group at approximately 70 feet bgs). The base of the surficial aquifer is defined by the upper clay of the underlying Hawthorn Group that occurs at approximately 70 feet bgs at the site.

The upper portion of the Hawthorn Group (which is part of the intermediate aquifer) includes upper and lower clay layers separated by a water-bearing zone (referred to as Hawthorn WBZ) that was included in the investigations conducted at OU 4. The Upper Hawthorn Clay (UHC) ranges from 70 feet to 90 feet bgs, the Lower Hawthorn Clay (LHC) ranges from 120 feet to 150 feet bgs, and the WBZ is comprised of approximately 40 feet of phosphatic, coarse-grained sands and clay-rich carbonate shell beds that lies between the two clay layers. This unit is considered a semi-confined aquifer system, which implies some hydraulic connection with the overlying surficial aquifer. The Ocala Group limestones, which underlie the Hawthorn Group and define the upper extent of the Floridan aquifer, are expected to occur at depths of 200 to 210 feet bgs at OU 4. The groundwater flow direction at OU 4 within the central portion of the Hawthorn WBZ is toward the north-northwest. Based on a United States Geological Survey (USGS) report for Orange County (USGS, 2004), the prevailing groundwater flow direction for the underlying Floridan aquifer is eastward in the Orlando area.

A graphical depiction of the CSM is presented in Figure 1-4. As depicted in the model, dry cleaning chemicals and fluids leaked or spilled to the ground at the former dry cleaning building have migrated vertically through the vadose soil to the shallow water table. At various locations, the contaminants have moved through the soil as a separate phase liquid, dissolved in water, or as a soil vapor phase (soil gas).

Fluids with densities greater than water, for example liquid PCE, have moved downward through the surficial aquifer under the influence of gravity. Site data demonstrate that a sufficient quantity of PCE was released such that the chemical penetrated both the shallow and intermediate zones in the surficial aquifer with some residual or pool accumulation along less permeable layers in the shallow and deep aquifer zones (i.e., the cemented, silty layer at approximately 5 to 15 feet bgs and the UHC and silty clay layer at approximately 65 feet bgs). Dissolved contamination in the surficial aquifer has migrated westward with groundwater flow toward Lake Druid and is present at the shoreline where groundwater seepage occurs. Two groundwater extraction wells located to the west of the former dry cleaner building have been operating to create a plume capture zone to mitigate contaminant migration to the lake. Deep groundwater in the Hawthorn WBZ moves northward through the phosphatic sands (i.e., flow is into the page on Figure 1-4) in response to the direction of the groundwater hydraulic gradient in that zone. The vertical extent of groundwater contamination has been limited by the LHC zone that is shown at the bottom of the CSM.

1.3 PREVIOUS INVESTIGATIONS AND INTERIM REMEDIAL ACTIONS

Investigation of OU 4 began with a screening assessment that was performed at SA 13 in 1995 (ABB-ES, 1996). Soil samples showed high level of CVOCs. Groundwater samples detected CVOCs such as PCE and TCE in the surficial aquifer at concentrations greater than State of Florida Primary Drinking Water Standards. In the spring of 1995, surface water and sediment samples were collected along the shore line of Lake Druid. CVOCs detected in surface water and sediment samples included PCE, TCE, cis-1,2-DCE, 1,1-DCE, and VC. Additional surface water and sediment samples were collected in December 1997.

Based on the site screening data, a Focused Field Investigation (FFI) for an IRA was initiated. The focus of the IRA was twofold: determine the source of surface water contamination and evaluate ways to mitigate CVOC contamination in the lake. The FFI analytical data showed the following conditions at the site:

- Surface water: Contamination was primarily concentrated around the mouth of a small drainage feature where it discharges to the lake. The drainage is a topographic feature located west of the former Building 1100 and near the northern property line that receives surface runoff from a portion the site. CVOCs detected included PCE, TCE, 1,1-DCE, trans- and cis-1,2-DCE, VC, benzene, toluene, ethylbenzene, and xylenes.

- Sediment: Contamination concentration was high around the mouth of the small drainage where it discharges to the lake. CVOCs detected included PCE, TCE, 1,1-DCE, trans- and cis-1,2-DCE, VC, benzene, toluene, ethylbenzene, and xylenes.

- Groundwater: The groundwater plume was observed to begin beneath Building 1100 and end at the lake to the west. Groundwater samples showed a total CVOC concentration range of non-detect (ND) to 1,605 micrograms per liter (µg/L). VC was not detected in samples from near the shoreline.

A hydrogeologic survey was also conducted to develop a potentiometric surface contour of the surficial aquifer, determine hydraulic conductivity (by performing slug tests), and measure groundwater velocity (using a seepage meter). The FFI concluded that the CVOC plume in the surficial aquifer was contributing to surface water contamination of Lake Druid, and the extent of the CVOC plume in the surficial aquifer reached all the way to the lake.

In 1996 a Focused Feasibility Study (FFS) was prepared and included the results of a pump test conducted using a recovery well (RW) and several observation wells at SA 13 and the results of a Treatability Study. The purpose of the pump test was to identify aquifer properties and suitability of pump and treat as a remedial alternative to prevent plume migration towards Lake Druid. The RW was located down gradient from Building 1100. The results of the pump test showed the aquifer was suitable for hydraulic plume containment through pumping. The remedial alternative selected in the FFS consisted of in situ treatment using in-well air stripping and recirculation wells to capture and treat contaminated groundwater, stop migration of the plume toward the lake, and reduce CVOC concentrations in the down-gradient plume. The two recirculation wells were installed in December 1997 and began operation in January 1998 as part of the groundwater in situ treatment IRA.

A focused source confirmation investigation was conducted in 1997. Soil and groundwater samples were collected around Building 1100 and the wastewater surge tank during March and April 1997. The presence of dense non-aqueous phase liquid (DNAPL) in soil was suspected but not proven. In general, soil CVOC concentrations decreased with depth. CVOC concentrations in groundwater were very high under the building and in the northeast portion of the building (at an upgradient location). DNAPL presence in the groundwater was suspected in the northwestern corner of Building 1100 (based on a PCE concentration of 28,000 µg/L that was greater than 1 percent of PCE solubility in water).

A comprehensive RI was performed at OU 4 from January 1997 through March 1998. The RI identified antimony in groundwater in addition to the CVOCs. The presence of polynuclear aromatic hydrocarbons (PAHs) and arsenic at levels exceeding the soil screening levels was also identified by the RI. In May 1999, approximately 32 tons of surface soil contaminated with PAHs and arsenic were removed from OU 4 and replaced with clean fill. A natural attenuation evaluation was performed at OU 4 in December 1997 and an air sparging pilot study was performed in May 1998.

In the spring of 2000, operation of the two in situ treatment IRA recirculation wells was found to be ineffective. A new IRA methodology that used the existing recirculation wells for groundwater extraction and an above ground treatment system for CVOCs (i.e., air stripping) was proposed. The new groundwater extraction IRA treatment system, which included treated water discharge to a nearby sanitary sewer, became operational in January 2001. This system is currently in operation to intercept the CVOCs plume that migrates toward Lake Druid in response to the ambient water table gradient.

An FS was finalized in February 2001 (HLA, 2001b). The FS provided seven alternatives for the CVOC plume and four alternatives for the antimony plume at OU 4. All alternatives described in the FS for the CVOC plume included continued operation of the Groundwater Extraction IRA to provide continued protection for Lake Druid as a component of the remedy.

In March 2003, an ISCO IRA was implemented to treat the source area consistent with Alternative V-3 in the FS. The system was constructed and housed in the former laundry building. Injection operations and oxidant distribution were found to be significantly hindered by injection well fouling and the accumulation of oxidation product solids. Changes and adjustments to the system were not effective and the ISCO IRA was shut down and dismantled in December 2003 to allow the demolition of former laundry facilities (January through March 2004).

Following removal of the laundry building, vadose soil sampling under the footprint of former facility was conducted in July 2006. Additional vadose zone locations were sampled in October 2006 to delineate the lateral and vertical extent of vadose soil contamination that exceeded the State of Florida soil cleanup target levels (SCTLs). Also, a program of deep borings and groundwater profile sampling was implemented to examine the lithology of the Hawthorn Group sediments beneath the surficial aquifer and to locate wells to complete the delineation of CVOC impacts in deep groundwater below the surficial aquifer. One soil boring was installed to a depth of 275 feet bgs to log the lithology of the Hawthorn Group and evaluate potential groundwater contamination pathways based on geology and the physical /hydraulic properties of the deeper materials. Another six soil borings were installed to depths of 134 to 144 feet bgs to focus on the potential contamination in permeable sediments that lie between the Upper and LHC layers; this zone was identified as the Hawthorn WBZ. Continuous multi-channel tubing (CMT) wells were installed in the borings, primarily screened in the Hawthorn WBZ, to define the lateral and vertical extent of the CVOC plume.

In early 2007, preparations were conducted to implement enhanced bioremediation of the CVOCs source areas that was recommended in an optimization study (CCI, 2007). The goal of this action was to biostimulate the surficial aquifer to promote enhanced reductive dechlorination (ERD) of the chlorinated CVOCs in groundwater. Between July and September 2007, injection of EOS® and recirculation of groundwater were conducted at source areas located at several depths in the surficial aquifer as part of the EOS® IRA. It was found that groundwater recirculation was unsuccessful in distributing the EOS® in one of the targeted source areas because of the low permeability soils encountered. Therefore, recirculation of groundwater was discontinued and only direct injection of EOS® was conducted to effect biostimulation of the aquifer.

Groundwater monitoring results subsequent to the EOS® IRA indicated a substantial decrease in contaminant concentrations in wells located in or down gradient of source area injection locations (CCI, 2009a). Also, downward trends, or depressed CVOC concentration levels, have been observed through the April 2011 sampling event at some locations. In addition, geochemical indicator parameter results for groundwater in the surficial aquifer have shown favorable conditions for increased biostimulation activity (e.g., increase in carbon, increases in hydrogen and methane) where the injections occurred. Lower concentrations of the more highly oxidized CVOCs (e.g., PCE, TCE) were also observed in groundwater extracted down gradient at wells UVB-1 and UVB-2 (i.e., based on analysis of influent to the air stripper).

1.4 NATURE AND EXTENT OF CONTAMINATION

Groundwater monitoring is currently being performed semiannually to monitor the concentration trend of chemicals of concern (COCs) following the EOS® IRA treatments, to monitor the longevity of the biostimulant (carbon source in the aquifer), and to assess progress of enhanced and natural attenuation processes. Monitoring conducted following the EOS® IRA (CCI, 2009a) and the most recent available sampling results for April 2011 have shown favorable trends for some wells within the treatment zones (Solutions-IES, 2011). However, PCE, TCE, cis-1,2-DCE, and VC still remain at concentrations greater than the State of Florida Groundwater Cleanup Target Levels (GCTLs). Select monitoring wells were also sampled for antimony consistent with the historical location of this plume. The data showed concentrations consistent with historical results, indicating a generally stable trend for the antimony plume area. Figures showing the most recent monitoring results for the various surficial aquifer zones (shallow, intermediate, and deep) and the Hawthorn WBZ, for both CVOCs and antimony, are provided in Appendix A (Solutions, 2011).

1.4.1 Surficial Aquifer

A membrane interface probe (MIP) investigation and confirmatory soil and groundwater sampling data were used to further define the extent of the PCE source area contamination in the shallow and deep zones of the surficial aquifer, especially in the vicinity of the former Building 1100 (CCI, 2005a). The cemented silt/sand layer at 20 feet bgs and the clay/shell layer at approximately 65 feet bgs both appear to have an impact on the PCE distribution because of their low permeabilities. The highest PCE concentrations have typically been observed in soil and groundwater samples obtained from depth intervals consistent with these layers. PCE concentrations from beneath the former building footprint are significantly higher than those in down-gradient sampling locations. DNAPL was not encountered in the surficial aquifer during the numerous investigations to evaluate the nature and extent of contamination. However, PCE was detected in groundwater samples at concentrations greater than 1 percent of the maximum solubility. Concentrations at this level suggest the presence of DNAPL, most likely as ganglia representing small volumes of non-aqueous phase liquid in pore space. The location of CVOC concentrations greater than the GCTLs in the shallow, intermediate, and deep zones of the surficial aquifer, respectively, from the most recent surficial aquifer sampling event (Solutions-IES, 2011) are depicted on Figures 7, 8, and 9, respectively, provided in Appendix A.

1.4.2 Hawthorn WBZ

Investigation of the Hawthorn Group beneath OU 4 was conducted in 2004 using sonic drilling techniques with continuous lithologic core recovery, and with consideration of additional information obtained from USGS Water Resources Investigation Report 03-4257 (USGS, 2004). Sampling of soil and groundwater during installation of the deep wells indicated that significant PCE source material is located beneath the footprint of former Building 1100 at depths of 83 to 115 feet bgs in the Hawthorn sediments [e.g., 303,000 micrograms per kilogram (µg/kg) at 115 feet bgs]. During sampling, screening was conducted to evaluate the presence of DNAPL at depth, but none was confirmed. However, based on concentrations of PCE in soil and groundwater samples, a potential for residual DNAPL to be present was recognized. CVOCs were not detected in the five soil samples collected below 120 feet bgs during the well drilling activities, which suggests that the LHC layer encountered at this depth interval limits the vertical migration of PCE contamination.

The vertical and horizontal extents of CVOC contamination in the Hawthorn Group were confirmed by a subsequent field investigation (Tetra Tech, 2009). The results of soil samples from the UHC layer demonstrate that this predominantly clay unit lying at the base of the surficial aquifer contains relatively high concentrations of CVOCs in the form of sorbed contamination and possibly residual DNAPL. The area of impacted soil in the UHC with PCE concentrations greater than 4,500 µg/kg (4,800 to 490,000 µg/kg), considered “source material” that would result in leaching to groundwater at a concentration greater than 1,000 μg/L, was estimated to be approximately 5,700 square feet, or 0.13 acre (CCI, 2005a). The thickness of the impacted, clay-rich soil ranged from 2 feet to 16 feet at a depth of about 65 to 70 feet bgs.

Groundwater from the Hawthorn WBZ contains concentrations of CVOCs, specifically PCE, TCE, cis-1,2-DCE, 1,1-DCE, and VC, that exceed the State of Florida GCTLs. The lateral and vertical extent of contamination was delineated using single screen and multi-chamber wells. High CVOC concentrations were detected in the WBZ beneath the northern portion of the former laundry facility (former Building 1100) and DNAPL consisting of approximately 81 percent PCE was recovered from well 62D located in the suspected release site of the former laundry building. The potentiometric surface for the Hawthorn WBZ shows a northward flow direction (approximately 90 degrees flow direction change compared to the westward flow direction in the overlying surficial aquifer). The vertical extent of contamination was defined by the multi-chambered wells that showed the zone of groundwater contamination is present to a depth of approximately 120 feet bgs with deeper chambers (>125 feet bgs) showing an absence of CVOCs. Wells installed along the northern property line of OU 4 indicated that the CVOC plume was present at the property line. A pair of off-site wells was installed directly north of the projected plume flow path to determine the extent of off-site plume migration. Sampling to date has not shown the presence of CVOCs in the off-site wells and has confirmed that the down-gradient extent of the CVOC plume in the Hawthorn WBZ is limited to the area along the NTC property at this time. CVOC concentrations greater than the GCTLs from the most recent site sampling events (Solutions-IES, 2011) are depicted for the Hawthorn WBZ on Figure 10 provided in Appendix A.

1.5 CONTAMINANT DISTRIBUTION, FATE, AND TRANSPORT

The residual PCE associated with lower permeability layers in the subsurface acts as a source for the dissolved plumes. Dissolution and back-diffusion of the PCE from these low permeability source materials combined with advection and dispersion results in contamination that is carried both hydraulically down gradient and vertically through the surficial aquifer away from the source areas. As PCE moves in the plume it establishes equilibrium with the aquifer media and with the ambient microbial population. The chemical and biotic equilibrium is dynamic and controls the amount of PCE sorbed versus PCE in the dissolved phase and the amount of daughter products produced (e.g., cis,1,2-DCE). These processes retard the migration of CVOCs, which results in the CVOCs generally moving slower than groundwater. Groundwater CVOCs were identified as risk drivers in the human health risk assessment and pose unacceptable exposure risks for on-site future use of groundwater and on-site surface water use if the groundwater plume is not controlled or mitigated.

There is evidence that natural attenuation is occurring at OU 4, but the data suggest it is limited. The areas with the most positive indications for reductive dechlorination occur immediately down gradient of the source areas in the shallow and deep groundwater surficial aquifer zones and in the Hawthorn WBZ, in which oxidation-reduction potential (ORP) levels were less than 50 microvolts, and where cis-1,2-DCE, VC and sulfide, products of reductive dechlorination and sulfate reduction, respectively, have been observed. Additionally, elevated methane concentrations, with respect to background, have been observed in down-gradient, shallow groundwater wells and in the Hawthorn WBZ, and ferrous iron, the by-product of iron reduction, has been observed in deep down-gradient surficial aquifer and Hawthorn wells. However, the absence of an adequate carbon source for the reductive dechlorination process is surmised to be the controlling factor for the rate and sustainability of natural attenuation at the site.

As contaminants migrate toward Lake Druid in the surficial aquifer, reduction of the suspected source material, PCE, to its anaerobic biodegradation daughter products becomes more apparent. The presence of cis-1,2-DCE, and to a lesser extent TCE and VC, in down-gradient groundwater indicates that reductive dechlorination is occurring between the source areas and the Lake Druid shoreline. The high ratio of daughter products to parent compound (i.e., PCE) indicates a high degree of biotransformation is occurring.

1.6 HUMAN HEALTH RISK ASSESSMENT

A baseline human health risk assessment was completed during the RI for all media using the applicable criteria and site data available at that time (HLA, 2001a). Potential future use of groundwater was identified as the primary pathway for unacceptable human health risk; a relatively lower risk was calculated for current and future exposure to surface water along the shoreline of OU 4 with Lake Druid. Risks due to soils contamination identified in the RI were mitigated by a soil removal IRA conducted in 1999.

Because risk via surface water had been identified in the baseline risk assessment and because the groundwater plume was known to impact Lake Druid, a re-evaluation of risk via the surface water route of exposure was conducted in 2006 based on an extensive study of sediment and surface water. The risk re-evaluation was deemed necessary in order to account for changes at the site resulting from IRA remedial activities, changes in the site conditions, and additional data collection (Tetra Tech, 2006). Risk re-evaluation was performed to estimate the risks associated with exposure of a resident/trespasser/recreational user to surface water along the shoreline of OU 4 and local resident exposure to Lake Druid away from OU 4. In order to determine the need for remediation, both a reasonable maximum exposure (RME) and a central tendency estimate (CTE) of risk were calculated following USEPA guidelines (USEPA, 1992). For the OU 4 risk re-evaluation, the surface water ingestion intakes for each receptor were calculated using methods presented in Risk Assessment Guidance for Superfund (RAGS) Part A (USEPA, 1989) and other standard guidance documents. The absorbed doses estimated for dermal contact were estimated primarily using methods from RAGS Part E, Supplemental Guidance for Dermal Risk Assessment (USEPA, 2004).

Non-cancer and cancer risk for residents wading in Lake Druid away from the shoreline area of OU 4 were all below the USEPA risk range and Florida Department of Environmental Protection (FDEP) target risk (using both RME and CTE factors). Risk to a potential future surface water user along the shoreline of OU 4 is presented below.

RME non-cancer risk estimates based on the Hazard Index (HI) for all chemicals of potential concern (COPCs) did not exceed 1 for either the resident/trespasser/recreational user (adult and child) exposed to near-shore surface water at OU 4. The risk re-evaluation concluded that no adverse health effects are expected from exposure to any non-carcinogenic COPCs along the shoreline of OU 4.

The RME cancer risk for the resident/trespasser/recreational user (combined adult and child) assumed to wade in near-shore surface water at OU 4 was estimated as 1.2×10^{-5}, greater than the State of Florida cancer risk benchmark of 1×10^{-6} but within the USPEA target cancer risk range of 1×10^{-4} to 1×10^{-6}.

CTE risk estimates were also developed for the recreational user (adult and child) assumed to wade in near-shore surface water at OU 4. HIs estimated for all receptors for the CTE scenario were less than 1, indicating that adverse non-carcinogenic health effects were not anticipated under the conditions established in the CTE exposure assessment. Cancer risk estimates for the CTE scenario developed for all receptors did not exceed the FDEP benchmark of 1.0×10^{-6} indicating no unacceptable risk associated with the CTE exposure to surface water for the receptors.

The baseline risk assessment (HLA, 2001b) did not assess potential risk associated with contaminated groundwater in the Hawthorn WBZ because the impacts were not known at that time. The following presents a qualitative assessment of potential risk due to the presence of volatile organic compounds (VOCs) in the groundwater:

- Groundwater contains concentrations of VOCs that exceed the FDEP GCTLs and represents health risks due to ingestion, dermal contact, and other domestic use of the groundwater. However, use of groundwater from the OU 4 site is prohibited by a land use control (LUC) that was stipulated in the property transfer document [i.e., the Finding of Suitability for Early Transfer (FOSET)] that cannot be removed without FDEP concurrence. For off-site groundwater, contamination has not been detected in the down-gradient, off-site wells to date. Also, there is no current use of groundwater and local municipal water is supplied and use is required by a City of Orlando statute. The contaminated groundwater lies between 100 to 120 feet bgs and is not accessible without the installation of a well which requires a permit from the city. Furthermore, the WBZ is thin and of low yield which is unlikely to support domestic use. There is no current receptor for the groundwater and future use of off-site groundwater is unlikely to occur.

- The groundwater contains COVCs which are volatile and could represent a potential vapor intrusion risk for overlying buildings in some settings. However, at OU 4, the contaminated Hawthorn WBZ lies at a depth of 100 to 120 feet and is semi-confined by the UHC (a low permeability unit) and up to 70 feet of the overlying surficial aquifer. There is little risk that vapors originating in the Hawthorn WBZ could migrate to the surface,

- The groundwater and contaminant velocity in the Hawthorn WBZ is low, less than 10 feet per year. This is confirmed by the limited down-gradient plume extent associated with the release that may have occurred up to 50 years ago. There is no known potential for groundwater discharge to surface water within several hundred feet down gradient of the site and thus no receptor for the groundwater via the surface water pathway.

- The vertical extent of the contamination in groundwater was defined and is currently monitored using multi-chambered wells. Well chambers screened at the bottom of the Hawthorn WBZ and soil samples from the LHC have shown an absence of CVOCs. A deep soil boring installed during the 2006 investigation (Tetra Tech, 2009) also showed that a thick sequence of low permeability sedimentary units (e.g., high clay content) lies between the Hawthorn WBZ and the underlying Floridan aquifer, Thus, the contaminated groundwater is unlikely to migrate vertically downward to the Floridan aquifer.

In summary, a qualitative assessment of risk from contaminated groundwater in the Hawthorn WBZ indicates there is no current unacceptable risk and a low potential for future or off-site risk.

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2.0 REMEDIAL ACTION OBJECTIVES

The goals and objectives for remedial action at OU 4 that provide the basis for selecting remedial action objectives (RAOs) and lead to identifying remedial technologies and developing alternatives to address site contamination were presented in the original FS (HLA, 2001b). A discussion of the pertinent regulatory requirements, including the applicability of CERCLA to OU 4, ARARs, RAOs, and the action and treatment levels for OU 4 were presented in that document and are summarized below as they pertain to the new alternatives presented in this FS Addendum.

2.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

An analysis of ARARs and To Be Considered (TBC) criteria for OU 4 was provided in the FS Report (HLA, 2001b). New alternatives presented in this FS Addendum for groundwater in the surficial aquifer and for the Hawthorn WBZ involve the same remedial technologies as those proposed in the FS Report and address the same contaminants in the same environmental media. Thus, the ARAR analysis provided in the FS Report is applicable to the FS Addendum and is not repeated. For reference, tables identifying applicable ARARs for the new alternatives only are provided in Section 4.0.

2.2 IDENTIFICATION OF RAOs

The RAOs that protect human health and the environment from current and future risks resulting from exposure to contaminants present in soil, groundwater, sediment, and surface water at OU 4 were presented in the original FS (HLA, 2001b). The new alternatives presented in this FS Addendum address only groundwater. Although there is no current use of groundwater at OU 4, the groundwater is classified as G-II by the State of Florida indicating a potential for future use. The following summarizes the RAOs for groundwater at the site:

- **RAO 1:** Reduce the potential for human ingestion of groundwater containing concentrations of COCs that exceed drinking water-based regulatory requirements or risk-based acceptable exposure levels.

- **RAO 2:** Gain control over groundwater migration of CVOC concentrations that could contribute to exceedances of FDEP surface water standards in Lake Druid.

2.3 ACTION AND TREATMENT LEVELS

Action levels represent the concentrations of chemicals in environmental media above which remedial action is necessary. Treatment levels are the concentrations of chemicals that a treatment technology would be required to achieve if implemented. Action levels for groundwater are based on the FDEP GCTLs. Action levels also represent the treatment levels for all in situ groundwater treatment technologies (such as bioremediation) because groundwater is not extracted from the aquifer. The only ex situ treatment technology included in the new alternatives is continuation of the existing groundwater extraction with treatment and discharge to the City of Orlando sewer or to the shallow subsurface (e.g., infiltration gallery); therefore, treatment levels are based on the current city discharge permit requirements or GCTLs, respectively. A summary of the action and treatment levels for the new alternatives for the current COCs at OU 4 is presented in Table 2-1.

TABLE 2-1
SUMMARY OF ACTION AND TREATMENT LEVELS

COC	Action Level (µg/L)	Treatment Level for Sewer Discharge (µg/L)	Treatment Level for Subsurface Discharge (µg/L)
PCE	3	**	3
TCE	3	**	3
cis-1,2-DCE	70	**	70
VC	1	**	1
Antimony	6	**	6
Manganese	50	2.50	50
pH	*	5.5 – 10.5	*

* Manganese and pH are not groundwater COCs.

** Not required by city discharge permit.

It is noted that all action levels based on GCTLs for the COCs are lower than the FDEP fresh surface water cleanup target levels (CTLs); thus meeting the GCTLs is protective of surface water in Lake Druid.

3.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

Remedial technologies that were identified in the FS Report for OU 4 (HLA, 2001b) included the in situ treatment options of chemical oxidation and enhanced bioremediation (e.g., Alternative V-3). ISCO was tried but could not be effectively implemented during the ISCO IRA for CVOC source areas in the surficial aquifer. The process option considered for enhanced bioremediation in the previous FS specified the use of an injected amendment to stimulate anaerobic biological activity [i.e., lactic acid in the form of Hydrogen Release Compound (HRC™) to produce hydrogen in the aquifer] in the plume and the possible addition of amendments to stimulate aerobic aquifer conditions in the down-gradient areas of the CVOC plumes to complete degradation of daughter products (e.g., cis-1,2-DCE, VC). Since the original FS was completed, enhanced bioremediation using the anaerobic pathway has been proven effective for the highly contaminated source areas that were identified at OU 4. The EOS® IRA conducted between 2007 and 2008 and subsequent groundwater monitoring has shown that injecting a carbon source (e.g., emulsified oil substrate) into the aquifer to provide an electron donor can be an effective method of enhancing anaerobic bioremediation. Based on this experience, new alternatives that utilize enhanced in situ biodegradation (EISB) as the primary treatment technology for source materials and for dissolved plumes are detailed in this FS Addendum. Since the new alternatives invoke technologies that were retained in the FS (HLA, 2001b), a new technology screening is not included in this addendum.

In situ treatment involves the modification of the subsurface environment to treat the contaminants without removing them from the ground. Through enhancement or modification of the geochemical conditions, CVOCs can be biologically treated to levels that meet regulatory guidelines. In anaerobic-reducing environments, the main biodegradation mechanism for PCE is reductive dechlorination, which involves the sequential replacement of chlorine atoms on the alkene molecule by hydrogen atoms. The chlorinated ethenes serve as electron acceptors in these microbially-mediated degradation reactions and a sufficient supply of carbon is provided as the electron donor to produce hydrogen in the aquifer. The complete sequential dechlorination of PCE proceeds through TCE, cis-1,2-DCE, and VC to ethene.

As discussed above, one process option for EISB at OU 4 involves adding a soluble carbon substrate (such as EOS®) to the subsurface through permanent injection wells or drive points. By placing these injection points close to each other, a microbial treatment zone can be formed to treat contaminants in source areas before they migrate down gradient or a bio-barrier may be constructed to intercept the down gradient, dissolved plume as it migrates through the aquifer. An adequate supply of soluble organic carbon substrate is required to induce a reducing, anoxic environment in the aquifer and stimulate natural anaerobic microorganisms. When applied to sites with chlorinated organic compounds, this process is referred to as ERD.

The applicability of EISB at OU 4 has been demonstrated. EOS® was injected into several surficial aquifer source areas at OU 4 as an IRA during the period July 2007 through July 2008. Two shallow zone areas and two deep zones in the surficial aquifer were targeted. The optimum placement, depth, diameter, and screen intervals of injection were determined based on the site specific information including the depth to contamination, hydraulic conductivity, horizontal and vertical gradients, and seepage velocity. A recirculation process was initially used in one shallow zone area where groundwater was extracted from a central location of a treatment zone and EOS® was mixed with extracted water and then injected at the periphery of the treatment zone. The process was discontinued due to substantially lower extraction rates than anticipated, and this area was subsequently treated by directly injecting the EOS® using direct push technology (DPT) tools (CCI, 2009a).

4.0 ASSEMBLY AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section describes the new groundwater alternatives for the surficial aquifer and the Hawthorn WBZ. Alternatives for the surficial aquifer previously presented in the FS for OU 4 (HLA, 2001b) did not benefit from knowledge of interim actions that have more recently been implemented and shown to be successful; therefore a new alternative is analyzed in this addendum for the surficial aquifer that builds upon this information (see Section 1.3). Also, knowledge that the groundwater in the upper Hawthorn Group had been impacted by the release of CVOCs at OU 4 did not exist at the time the original FS was completed. Therefore, a set of new alternatives for the groundwater contamination in the Hawthorn WBZ is also presented.

The new alternatives for the surficial aquifer and Hawthorn WBZ are evaluated against the nine CERCLA criteria. The CERCLA criteria are described in the FS Report (HLA, 2001b). Detailed analysis of the original alternatives for the surficial aquifer can be found in the FS Report (HLA, 2001b) and are not repeated in this addendum. The regulatory and community acceptance criteria will be presented as part of the OU 4 Final Record of Decision (ROD) after receiving the comments from the public and regulators.

4.1 ALTERNATIVES FOR THE SURFICIAL AQUIFER

Alternatives presented in the original FS for the surficial aquifer at OU 4 (HLA, 2001b) included various combinations of the applicable technologies. A separate set of alternatives were selected to address the CVOC and antimony contaminated groundwater, respectively, in the surficial aquifer. The original FS alternatives for the CVOC plume in the surficial aquifer were as follows:

- Alternative V-1: No Action
- Alternative V-2: Limited Action
- Alternative V-3: In Situ Treatment by Chemical Oxidation and Enhanced Biodegradation
- Alternative V-4: In Situ Treatment by Air Sparging and Enhanced Biodegradation
- Alternative V-5: Recirculation Wells/Enhanced Biodegradation
- Alternative V-6: Ex Situ Treatment by Air Stripping
- Alternative V-7: Ex Situ Treatment by UV/oxidation

The No Action alternative referenced above (Alternative V-1) included continued operation of the Groundwater Extraction IRA to intercept the down-gradient CVOC plume to prevent continued plume migration toward Lake Druid. In order to represent an alternative that does not include any action, a new No Action alternative, V-1A, is presented in this FS Addendum.

Alternative V-3 referenced above included ISCO and enhanced bioremediation for different portions of the CVOC plume. ISCO was attempted for source areas at OU 4 and it was found that the technology could not be effectively or efficiently implemented in the surficial aquifer (CCI, 2005b). Since the FS was prepared, enhanced bioremediation (e.g., direct injection of a carbon source into the aquifer) has gained wide spread use for addressing both dissolved plumes and source areas for CVOCs and is well documented in current literature. As mentioned previously, injection of a carbon source in the OU 4 surficial aquifer was shown to be successful during the more recent EOS® IRA to address the CVOC source area contamination. Therefore, a new alternative, V-8, that combines enhanced bioremediation (i.e., injection of a carbon source) with other technologies that were also retained in the original FS is presented in this FS addendum. LUCs are included as a means to prevent exposure to contaminants during active remediation before contamination would be reduced to acceptable levels. In summary, the new groundwater alternatives for CVOC contamination in the surficial aquifer are:

- Alternative V-1A: No Action
- Alternative V-8: LUCs, enhanced bioremediation, groundwater extraction, monitoring, and natural attenuation

The original FS alternatives for the antimony plume in the surficial aquifer were as follows:

- Alternative A-1: No Action
- Alternative A-2: Limited Action
- Alternative A-3: Groundwater extraction with discharge to the Orlando Sewage Treatment Plant
- Alternative A-4: On-Site Ex Situ Treatment

Alternative A-2 involves zoning/groundwater-use restrictions to prevent exposure until the antimony concentrations are less than the GCTL and long-term monitoring of groundwater. Current and final remedial actions are adequately addressed by Alternative A-2 for antimony contamination, and no new alternatives for antimony are presented in this FS Addendum.

4.1.1 Alternative V-1A: No Action

The inclusion of a No Action scenario is typical in feasibility studies, and it is used as a baseline to compare all alternatives. The No Action alternative represents a response action wherein no remedial actions are implemented at the site. Furthermore, under the No Action alternative any existing ongoing IRA activities would be terminated and no additional activities would be conducted at the site to address contamination. For the No Action alternative, environmental risks would be the same as those identified in the baseline risk assessment.

This alternative does not address the groundwater contamination and is retained to provide a baseline for comparison to other alternatives. There would be no reduction in toxicity, mobility, or volume of the contaminants other than what would result from natural dispersion, dilution, and other natural attenuation factors. The existing interim groundwater pump and treat system at OU 4 would be removed from service under the No Action Alternative V-1A.

Reviews would be conducted at 5-year intervals to document the condition of the site.

4.1.1.1 Overall Protection of Human Health and the Environment

This alternative would not provide protection of human health and the environment. There could be unacceptable risks to human health from exposure to contaminated groundwater or surface water. Because no monitoring would be performed, potential migration of contaminants would not be detected. The No Action alternative would do nothing to address the source areas or prevent migration of contaminants to Lake Druid.

4.1.1.2 Compliance with ARARs

Alternative V-1A would not comply with ARARs or TBCs because no action would be taken to reduce contaminant concentrations and because the alternative continues to allow contaminated groundwater to reach Lake Druid. Chemical-specific ARARs may be eventually met by natural attenuation [estimated to be 50 years (see Section 4.1.2.2 below)], but there would be no monitoring to verify the changes. Compliance with ARARs or TBCs would be purely incidental. Action-specific ARARs or TBCs are not applicable.

4.1.1.3 Long-Term Effectiveness and Permanence

Alternative V-1A would have little long-term effectiveness and permanence because contaminated groundwater would remain on site and there would be no groundwater monitoring, so potential off-site migration of COCs would not be detected. Although COC concentrations might eventually decrease through natural attenuation, no monitoring would verify this.

4.1.1.4 Reduction of Mobility, Toxicity, or Volume through Treatment

Alternative V-1A would not reduce toxicity, mobility, or volume of groundwater COCs because no treatment would occur. Some reduction of the toxicity and volume of COCs might occur through natural dispersion, dilution, or other attenuation processes, but no monitoring would be performed to verify this.

4.1.1.5 Short-Term Effectiveness

Because no action would occur, implementation of Alternative V-1A would not have any short-term adverse impact from cleanup activities to the local community or the environment. Alternative V-1A might achieve the RAOs. Although the Action Levels might eventually be achieved through natural attenuation, this would not be verified through monitoring.

4.1.1.6 Implementability

Because no action would occur, Alternative V-1A would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable. Implementability of additional administrative measures is not applicable because no such measures would be taken.

4.1.1.7 Cost

Because no remedial action would occur and nothing would be implemented, there would be no costs associated with No Action Alternative V-1A.

4.1.2 Alternative V-8: Land Use Controls, Enhanced Bioremediation, Groundwater Extraction and Treatment, Monitoring, and Natural Attenuation

Alternative V-8 would consist of five major components: (1) LUCs, (2) enhanced bioremediation (3) groundwater extraction with ex situ treatment and discharge to the municipal sewer or shallow subsurface, (4) monitoring, and (5) natural attenuation.

Component 1: LUCs

LUCs are rules, directives, policies, and other measures (e.g., preventing the usage of groundwater and drilling new wells, posting signs to prevent access) adopted by the appropriate authorities in a manner consistent with applicable federal, state, and local laws. LUCs include any type of physical, legal, or administrative mechanism that restricts the use of, or limits access to, real property to prevent or reduce risks to human health and the environment. Physical methods include a variety of engineered remedies to contain or reduce contamination and/or physical barriers to limit access to property, such as fences or signs. The legal mechanisms are primarily imposed to ensure the continued effectiveness of land use restrictions imposed as part of a remedial decision. Legal mechanisms include restrictive covenants, negative easements, equitable servitudes, and deed notices. Administrative mechanisms include notices, adopted local land use plans and ordinances, construction permitting or other existing land use management systems that may be used to ensure compliance with use restriction.

LUCs that would be implemented at OU 4 would include deed restrictions that would maintain commercial and industrial uses and prevent residential uses. Groundwater use would also be prohibited and vapor intrusion prevention measures would be required for any new construction over contaminated soils and groundwater containing CVOCs. Such controls would be implemented to ensure that access to the site is restricted during remediation. The LUCs would serve to protect human health by preventing exposure to contamination.

<u>Component 2: Enhanced Bioremediation</u>

EISB would be conducted by direct injection of an amendment into the CVOC plume source areas and/or as future, localized bio-barriers to stimulate biological processes that contact, intercept, and degrade the contaminants moving with groundwater flow. The results of the EOS® IRA demonstrate that treatment injections providing a carbon source to the aquifer are having the intended effect of promoting the ERD process in the source areas. The longevity of the biostimulation appears to be related to providing an adequate and lasting carbon supply. CVOC concentrations at the injection areas and at down-gradient wells in the vicinity have decreased; however, concentrations greater than GCTLs in the source area and plume still persist. This component of the alternative includes recurring injections of amendments, as needed, in the source areas and/or at bio-barrier locations to remediate contaminant mass in source areas, to control the release of contaminants from the source area to the plume, and to mitigate plume migration (i.e., prevent contaminant discharge to Lake Druid).

The remedial design is based on targeting the PCE source areas that have been previously identified and possibly extending EISB to selected areas of the plume to affect plume cutoff. Figures showing the most recent well monitoring results for the shallow, intermediate, and deep zones of the surficial aquifer (Solutions, 2011) are included in Appendix A. Figures showing the CVOC plume in the shallow, intermediate, and deep surficial aquifer zones (CCI, 2009a) and showing the previously treated source areas in the surficial aquifer (CCI, 2009a) are included in Appendix B. Two target treatment zones, Shallow Zone A (SZA) and Shallow Zone B (SZB) were established during the interim action, as shown on Figure 4-1. Direct injections of 1 to 6 percent solution of EOS® using a DPT rig would be performed based on the results from previous interim actions. Bio-barriers for targeted areas of the plume would also be considered, in addition to, or in lieu of future source area treatments, to address VOC plumes. For estimating purposes, direct injection of EOS® into the SZA and SZB is assumed to be required, but at one-half the original dose. Based on this approach, 12 injection locations at 15-foot grid spacing to a depth of 20 feet bgs would be required at the SZA. The thickness of the treatment zone is assumed to be 12 feet. A total of 4,500 pounds of EOS® would be required at concentrations of 2 to 6 percent. Approximately 130 pounds of sodium bicarbonate would be required for pH control. Similarly, for the SZB, 5 injection locations at 10 foot grid spacing would be required, but it is assumed that the existing 20-foot injection wells would be used. The thickness of the treatment zone is assumed to be 10 feet. A total of 1,200 pounds of EOS® would be required at concentrations of 2 to 6 percent. Approximately 40 pounds of sodium bicarbonate would be required for pH control. Additional injections at these two treatment zones or installation of bio-barriers would be required based on the results of monitoring (CCI, 2009c). Figure 4-1 indicates the locations of the proposed source area treatment injection grids to support EISB treatments for Alternative V-8. Based on the decline in contaminant concentrations and sustainability of lower CVOC concentration trends following the EOS® IRA (CCI, 2009a), two additional injection events are assumed during the first 5 years of this alternative.

<u>Component 3: Groundwater Extraction and Ex Situ Treatment</u>

Continued extraction of groundwater using the existing recovery wells and treating extracted water with the existing air stripper for a nominal period of 5 years is included in this component to intercept plume migration toward Lake Druid. Treated water would be discharged to City of Orlando Treatment Plant using an existing permit; however, reinjection of the treated discharge to the surficial aquifer is an option that may prove more cost effective for future system operation. No modifications to the existing permit would be required. No off-gas treatment would be required. The groundwater extraction system would be in operation until it can be shown by site data that the portion of the plume captured by the groundwater extraction will meet the RAOs without extraction, unless an alternate technology is implemented to protect Lake Druid (see below). Figure 4-1 shows the location of the Groundwater Extraction IRA system that will continue to operate during Alternative V-8.

A bio-barrier, in lieu of, or in addition to, groundwater extraction, may be implemented to address contaminant migration into Lake Druid. In this option, a localized grid of injection points would be used to periodically inject amendments into the surficial aquifer at critical locations/depths to stimulate biological activity that would intercept and degrade the CVOC plume prior to groundwater discharge into the lake. The option may become more cost effective and sustainable than groundwater extraction and ex situ treatment in the future once EISB at the upgradient source areas has been shown to be effective at limiting the release of dissolved contaminants to the plume.

<u>Component 4: Monitoring</u>

Groundwater monitoring consists of periodic sampling and analysis of groundwater samples from existing monitoring wells. A specified set of monitoring wells positioned at multiple depths (A, B, and C aquifer zones) in the surficial aquifer would be sampled and analyzed for CVOCs and monitored natural attenuation (MNA) parameters. Semiannual monitoring would be conducted for the first five years, followed by annual events. Frequency of monitoring, number of wells, and list of analytes would be adjusted as conditions dictate. Evaluating analytical results over time would allow monitoring of plume movement, if any, and aid evaluation of progress of the EISB, groundwater extraction, and natural attenuation.

Component 5: Natural Attenuation

Natural attenuation would address the residual contamination utilizing natural dispersion, adsorption, dilution, volatilization, and/or biodegradation processes. The RI (HLA, 2001b) and recent findings (CCI, 2009b) concluded that natural biodegradation is occurring at OU 4. Natural attenuation would be the final step in the remediation of groundwater and would be applicable when concentrations of COCs in groundwater are at or below FDEP natural attenuation default criteria (Chapter 62-777, Table V), or when either a technical evaluation, scientific evaluation, or life-cycle cost analysis demonstrates the appropriateness of natural attenuation with monitoring for OU 4 groundwater.

A 5-year review would be performed to assess the site conditions and future monitoring requirements.

4.1.2.1 Overall Protection of Human Health and the Environment

EISB is a proven, effective in situ treatment technology, and the substrate injections (as observed following the EOS® IRA) are likely to have an effective life span of at least 2 years. EISB would destroy contaminant mass, reduce the contaminant source concentrations, and help reduce the contaminant plume. Groundwater extraction and/or EISB bio-barriers would prevent contaminant transport to Lake Druid. Treatment and extraction combined with LUCs, such as groundwater use restrictions, would eliminate pathways of exposure to contaminated groundwater. Monitoring would provide data to help evaluate the success of this alternative. Natural attenuation would address the residual contamination aiding the overall protection and would become the final treatment step once EISB and groundwater extraction are deemed unnecessary. This alternative would be protective of human health and the environment by treating the source areas, containing/treating the contaminated groundwater before it reaches the lake, and eliminating the groundwater plume on the site.

4.1.2.2 Compliance with ARARs

Alternative V-8 would meet the ARARs (see Tables 4-1 and 4-2). This alternative would control exposure to the impacted groundwater through enforcement of deed restrictions until chemical-specific and action-specific ARARs are met. Initially, continued operation of the groundwater extraction system would meet the chemical-specific ARARs and prevent CVOCs in groundwater released from the source areas from discharging into a surface water body; the system would be operated in a manner such that action-specific ARARs are also met. Ultimately, EISB will reduce concentrations in the source area, the plume will shrink, natural attenuation will provide the final reduction of COC concentrations to cleanup levels, and chemical-specific ARARs will be met.

Time of Remediation (TOR) modeling conducted in the Optimization Study Report (Appendix E, CCI, 2007) indicated that a maximum time of between 54 to 74 years from the contamination release would be required for the shallow and deep portions of the surficial aquifer to reach cleanup levels if no source area remediation is performed and natural attenuation is allowed to degrade the plume (i.e., Alternative V-1A). It is noted that the modeling report was qualified and stated that the model was unable to accommodate the complex site conditions. However, based on the potential age of the release (prior to facility closure in 1994 [17 years ago], as long ago as start of facility operations in 1943 [68 years ago]), the potential for residual DNAPL, and the current concentrations of PCE and daughter products observed in the plume that are several orders of magnitude greater than cleanup levels, the upper model time range for TOR (i.e., 54 to 74 years) is considered applicable to current conditions. The modeling also indicated, consistent with site historical results, that natural attenuation alone would not prevent contaminants from entering Lake Druid.

Based on the above information, and for the purposes of this FS Addendum, the no action alternative (V-1A) that relies solely on natural attenuation with no source removal is estimated to require 35 years from current time for completion for the purposes of this FS Addendum. However, mass reduction provided by EISB and containment provided by the groundwater extraction to be implemented under Alternative V-8 will protect the lake, shorten the time to achieve conditions favorable for applying only natural attenuation of the residual plume, and shorten the time for natural attenuation to achieve Action Levels. On this basis, and noting that the initial EOS treatment was conducted in 2006, the cleanup of groundwater under Alternative V-8 is estimated to require 25 years for completion, with an estimated sequence as follows: two EISB treatment events in the first 5 years with 10 or more years of concurrent active groundwater extraction (or bio-barrier implementation), followed by a period of natural attenuation for up to 15 years to reach chemical-specific ARARs.

4.1.2.3 Long-Term Effectiveness and Permanence

Alternative V-8 would focus on the treatment of CVOC-contamination within the source/plume areas. Downgradient groundwater would be extracted and treated, or intercepted by a bio-barrier, prior to reaching the surface water body. Contaminant mass and transport in the groundwater would be reduced by EISB and by using extraction wells or bio-barriers. The previously implemented EISB interim actions completed at OU 4 (EOS® IRA) showed a decrease in contaminant concentrations in the source areas and down-gradient wells. Additional substrate injections and/or bio-barrier construction would take place as plume conditions dictate. Once the OU 4 groundwater meets the Action Levels, or the monitoring data indicate that natural attenuation is capable of protecting Lake Druid and degrading the plume, the EISB injections and extraction/treatment system would cease operations. The magnitude of residual risk depends on the efficiency of enhanced bioremediation and groundwater extraction; however, the natural attenuation component of the alternative will be required to be proven capable of addressing any residual contamination.

The proposed process components in Alternative V-8 are reliable and well proven. Enhanced bioremediation is a proven technology at OU 4, and the process permanently destroys chlorinated organic compounds. Groundwater extraction and treatment is currently in use at OU 4 and are observed to be reliable. The alternative offers irreversible processes. Source treatment, collection, and treatment of groundwater would provide long-term effectiveness and permanence at OU 4. Management of the alternative would be required as long as the groundwater within OU 4 contains COC concentrations greater than the action levels.

To maintain reliability of Alternative V-8 during active remediation, the treatment components of this alternative would require qualified operations and maintenance (O&M) personnel. Deed restrictions would be enforced to prevent access to the impacted areas and groundwater use. Extraction wells, pumps, air stripping equipment, and piping would need periodic repairs, cleaning, and replacement. O&M activities for the alternative would be moderate.

4.1.2.4 Reduction of Mobility, Toxicity, or Volume Through Treatment

EISB, bio-barriers, groundwater extraction, and natural attenuation would reduce mobility, toxicity, and volume of constituents in groundwater through treatment. EISB irreversibly reduces the toxicity by degrading constituents in groundwater to non-toxic compounds. The down-gradient plume would be intercepted and treated by the existing Groundwater Extraction IRA system and/or future use of bio-barriers. The air stripper physically removes the CVOCs from extracted groundwater and transfers them to air. Groundwater extraction would reduce the volume of the COCs. Natural attenuation would reduce the toxicity and volume of residual groundwater contamination. There may be a temporary increase in toxicity if VC accumulates in groundwater during biological degradation. The biological processes involved in natural attenuation are irreversible.

Alternative V-8 would leave insignificant quantities of residuals in groundwater at OU 4 and air stripping would generate a small volume of emissions that would not require collection or treatment.

4.1.2.5 Short-Term Effectiveness

A portion of construction required to implement Alternative V-8 has already been completed as part of the previous IRAs. Additional injection wells for source areas and/or construction of bio-barriers would be required as needed. The short-term risks to workers and the public from constructing and operating the remedy outlined in the alternative would be controllable. These risks would result from additional monitoring wells, injection wells, sampling of monitoring wells, injection of additional substrate, and operation of existing pump and treat system. Exposure of workers to contamination during groundwater sampling and amendment injection would be minimized by compliance with the requirements of the

Occupational Safety and Health Administration (OSHA), including wearing of appropriate personal protective equipment (PPE) and adherence to site-specific health and safety procedures. There will be a slight impact on the local community during the transport of treatment amendments to the site. Exposure to vapor emissions from the air stripper would be negligible and necessary monitoring would be in place to check the emission rates. Additional injections of substrate and/or bio-barrier construction, if needed, would take less than 3 months to implement.

4.1.2.6 Implementability

A portion of the components of the proposed remedy in Alternative V-8 are already in place as part of the previous IRAs and additional activities, if needed, would be readily implementable. Vendors providing enhanced bioremediation amendments are limited; however, earlier activities for the EOS® IRA were successfully completed with the available vendors. The utilities for the operation of the Groundwater Extraction IRA system are already available at the site. Personnel to operate the groundwater extraction system and provide bio-barriers and additional injection wells would be readily available. Additional remedial activity such as new substrate injections in the source areas and/or bio-barrier injections would not interfere with on-going activities and would be relatively easy to implement.

4.1.2.7 Cost

Costs are based on the assumption that EISB injection events will be conducted twice during the first 5 years to further degrade the source areas. The Groundwater Extraction IRA system would continue to operate for a period of up to 10 years, pending long-term effectiveness of source mass reduction and source release control (i.e., plume cut off) provided by the EISB injections. Natural attenuation to address residual contamination is estimated to be required for approximately 15 years following termination of EISB source mass reduction/control and groundwater extraction efforts. Periodic groundwater monitoring would determine the actual time frame requirements of the natural attenuation. Amendment injection for the purpose of estimating costs of EISB to treat the identified source areas in the surficial aquifer were based on a treatment plan similar to the EOS® IRA that was performed in 2007 and 2008. The estimated present worth with 2.3 percent rate for Alternative V-8 is $1,249,000. The capital cost is $562,000 and the initial annual O&M cost is $53,000 for years 1 through 5 (and decreases in years 6 through 25 as fewer wells are sampled). Appendix C presents the details of the cost estimate for Alternative V-8.

4.2 ALTERNATIVES FOR HAWTHORN WATER BEARING ZONE

The Hawthorn WBZ lies below the surficial aquifer and has been impacted by downward migration of CVOC contamination. The WBZ is considered a semi-confined aquifer system, and the site hydrologic and chemical data show that some hydraulic connection with the overlying surficial aquifer exists. Soil associated with the UHC that lies at the top of the WBZ contains high concentrations of CVOCs and the presence of DNAPL is indirectly indicated. A groundwater plume containing CVOCs was detected near the middle of the WBZ within a layer of relatively permeable sediments (sand, pebbles, and shells) in wells screened between 100 to 120 feet bgs and a small volume of DNAPL was recovered in 2006 from a well screened within this interval. The areal extent of impacted soil associated with the UHC has been estimated to be approximately 4,800 square feet and ranges in thickness from 2 to 16 feet (Tetra Tech, 2009). Because the depth to this source material 100 to 120 feet bgs and the ability to extract contaminants is low due to the physical and chemicals properties of the impacted media, any remedial measures involving removal of contamination would be difficult to implement. The alternatives considered for the Hawthorn WBZ are as follows:

- Alternative H-1: No Action
- Alternative H-2: Land Use Controls, Monitoring, Natural Attenuation
- Alternative H-3: Land Use Controls, Enhanced Bioremediation, Barrier Wall, Monitoring, Natural Attenuation

4.2.1 Alternative H-1: No Action

The No Action alternative serves as a baseline consideration and assumes that no remedial action would occur at the site. This alternative does not address the groundwater contamination and is retained to provide a baseline for comparison to other alternatives. There would be no reduction in toxicity, mobility, or volume of the contaminants other than what would result from natural dispersion, dilution, and other attenuating factors.

Reviews would be conducted at 5-year intervals to document the condition of the site.

4.2.1.1 Overall Protection of Human Health and the Environment

This alternative would not provide protection of human health and the environment. There could be unacceptable risks to human health from exposure to contaminated groundwater. Because no monitoring would be performed, potential migration of contaminants to off-site residential areas would not be detected.

4.2.1.2 Compliance with ARARs

Alternative H-1 would not comply with ARARs or TBCs because no action would be taken to reduce contaminant concentrations and because the alternative continues to allow potential impact to off-site properties. Chemical-specific ARARs may be eventually met by natural attenuation [estimated to be 50 years (see Section 4.2.2.2 below)], but there would be no monitoring to verify the changes.

Compliance with ARARs or TBCs would be purely incidental. Action-specific ARARs or TBCs are not applicable.

4.2.1.3 Long-Term Effectiveness and Permanence

Alternative H-1 would have little long-term effectiveness and permanence because source contamination would not be treated, contaminated groundwater would remain on site, and there would be no groundwater monitoring, so potential off-site migration of COCs would not be detected. Although COC concentrations might eventually decrease through natural attenuation, no monitoring would verify this.

4.2.1.4 Reduction of Mobility, Toxicity, or Volume Through Treatment

Alternative H-1 would not reduce toxicity, mobility, or volume of groundwater COCs because no treatment would occur. Some reduction of the toxicity and volume of COCs might occur through natural dispersion, dilution, or other attenuation processes, but no monitoring would be performed to verify this.

4.2.1.5 Short-Term Effectiveness

Because no action would occur, implementation of Alternative H-1 would not have any short-term adverse impact from cleanup activities to the local community or the environment. Alternative H-1 might achieve the RAOs. Although the Action Levels might eventually be achieved through natural attenuation, this would not be verified through monitoring.

4.2.1.6 Implementability

Because no action would occur, Alternative H-1 would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable. Implementability of additional administrative measures is not applicable because no such measures would be taken.

4.2.1.7 Cost

Because no remedial action would occur, nothing would be implemented. There would be no costs associated with the No Action alternative.

4.2.2 <u>Alternative H-2: Land Use Controls, Monitoring, and Natural Attenuation</u>

Alternative H-2 would consist of three major components: (1) LUCs, (2) groundwater monitoring, and (3) natural attenuation.

This alternative relies on natural attenuation processes in the aquifer to limit plume development and prevent off-site migration while allowing source areas to be naturally degraded, prevents groundwater exposure during the period of natural attenuation, and includes monitoring to document the process. This alternative benefits from the previous EOS® IRA in the deep surficial aquifer (i.e., injections at the top layer of Hawthorn Group) conducted during 2007, as described in Section 1.3. No additional active remedial measures would be undertaken under this alternative. However, because the plume in the Hawthorn WBZ is partially sourced via downward migration of contamination from the surficial aquifer and the contaminated UHC, this alternative may benefit from some source area mass destruction resulting from any future EISB treatment of the deep surficial aquifer (see Section 4.1.2).

Groundwater within the Hawthorn WBZ is slow moving due to the low hydraulic gradient and the volumetric flow of groundwater in this zone is relatively small due to the thinness of the permeable geologic units (typically 5 to 10 feet). Ongoing monitoring of Hawthorn WBZ wells installed on private property approximately 180 feet beyond the northern boundary of OU 4 showed no contamination. Because the age of the release is likely 30 years, or greater, the limited plume length (less than 300 feet) confirms the slow nature of groundwater flow and plume movement in the Hawthorn WBZ. In summary, hydrogeologic conditions limit groundwater flow through the WBZ, there is no nearby surface water body that is likely to receive groundwater discharge from the WBZ, vapor intrusion is mitigated by overlying low permeability units and a thick column of surficial aquifer groundwater, and local municipal water is available for domestic use (and use is required by city regulations). This combination of site conditions indicates that there is a low potential for human or environmental exposure to contaminants in this deep, low-yield aquifer zone and limits the need for active remediation.

Component 1: LUCs

LUCs such as deed restrictions would prohibit groundwater use and prevent potential exposure to the groundwater on the OU 4 property and off-site property, if required. The alternative would prohibit installation of water extraction wells into the Hawthorn WBZ at OU 4 until action levels are met.

Component 2: Monitoring

Groundwater monitoring would document COC concentrations and allow evaluation of natural attenuation processes. Periodic groundwater monitoring in selected wells would be conducted for COCs and natural attenuation parameters. Semiannual monitoring would be conducted for the first 5 years, followed by annual events. Frequency of monitoring, number of wells, and list of analytes would be adjusted as conditions dictate. Evaluating analytical results over time would allow monitoring of plume movement, if any, and the progress of natural attenuation.

Component 3: Natural attenuation

Natural attenuation would address the contamination utilizing natural dispersion, adsorption, dilution, volatilization, and/or biodegradation processes. The investigation of the Hawthorn WBZ (Tetra Tech, 2009) concluded that natural biodegradation is occurring at OU 4. Natural attenuation is applicable when concentrations of COCs in groundwater are at or below FDEP natural attenuation default criteria (Chapter 62-777, Table V), or when technical evaluation, scientific evaluation, or life-cycle cost analysis demonstrates the appropriateness of natural attenuation with monitoring for OU 4 groundwater.

A 5-year review would be performed to assess the site conditions and future monitoring requirements.

4.2.2.1 Overall Protection of Human Health and the Environment

There is no known or likely exposure pathway for the contaminated groundwater in the Hawthorn WBZ that lies at a depth of approximately 100 to 120 feet bgs. Vapor intrusion from the WBZ (where the surficial aquifer is not contaminated) is mitigated by the presence of overlying low permeability sediment (UHC) and a thick column (up to 70 feet) of overlying surficial aquifer groundwater. No water wells are expected to be installed in the Hawthorn WBZ due to its low yield (relative to shallower or deeper aquifers) and due to availability of municipal water. Previous injections of electron donor substrate during the EOS® IRA in the deep surficial aquifer have provided some source area treatment for the Hawthorn WBZ. Natural attenuation would reduce the contaminant source concentrations and reduce the groundwater concentrations. LUCs, such as groundwater use restrictions, would eliminate on-site and off-site pathways for potential exposure to contaminated groundwater. The off-site temporary point of compliance (TPOC) wells would continue to be monitored to demonstrate that off-site human or environmental exposure to contaminated groundwater does not occur. Monitoring would provide data to help evaluate the success of this alternative. Natural attenuation would address the contamination eventually supporting removal of LUCs. This alternative would be protective of human health and the environment by a combination of on-site prevention of groundwater use, by off-site monitoring at a TPOC, and by natural attenuation of the source contamination and the plume.

4.2.2.2 Compliance with ARARs

Alternative H-2 would meet the ARARs (see Tables 4-1 and 4-2) after many years; however, there is no assurance that natural attenuation will prevent off-site plume migration. This alternative would require monitoring of the TPOC wells that are located off-site and require continued cooperation from the off-site property owner for monitoring access. This alternative would control exposure to the impacted groundwater through enforcement of LUCs until chemical-specific ARARs are met. Location- and action-specific ARARs are not applicable to this alternative.

TOR modeling for natural attenuation of the source area and plume has not been conducted for the Hawthorn WBZ. However, because the contaminants, hydrogeologic, and geochemical conditions are similar, TOR modeling for no action (i.e., natural attenuation without source removal) in the surficial aquifer provides an indication of the expected time frame for natural attenuation in the Hawthorn WBZ. Based on the potential age of the release [prior to facility closure in 1994 (17 years ago), as long ago as start of facility operations in 1943 (68 years ago)], the presence of DNAPL, and current concentrations of PCE and daughter products that are several orders of magnitude greater than the Action Levels in the WBZ plume, the upper model time range for TOR in the surficial aquifer (i.e., 54 to 74 years) is considered relevant to current conditions in the WBZ. Based on this information, and for the purposes of this FS Addendum, Alternative H-2 that relies solely on natural attenuation is estimated to require 50 years from current time for completion.

4.2.2.3 Long-Term Effectiveness and Permanence

Risk posed by residual contaminants in the groundwater would be reduced by LUCs. The duration of residual risk depends on the future efficiency of the natural attenuation component of the alternative.

The process options required for Alternative H-2 are reliable and well proven. Natural attenuation is a proven process that permanently destroys chlorinated organic compounds. LUCs would be enforced to prevent access and exposure to the impacted areas.

4.2.2.4 Reduction of Mobility, Toxicity, or Volume through Treatment

Natural attenuation of groundwater contamination will reduce toxicity and volume of constituents. Natural attenuation may reduce the toxicity by degrading constituents in groundwater to non-toxic compounds. The biological processes involved in natural attenuation are also irreversible. Alternative H-2 would leave insignificant quantities of residuals in groundwater once the natural attenuation process goals are accomplished.

4.2.2.5 Short-Term Effectiveness

No additional construction would be required to implement Alternative H-2. The short-term risks to workers from new monitoring wells would be controllable. Exposure of workers to contamination during groundwater sampling would be minimized by compliance with the requirements of the OSHA, including wearing of appropriate PPE and adherence to site-specific health and safety procedures. There will be little impact on the local community during the implementation of this alternative. Natural attenuation to address the residual groundwater contamination would be required for approximately 50 years.

4.2.2.6 Implementability

All components of the proposed remedy in Alternative H-2 can be easily implemented and additional activities, such as the installation of new injection wells would be readily accomplished. Additional remedial activity such as new monitoring wells and sampling would not interfere with on-going activities and would be easy to implement.

4.2.2.7 Cost

The estimated present worth with 2.3 percent rate for Alternative H-2 is $533,000. The capital cost is $41,000, and the initial annual O&M costs are $22,000 for years 1 through 5 (and decrease for years 6 through 50). Appendix C presents the details of the cost estimate for Alternative H-2.

4.2.3 Alternative H-3: Land Use Controls, Enhanced Bioremediation, Barrier Wall, Groundwater Monitoring, Natural attenuation

Alternative H-3 would consist of five major components: (1) LUCs, (2) enhanced bioremediation (3) barrier wall, (4) groundwater monitoring, and (5) natural attenuation.

This alternative would be similar to Alternative H-2 except that EISB injections and/or placement of a barrier wall (e.g., biological or reactive) would be performed to address the source areas/contaminant plumes and accelerate the remediation.

Component 1: LUCs
This component would be the same as Component 1 of Alternative H-2.

Component 2: Enhanced Bioremediation
EISB using temporary injection points, or a grid of permanent injection wells, would be used to periodically treat the source areas and reduce the potential for a larger plume and off-site plume migration. Temporary injection points, or a grid of permanent injection wells, would be installed to construct and periodically renew a bio barrier along the property line. Additional investigation/field work may be needed to identify the optimum depths for EISB injections and to provide some additional monitoring points to track treatment progress and effectiveness.

Similar to the surficial aquifer, multiple injection locations positioned in relatively tight grid spacing would be required in the WBZ to treat the source area approximately defined by the locations of wells 60D and 62D, where high concentrations of CVOCs have been consistently observed. The injection depth would be approximately 100 to 120 feet bgs, and the thickness of the treatment zone is assumed to be up to

20 feet. For the purposes of this FS Addendum, it is assumed that EISB would utilize EOS® as a substrate; however, other similar, carbon-source substrates could be used (i.e., lactic acid). Based on the use of 44 injection points placed on 15-foot grid spacing, calculations indicate that approximately 4,000 pounds of EOS® would be required at concentrations of 2 to 6 percent. Figures showing the most recent well monitoring results for Hawthorn WBZ (Solutions-IES, 2011) are included in Appendix A. Figures showing the CVOC plume in the Hawthorn WBZ (CCI, 2009a) are included in Appendix B. Figure 4-2 indicates the location of the proposed source area injection grid to support EISB treatments for Alternative H-3.

For costing purposes, the EISB amendments would be replenished at 5-year intervals based on the slow velocity of the groundwater. Similarly, due to the slow movement of groundwater and extended period of time needed for the biological treatment zone to contact source material and the dissolved plume, monitoring and periodic re-treatment injection events for the source area and barrier wall along the property line is expected to continue for approximately 15 years.

Component 3: Barrier Wall

To prevent off-site plume migration, a permeable barrier wall (e.g., reactive, biological) would be installed near the property line. An estimated 14 injection locations at 10-foot spacing would be required. Figure 4-2 indicates the location of the proposed down-gradient barrier wall to provide plume mitigation along the property line for Alternative H-3.

Component 4: Groundwater Monitoring

This component would be the same as Component 2 of Alternative H-2.

Component 5: Natural Attenuation

Natural attenuation would address the contamination utilizing natural dispersion, adsorption, dilution, volatilization, and/or biodegradation processes. The investigation of the Hawthorn WBZ (Tetra Tech, 2009) concluded that natural biodegradation is occurring at OU 4. Natural attenuation would be the final step in the remediation of groundwater and would be applicable when concentrations of COCs in groundwater are at or below FDEP natural attenuation default criteria (Chapter 62-777, Table V), or when either a technical evaluation, or scientific evaluation, or life-cycle cost analysis demonstrates the appropriateness of natural attenuation with monitoring for OU 4 groundwater.

4.2.3.1 Overall Protection of Human Health and the Environment

Enhanced bioremediation would be an effective in situ treatment technology and has been proven effective at OU 4. EISB substrate injections to the deep surficial aquifer during the EOS® IRA showed decreased contaminant concentrations at some wells in the Hawthorn WBZ source area. The alternative would provide destruction of contaminant mass and provide control on the migration of contamination, thus supporting protection to human health and the environment. Additional enhanced bioremediation injection events would reduce the contaminant source concentrations, help reduce the contaminant plume, and a barrier wall would mitigate off-site plume migration. Treatment and LUCs, such as groundwater use restrictions, would reduce or eliminate pathways of exposure to contaminated groundwater and provide risk reduction. Monitoring would provide data to evaluate the success of this alternative. Once source area and plume concentrations are lowered (i.e., groundwater conditions are consistent with natural attenuation goals, and are supported by trend data), natural attenuation would address the residual contamination aiding the overall protection. This alternative would be protective of human health and the environment by treating the source areas and contaminated groundwater before it migrates off-site.

4.2.3.2 Compliance with ARARs

Alternative H-3 would meet the ARARs (see Tables 4-1 and 4-2), but would require continued monitoring of the TPOC wells that are located off site. This alternative would control exposure to the impacted groundwater through enforcement of LUCs until chemical-specific ARARs are met. Action-specific ARARs would be met. There are no location-specific ARARs.

As discussed in Section 4.2.2.2, for the purposes of this FS addendum, Alternative H-2 that relies solely on natural attenuation with no source removal is estimated to require 50 years from current time for completion. However, source area mass reduction provided by EISB and plume cutoff using a barrier walls at the property line to be implemented under Alternative H-3 will shorten the time to achieve conditions favorable for applying only natural attenuation of the residual plume, reduce the time that control of plume migration at the property line is required, and shorten the time for natural attenuation to achieve Action Levels. On this basis, the cleanup of groundwater under Alternative H-3 is estimated to require 30 years for completion, with an estimated sequence as follows: 15 years of periodic EISB treatment events with 15 years of concurrent barrier wall implementation, followed by a period of natural attenuation for up to 15 years to reach chemical-specific ARARs.

4.2.3.3 Long-Term Effectiveness and Permanence

Alternative H-3 would focus on the treatment of CVOC contamination within the source area and down-gradient plume areas. Contaminant mass and transport in the groundwater would be reduced by enhanced bioremediation, a barrier wall, and natural attenuation. The duration of residual risk depends on the efficiency of source/barrier wall treatments; however, the natural attenuation component of the alternative would address the residual contamination effectively.

The proposed process options in Alternative H-3 are reliable and well proven. Enhanced bioremediation is a proven technology and the process permanently destroys chlorinated organic compounds. Similarly, biological or reactive barrier walls are proven technology and the process permanently destroys chlorinated organic compounds. The alternative offers irreversible processes. Source treatment would provide long-term effectiveness and permanence at OU 4.

To maintain reliability of Alternative H-3 during active remediation, the treatment components of this alternative would require qualified personnel. Accessing contaminated source areas at depth would be a challenge. Deed restrictions would be enforced to prevent groundwater use.

4.2.3.4 Reduction of Mobility, Toxicity, or Volume through Treatment

EISB and the barrier wall would reduce toxicity and volume of constituents in groundwater through treatment. Natural attenuation would also reduce toxicity and volume of constituents in groundwater. Bioremediation irreversibly reduces the toxicity by degrading constituents in groundwater to non-toxic compounds. Natural attenuation may reduce the toxicity and volume of groundwater with residual contamination. The biological processes involved in natural attenuation are also irreversible.

4.2.3.5 Short-Term Effectiveness

New injection wells and monitoring wells will need to be installed. New borings or wells may be needed to target injection of substrate in the source area, to define the barrier wall depth and location, and to support periodic treatment events. Additional monitoring wells may be needed to provide intermediate monitoring points between the source area and the northern property line to provide feedback on chemical changes at selected intervals along the plume pathway. Exposure of workers to contamination during groundwater sampling and amendment injection would be minimized by compliance with the requirements of the OSHA, including wearing of appropriate PPE and adherence to site-specific health and safety procedures. There will be a slight impact on the local community during the transport of the amendments to the site. Additional investigation activity and injections of substrate/barrier wall construction would take less than three months to implement; subsequent injection events would last between one to two weeks for each event.

4.2.3.6 Implementability

This alternative would be relatively more difficult to implement than H-1 or H-2 primarily due to the subsurface depths required for injection of substrate into the source areas. Investigative work to further refine definition of the source areas or to locate a barrier wall would also be difficult due to the depth, the heterogeneous lithology of the impacted soils, and the complex architecture of the contaminant distribution. But, well installation and associated activities would be implementable. Vendors providing special drilling services to reach greater depths to implement enhanced bioremediation injections and/or to install a barrier wall are limited. Personnel to install injection wells would be available. Additional remedial activity such as further investigation for source areas and substrate injections would not interfere with on-going activities.

4.2.3.7 Cost

The estimated present worth with 2.3 percent rate for Alternative H-3 is $2,100,000. The capital cost is $1,805,000 the and initial annual O&M costs are $22,000 for years 1-5 and are $14,000 for years 6-30. Appendix C presents the details of the cost estimate for Alternative H-3.

5.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

The comparative analysis evaluates the relative performance of each alternative in relation to each specific evaluation criterion. This analysis focuses on the key differences between the alternatives and attempts to highlight critical issues of concern so that a preferred remedial alternative can be selected. For an alternative to be selected as final, the threshold criteria of protection of human health and the environment, and compliance with ARARs must be satisfied. The following are the comparative analyses for CVOC contamination in the surficial aquifer and WBZ of the Hawthorn Group. Note that regulatory and community acceptance criteria will be presented as part of OU 4 ROD.

5.1 COMPARATIVE ANALYSIS OF ALTERNATIVES FOR SURFICIAL AQUIFER

A summary of the comparative analysis of alternatives for the surficial aquifer against the standard CERCLA criteria is presented in Table 5-1. Alternative V-3, ISCO and Enhanced Biodegradation that was included in the original FS (HLA, 2001b) and previously selected in the Proposed Plan (NAVFAC, 2001) is also included for comparison to highlight the differences.

5.1.1 Overall Protection of Human Health and the Environment

Alternative V-8 is expected to be protective of human health and the environment because source area CVOCs will be destroyed by biological activity, the plume will be intercepted by groundwater extraction or a bio-barrier, and LUCs will prevent exposure and reduce risk from contact with contaminated groundwater and surface water along the shoreline of OU 4. Alternative V-3 (that included ISCO) cannot be effectively implemented in the surficial aquifer; therefore, the alternative could not provide the required protection of human health and the environment. Because Alternative V-3 cannot address the source areas adequately, contaminants would continue to be released to the plume and possibly reach Lake Druid. Alternative V1-A would not include any treatment or monitoring, would allow contamination migration to Lake Druid, and therefore would not provide adequate protection of human health and the environment.

5.1.2 Compliance with ARARs

Alternative V-8 is estimated to meet the chemical-specific ARARs and TBCs in about 25 years. Alternative V-3 would have difficulty in satisfying the ARARs due to its ineffectiveness in treating the source area contamination. Action-specific ARARs in Alternative V-8 would be easier to meet compared to those in Alternative V-3. Alternative V1-A would not comply with the ARARs. There are no location-specific ARARs.

5.1.3 Long-Term Effectiveness and Permanence

Alternative V-8 would irreversibly reduce groundwater concentrations of CVOCs, offering a high level of long-term effectiveness and permanence. Alternative V-3 has been proven difficult to implement and therefore would be less likely to provide the long-term effectiveness and permanence. Chemical oxidation in Alternative V-3 would be much faster than the processes in Alternative V-8; however, accessing source materials to ensure contact of the short-lived oxidant utilized in Alternative V-3 has been proven very difficult. The processes in Alternatives V-3 and V-8 are irreversible and would provide significant contaminant mass reduction, control contaminant transport, and provide a mechanism to ultimately achieve cleanup standards. Both Alternatives V-3 and V-8 require long-term operation of the Groundwater Extraction IRA system, monitoring, and 5-year reviews until the remediation goals are met. Alternative V-1A would not provide any effective treatment.

5.1.4 Reduction of Mobility, Toxicity, or Volume through Treatment

Alternative V-8 would reduce contaminant toxicity through treatment. The reduction in Alternative V-3 would be more aggressive and less time consuming; however, implementation difficulties (i.e., chemical oxidant could not be distributed through the aquifer) would make the reduction difficult to achieve. Source area treatment methods in these two alternatives would reduce the toxicity and volume of contaminants. The chemical oxidant utilized in Alternative V-3 would directly react with the contaminants in the source areas, whereas the substrate in Alternative V-8 would enhance the on-going bioremediation treatment of the source material and reduce the strength of down-gradient plume areas. Both alternatives have elements to reduce the existing down-gradient plume contaminant volume by extracting contaminated groundwater. Alternative V-1A (No Action alternative) would leave contaminants untreated.

5.1.5 Short-Term Effectiveness

Alternative V-1A would not have any impacts as there would be no treatment. Alternative V-3 would have greater potential short-term worker impacts than Alternative V-8, because it would involve use of a relatively hazardous oxidant solution and its delivery system. Impact to the public would be about the same for both alternatives. Construction activity and related impacts to workers would be similar for Alternatives V-3 and V-8 in terms of drilling, mixing the reactant/substrate solutions, and pumping into the subsurface. Alternative V-8 would involve more injection points compared to Alternative V-3 because enhanced bioremediation relies on injection pressure and natural groundwater flow for distribution while chemical oxidation utilizes an artificially induced hydraulic gradient (i.e., groundwater recirculation) for distribution.

5.1.6 Implementability

Alternative V-1A would be the easiest to implement, and Alternative V-3 would be the most difficult to implement. Previous attempts to deliver and distribute a chemical oxidant in the surficial aquifer for source areas at OU 4 were found to be impractical and the ISCO system was dismantled. Conventional and commercially available methods did not work for Alternative V-3. Direct injection during the EOS® IRA at OU 4 was readily implemented and successfully promoted enhanced bioremediation. Alternative V-8 would include continuation of the Groundwater Extraction IRA system at OU 4 that is currently active and there would be no implementability concerns if an additional biostimulant needs to be injected to address the source material and/or the down-gradient plume areas. There would be no concerns regarding O&M of these systems. Qualified personnel and equipment to implement Alternative V-8 would be readily available, whereas previous experience with ISCO indicated difficulty in obtaining the required services.

5.1.7 Cost

A comparative analysis for the surficial aquifer alternatives is presented in Table 5-1. Alternative V-1A presents the lowest cost (i.e., no cost). It is noted that Alternative V-8 has a lower net present worth cost than all alternatives presented in the original FS (HLA, 2001b), with the exceptions of V-1, No Action and V-2, Limited Action. A cost summary of the new alternatives is presented below.

Alternative	Description	Time Frame	Total Present Worth Cost
V-1A	No Action	50 yrs.	$0
V-8	LUCs, EISB, Groundwater Extraction and Treatment, Natural Attenuation, and Monitoring	25 yrs.	$1,249,000

5.2 COMPARATIVE ANALYSIS OF ALTERNATIVES FOR THE HAWTHORN WBZ

Three new alternatives are presented for the Hawthorn WBZ. A summary of the comparative analysis of alternatives for the Hawthorn WBZ against the standard CERCLA criteria is presented in Table 5-2.

5.2.1 Overall Protection of Human Health and the Environment

Alternatives H-2 and H-3 are protective of human health and the environment. Alternative H-3 would provide substrate injections to conduct EISB in the source area and at a down-gradient bio-barrier location; however, the depth of the source material and plume (>100 feet) makes the active treatment component of Alternative H-3 technically difficult. If treatment is successful, Alternative H-3 would provide greater chemical mass destruction and plume control compared to Alternative H-2. Direct risk from contact exposure would be reduced by implementation of LUCs for both of these alternatives. Residual contamination at low concentrations in these two alternatives would be addressed by natural attenuation and monitoring. Alternative H-1 would not provide any treatment or monitoring and, therefore, would not provide adequate protection of human health and the environment.

5.2.2 Compliance with ARARs

Alternative H-2 would meet the chemical-specific ARARs and TBCs in approximately 50 years. If substrate injections are successful, Alternative H-3 is estimated to meet the ARARs in approximately 30 years. Alternatives H-2 and H-3 would meet action-specific ARARs. Alternative H-1 would not comply with the ARARs. There are no location-specific ARARs.

5.2.3 Long-Term Effectiveness and Permanence

Both Alternatives H-2 and H-3 would effectively reduce groundwater concentrations of CVOCs in the WBZ and provide long-term effectiveness and permanence. Groundwater in the WBZ moves very slowly; however, increasing concentrations at the property line indicate that injections of substrate under Alternative H-3 will provide greater effectiveness, although accessing source materials and the down-gradient plume areas at depth would be difficult. The processes in Alternatives H-2 and H-3 are irreversible, reliable, and would provide significant contaminant mass reduction, control contaminant transport, and provide a mechanism to ultimately achieve cleanup standards. Both Alternatives H-2 and H-3 include natural attenuation for addressing contamination, and 5-year reviews would be needed until the remediation goals are met. Alternative H-1 would not provide any processes that offer effective treatment.

5.2.4 Reduction of Mobility, Toxicity, or Volume Through Treatment

Alternatives H-2 and H-3 would reduce contaminant toxicity through biological treatment. Source area treatment provided in Alternative H-3 would reduce the mass of contaminants and would provide greater contaminant reduction over a shorter time frame compared to Alternative H-2. Both alternatives include components to reduce contaminant mass by natural attenuation. Alternative H-1 (No Action alternative) would provide reduction by natural processes (similar to H-2); however, the progress would not be monitored.

5.2.5 Short-Term Effectiveness

Alternative H-1 would not have any impacts because no actions would be implemented. Alternative H-3 would have more potential short-term worker impacts than Alternative H-2 because of additional field work and subsurface injection activities. Potential impacts to the public would be slightly higher for Alternative H-3 compared to Alternative H-2. Construction activity and potential impacts to workers would be higher for Alternatives H-3 in terms of drilling, mixing the substrate solutions, and pumping fluids into the subsurface.

5.2.6 Implementability

Alternative H-1 would be the easiest to implement, and Alternative H-3 would be the most difficult to implement. Reaching deep contamination would be difficult in Alternative H-3, but the EOS® IRA in the deep surficial aquifer has indicated that EOS® injections would reduce CVOC concentrations in the underlying Hawthorn WBZ at OU 4. Alternative H-2 would not include active treatment and therefore there would be no implementation concerns. Deep injection of substrate included in Alternative H-3 requires special, but readily available equipment. Qualified personnel and equipment to implement Alternative H-2 would be readily available, whereas specialized personnel and equipment may be needed for Alternative H-3.

5.2.7 Cost

A comparative analysis for the Hawthorn WBZ alternatives is presented in Table 5-2. Alternative H-1 presents the lowest cost. Alternative H-2 has lower cost than Alternative H-3. A cost summary is presented below.

Alternative	Description	Time Frame	Total Present Worth Cost
H-1	No Action	50 yrs.	$0
H-2	LUCs, Natural Attenuation, and Monitoring	50 yrs.	$533,000
H-3	LUCs, EISB, Groundwater Extraction and Treatment, Natural Attenuation, and Monitoring	30 yrs.	$2,100,000

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TABLES

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TABLE 4-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVES V-8, H-2, AND H-3
OPERABLE UNIT 4, FEASIBILITY STUDY ADDENDUM
NTC ORLANDO
ORLANDO, FLORIDA

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Safe Drinking Water Act (SDWA) Regulations, Maximum Contaminant Levels (MCLs)	40 Code of Federal Regulations (CFR) Part 141, Subpart G	Relevant and Appropriate	Establishes enforceable standards for potable water for specific contaminants that have been determined to adversely affect human health.	Would be used as protective levels for groundwater that is a potential drinking water source.
Cancer Slope Factors (CSFs)	-	TBC	Guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Risks due to carcinogens as assessed with slope factors are used to evaluate exposures to contaminated soil.
Reference Doses (RfDs)	-	TBC	Guidance values used to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	RfDs will be used to characterize noncarcinogenic risks associated with residual COC concentrations.
State				
Groundwater Classes, Standards and Exemptions	Chapter 62-520, Florida Administrative Code (F.A.C.)	Applicable	This rule designates the groundwater of the state into five classes and establishes minimum “free from” criteria.	Used to establish cleanup goals for groundwater that is a potential source of drinking water. Surficial groundwater at the site is classified as G-II.
Drinking Water Criteria	Chapter 62-550.310, F.A.C.	Relevant and Appropriate	This rule provides primary and secondary drinking water quality criteria.	Any pertinent state primary drinking water standard(s) more stringent than federal MCLs will be used to establish groundwater cleanup goals for this site.
Contaminant Cleanup Target Levels Rule	Chapter 62-777.170, F.A.C.	Relevant and Appropriate	This rule provides guidance for soil, groundwater, and surface water cleanup levels that can be developed on a site-by-site basis.	These target levels for groundwater (Table II) would be used in determining cleanup goals for groundwater.

Note:
Requirements are for all alternatives (V-8, H-2, and H-3) unless noted.

TABLE 4-2

**FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVES V-8, H-2, AND H-3
OPERABLE UNIT 4, FEASIBILITY STUDY ADDENDUM
NTC ORLANDO
ORLANDO, FLORIDA**

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
CWA Regulations, National Pretreatment Standards	40 CFR Part 403.1, 403.2, 403.4, and 403.5	Applicable	Sets pretreatment standards through the National Categorical Standards of the General Pretreatment Regulations for the introduction of pollutants from non-domestic sources into a publicly owned treatment works (POTW) in order to control pollutants that pass through, cause interference with, or are otherwise incompatible with treatment processes at a POTW.	Groundwater discharged to a POTW in Alternative V-8 must meet local limits imposed by the POTW. A discharge from a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site must meet the POTW's pretreatment standards. Discharge to a POTW is considered an off-site activity and is therefore subject to the substantive requirements of this rule.
Resource Conservation and Recovery Act (RCRA)	42 U.S.C. §§ 6901 et seq.	Applicable	Florida has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. These provisions have been adopted by the state.	Wastes generated during well installation and well purging must be classified as hazardous or non-hazardous. Hazardous waste must be managed according to generator requirements until disposed.
Solid Waste Disposal Act (SWDA) Regulations, Underground Injection Control Regulations	40 CFR Parts 144 Subpart G, 146 Subpart F, and 147.500	Relevant and Appropriate	Establishes minimum program and performance standards for underground injection programs. Technical criteria and standards for siting, operation, and maintenance, are included in Part 146.	Underground Injection Control regulations are relevant and appropriate for the injection of biostimulant amendment (e.g., EOS®) in Alternatives V-8 and H-3.

TABLE 4-2

**FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVES V-8, H-2, AND H-3
OPERABLE UNIT 4, FEASIBILITY STUDY ADDENDUM
NTC ORLANDO
ORLANDO, FLORIDA**

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State				
Florida Hazardous Waste Rules - Definition and Identification	Chapter 62-730.030, Florida Administrative Code (F.A.C.) (40 CFR 261.3)	Applicable	Adopts by reference sections of the federal hazardous waste regulations and establishes minor additions to these regulations concerning the generation, storage, treatment, transportation, and disposal of hazardous wastes. (In general, the Florida regulations adopt the federal regulations by reference, and then provide exceptions or amendments. The 40 CFR citation is included for convenience.)	These regulations would apply to waste such as monitoring well purge water and drill cuttings.
Florida Hazardous Waste Rules - Standards Applicable to Generators of Hazardous Waste	Chapter 62-730.160, F.A.C. (40 CFR 262 Subparts A, B, and C)	Applicable	Establishes manifesting and pre-transport requirements for hazardous waste.	These regulations would apply if wastes such as purge water and drill cuttings are determined to me hazardous and need to be stored prior to off-site disposal.
Pretreatment Requirements for Existing and New Sources of Pollution	Chapter 62-625.300, .400, and .500, F.A.C.	Applicable	Establishes responsibilities of state and local government, industry, and the public to implement pretreatment standards to control pollutants which pass through or interfere with treatment processes in domestic wastewater facilities or which may contaminate domestic wastewater residuals.	Treated groundwater from air stripper discharged to POTW and must meet the requirements of the POTW (Alternative V-8 only)

TABLE 4-2

**FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVES V-8, H-2, AND H-3
OPERABLE UNIT 4, FEASIBILITY STUDY ADDENDUM
NTC ORLANDO
ORLANDO, FLORIDA**

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Florida Underground Injection Control Regulations	Chapter 62-528.605, .610, .615, .625, and .645, F.A.C.	Applicable	Establishes a state Underground Injection Control Program consistent with federal requirements and establishes standards and criteria for construction, operation, monitoring, plugging, and abandonment for Class V wells.	Injection well for biostimulant amendments would be required to meet these requirements (Alternatives V-8 and H-3)
Florida Water Well Permitting and Construction Requirements	Chapter 62-532.500, F.A.C.	Applicable	Establishes minimum standards for the location, construction, repair, and abandonment of water wells. Permitting requirements and procedures are established.	The substantive requirements for permitting would be met for the construction, repair, or abandonment of monitoring, extraction, or injection wells.
Florida Hazardous Waste - Requirements for Remedial Action	Chapter 62-730.225(4), F.A.C.	Applicable	Requires warning signs at sites suspected or confirmed to be contaminated with hazardous waste.	This requirement will be met.
Florida Natural Attenuation with Monitoring Regulation	Chapter 62-780.690 (8)(a) thru (c), F.A.C	Relevant and Appropriate	Specifies minimum number of wells and sampling frequency for conducting groundwater monitoring as part of a natural attenuation remedy.	The requirements associated with implementation of groundwater monitoring for natural attenuation will be met.
Florida Post Active Remediation Monitoring Regulation	Chapter 62-780.750(4)(a) thru (c), F.A.C	Relevant and Appropriate	Specifies minimum number of wells and sampling frequency for conducting groundwater monitoring as part of post active remediation monitoring.	Post-active remediation monitoring will follow the relevant requirements of this rule. (Alternatives V-8 and H-3)

TABLE 4-2

**FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVES V-8, H-2, AND H-3
OPERABLE UNIT 4, FEASIBILITY STUDY ADDENDUM
NTC ORLANDO
ORLANDO, FLORIDA**

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Florida Active Remediation Regulation for Groundwater In situ System(s)	Chapter 62-780.700(12)(f), (g), and (h), F.A.C.	Relevant and Appropriate	Specifies that operational parameters for in situ system(s) should include measurements of biological, chemical, or physical indicators that will verify the radius of influence at representative monitoring locations, weekly for the first month, monthly for the next 2 months, quarterly for the first 2 years, and semiannually thereafter.	In situ groundwater remediation will follow the relevant requirements of this rule. (Alternatives V-8 and H-3)
Florida Regulation of Stormwater Discharge	Chapter 6225.025(7), F.A.C.	Relevant and Appropriate	Establishes requirements for stormwater discharges to ensure protection of the surface water of the state.	Erosion and stormwater control best management practices will be implemented during well installation to retain sediment on site. (Alternatives V-8 and H-3)
Florida General Pollutant Emission Limitation Standards	Chapter 62-296.320, F.A.C.	Applicable	Establishes requirements for generation of unconfined emissions of particulate matter from any activity.	Requires reasonable precautions such as application of water or other dust suppressants to control emission from construction activities, such as well installation. (Alternatives V-8 and H-3)

TABLE 5-1

**COMPARATIVE ANALYSIS OF ALTERNATIVES FOR THE SURFICIAL AQUIFER
OPERABLE UNIT 4 FEASIBILITY STUDY ADDENDUM
NTC ORLANDO
ORLANDO, FLORIDA**

Remedial Alternative	Threshold Criteria		Balancing Criteria				
	Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness and Permanence	Reduction in Toxicity, Mobility, or Volume	Short-term Effectiveness	Implementability	Total Present Worth (30 Years at 2.3% rate)
Alternative V-1A - No Action	Not protective. RAOs would not be achieved.	Does not comply with ARARs	Poor long-term effectiveness. PCE may eventually break down to meet the Action Levels, it would take up to 30 years, during which COCs would reach Lake Druid.	By definition no reduction would occur, but in reality some reduction in toxicity might occur due to natural attenuation processes; however, this would not be monitored.	Remedial time up to 30 years. No short-term risks to community or workers because no remedial action would occur.	Alternative would be readily implementable.	$0
Alternative V-3 - Chemical Oxidation and Enhanced Biodegradation	Protective	Complies with ARARs	Effective and permanent. In situ contact of reactant with contaminants results in chemical oxidation that permanently destroys contaminants. Contaminant migration to Lake Druid would be addressed by recovery wells.	Chemical oxidation would reduce toxicity and groundwater collection and treatment would reduce the mobility and volume of contaminants.	Higher short-term risks to community or workers in handling the oxidant. Remediation time up to15 years while most of the contamination would be addressed in the first 5 years.	Not readily implementable. Experience at site shows technology is difficult to implement effectively. Oxidant distribution in subsurface difficult to achieve.	$1,500,000 Refer to Table 5-4 in FS Report (HLA, 2001). (Cost from 2001 report has been scaled up to reflect 2011 costs.)
Alternative V-8 - Land Use Controls, Enhanced In Situ Bioremediation, Air Stripping, Monitoring, Natural attenuation	Protective	Complies with ARARs	Effective and permanent. Biostimulation is an established in situ remediation technology for reducing volume and mass in the subsurface that has been proven effective at the site. Contaminant migration to Lake Druid would be addressed by existing pump and treat system or new bio-barriers.	Bioremediation would reduce toxicity and groundwater collection and treatment would reduce the mobility and volume of contaminants.	Remediation time 25 years while most of the contamination would be addressed in the first 10 years. Limited short-term risks to community or workers	Readily implementable. Most of the components already in place.	$1,249,000 Refer to Appendix C for cost detail.

TABLE 5-2

COMPARATIVE ANALYSIS OF ALTERNATIVES FOR THE HAWTHORN WBZ
OPERABLE UNIT 4 FEASIBILITY STUDY ADDENDUM
NTC ORLANDO
ORLANDO, FLORIDA

Remedial Alternative	Threshold Criteria		Balancing Criteria				
	Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness and Permanence	Reduction in Toxicity, Mobility, or Volume	Short-term Effectiveness	Implementability	Total Present Worth (30 Years at 2.3 % rate)
Alternative H-1 - No Action	No activity to confirm protection. RAOs would not be achieved	No activity to confirm compliance	No monitoring to confirm long-term effectiveness. PCE may eventually break down to meet the Action Levels, the COCs may reach off-site.	No activity to confirm the reduction. In reality reduction would occur in toxicity due to the presence of bio-stimulant already in ground. Volume reduction would occur due to natural attenuation processes.	No short-term risks to community or workers because no remedial action would occur; however, no monitoring would make remedy unpredictable.	Alternative would be readily implementable.	$0.
Alternative H-2 - Land Use Controls, Monitoring, Natural Attenuation	Protective	Complies with ARARs	Effective and permanent. Contaminant migration to off-site property likely because the source area and plume are not actively remediated.	Bioremediation would reduce toxicity. Natural attenuation would reduce the mobility and volume of contaminants.	Remediation time approximately 50 years. Limited short-term risks to community or workers.	Readily implementable. All components already in place.	$533,000 Refer to Appendix C for cost detail.
Alternative H-3 - Land Use Controls, Enhanced In Situ Bioremediation, Monitoring, Natural Attenuation	Protective	Complies with ARARs	Effective and permanent. Substrate injection injections/barrier wall would enhance in-situ remediation technology, which is proven for reducing volume and mass in the subsurface. Contaminant migration to off-site property would be addressed by biostimulant injections.	Enhanced bioremediation / barrier wall would reduce toxicity. Natural attenuation would reduce the mobility and volume of contaminants.	Remediation time approximately 30 years while most of the contamination would be addressed in the first 15 years. Limited short-term risks to community or workers.	Difficult to implement due to drilling depth and recalcitrant source material.	$2,100,000 Refer to Appendix C for cost detail.

FIGURES

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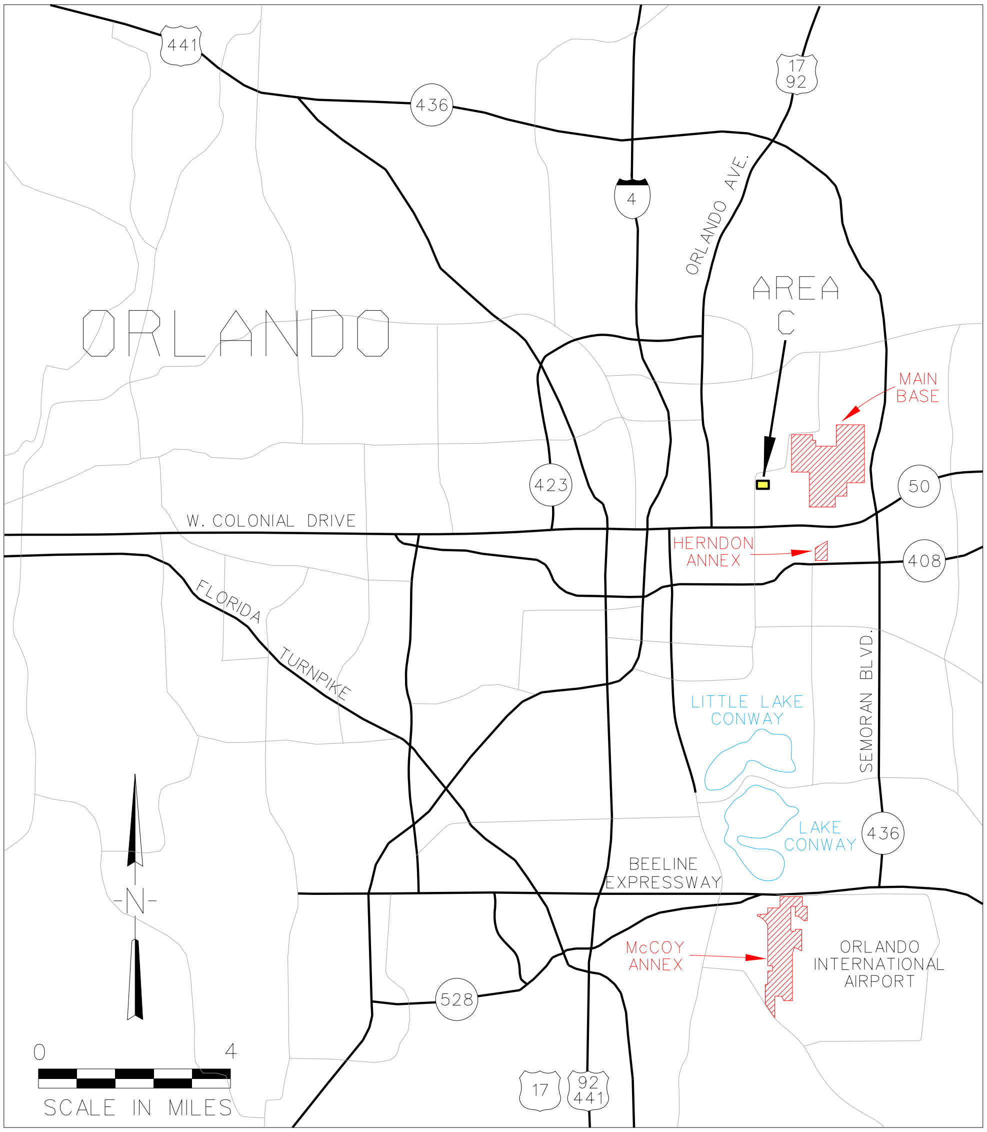

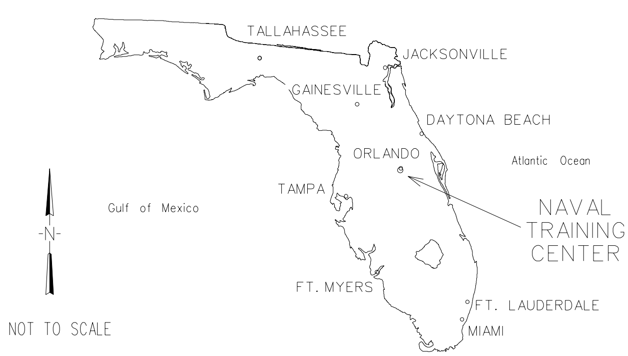

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CHECKED BY TKG	DATE 7-15-08		OWNER NO. ----------	
REVISED BY ---	DATE --------		APPROVED BY ---	DATE --------
SCALE AS NOTED			DRAWING NO. FIGURE 1-1	REV. 0

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CHECKED BY TKG	DATE 12-15-2011		OWNER NO. ----
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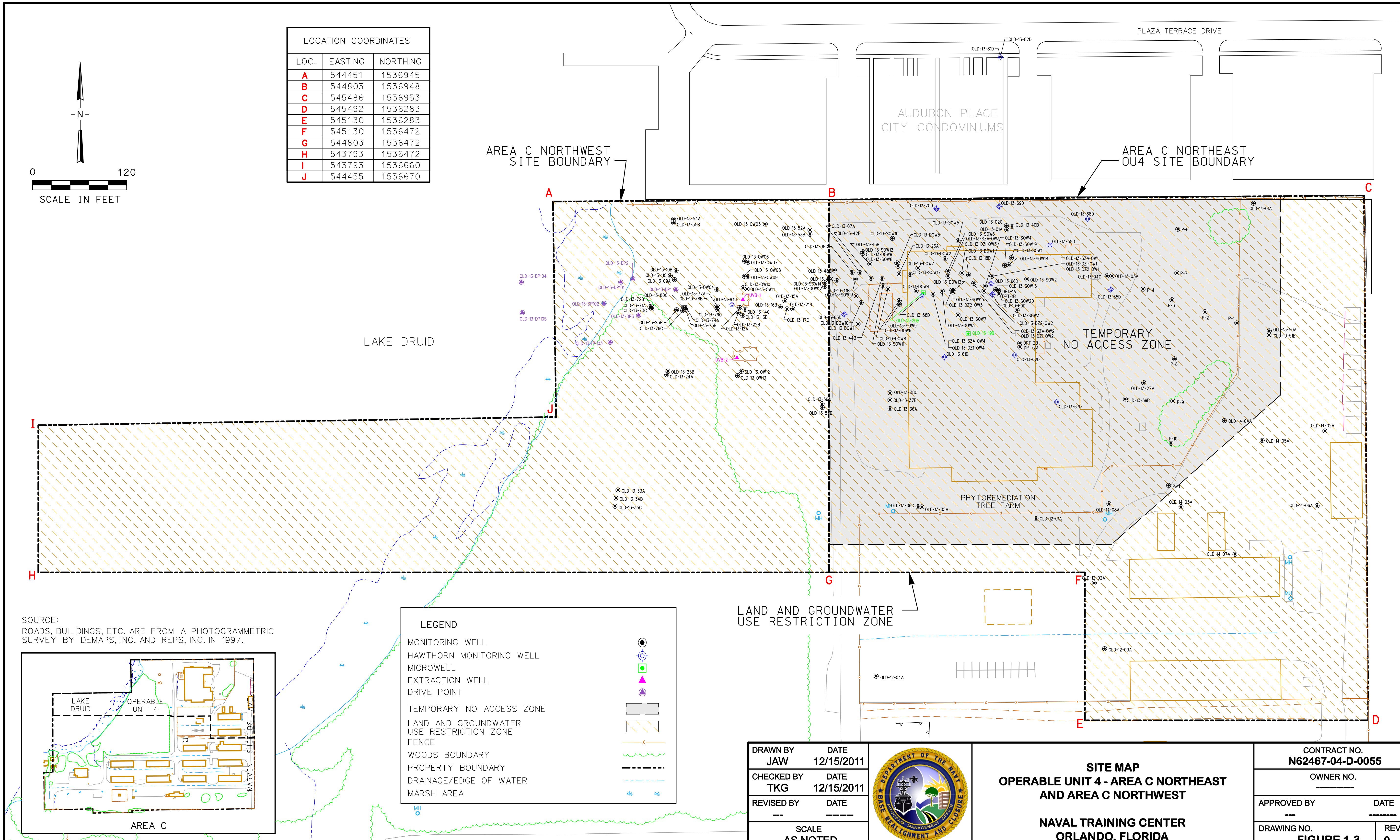

LOCATION COORDINATES

LOC.	EASTING	NORTHING
A	544451	1536945
B	544803	1536948
C	545486	1536953
D	545492	1536283
E	545130	1536283
F	545130	1536472
G	544803	1536472
H	543793	1536472
I	543793	1536660
J	544455	1536670

SOURCE:
ROADS, BUILIDINGS, ETC. ARE FROM A PHOTOGRAMMETRIC SURVEY BY DEMAPS, INC. AND REPS, INC. IN 1997.

LEGEND

- MONITORING WELL
- HAWTHORN MONITORING WELL
- MICROWELL
- EXTRACTION WELL
- DRIVE POINT
- TEMPORARY NO ACCESS ZONE
- LAND AND GROUNDWATER USE RESTRICTION ZONE
- FENCE
- WOODS BOUNDARY
- PROPERTY BOUNDARY
- DRAINAGE/EDGE OF WATER
- MARSH AREA

DRAWN BY	DATE
JAW	12/15/2011
CHECKED BY	DATE
TKG	12/15/2011
REVISED BY	DATE
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SCALE	
AS NOTED	

SITE MAP
OPERABLE UNIT 4 - AREA C NORTHEAST AND AREA C NORTHWEST

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

CONTRACT NO. N62467-04-D-0055
OWNER NO. ----------
APPROVED BY --- DATE --------
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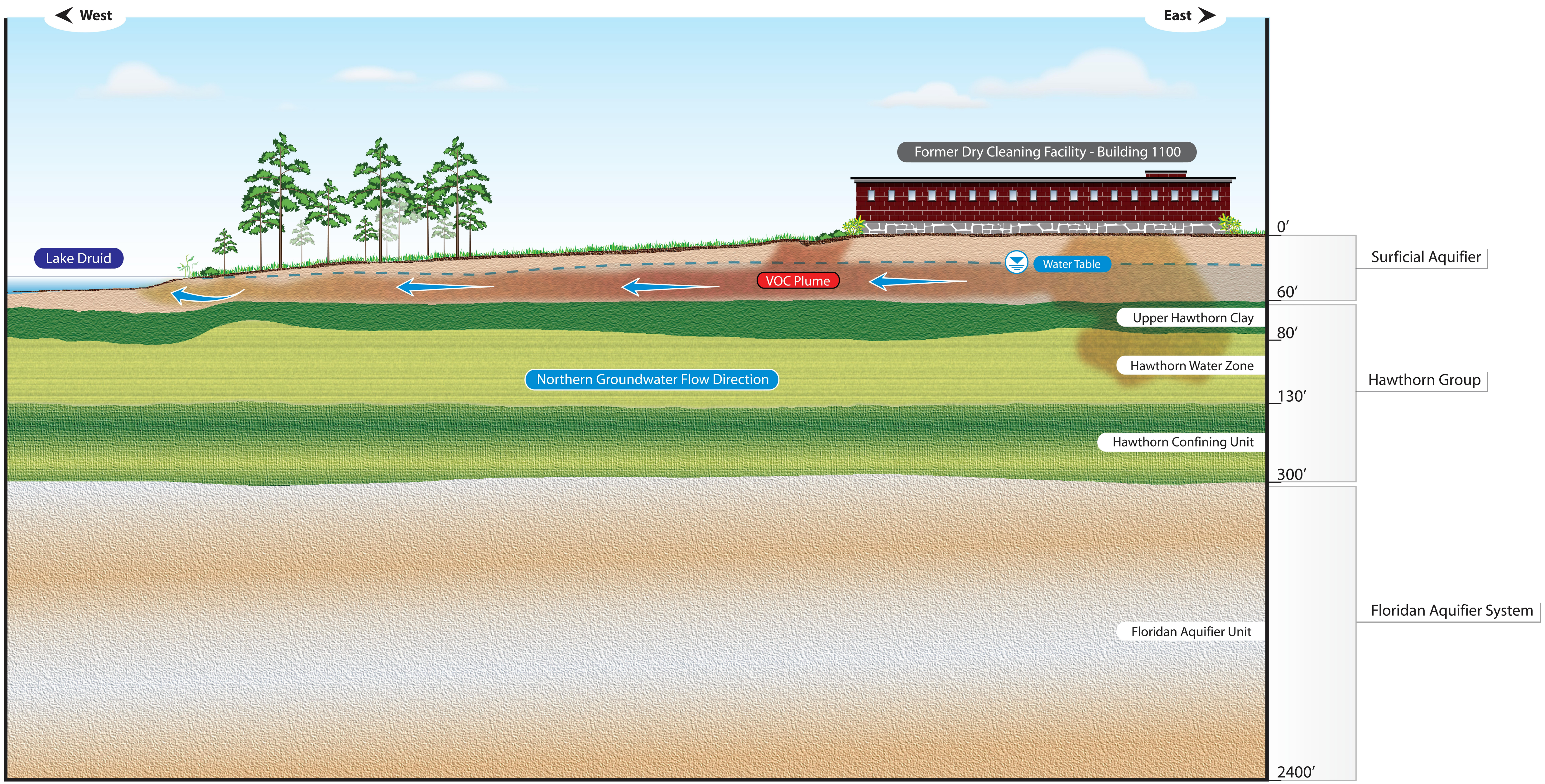

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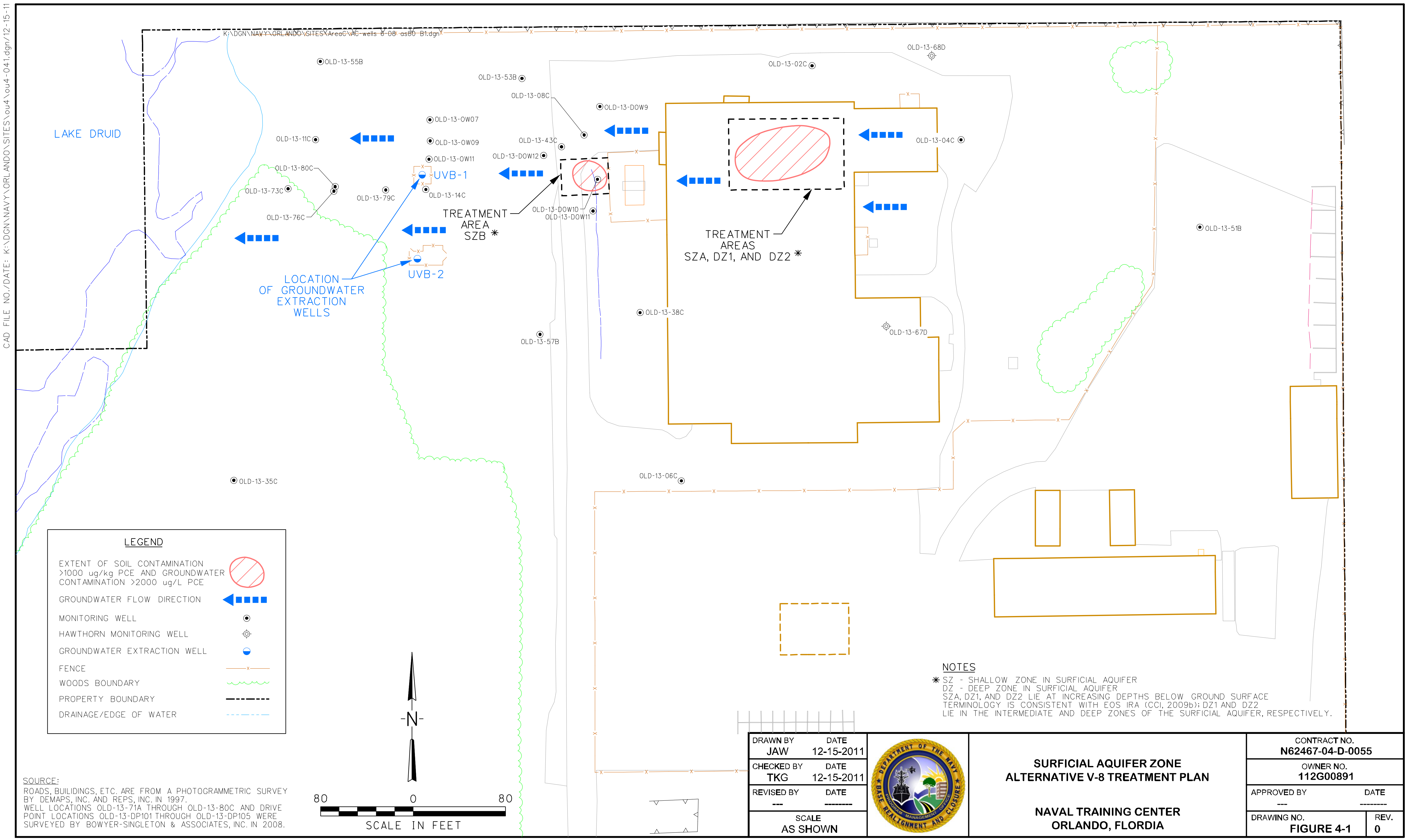
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LAKE DRUID
OLD-13-55B
OLD-13-53B
OLD-13-08C
OLD-13-DOW9
OLD-13-02C
OLD-13-68D
OLD-13-OW07
OLD-13-11C
OLD-13-OW09
OLD-13-43C
OLD-13-04C
OLD-13-OW11
OLD-13-DOW12
OLD-13-80C
UVB-1
OLD-13-73C
OLD-13-79C
OLD-13-14C
OLD-13-DOW10
OLD-13-DOW11
OLD-13-76C
TREATMENT AREA SZB *
TREATMENT AREAS SZA, DZ1, AND DZ2 *
OLD-13-51B
LOCATION OF GROUNDWATER EXTRACTION WELLS
UVB-2
OLD-13-38C
OLD-13-67D
OLD-13-57B
OLD-13-06C
OLD-13-35C
LEGEND
EXTENT OF SOIL CONTAMINATION >1000 ug/kg PCE AND GROUNDWATER CONTAMINATION >2000 ug/L PCE
GROUNDWATER FLOW DIRECTION
MONITORING WELL
HAWTHORN MONITORING WELL
GROUNDWATER EXTRACTION WELL
FENCE
WOODS BOUNDARY
PROPERTY BOUNDARY
DRAINAGE/EDGE OF WATER
N
80 0 80
SCALE IN FEET
SOURCE:
ROADS, BUILDINGS, ETC. ARE FROM A PHOTOGRAMMETRIC SURVEY BY DEMAPS, INC. AND REPS, INC. IN 1997.
WELL LOCATIONS OLD-13-71A THROUGH OLD-13-80C AND DRIVE POINT LOCATIONS OLD-13-DP101 THROUGH OLD-13-DP105 WERE SURVEYED BY BOWYER-SINGLETON & ASSOCIATES, INC. IN 2008.
NOTES
* SZ - SHALLOW ZONE IN SURFICIAL AQUIFER
DZ - DEEP ZONE IN SURFICIAL AQUIFER
SZA, DZ1, AND DZ2 LIE AT INCREASING DEPTHS BELOW GROUND SURFACE
TERMINOLOGY IS CONSISTENT WITH EOS IRA (CCI, 2009b); DZ1 AND DZ2 LIE IN THE INTERMEDIATE AND DEEP ZONES OF THE SURFICIAL AQUIFER, RESPECTIVELY.
DRAWN BY JAW DATE 12-15-2011
CHECKED BY TKG DATE 12-15-2011
REVISED BY --- DATE --------
SCALE AS SHOWN
DEPARTMENT OF THE NAVY BASE REALIGNMENT AND CLOSURE PROGRAM MANAGEMENT OFFICE
SURFICIAL AQUIFER ZONE ALTERNATIVE V-8 TREATMENT PLAN
NAVAL TRAINING CENTER ORLANDO, FLORDIA
CONTRACT NO. N62467-04-D-0055
OWNER NO. 112G00891
APPROVED BY --- DATE --------
DRAWING NO. FIGURE 4-1
REV. 0

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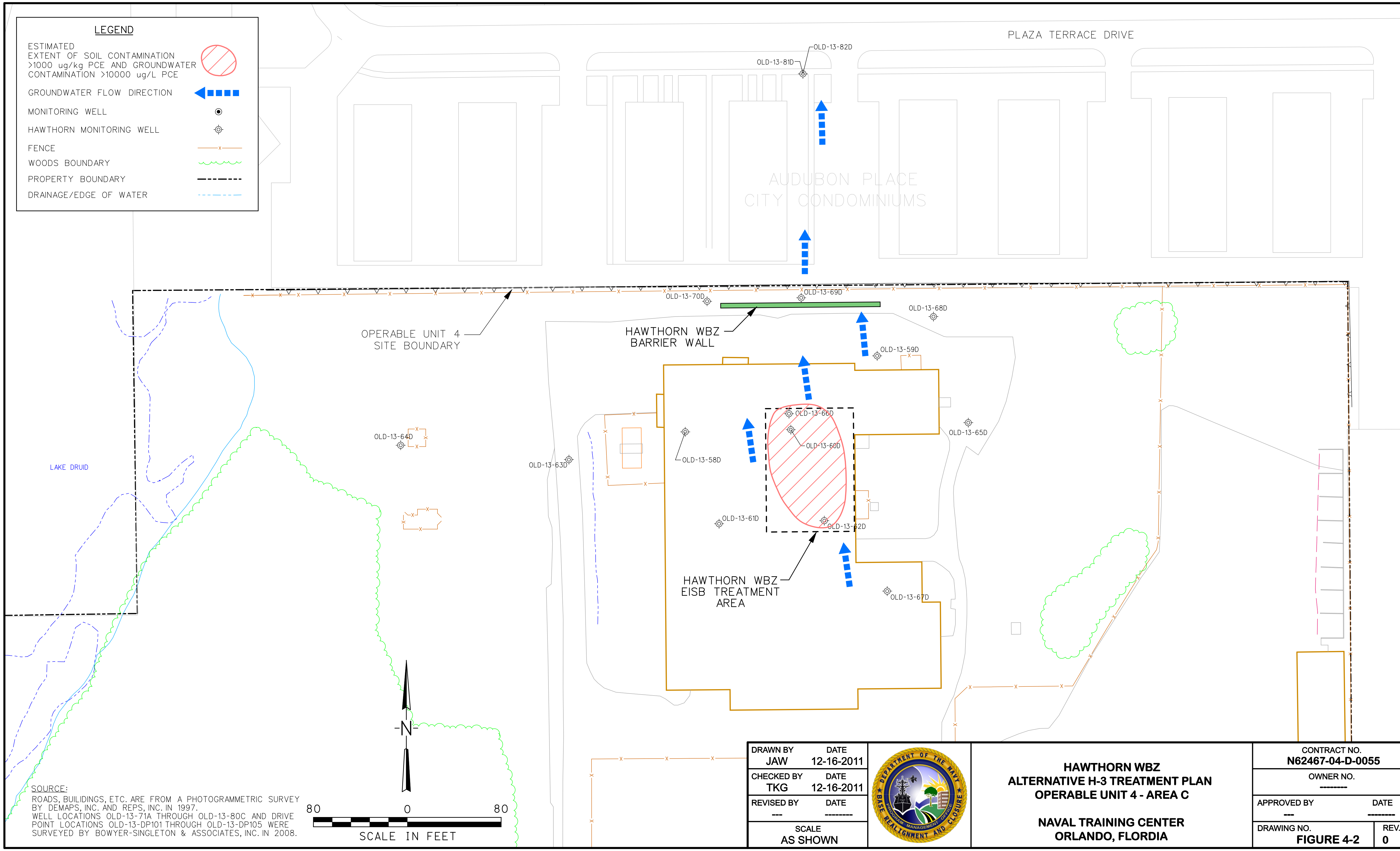
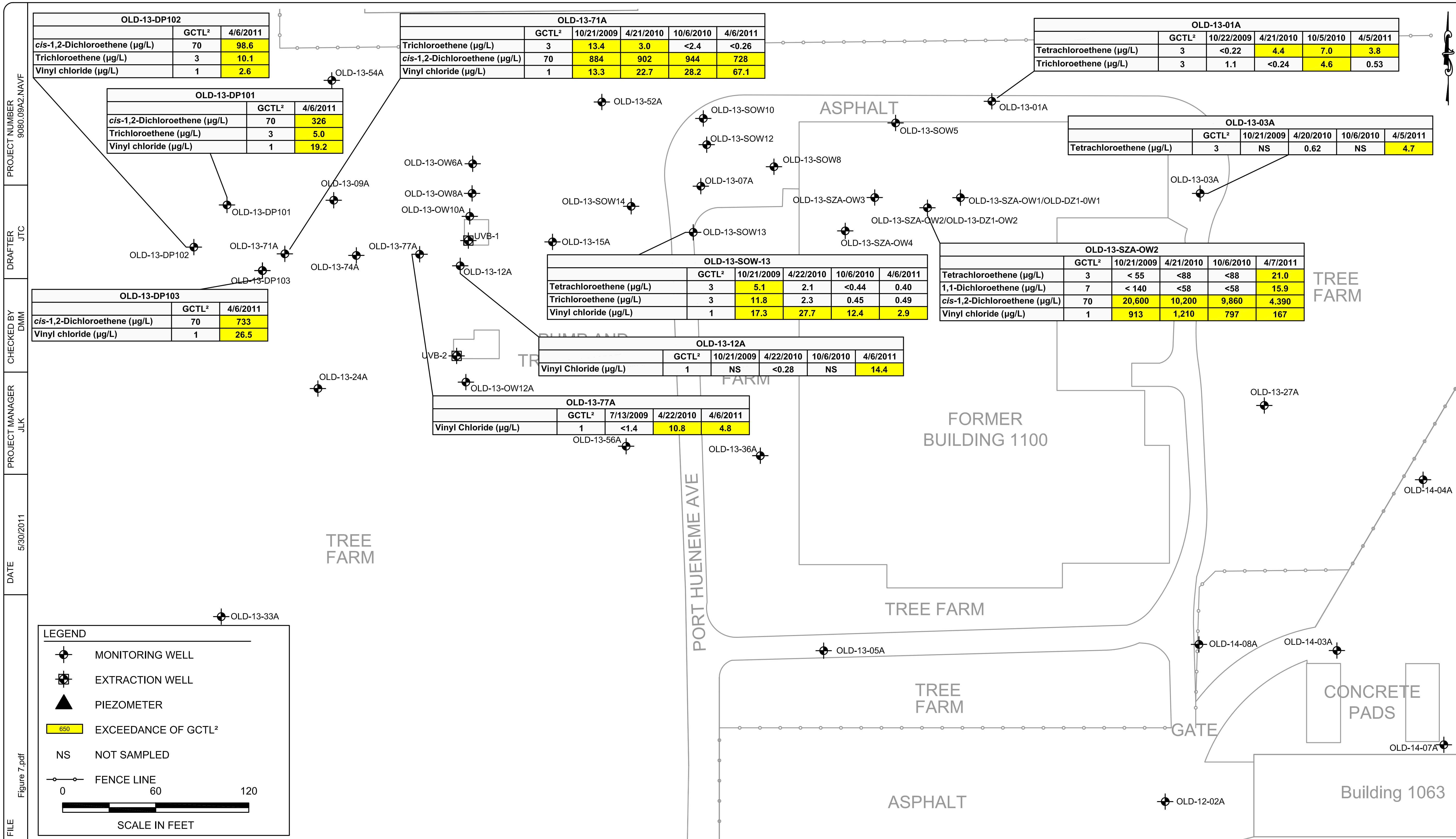


APPENDIX A

FIGURES SHOWING RECENT GROUNDWATER SAMPLING RESULTS SOLUTIONS-IES, APRIL 2011

PROJECT NUMBER 9080.09A2.NAVF
DRAFTER JTC
CHECKED BY DMM
PROJECT MANAGER JLK
DATE 5/30/2011
FILE Figure 7.pdf



OLD-13-DP102	GCTL²	4/6/2011
cis-1,2-Dichloroethene (µg/L)	70	98.6
Trichloroethene (µg/L)	3	10.1
Vinyl chloride (µg/L)	1	2.6

OLD-13-DP101	GCTL²	4/6/2011
cis-1,2-Dichloroethene (µg/L)	70	326
Trichloroethene (µg/L)	3	5.0
Vinyl chloride (µg/L)	1	19.2

OLD-13-DP103	GCTL²	4/6/2011
cis-1,2-Dichloroethene (µg/L)	70	733
Vinyl chloride (µg/L)	1	26.5

OLD-13-71A	GCTL²	10/21/2009	4/21/2010	10/6/2010	4/6/2011
Trichloroethene (µg/L)	3	13.4	3.0	<2.4	<0.26
cis-1,2-Dichloroethene (µg/L)	70	884	902	944	728
Vinyl chloride (µg/L)	1	13.3	22.7	28.2	67.1

OLD-13-01A	GCTL²	10/22/2009	4/21/2010	10/5/2010	4/5/2011
Tetrachloroethene (µg/L)	3	<0.22	4.4	7.0	3.8
Trichloroethene (µg/L)	3	1.1	<0.24	4.6	0.53

OLD-13-03A	GCTL²	10/21/2009	4/20/2010	10/6/2010	4/5/2011
Tetrachloroethene (µg/L)	3	NS	0.62	NS	4.7

OLD-13-SOW-13	GCTL²	10/21/2009	4/22/2010	10/6/2010	4/6/2011
Tetrachloroethene (µg/L)	3	5.1	2.1	<0.44	0.40
Trichloroethene (µg/L)	3	11.8	2.3	0.45	0.49
Vinyl chloride (µg/L)	1	17.3	27.7	12.4	2.9

OLD-13-SZA-OW2	GCTL²	10/21/2009	4/21/2010	10/6/2010	4/7/2011
Tetrachloroethene (µg/L)	3	< 55	<88	<88	21.0
1,1-Dichloroethene (µg/L)	7	< 140	<58	<58	15.9
cis-1,2-Dichloroethene (µg/L)	70	20,600	10,200	9,860	4,390
Vinyl chloride (µg/L)	1	913	1,210	797	167

OLD-13-12A	GCTL²	10/21/2009	4/22/2010	10/6/2010	4/6/2011
Vinyl Chloride (µg/L)	1	NS	<0.28	NS	14.4

OLD-13-77A	GCTL²	7/13/2009	4/22/2010	4/6/2011
Vinyl Chloride (µg/L)	1	<1.4	10.8	4.8

Solutions-IES
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NOTES:
1) BASEMAP DRAWN FROM AERIAL PHOTOGRAPH. (GOOGLE EARTH 2009)
2) GCTL - GROUNDWATER CLEANUP TARGET LEVEL
3) RESULTS ARE SHOWN ONLY FOR WELLS WITH ONE OR MORE CVOCs EXCEEDING THE GCTLs.
4) WELL LOCATIONS PROVIDED BY CH2M HILL

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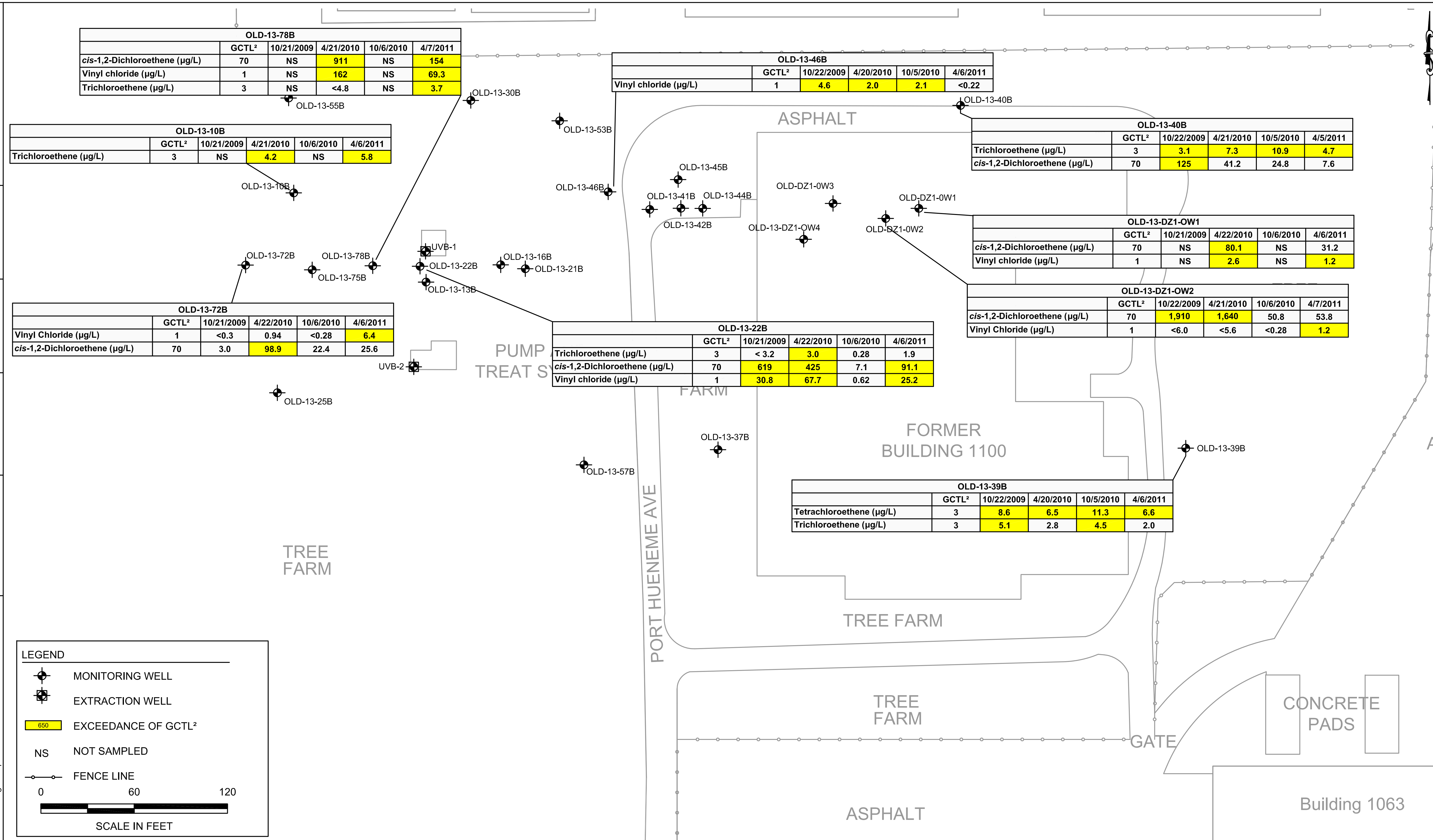
ORLANDO, ORANGE COUNTY, FLORIDA

CONTAMINANT CONCENTRATION MAP
SHALLOW SURFICIAL AQUIFER ZONE
APRIL 2011

FIGURE: 7



OLD-13-78B

	GCTL²	10/21/2009	4/21/2010	10/6/2010	4/7/2011
cis-1,2-Dichloroethene (µg/L)	70	NS	911	NS	154
Vinyl chloride (µg/L)	1	NS	162	NS	69.3
Trichloroethene (µg/L)	3	NS	<4.8	NS	3.7

OLD-13-46B

	GCTL²	10/22/2009	4/20/2010	10/5/2010	4/6/2011
Vinyl chloride (µg/L)	1	4.6	2.0	2.1	<0.22

OLD-13-10B

	GCTL²	10/21/2009	4/21/2010	10/6/2010	4/6/2011
Trichloroethene (µg/L)	3	NS	4.2	NS	5.8

OLD-13-40B

	GCTL²	10/22/2009	4/21/2010	10/5/2010	4/5/2011
Trichloroethene (µg/L)	3	3.1	7.3	10.9	4.7
cis-1,2-Dichloroethene (µg/L)	70	125	41.2	24.8	7.6

OLD-13-DZ1-OW1

	GCTL²	10/21/2009	4/22/2010	10/6/2010	4/6/2011
cis-1,2-Dichloroethene (µg/L)	70	NS	80.1	NS	31.2
Vinyl chloride (µg/L)	1	NS	2.6	NS	1.2

OLD-13-DZ1-OW2

	GCTL²	10/22/2009	4/21/2010	10/6/2010	4/7/2011
cis-1,2-Dichloroethene (µg/L)	70	1,910	1,640	50.8	53.8
Vinyl Chloride (µg/L)	1	<6.0	<5.6	<0.28	1.2

OLD-13-72B

	GCTL²	10/21/2009	4/22/2010	10/6/2010	4/6/2011
Vinyl Chloride (µg/L)	1	<0.3	0.94	<0.28	6.4
cis-1,2-Dichloroethene (µg/L)	70	3.0	98.9	22.4	25.6

OLD-13-22B

	GCTL²	10/21/2009	4/22/2010	10/6/2010	4/6/2011
Trichloroethene (µg/L)	3	< 3.2	3.0	0.28	1.9
cis-1,2-Dichloroethene (µg/L)	70	619	425	7.1	91.1
Vinyl chloride (µg/L)	1	30.8	67.7	0.62	25.2

OLD-13-39B

	GCTL²	10/22/2009	4/20/2010	10/5/2010	4/6/2011
Tetrachloroethene (µg/L)	3	8.6	6.5	11.3	6.6
Trichloroethene (µg/L)	3	5.1	2.8	4.5	2.0

PROJECT NUMBER 9080.09A2.NAVF
DRAFTER JTC
CHECKED BY DMM
PROJECT MANAGER JLK
DATE 5/30/2011
FILE Figure 8.pdf

Solutions-IES
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1101 NOWELL ROAD
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NOTES:
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FORMER NTC ORLANDO - OU4
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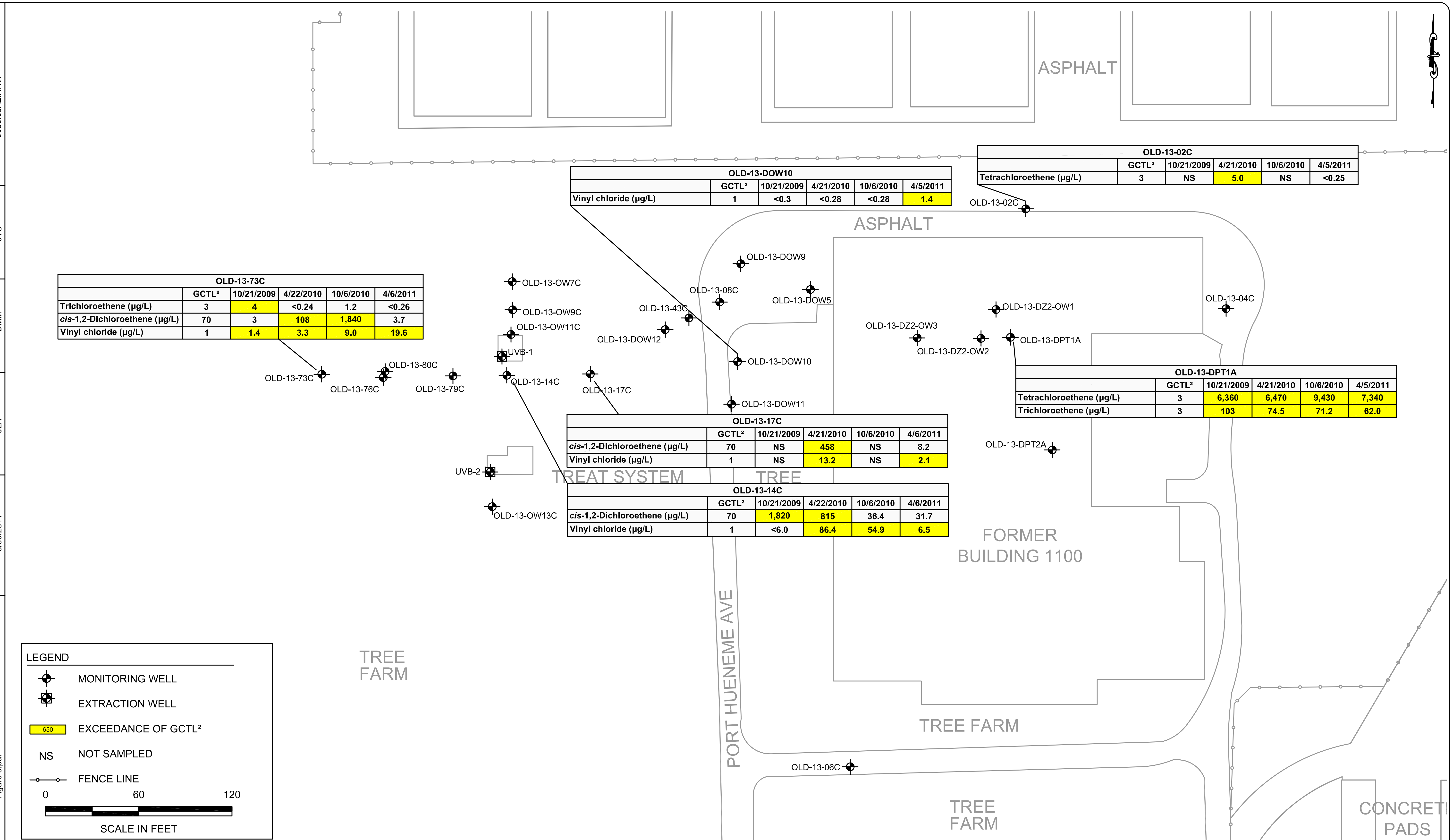
ORLANDO, ORANGE COUNTY, FLORIDA

CONTAMINANT CONCENTRATION MAP
INTERMEDIATE SURFICIAL AQUIFER ZONE
APRIL 2011

FIGURE: 8



OLD-13-02C

	GCTL²	10/21/2009	4/21/2010	10/6/2010	4/5/2011
Tetrachloroethene (µg/L)	3	NS	5.0	NS	<0.25

OLD-13-DOW10

	GCTL²	10/21/2009	4/21/2010	10/6/2010	4/5/2011
Vinyl chloride (µg/L)	1	<0.3	<0.28	<0.28	1.4

OLD-13-73C

	GCTL²	10/21/2009	4/22/2010	10/6/2010	4/6/2011
Trichloroethene (µg/L)	3	4	<0.24	1.2	<0.26
cis-1,2-Dichloroethene (µg/L)	70	3	108	1,840	3.7
Vinyl chloride (µg/L)	1	1.4	3.3	9.0	19.6

OLD-13-DPT1A

	GCTL²	10/21/2009	4/21/2010	10/6/2010	4/5/2011
Tetrachloroethene (µg/L)	3	6,360	6,470	9,430	7,340
Trichloroethene (µg/L)	3	103	74.5	71.2	62.0

OLD-13-17C

	GCTL²	10/21/2009	4/21/2010	10/6/2010	4/6/2011
cis-1,2-Dichloroethene (µg/L)	70	NS	458	NS	8.2
Vinyl chloride (µg/L)	1	NS	13.2	NS	2.1

OLD-13-14C

	GCTL²	10/21/2009	4/22/2010	10/6/2010	4/6/2011
cis-1,2-Dichloroethene (µg/L)	70	1,820	815	36.4	31.7
Vinyl chloride (µg/L)	1	<6.0	86.4	54.9	6.5

PROJECT NUMBER 9080.09A2.NAVF

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PROJECT MANAGER JLK

DATE 5/30/2011

FILE Figure 9.pdf

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RALEIGH, NORTH CAROLINA 27607
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NOTES:
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4) WELL LOCATIONS PROVIDED BY CH2M HILL

FORMER NTC ORLANDO - OU4
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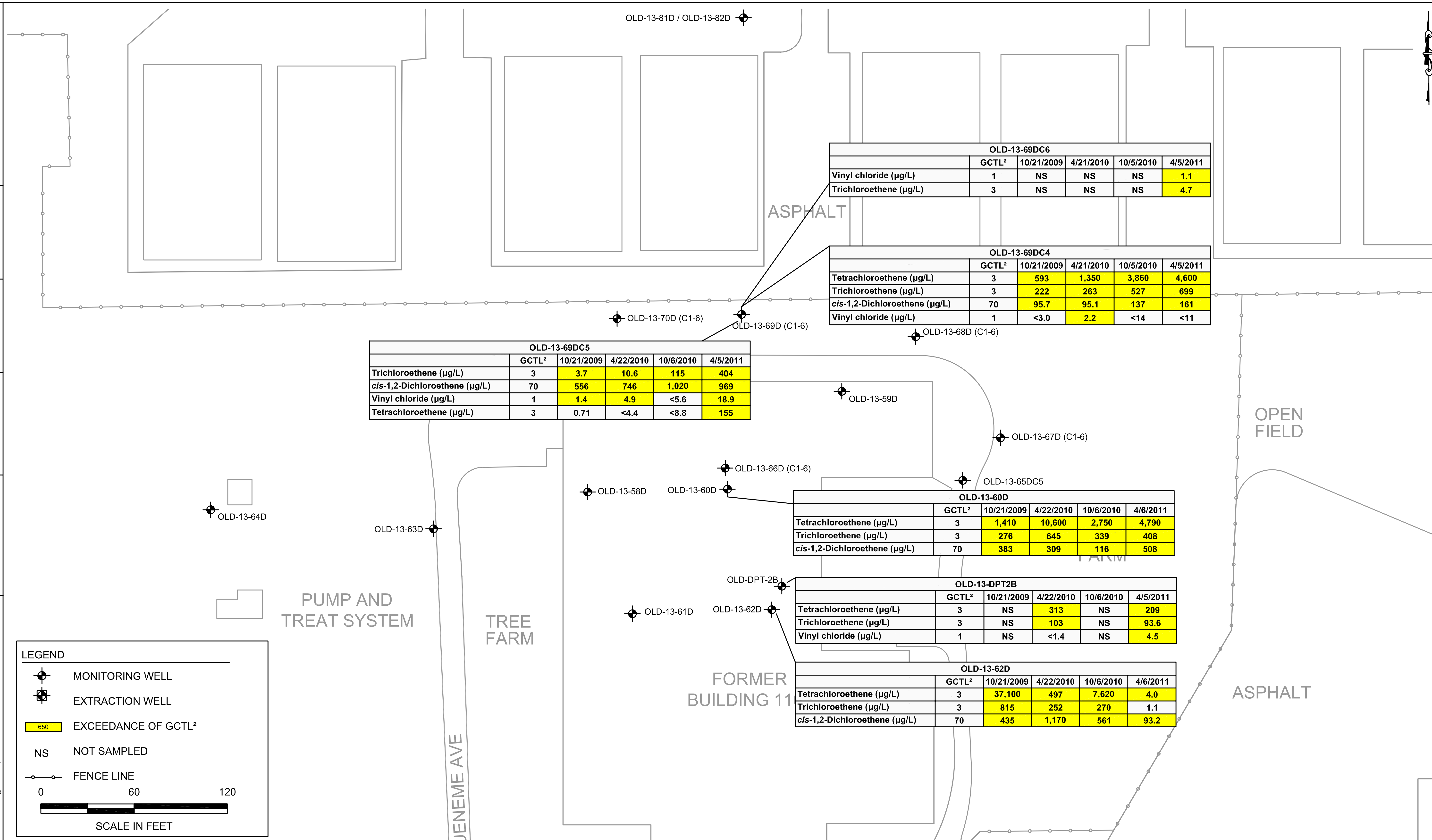
ORLANDO, ORANGE COUNTY, FLORIDA

CONTAMINANT CONCENTRATION MAP
DEEP SURFICIAL AQUIFER ZONE
APRIL 2011

FIGURE: 9



OLD-13-69DC6	GCTL²	10/21/2009	4/21/2010	10/5/2010	4/5/2011
Vinyl chloride (µg/L)	1	NS	NS	NS	1.1
Trichloroethene (µg/L)	3	NS	NS	NS	4.7

OLD-13-69DC4	GCTL²	10/21/2009	4/21/2010	10/5/2010	4/5/2011
Tetrachloroethene (µg/L)	3	593	1,350	3,860	4,600
Trichloroethene (µg/L)	3	222	263	527	699
cis-1,2-Dichloroethene (µg/L)	70	95.7	95.1	137	161
Vinyl chloride (µg/L)	1	<3.0	2.2	<14	<11

OLD-13-69DC5	GCTL²	10/21/2009	4/22/2010	10/6/2010	4/5/2011
Trichloroethene (µg/L)	3	3.7	10.6	115	404
cis-1,2-Dichloroethene (µg/L)	70	556	746	1,020	969
Vinyl chloride (µg/L)	1	1.4	4.9	<5.6	18.9
Tetrachloroethene (µg/L)	3	0.71	<4.4	<8.8	155

OLD-13-60D	GCTL²	10/21/2009	4/22/2010	10/6/2010	4/6/2011
Tetrachloroethene (µg/L)	3	1,410	10,600	2,750	4,790
Trichloroethene (µg/L)	3	276	645	339	408
cis-1,2-Dichloroethene (µg/L)	70	383	309	116	508

OLD-13-DPT2B	GCTL²	10/21/2009	4/22/2010	10/6/2010	4/5/2011
Tetrachloroethene (µg/L)	3	NS	313	NS	209
Trichloroethene (µg/L)	3	NS	103	NS	93.6
Vinyl chloride (µg/L)	1	NS	<1.4	NS	4.5

OLD-13-62D	GCTL²	10/21/2009	4/22/2010	10/6/2010	4/6/2011
Tetrachloroethene (µg/L)	3	37,100	497	7,620	4.0
Trichloroethene (µg/L)	3	815	252	270	1.1
cis-1,2-Dichloroethene (µg/L)	70	435	1,170	561	93.2

LEGEND

- MONITORING WELL
- EXTRACTION WELL
- 650 EXCEEDANCE OF GCTL²
- NS NOT SAMPLED
- FENCE LINE

0 60 120

SCALE IN FEET

PROJECT NUMBER 9080.09A2.NAVF

DRAFTER JTC

CHECKED BY DMM

PROJECT MANAGER DMM

DATE 5/30/2011

FILE Figure 10.pdf

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TEL.: (919) 873-1060 FAX.: (919) 873-1074

NOTES:
1) BASEMAP DRAWN FROM AERIAL PHOTOGRAPH. (GOOGLE EARTH 2009)
2) GCTL - GROUNDWATER CLEANUP TARGET LEVEL
3) RESULTS ARE SHOWN ONLY FOR WELLS WITH ONE OR MORE CVOCs EXCEEDING THE GCTLs.
4) WELL LOCATIONS PROVIDED BY CH2M HILL

FORMER NTC ORLANDO - OU4
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ORLANDO, ORANGE COUNTY, FLORIDA

CONTAMINANT CONCENTRATION MAP
HAWTHORN AQUIFER
APRIL 2011

FIGURE: 10

APPENDIX B

PLUME MAPS AND
PREVIOUSLY TREATED SOURCE AREAS FIGURES
CCI, 2009

Monitoring and Maintenance Status Report

Monitoring Activities and Results at Operable Unit 4

Naval Training Center Orlando, Florida

July 2009 Sampling Event

Revision No. 00

Contract No. N62470-08-D-1006
Task Order No. JM05

Submitted to:

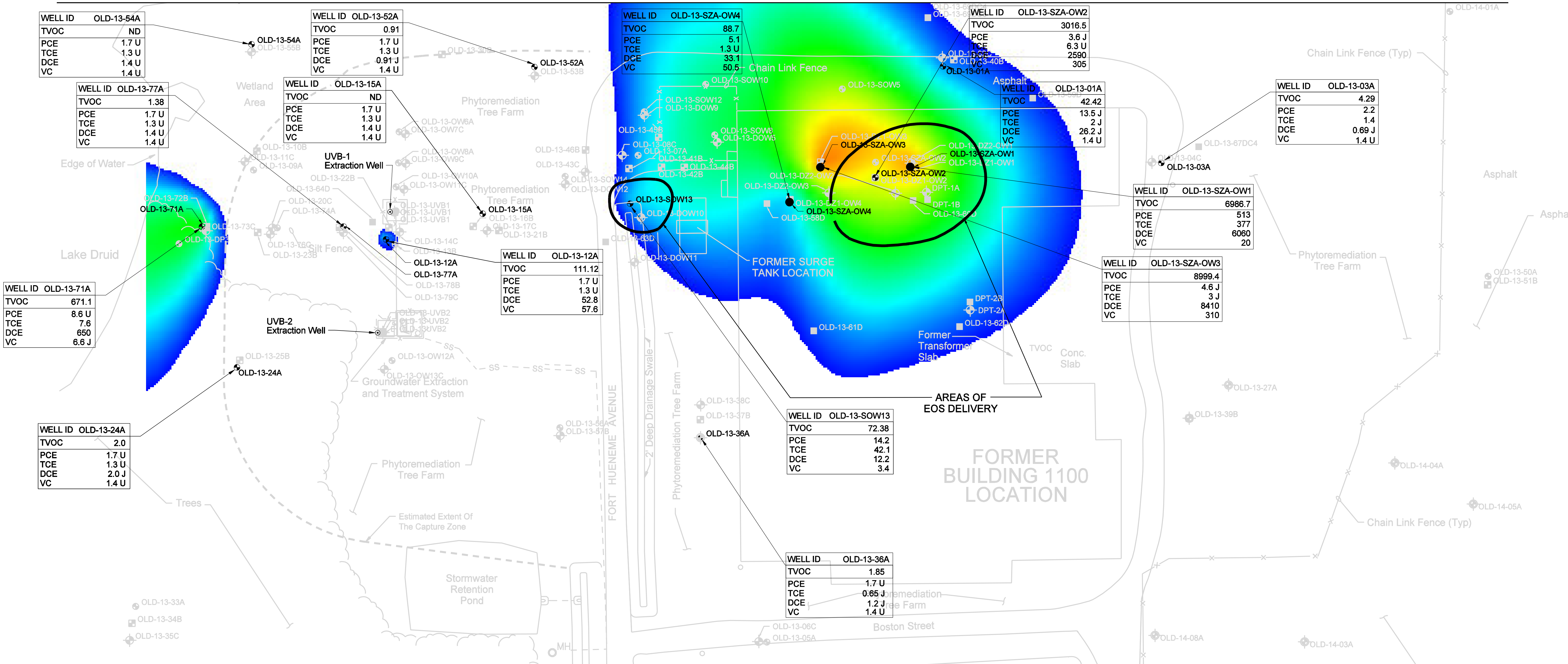
U.S. Naval Facilities
Engineering Command
Southeast

Prepared by:

AGVIQ Environmental Services
CH2M HILL Joint Venture

1000 Abernathy Road
Northpark 400, Suite 1600
Atlanta, GA 30328

November 2009



LEGEND

- Existing Monitoring Well Location (not sampled)
- Antimony Plume Monitoring Well
- EOS Observation Well
- Monitoring Well (MW)
  - VOC Plume Monitoring Well (Shallow)
  - VOC Plume Monitoring Well (Deep)
  - VOC Plume Monitoring Well (Intermediate)
  - Shallow ISCO System Monitoring Well
- Groundwater extraction and treatment system capture zone (Approx.)
- Area of EOS Delivery

Notes:

1. Samples collected July 2009.
2. Concentrations are in micrograms per liter (µg/L).

   The cleanup criteria for VOCs are:

cis,-1,2-Dichloroethene (DCE)	70 µg/L
Tetrachloroethene (PCE)	3 µg/L
Trichloroethene (TCE)	3 µg/L
Vinyl Chloride (VC)	1 µg/L

3. Total VOC (TVOC) isoconcentration contours are approximate.
4. ND : No detections above reporting limits
   J : Estimated Concentration U : Not detected at reporting limit
5. TVOC values based on all detected VOCs by Method 8260.
6. Color plumes identify TVOC concentrations above 20ug/L.

LEGEND

TVOC

10,000 ug/L
5,000 ug/L
2,000 ug/L
1,000 ug/L
500 ug/L
200 ug/L
100 ug/L
50 ug/L
20 ug/L

N

0 60 120

Scale: 1" = 60'

FIGURE 2-7

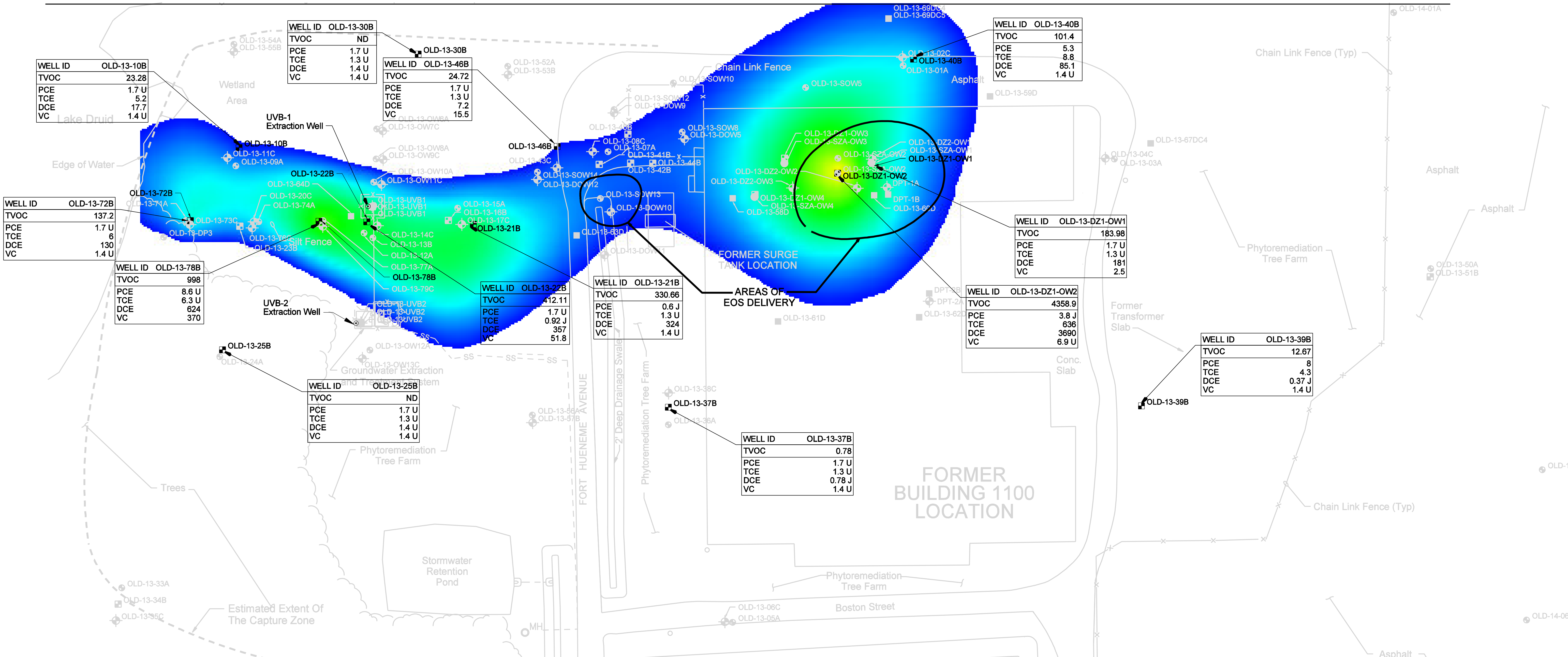
Total VOCs Detected In Shallow Surficial Aquifer Groundwater (July 2009)

Operable Unit 4

Naval Training Center, Orlando, FL

CH2MHILL

July2-7.dgn
11-SEPTEMBER-2009



WELL ID	OLD-13-10B
TVOC	23.28
PCE	1.7 U
TCE	5.2
DCE	17.7
VC	1.4 U

WELL ID	OLD-13-30B
TVOC	ND
PCE	1.7 U
TCE	1.3 U
DCE	1.4 U
VC	1.4 U

WELL ID	OLD-13-46B
TVOC	24.72
PCE	1.7 U
TCE	1.3 U
DCE	7.2
VC	15.5

WELL ID	OLD-13-40B
TVOC	101.4
PCE	5.3
TCE	8.8
DCE	85.1
VC	1.4 U

WELL ID	OLD-13-72B
TVOC	137.2
PCE	1.7 U
TCE	6
DCE	130
VC	1.4 U

WELL ID	OLD-13-78B
TVOC	998
PCE	8.6 U
TCE	6.3 U
DCE	624
VC	370

WELL ID	OLD-13-22B
TVOC	412.11
PCE	1.7 U
TCE	0.92 J
DCE	357
VC	51.8

WELL ID	OLD-13-21B
TVOC	330.66
PCE	0.6 J
TCE	1.3 U
DCE	324
VC	1.4 U

WELL ID	OLD-13-DZ1-OW1
TVOC	183.98
PCE	1.7 U
TCE	1.3 U
DCE	181
VC	2.5

WELL ID	OLD-13-DZ1-OW2
TVOC	4358.9
PCE	3.8 J
TCE	636
DCE	3690
VC	6.9 U

WELL ID	OLD-13-39B
TVOC	12.67
PCE	8
TCE	4.3
DCE	0.37 J
VC	1.4 U

WELL ID	OLD-13-25B
TVOC	ND
PCE	1.7 U
TCE	1.3 U
DCE	1.4 U
VC	1.4 U

WELL ID	OLD-13-37B
TVOC	0.78
PCE	1.7 U
TCE	1.3 U
DCE	0.78 J
VC	1.4 U

LEGEND

Existing Monitoring Well Location (not sampled)
Antimony Plume Monitoring Well
EOS Observation Well
Monitoring Well (MW)
VOC Plume Monitoring Well (Shallow)
VOC Plume Monitoring Well (Deep)
VOC Plume Monitoring Well (Intermediate)
Deep ISCO System Monitoring Well
Groundwater extraction and treatment system capture zone (Approx.)
Area of EOS Delivery

Notes:

1. Samples collected July 2009.
2. Concentrations are in micrograms per liter (µg/L).

   The cleanup criteria for VOCs are:

cis,-1,2-Dichloroethene (DCE)	70 µg/L
Tetrachloroethene (PCE)	3 µg/L
Trichloroethene (TCE)	3 µg/L
Vinyl Chloride (VC)	1 µg/L

3. Total VOC (TVOC) isoconcentration contours are approximate.
4. ND : No detections above reporting limits J : Estimated Concentration
   U : Not detected at reporting limit
5. TVOC values based on all detected VOCs by Method 8260.
6. Color plumes identify TVOC concentrations above 20ug/L.

LEGEND

TVOC

10,000 ug/L
5,000 ug/L
2,000 ug/L
1,000 ug/L
500 ug/L
200 ug/L
100 ug/L
50 ug/L
20 ug/L

0 60 120

Scale: 1" = 60'

FIGURE 2-8

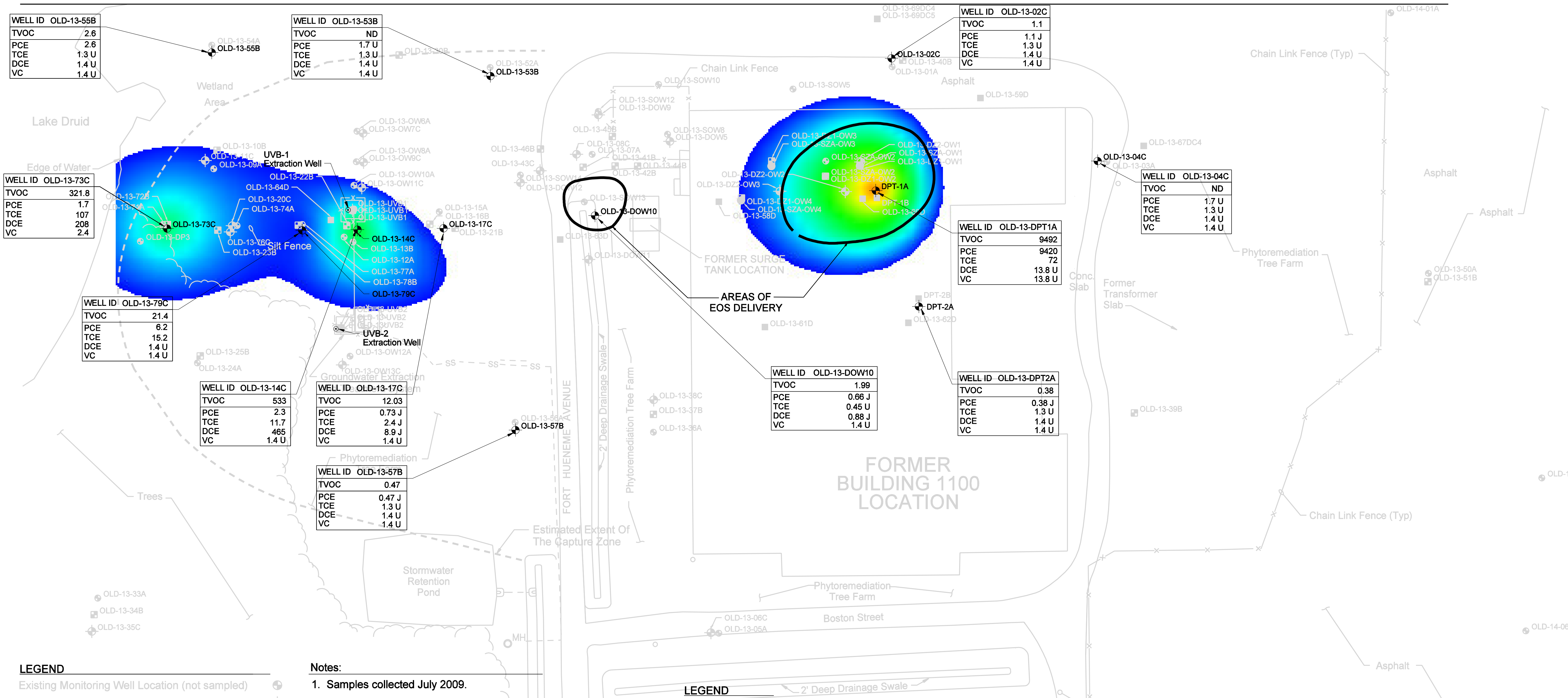
Total VOCs Detected in Intermediate Surficial Aquifer Groundwater (July 2009)

Operable Unit 4

Naval Training Center, Orlando, FL

CH2MHILL

July 2-8.dgn
11-SEPTEMBER-2009



LEGEND

- Existing Monitoring Well Location (not sampled)
- Antimony Plume Monitoring Well
- EOS Observation Well
- Monitoring Well (MW)
  - VOC Plume Monitoring Well (Shallow)
  - VOC Plume Monitoring Well (Deep)
  - VOC Plume Monitoring Well (Intermediate)
  - Deep ISCO System Monitoring Well
- Groundwater extraction and treatment system capture zone (Approx.)
- Area of EOS Delivery

Notes:

1. Samples collected July 2009.
2. Concentrations are in micrograms per liter (µg/L).

   The cleanup criteria for VOCs are:

cis,-1,2-Dichloroethene (DCE)	70 µg/L
Tetrachloroethene (PCE)	3 µg/L
Trichloroethene (TCE)	3 µg/L
Vinyl Chloride (VC)	1 µg/L
3. Total VOC (TVOC) isoconcentration contours are approximate.
4. ND : No detections above reporting limits J : Estimated Concentration
   U : Not detected at reporting limit
5. TVOC values based on all detected VOCs by Method 8260.
6. Color plumes identify TVOC concentrations above 20ug/L.

LEGEND

TVOC

10,000 ug/L
5,000 ug/L
2,000 ug/L
1,000 ug/L
500 ug/L
200 ug/L
100 ug/L
50 ug/L
20 ug/L

N

0 60 120

Scale: 1" = 60'

FIGURE 2-9

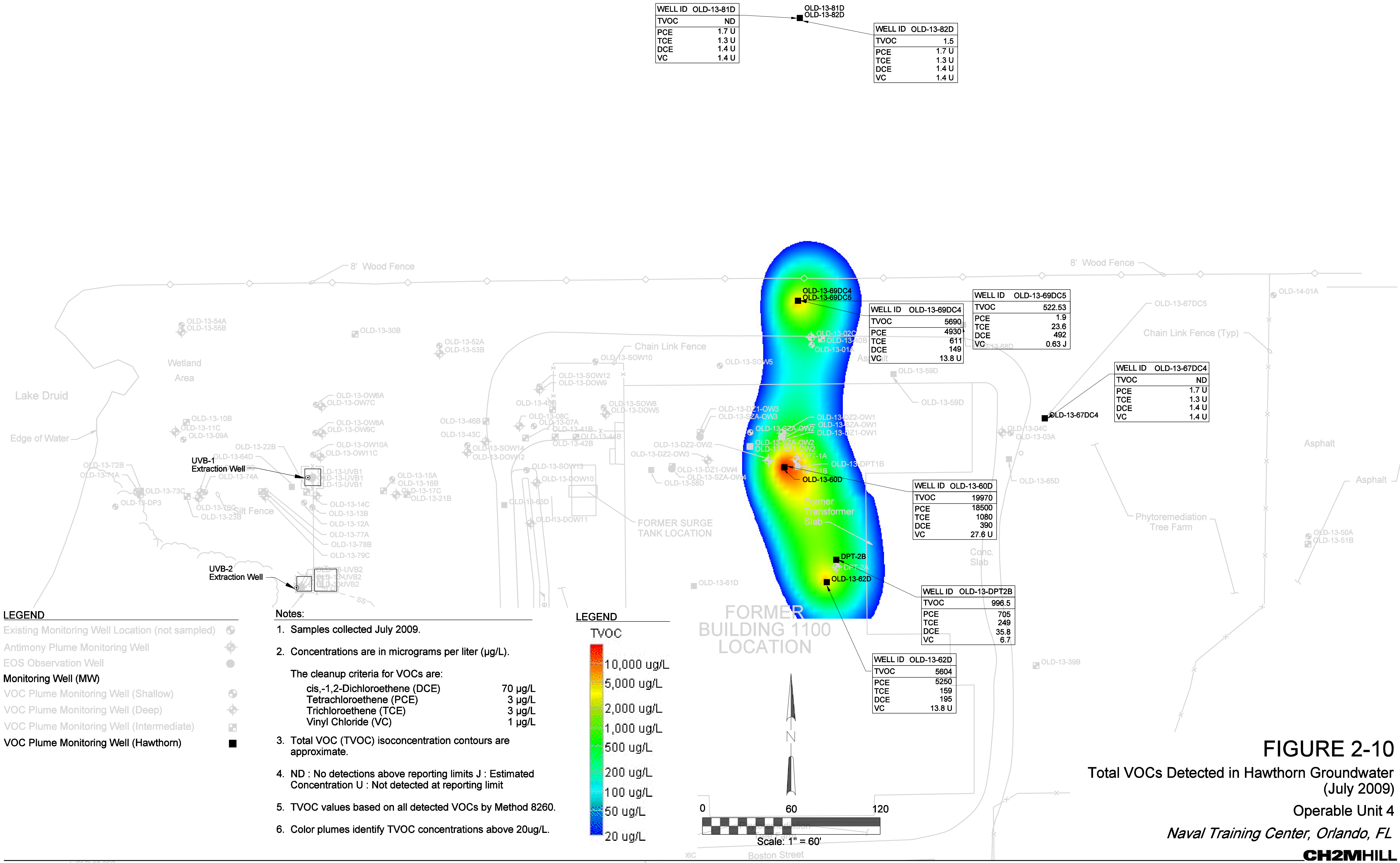
Total VOCs Detected in Deep Surficial Aquifer Groundwater (July 2009)

Operable Unit 4

Naval Training Center, Orlando, FL

CH2MHILL

July 2-9.dgn
11-SEPTEMBER-2009



Notes:

1. Samples collected July 2009.
2. Concentrations are in micrograms per liter (µg/L).

   The cleanup criteria for VOCs are:

cis,-1,2-Dichloroethene (DCE)	70 µg/L
Tetrachloroethene (PCE)	3 µg/L
Trichloroethene (TCE)	3 µg/L
Vinyl Chloride (VC)	1 µg/L

3. Total VOC (TVOC) isoconcentration contours are approximate.
4. ND : No detections above reporting limits J : Estimated Concentration U : Not detected at reporting limit
5. TVOC values based on all detected VOCs by Method 8260.
6. Color plumes identify TVOC concentrations above 20ug/L.

FIGURE 2-10

Total VOCs Detected in Hawthorn Groundwater (July 2009)

Operable Unit 4

Naval Training Center, Orlando, FL

CH2MHILL

Remedial Action Completion Report Enhanced Reductive Dechlorination at Operable Unit 4

Former Naval Training Center Orlando Orlando, Florida

Revision No. 00

Contract No. N62467-01-D-0331
Contract Task Order No. 0058

Submitted to:

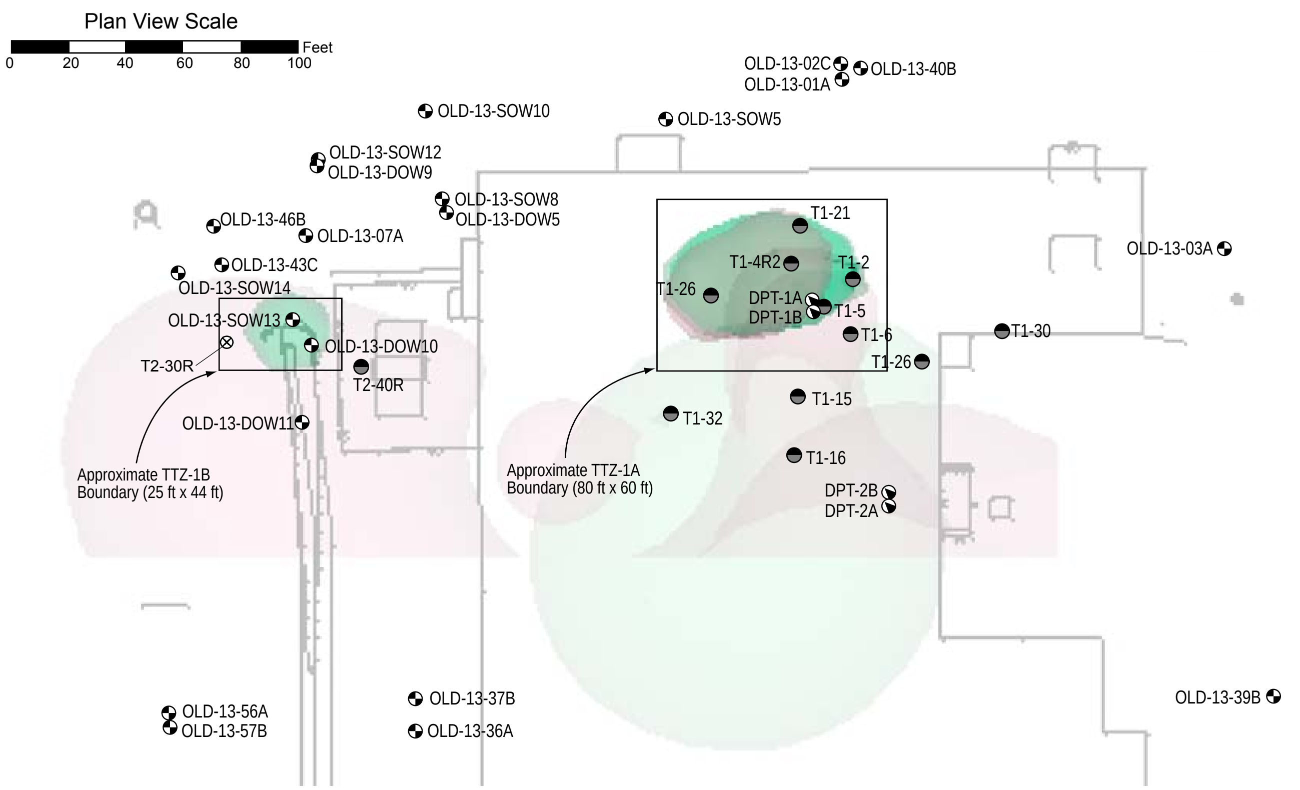
NAVFAC Naval Facilities Engineering Command SOUTHERN DIVISION

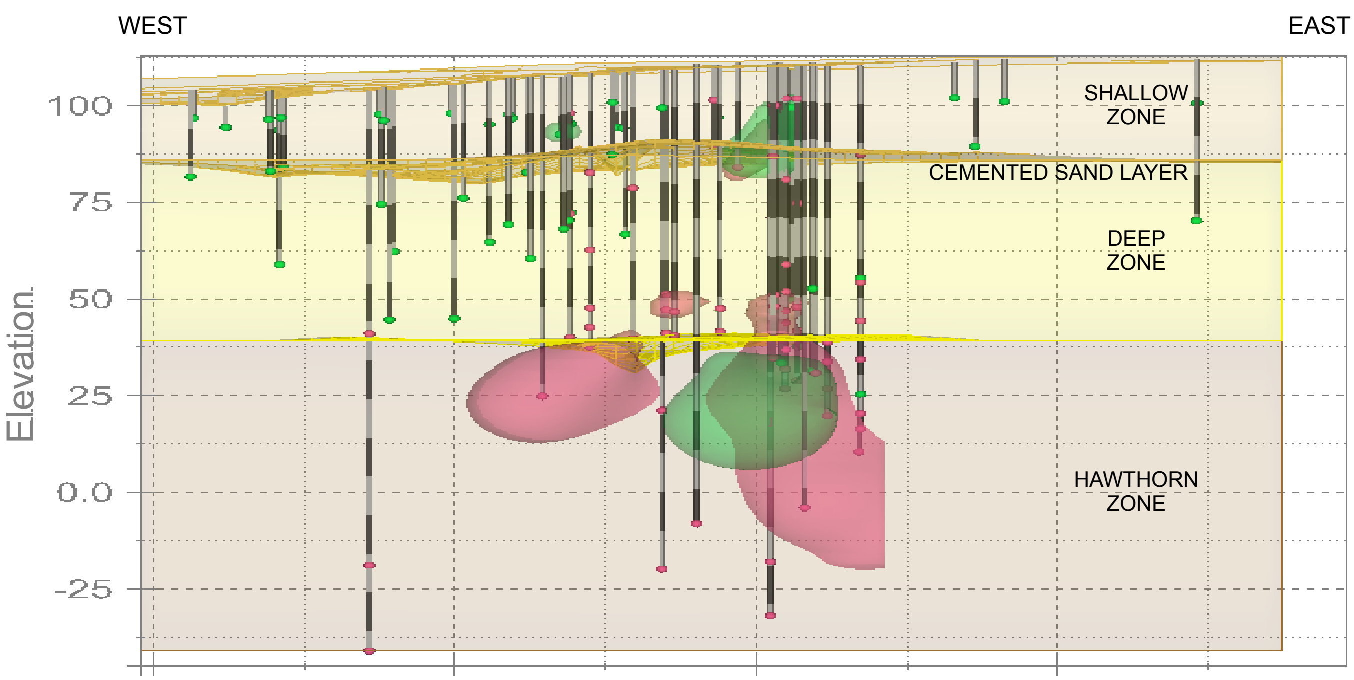
U.S. Naval Facilities
Engineering Command,
Southeast

Prepared by:

CH2MHILL Constructors, Inc.
Northpark 400
1000 Abernathy Road
Suite 1600 Atlanta, GA 30328

December 2009





North

NOTE

TTZ-1A and TTZ-1B are defined using 3-dimensional kriging of groundwater data at a PCE concentration greater than 2,000 ug/L.

Expansion of TTZ-1B due to Electron Capture Detector results from MIP boring TZ-30R.

Building 1100 demolished in March 2004 shown as a site reference.

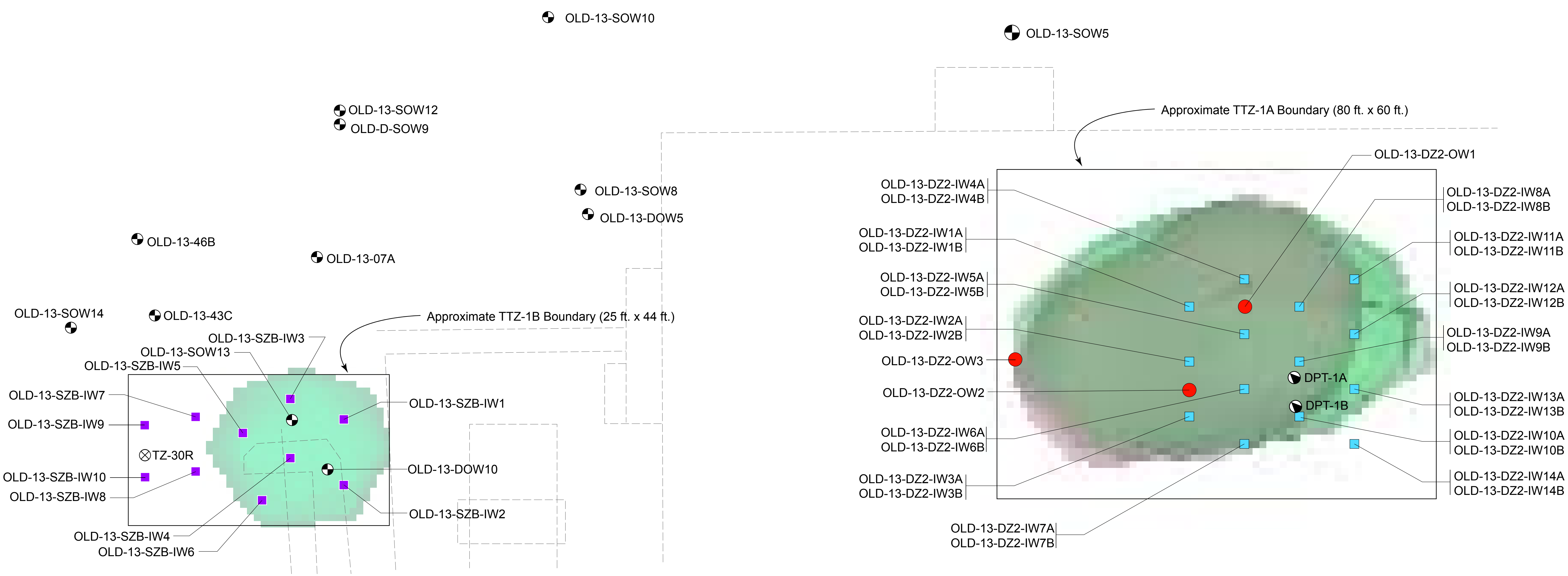
LEGEND

- Monitoring Well OLD-13-56A
- Micro Well DPT-1A
- MIP Confirmation Sample Location T1-21
- MIP Boring
- Extent of soil contamination is defined using 3-dimensional kriging at a PCE concentration greater than 1,000 µg/kg.
- Extent of groundwater contamination is defined using 3-dimensional kriging at a PCE concentration greater than 2,000 µg/L.

FIGURE 2-5
Plan and West-East Profile View of PCE TTZ-1
OU4, Orlando Naval Training Center
Orlando, Florida

CH2MHILL

ES082006013ATL ONTC-101.ai



LEGEND

- Monitoring Well
- Micro Well
- MIP Boring
- Shallow Zone B Injection Well (Screen Interval 10 to 20 Feet BLS)
- Injection Well Pair - Deep Zone Interval D2 (Screen Interval 53 to 58 and 60 to 65 Feet BLS)
- Observation Well - Deep Zone Interval D2 (Screen Interval 55 to 65 Feet BLS)
- Extent of soil contamination is defined using 3-dimensional kriging at a PCE concentration greater than 1,000 µg/kg.
- Extent of groundwater contamination is defined using 3-dimensional kriging at a PCE concentration greater than 2,000 µg/L.

NOTES

Target treatment zone defined using 3-dimensional kriging at a PCE concentration greater than 2,000 µg/L.

Building 1100 demolished in March 2004 shown as a site reference.

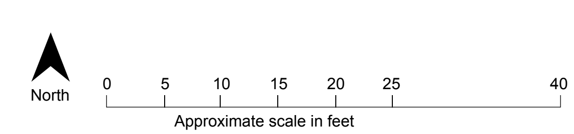
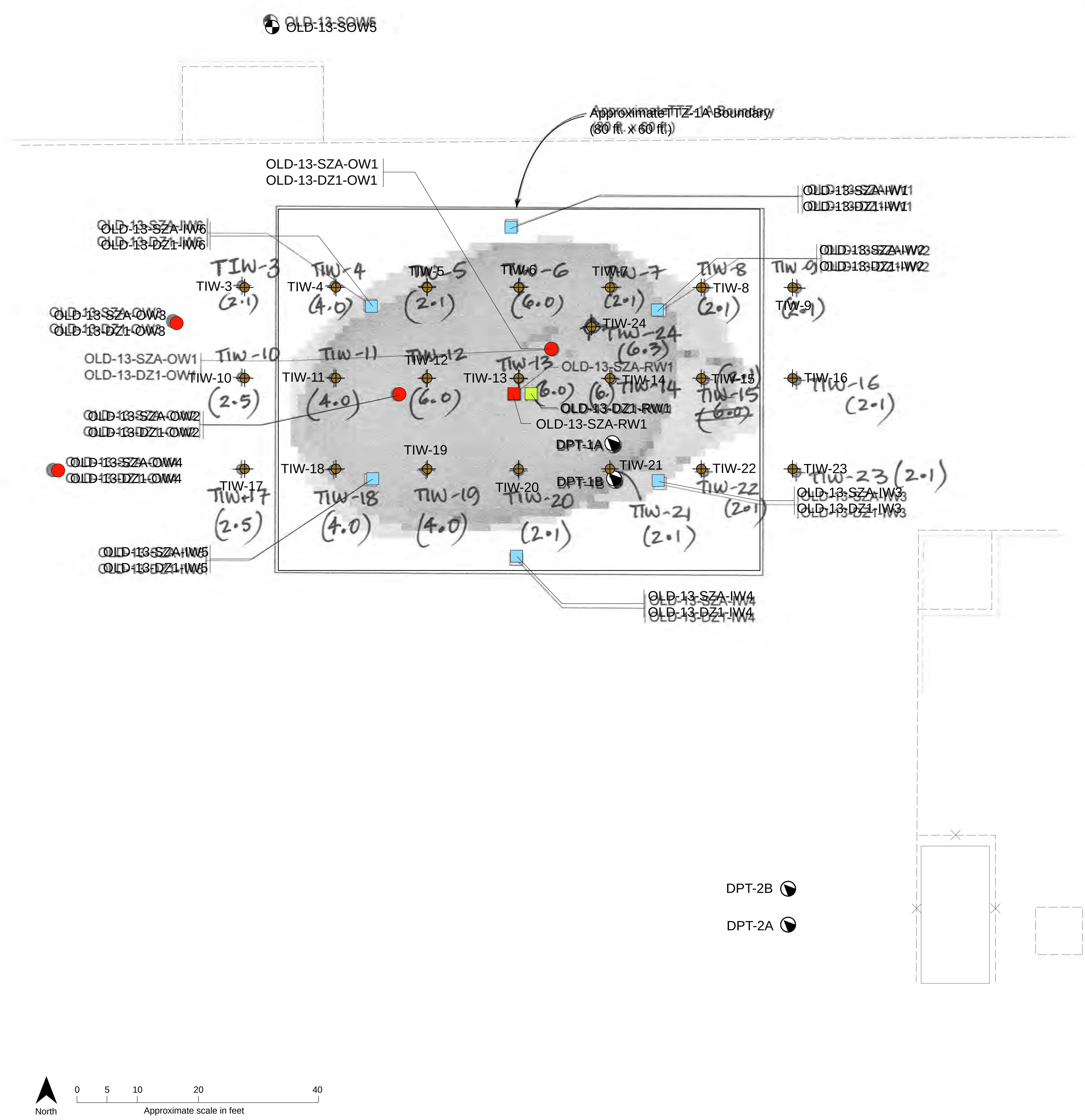


FIGURE 2-2
EOS Direct Injection Well Layout -
Shallow Zone B and Deep Zone Interval D2
OU4, Orlando Naval Training Center
Orlando, Florida

ES082006013ATL ONTC-102.ai

CH2MHILL



LEGEND

- Temporary Injection Well
- Monitoring Well
- Micro Well DPT-1A
- Recovery Well - Shallow Zone A (Screen Interval 5 to 20 Feet BLS)
- Recovery Well - Shallow Zone D1 (Screen Interval 25 to 30 Feet BLS)
- Injection Well Pair (Screen Interval 5 to 20 and 25 to 30 Feet BLS)
- Observation Well Pair (Screen Interval 5 to 20 and 25 to 30 Feet BLS)
- (2.1) Emulsified Vegetable Oil Concentration
- Extent of soil contamination is defined using 3-dimensional kriging at a PCE concentration greater than 1,000 µg/kg.
- Extent of groundwater contamination is defined using 3-dimensional kriging at a PCE concentration greater than 2,000 µg/L.

NOTES

Target treatment zone defined using 3-dimensional kriging at a PCE concentration greater than 2,000 µg/L.

Building 1100 demolished in March 2004 shown as a site reference.

FIGURE 2-5
EOS Direct Injection Layout - 15 Ft. Spacing
Shallow Zone A and Deep Zone Interval D1
OU4, Orlando Naval Training Center
Orlando, Florida

ES052009001ATL ONTC-102.ai

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APPENDIX C

COST ESTIMATES

Surficial Aquifer Groundwater Alternative V-8: Land Use Controls, In-Situ Bio, Air Stripping, MNA
Operable Unit 4
NTC Orlando, Florida
Capital Cost

Item	Quantity	Unit	Unit Cost				Total Cost				Total Direct
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	Cost
1 PROJECT DOCUMENTS/INSTITUTIONAL CONTROLS											
1.1 Prepare Documents & Plans including Permits	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
1.2 Prepare SAP Documents & Plans	250	hr			$39.00		$0	$0	$9,750	$0	$9,750
1.3 Prepare LUCs and 5-year Review Plan	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
1.4 Modify Master Plan and Prepare Deed Restrictions	80	hr			$39.00		$0	$0	$3,120	$0	$3,120
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Drill Rig Equipment Mobilization/Demobilization	1	ea	$2,500.00				$2,500	$0	$0	$0	$2,500
2.3 Equipment Mobilization/Demobilization	2	ea			$183.00	$518.00	$0	$0	$366	$1,036	$1,402
3 FIELD SUPPORT											
3.1 Office Trailer	2	mo				$360.00	$0	$0	$0	$720	$720
3.2 Field Office Equipment, Utilities, & Support	2	mo		$519.00			$0	$1,038	$0	$0	$1,038
3.3 Storage Trailer	2	mo				$94.00	$0	$0	$0	$188	$188
3.4 Utility Connection/Disconnection (phone/electric	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3.5 Construction Layout Survey	2	day	$1,800.00				$3,600	$0	$0	$0	$3,600
3.6 Site Superintendent	30	day		$123.00	$384.64		$0	$3,690	$11,539	$0	$15,229
3.7 Site Health & Safety and QA/QC	30	day		$123.00	$307.68		$0	$3,690	$9,230	$0	$12,920
3.8 Underground Utility Clearance	1	ls	$10,000.00				$10,000	$0	$0	$0	$10,000
4 DECONTAMINATION											
4.1 Decontamination Services	2	mo		$1,220.00	$2,245.00	$1,550.00	$0	$2,440	$4,490	$3,100	$10,030
4.2 Equipment Decon Pad	1	ls		$7,000.00	$6,500.00	$1,200.00	$0	$7,000	$6,500	$1,200	$14,700
4.3 Decon Water	2,000	gal		$0.20			$0	$400	$0	$0	$400
4.4 Decon Water Storage Tank, 6,000 gallon	2	mo				$780.00	$0	$0	$0	$1,560	$1,560
4.5 Clean Water Storage Tank, 4,000 gallon	2	mo				$702.00	$0	$0	$0	$1,404	$1,404
4.6 Disposal of Decon Waste (liquid & solid)	2	mo	$985.00				$1,970	$0	$0	$0	$1,970
5 INJECTION WELLS											
5.1 Hollow Stem Auger, 12 wells	240	lf	$40.00				$9,600	$0	$0	$0	$9,600
5.2 Well Heads	12	ea	$150.00				$1,800	$0	$0	$0	$1,800
6 EOS INJECTION											
6.1 EOS	14	drum		$900.00			$0	$12,600	$0	$0	$12,600
6.2 Pressurized Injection System: Equipment and Materials	1	ls	$20,000.00				$20,000	$0	$0	$0	$20,000
6.3 Equipment Construction	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000
6.4 Travel and Other expenses	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
6.5 Site Work - Labor - Technicians	104	hr	$130.00				$13,520	$0	$0	$0	$13,520
6.6 Site Restoration - topsoil/seed	1	ls	$1,625.00				$1,625	$0	$0	$0	$1,625
7 POST CONSTRUCTION DOCUMENTS											
7.1 Completion Report	250	hr			$39.00		$0	$0	$9,750	$0	$9,750
Subtotal							$73,865	$31,858	$70,346	$12,708	$188,777
Overhead on Labor Cost @ 30%									$21,104		$21,104
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$7,387	$3,186	$7,035	$1,271	$18,878
Tax on Materials and Equipment @ 6%								$1,911		$762	$2,674
Total Direct Cost							$81,252	$36,955	$98,484	$14,741	$231,432
Indirects on Total Direct Cost @ 20%											$46,286
Profit on Total Direct Cost @ 10%											$23,143

NTC Orlando, Florida
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
Subtotal											$300,861
Health & Safety Monitoring @ 1%											$3,009
Total Field Cost											$303,870
Contingency on Total Field Cost @ 20%											$60,774
Engineering on Total Field Cost @ 15%											$45,581
TOTAL COST											**$410,225**

Surficial Aquifer Groundwater Alternative V-8: Land Use Controls, In-Situ Bio, Air Stripping, MNA
Operable Unit 4
NTC Orlando, Florida
Reinjection Year 4
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
1 PROJECT DOCUMENTS/INSTITUTIONAL CONTROLS											
1.1 Prepare Documents & Plans including Permits	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
1.2 Prepare SAP Documents & Plans	0	hr			$39.00		$0	$0	$0	$0	$0
1.3 Prepare LUCs and 5-year Review Plar	0	hr			$39.00		$0	$0	$0	$0	$0
1.4 Modify Master Plan and Prepare Deed Restrictions	0	hr			$39.00		$0	$0	$0	$0	$0
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	0	ls		$1,000.00		$3,500.00	$0	$0	$0	$0	$0
2.2 Drill Rig Equipment Mobilization/Demobilization	0	ea	$2,500.00				$0	$0	$0	$0	$0
2.3 Equipment Mobilization/Demobilization	0	ea			$183.00	$518.00	$0	$0	$0	$0	$0
3 FIELD SUPPORT											
3.1 Office Trailer	0	mo				$360.00	$0	$0	$0	$0	$0
3.2 Field Office Equipment, Utilities, & Support	0	mo		$519.00			$0	$0	$0	$0	$0
3.3 Storage Trailer	0	mo				$94.00	$0	$0	$0	$0	$0
3.4 Utility Connection/Disconnection (phone/electric	0	ls	$1,250.00				$0	$0	$0	$0	$0
3.5 Construction Layout Survey	0	day	$1,800.00				$0	$0	$0	$0	$0
3.6 Site Superintendent	5	day		$123.00	$384.64		$0	$615	$1,923	$0	$2,538
3.7 Site Health & Safety and QA/QC	0	day		$123.00	$307.68		$0	$0	$0	$0	$0
3.8 Underground Utility Clearance	0	ls	$10,000.00				$0	$0	$0	$0	$0
4 DECONTAMINATION											
4.1 Decontamination Services	1	mo		$1,220.00	$2,245.00	$1,550.00	$0	$1,220	$2,245	$1,550	$5,015
4.2 Equipment Decon Pad	0	ls		$7,000.00	$6,500.00	$1,200.00	$0	$0	$0	$0	$0
4.3 Decon Water	1,000	gal		$0.20			$0	$200	$0	$0	$200
4.4 Decon Water Storage Tank, 6,000 gallon	0	mo				$780.00	$0	$0	$0	$0	$0
4.5 Clean Water Storage Tank, 4,000 gallon	0	mo				$702.00	$0	$0	$0	$0	$0
4.6 Disposal of Decon Waste (liquid & solid)	1	mo	$985.00				$985	$0	$0	$0	$985
5 INJECTION WELLS											
5.1 Hollow Stem Auger, 12 wells	0	lf	$40.00				$0	$0	$0	$0	$0
5.2 Well Heads	0	ea	$150.00				$0	$0	$0	$0	$0
6 EOS INJECTION											
6.1 EOS	14	drum		$900.00			$0	$12,600	$0	$0	$12,600
6.2 Pressurized Injection System: Equipment and Materials	1	ls	$20,000.00				$20,000	$0	$0	$0	$20,000
6.3 Equipment Construction	0	ls	$5,000.00				$0	$0	$0	$0	$0
6.4 Travel and Other expenses	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
6.5 Site Work - Labor - Technicians	104	hr	$130.00				$13,520	$0	$0	$0	$13,520
6.6 Site Restoration - topsoil/seed	0	ls	$1,625.00				$0	$0	$0	$0	$0
7 POST CONSTRUCTION DOCUMENTS											
7.1 Completion Report	250	hr			$39.00		$0	$0	$9,750	$0	$9,750
Subtotal							$37,505	$14,635	$21,718	$1,550	$75,408
Overhead on Labor Cost @ 30%									$6,515		$6,515
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$3,751	$1,464	$2,172	$155	$7,541
Tax on Materials and Equipment @ 6%								$878		$93	$971
Total Direct Cost							$41,256	$16,977	$30,405	$1,798	$90,436
Indirects on Total Direct Cost @ 10%											$9,044
Profit on Total Direct Cost @ 10%											$9,044

NTC Orlando, Florida
Reinjection Year 4
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
Subtotal											$108,523
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$108,523
Contingency on Total Field Cost @ 20%											$21,705
Engineering on Total Field Cost @ 20%											$21,705
TOTAL COST											**$151,932**

Surficial Aquifer Groundwater Alternative V-8: Land Use Controls, In-Situ Bio, Air Stripping, MNA
Operable Unit 4
NTC Orlando, Florida
Operation and Maintenance Costs per Year

	Item	Qty	Unit	Unit Cost	Subtotal Cost	Notes
1	Maintenance/Repair of Monitoring Wells	1	ls	$1,000.00	$1,000	
2a	Energy - Electric	26,140	kWh	$0.12	$3,058	Total of 4 HP for Air Stripper
2b	Energy - Electric	6,535	kWh	$0.12	$765	Total of 1 HP for two well pumps
3	O & M for Air Stripper	1	ls	$5,000.00	$5,000	
	Cost for One Year Operation (years 1 - 10				$9,823	
1	Maintenance/Repair of Monitoring Wells	1	ls	$1,000.00	$1,000	
	Cost for One Year Operation (years 11 - 30				$1,000	

Costs assume that treated water discharge will be directed to subsurface and not to city sewer

Surficial Aquifer Groundwater Alternative V-8: Land Use Controls, In-Situ Bio, Air Stripping, MNA
Operable Unit 4
NTC Orlando, Florida
Annual Cost

Item	Item Cost Years 1 - 5	Item Cost Years 6 - 10	Item Cost Years 11 - 15	Item Cost Years 16 - 30	Item Cost every 5 years	Notes
Site Inspection & Report	$3,200	$3,200	$3,200	$3,200		One-day visit to verify LUCs
Groundwater Water Sampling	$14,760	$9,840	$6,280	$3,200		Labor and supplies to collect samples from 37 wells (annual event) and 16 wells (semi-annual event), semi-annually years 1 through 5 & annually years 6 through 30. The number of wells sampled each year decreases after Year 6.
Groundwater Analysis Annual Event	$9,200	$8,200	$7,200	$4,600		VOCs, MNA and Miscellaneous Parameters
Groundwater Analysis Semi-annual Event	$2,700					VOCs at 16 wells and Antimony at 5 wells
Quarterly Sampling of IRA System	$1,000	$1,000				Years 1 through 10, treatment system influent & effluent
Sampling Reports	$8,000	$8,000	$4,000	$4,000		Years 1 through 10 include treatment system
Five-Year Review					$6,700	
Subtotal	$38,860	$30,240	$20,680	$15,000	$6,700	
Contingency @ 10%	$3,886	$3,024	$2,068	$1,500	$670	
TOTAL	**$42,746**	**$33,264**	**$22,748**	**$16,500**	**$7,370**	

Surficial Aquifer Groundwater Alternative V-8: Land Use Controls, In-Situ Bio, Air Stripping, MNA
Operable Unit 4
NTC Orlando, Florida
Present Worth Analysis

Year	Capital Cost	Operation & Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.3%	Present Worth
0	$410,225			$410,225	1.000	$410,225
1		$9,823	$42,746	$52,569	0.978	$51,387
2		$9,823	$42,746	$52,569	0.956	$50,232
3		$9,823	$42,746	$52,569	0.934	$49,102
4	$151,932	$9,823	$42,746	$204,501	0.913	$186,721
5		$9,823	$50,116	$59,939	0.893	$53,497
6		$9,823	$33,264	$43,087	0.872	$37,592
7		$9,823	$33,264	$43,087	0.853	$36,747
8		$9,823	$33,264	$43,087	0.834	$35,920
9		$9,823	$33,264	$43,087	0.815	$35,113
10		$9,823	$40,634	$50,457	0.797	$40,194
11		$1,000	$22,748	$23,748	0.779	$18,492
12		$1,000	$22,748	$23,748	0.761	$18,077
13		$1,000	$22,748	$23,748	0.744	$17,670
14		$1,000	$22,748	$23,748	0.727	$17,273
15		$1,000	$30,118	$31,118	0.711	$22,125
16		$1,000	$16,500	$17,500	0.695	$12,163
17		$1,000	$16,500	$17,500	0.679	$11,889
18		$1,000	$16,500	$17,500	0.664	$11,622
19		$1,000	$16,500	$17,500	0.649	$11,361
20		$1,000	$23,870	$24,870	0.635	$15,782
21		$1,000	$16,500	$17,500	0.620	$10,855
22		$1,000	$16,500	$17,500	0.606	$10,611
23		$1,000	$16,500	$17,500	0.593	$10,373
24		$1,000	$16,500	$17,500	0.579	$10,140
25		$1,000	$23,870	$24,870	0.566	$14,086
26		$1,000	$16,500	$17,500	0.554	$9,689
27		$1,000	$16,500	$17,500	0.541	$9,471
28		$1,000	$16,500	$17,500	0.529	$9,258
29		$1,000	$16,500	$17,500	0.517	$9,050
30		$1,000	$23,870	$24,870	0.506	$12,572
					TOTAL PRESENT WORTH	**$1,249,288**

Hawthorn WBZ Groundwater Alternative H-2: Land Use Controls, Groundwater Monitoring, MNA
Operable Unit 4, NTC Orlando, Florida
Capital Cost

Item	Quantity	Unit	Unit Cost				Total Cost				Total Direct Cost
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT DOCUMENTS/INSTITUTIONAL CONTROLS											
1.1 Prepare SAP Documents & Plans	250	hr			$39.00		$0	$0	$9,750	$0	$9,750
1.2 Prepare LUCs and 5-year Review Plan	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
1.3 Modify Master Plan and Prepare Deed Restrictions	80	hr			$39.00		$0	$0	$3,120	$0	$3,120
Subtotal							$0	$0	$20,670	$0	$20,670
Overhead on Labor Cost @ 30%									$6,201		$6,201
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$0	$0	$2,067	$0	$2,067
Tax on Materials and Equipment @ 6%								$0		$0	$0
Total Direct Cost							$0	$0	$28,938	$0	$28,938
Indirects on Total Direct Cost @ 20%											$5,788
Profit on Total Direct Cost @ 10%											$2,894
Subtotal											$37,619
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$37,619
Contingency on Total Field Cost @ 10%											$3,762
Engineering on Total Field Cost @ 0%											$0
TOTAL COST											**$41,381**

Hawthorn WBZ Groundwater Alternative H-2: Land Use Controls, Groundwater Monitoring, MNA
Operable Unit 4, NTC Orlando, Florida
Operation and Maintenance Costs per Year

	Item	Qty	Unit	Unit Cost	Subtotal Cost	Notes
1	Maintenance/Repair of Monitoring Wells	1	ls	$1,000.00	$1,000	
	Cost for One Year Operatior				$1,000	

Hawthorn WBZ Groundwater Alternative H-2: Land Use Controls, Groundwater Monitoring, MNA
Operable Unit 4, NTC Orlando, Florida
Annual Cost

Item	Item Cost Years 1 - 5	Item Cost Years 6 - 50	Item Cost every 5 years	Notes
Site Inspection & Report	$3,200	$3,200		One-day visit to verify LUCs
Groundwater Water Sampling	$3,900	$1,950		Labor and supplies to collect samples from 9 wells, semi-annually years 1 through 5 & annually years 6 through 50.
Groundwater Analysis Annual Event	$2,700	$2,700		VOCs, MNA and Miscellaneous Parameters in 9 wells
Groundwater Analysis Semi-annual Event	$925			VOCs in 6 wells only
Sampling Reports	$8,000	$4,000		
Five-Year Review			$6,700	
Subtotal	$18,725	$11,850	$6,700	
Contingency @ 10%	$1,873	$1,185	$670	
TOTAL	**$20,598**	**$13,035**	**$7,370**	

Hawthorn WBZ Groundwater Alternative H-2: Land Use Controls, Groundwater Monitoring, MNA
Operable Unit 4, NTC Orlando, Florida
Present Worth Analysis

Year	Capital Cost	Operation & Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.3%	Present Worth
0	$41,381			$41,381	1.000	$41,381
1		$1,000	$20,598	$21,598	0.978	$21,112
2		$1,000	$20,598	$21,598	0.956	$20,637
3		$1,000	$20,598	$21,598	0.934	$20,173
4		$1,000	$20,598	$21,598	0.913	$19,720
5		$1,000	$27,968	$28,968	0.893	$25,854
6		$1,000	$13,035	$14,035	0.872	$12,245
7		$1,000	$13,035	$14,035	0.853	$11,970
8		$1,000	$13,035	$14,035	0.834	$11,701
9		$1,000	$13,035	$14,035	0.815	$11,438
10		$1,000	$20,405	$21,405	0.797	$17,051
11		$1,000	$13,035	$14,035	0.779	$10,929
12		$1,000	$13,035	$14,035	0.761	$10,683
13		$1,000	$13,035	$14,035	0.744	$10,443
14		$1,000	$13,035	$14,035	0.727	$10,208
15		$1,000	$20,405	$21,405	0.711	$15,219
16		$1,000	$13,035	$14,035	0.695	$9,754
17		$1,000	$13,035	$14,035	0.679	$9,535
18		$1,000	$13,035	$14,035	0.664	$9,321
19		$1,000	$13,035	$14,035	0.649	$9,111
20		$1,000	$20,405	$21,405	0.635	$13,583
21		$1,000	$13,035	$14,035	0.620	$8,706
22		$1,000	$13,035	$14,035	0.606	$8,510
23		$1,000	$13,035	$14,035	0.593	$8,319
24		$1,000	$13,035	$14,035	0.579	$8,132
25		$1,000	$20,405	$21,405	0.566	$12,123
26		$1,000	$13,035	$14,035	0.554	$7,770
27		$1,000	$13,035	$14,035	0.541	$7,596
28		$1,000	$13,035	$14,035	0.529	$7,425
29		$1,000	$13,035	$14,035	0.517	$7,258
30		$1,000	$20,405	$21,405	0.506	$10,820
31		$1,000	$13,035	$14,035	0.494	$6,935
32		$1,000	$13,035	$14,035	0.483	$6,779
33		$1,000	$13,035	$14,035	0.472	$6,627
34		$1,000	$13,035	$14,035	0.462	$6,478
35		$1,000	$20,405	$21,405	0.451	$9,658
36		$1,000	$13,035	$14,035	0.441	$6,190
37		$1,000	$13,035	$14,035	0.431	$6,051
38		$1,000	$13,035	$14,035	0.421	$5,915
39		$1,000	$13,035	$14,035	0.412	$5,782
40		$1,000	$20,405	$21,405	0.403	$8,620
41		$1,000	$13,035	$14,035	0.394	$5,525
42		$1,000	$13,035	$14,035	0.385	$5,401
43		$1,000	$13,035	$14,035	0.376	$5,279
44		$1,000	$13,035	$14,035	0.368	$5,160
45		$1,000	$20,405	$21,405	0.359	$7,693
46		$1,000	$13,035	$14,035	0.351	$4,931
47		$1,000	$13,035	$14,035	0.343	$4,820
48		$1,000	$13,035	$14,035	0.336	$4,712
49		$1,000	$13,035	$14,035	0.328	$4,606
50		$1,000	$20,405	$21,405	0.321	$6,866
					TOTAL PRESENT WORTH	**$532,757**

Hawthorn WBZ Groundwater Alternative H-3: Land Use Controls, In-Situ Bio, Groundwater Monitoring, MNA
Operable Unit 4, NTC Orlando, Florida
Capital Cost

			Unit Cost				Total Cost				Total Direct
Item	Quantity	Unit	Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	Cost
1 PROJECT DOCUMENTS/INSTITUTIONAL CONTROLS											
1.1 Prepare Documents & Plans including Permits	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
1.2 Prepare SAP Documents & Plans	250	hr			$39.00		$0	$0	$9,750	$0	$9,750
1.3 Prepare LUCs and 5-year Review Plan	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
1.4 Modify Master Plan and Prepare Deed Restrictions	80	hr			$39.00		$0	$0	$3,120	$0	$3,120
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Drill Rig Equipment Mobilization/Demobilization	1	ea	$2,500.00				$2,500	$0	$0	$0	$2,500
2.3 Equipment Mobilization/Demobilization	2	ea			$183.00	$518.00	$0	$0	$366	$1,036	$1,402
3 FIELD SUPPORT											
3.1 Office Trailer	4	mo				$360.00	$0	$0	$0	$1,440	$1,440
3.2 Field Office Equipment, Utilities, & Support	4	mo		$519.00			$0	$2,076	$0	$0	$2,076
3.3 Storage Trailer	4	mo				$94.00	$0	$0	$0	$376	$376
3.4 Utility Connection/Disconnection (phone/electric)	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3.5 Construction Layout Survey	3	day	$1,800.00				$5,400	$0	$0	$0	$5,400
3.6 Site Superintendent	90	day		$123.00	$384.64		$0	$11,070	$34,618	$0	$45,688
3.7 Site Health & Safety and QA/QC	90	day		$123.00	$307.68		$0	$11,070	$27,691	$0	$38,761
3.8 Underground Utility Clearance	1	ls	$10,000.00				$10,000	$0	$0	$0	$10,000
4 DECONTAMINATION											
4.1 Decontamination Services	4	mo		$1,220.00	$2,245.00	$1,550.00	$0	$4,880	$8,980	$6,200	$20,060
4.2 Equipment Decon Pad	1	ls		$7,000.00	$6,500.00	$1,200.00	$0	$7,000	$6,500	$1,200	$14,700
4.3 Decon Water	4,000	gal		$0.20			$0	$800	$0	$0	$800
4.4 Decon Water Storage Tank, 6,000 gallon	4	mo				$780.00	$0	$0	$0	$3,120	$3,120
4.5 Clean Water Storage Tank, 4,000 gallon	4	mo				$702.00	$0	$0	$0	$2,808	$2,808
4.6 Disposal of Decon Waste (liquid & solid)	4	mo	$985.00				$3,940	$0	$0	$0	$3,940
5 INJECTION WELLS											
5.1 Hollow Stem Auger, 58 wells	6,960	lf	$40.00				$278,400	$0	$0	$0	$278,400
5.2 Well Heads	58	ea	$150.00				$8,700	$0	$0	$0	$8,700
6 EOS INJECTION											
6.1 EOS	15	drum		$900.00			$0	$13,500	$0	$0	$13,500
6.2 Pressurized Injection System: Equipment and Materials	1	ls	$20,000.00				$20,000	$0	$0	$0	$20,000
6.3 Equipment Construction	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000
6.4 Travel and Other expenses	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
6.5 Site Work - Labor - Technicians	354	hr	$130.00				$46,020	$0	$0	$0	$46,020
6.6 Site Restoration - topsoil/seed	1	ls	$2,500.00				$2,500	$0	$0	$0	$2,500
7 POST CONSTRUCTION DOCUMENTS											
7.1 Completion Report	250	hr			$39.00		$0	$0	$9,750	$0	$9,750
Subtotal							$386,710	$51,396	$116,375	$19,680	$574,161
Overhead on Labor Cost @ 30%									$34,912		$34,912
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$38,671	$5,140	$11,637	$1,968	$57,416
Tax on Materials and Equipment @ 6%								$3,084		$1,181	$4,265
Total Direct Cost							$425,381	$59,619	$162,925	$22,829	$670,754
Indirects on Total Direct Cost @ 20%											$134,151
Profit on Total Direct Cost @ 10%											$67,075

Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
Subtotal											$871,980
Health & Safety Monitoring @ 1%											$8,720
Total Field Cost											$880,700
Contingency on Total Field Cost @ 20%											$176,140
Engineering on Total Field Cost @ 15%											$132,105
TOTAL COST											**$1,188,945**

Hawthorn WBZ Groundwater Alternative H-3: Land Use Controls, In-Situ Bio, Groundwater Monitoring, MNA
Operable Unit 4, NTC Orlando, Florida
Reinjection Year 5
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
1 PROJECT DOCUMENTS/INSTITUTIONAL CONTROLS											
1.1 Prepare Documents & Plans including Permits	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
1.2 Prepare SAP Documents & Plans	0	hr			$39.00		$0	$0	$0	$0	$0
1.3 Prepare LUCs and 5-year Review Plan	0	hr			$39.00		$0	$0	$0	$0	$0
1.4 Modify Master Plan and Prepare Deed Restrictions	0	hr			$39.00		$0	$0	$0	$0	$0
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.	0	ls		$1,000.00		$3,500.00	$0	$0	$0	$0	$0
2.2 Drill Rig Equipment Mobilization/Demobilization	0	ea	$2,500.00				$0	$0	$0	$0	$0
2.3 Equipment Mobilization/Demobilization	0	ea			$183.00	$518.00	$0	$0	$0	$0	$0
3 FIELD SUPPORT											
3.1 Office Trailer	0	mo				$360.00	$0	$0	$0	$0	$0
3.2 Field Office Equipment, Utilities, & Support	0	mo		$519.00			$0	$0	$0	$0	$0
3.3 Storage Trailer	0	mo				$94.00	$0	$0	$0	$0	$0
3.4 Utility Connection/Disconnection (phone/electric)	0	ls	$1,250.00				$0	$0	$0	$0	$0
3.5 Construction Layout Survey	0	day	$1,800.00				$0	$0	$0	$0	$0
3.6 Site Superintendent	25	day		$123.00	$384.64		$0	$3,075	$9,616	$0	$12,691
3.7 Site Health & Safety and QA/QC	0	day		$123.00	$307.68		$0	$0	$0	$0	$0
3.8 Underground Utility Clearance	0	ls	$10,000.00				$0	$0	$0	$0	$0
4 DECONTAMINATION											
4.1 Decontamination Services	1	mo		$1,220.00	$2,245.00	$1,550.00	$0	$1,220	$2,245	$1,550	$5,015
4.2 Equipment Decon Pad	1	ls		$7,000.00	$6,500.00	$1,200.00	$0	$7,000	$6,500	$1,200	$14,700
4.3 Decon Water	1,000	gal		$0.20			$0	$200	$0	$0	$200
4.4 Decon Water Storage Tank, 6,000 gallon	0	mo				$780.00	$0	$0	$0	$0	$0
4.5 Clean Water Storage Tank, 4,000 gallon	0	mo				$702.00	$0	$0	$0	$0	$0
4.6 Disposal of Decon Waste (liquid & solid)	1	mo	$985.00				$985	$0	$0	$0	$985
5 INJECTION WELLS											
5.1 Hollow Stem Auger, 58 wells	0	lf	$40.00				$0	$0	$0	$0	$0
5.2 Well Heads	0	ea	$150.00				$0	$0	$0	$0	$0
6 EOS INJECTION											
6.1 EOS	12	drum		$900.00			$0	$10,800	$0	$0	$10,800
6.2 Pressurized Injection System: Equipment and Materials	1	ls	$20,000.00				$20,000	$0	$0	$0	$20,000
6.3 Equipment Construction	0	ls	$5,000.00				$0	$0	$0	$0	$0
6.4 Travel and Other expenses	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
6.5 Site Work - Labor - Technicians	286	hr	$130.00				$37,180	$0	$0	$0	$37,180
6.6 Site Restoration - topsoil/seed	0	ls	$2,500.00				$0	$0	$0	$0	$0
7 POST CONSTRUCTION DOCUMENTS											
7.1 Completion Report	250	hr			$39.00		$0	$0	$9,750	$0	$9,750
Subtotal							$61,165	$22,295	$35,911	$2,750	$122,121
Overhead on Labor Cost @ 30%									$10,773		$10,773
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$6,117	$2,230	$3,591	$275	$12,212
Tax on Materials and Equipment @ 6%								$1,338		$165	$1,503
Total Direct Cost							$67,282	$25,862	$50,275	$3,190	$146,609
Indirects on Total Direct Cost @ 10%											$14,661
Profit on Total Direct Cost @ 10%											$14,661

Reinjection Year 5
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
Subtotal											$175,931
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$175,931
Contingency on Total Field Cost @ 20%											$35,186
Engineering on Total Field Cost @ 20%											$35,186
TOTAL COST											**$246,303**

Hawthorn WBZ Groundwater Alternative H-3: Land Use Controls, In-Situ Bio, Groundwater Monitoring, MNA
Operable Unit 4, NTC Orlando, Florida
Reinjection Year 10
Capital Cost

			Unit Cost				Total Cost				Total Direct
Item	Quantity	Unit	Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	Cost
1 PROJECT DOCUMENTS/INSTITUTIONAL CONTROLS											
1.1 Prepare Documents & Plans including Permits	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
1.2 Prepare SAP Documents & Plans	0	hr			$39.00		$0	$0	$0	$0	$0
1.3 Prepare LUCs and 5-year Review Plan	0	hr			$39.00		$0	$0	$0	$0	$0
1.4 Modify Master Plan and Prepare Deed Restrictions	0	hr			$39.00		$0	$0	$0	$0	$0
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.	0	ls		$1,000.00		$3,500.00	$0	$0	$0	$0	$0
2.2 Drill Rig Equipment Mobilization/Demobilization	0	ea	$2,500.00				$0	$0	$0	$0	$0
2.3 Equipment Mobilization/Demobilization	0	ea			$183.00	$518.00	$0	$0	$0	$0	$0
3 FIELD SUPPORT											
3.1 Office Trailer	0	mo				$360.00	$0	$0	$0	$0	$0
3.2 Field Office Equipment, Utilities, & Support	0	mo		$519.00			$0	$0	$0	$0	$0
3.3 Storage Trailer	0	mo				$94.00	$0	$0	$0	$0	$0
3.4 Utility Connection/Disconnection (phone/electric)	0	ls	$1,250.00				$0	$0	$0	$0	$0
3.5 Construction Layout Survey	0	day	$1,800.00				$0	$0	$0	$0	$0
3.6 Site Superintendent	15	day		$123.00	$384.64		$0	$1,845	$5,770	$0	$7,615
3.7 Site Health & Safety and QA/QC	0	day		$123.00	$307.68		$0	$0	$0	$0	$0
3.8 Underground Utility Clearance	0	ls	$10,000.00				$0	$0	$0	$0	$0
4 DECONTAMINATION											
4.1 Decontamination Services	1	mo		$1,220.00	$2,245.00	$1,550.00	$0	$1,220	$2,245	$1,550	$5,015
4.2 Equipment Decon Pad	1	ls		$7,000.00	$6,500.00	$1,200.00	$0	$7,000	$6,500	$1,200	$14,700
4.3 Decon Water	1,000	gal		$0.20			$0	$200	$0	$0	$200
4.4 Decon Water Storage Tank, 6,000 gallon	0	mo				$780.00	$0	$0	$0	$0	$0
4.5 Clean Water Storage Tank, 4,000 gallon	0	mo				$702.00	$0	$0	$0	$0	$0
4.6 Disposal of Decon Waste (liquid & solid)	1	mo	$985.00				$985	$0	$0	$0	$985
5 INJECTION WELLS											
5.1 Hollow Stem Auger, 58 wells	0	lf	$40.00				$0	$0	$0	$0	$0
5.2 Well Heads	0	ea	$150.00				$0	$0	$0	$0	$0
6 EOS INJECTION											
6.1 EOS	8	drum		$900.00			$0	$7,200	$0	$0	$7,200
6.2 Pressurized Injection System: Equipment and Materials	1	ls	$20,000.00				$20,000	$0	$0	$0	$20,000
6.3 Equipment Construction	0	ls	$5,000.00				$0	$0	$0	$0	$0
6.4 Travel and Other expenses	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
6.5 Site Work - Labor - Technicians	178	hr	$130.00				$23,140	$0	$0	$0	$23,140
6.6 Site Restoration - topsoil/seed	0	ls	$2,500.00				$0	$0	$0	$0	$0
7 POST CONSTRUCTION DOCUMENTS											
7.1 Completion Report	250	hr			$39.00		$0	$0	$9,750	$0	$9,750
Subtotal							$47,125	$17,465	$32,065	$2,750	$99,405
Overhead on Labor Cost @ 30%									$9,619		$9,619
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$4,713	$1,747	$3,206	$275	$9,940
Tax on Materials and Equipment @ 6%								$1,048		$165	$1,213
Total Direct Cost							$51,838	$20,259	$44,890	$3,190	$120,177
Indirects on Total Direct Cost @ 10%											$12,018
Profit on Total Direct Cost @ 10%											$12,018

Reinjection Year 10
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
Subtotal											$144,213
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$144,213
Contingency on Total Field Cost @ 20%											$28,843
Engineering on Total Field Cost @ 20%											$28,843
TOTAL COST											**$201,898**

Hawthorn WBZ Groundwater Alternative H-3: Land Use Controls, In-Situ Bio, Groundwater Monitoring, MNA
Operable Unit 4, NTC Orlando, Florida
Reinjection Year 15
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
1 PROJECT DOCUMENTS/INSTITUTIONAL CONTROLS											
1.1 Prepare Documents & Plans including Permits	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
1.2 Prepare SAP Documents & Plans	0	hr			$39.00		$0	$0	$0	$0	$0
1.3 Prepare LUCs and 5-year Review Plan	0	hr			$39.00		$0	$0	$0	$0	$0
1.4 Modify Master Plan and Prepare Deed Restrictions	0	hr			$39.00		$0	$0	$0	$0	$0
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.	0	ls		$1,000.00		$3,500.00	$0	$0	$0	$0	$0
2.2 Drill Rig Equipment Mobilization/Demobilization	0	ea	$2,500.00				$0	$0	$0	$0	$0
2.3 Equipment Mobilization/Demobilization	0	ea			$183.00	$518.00	$0	$0	$0	$0	$0
3 FIELD SUPPORT											
3.1 Office Trailer	0	mo				$360.00	$0	$0	$0	$0	$0
3.2 Field Office Equipment, Utilities, & Support	0	mo		$519.00			$0	$0	$0	$0	$0
3.3 Storage Trailer	0	mo				$94.00	$0	$0	$0	$0	$0
3.4 Utility Connection/Disconnection (phone/electric)	0	ls	$1,250.00				$0	$0	$0	$0	$0
3.5 Construction Layout Survey	0	day	$1,800.00				$0	$0	$0	$0	$0
3.6 Site Superintendent	10	day		$123.00	$384.64		$0	$1,230	$3,846	$0	$5,076
3.7 Site Health & Safety and QA/QC	0	day		$123.00	$307.68		$0	$0	$0	$0	$0
3.8 Underground Utility Clearance	0	ls	$10,000.00				$0	$0	$0	$0	$0
4 DECONTAMINATION											
4.1 Decontamination Services	1	mo		$1,220.00	$2,245.00	$1,550.00	$0	$1,220	$2,245	$1,550	$5,015
4.2 Equipment Decon Pad	1	ls		$7,000.00	$6,500.00	$1,200.00	$0	$7,000	$6,500	$1,200	$14,700
4.3 Decon Water	1,000	gal		$0.20			$0	$200	$0	$0	$200
4.4 Decon Water Storage Tank, 6,000 gallon	0	mo				$780.00	$0	$0	$0	$0	$0
4.5 Clean Water Storage Tank, 4,000 gallon	0	mo				$702.00	$0	$0	$0	$0	$0
4.6 Disposal of Decon Waste (liquid & solid)	1	mo	$985.00				$985	$0	$0	$0	$985
5 INJECTION WELLS											
5.1 Hollow Stem Auger, 58 wells	0	lf	$40.00				$0	$0	$0	$0	$0
5.2 Well Heads	0	ea	$150.00				$0	$0	$0	$0	$0
6 EOS INJECTION											
6.1 EOS	4	drum		$900.00			$0	$3,600	$0	$0	$3,600
6.2 Pressurized Injection System: Equipment and Materials	1	ls	$20,000.00				$20,000	$0	$0	$0	$20,000
6.3 Equipment Construction	0	ls	$5,000.00				$0	$0	$0	$0	$0
6.4 Travel and Other expenses	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
6.5 Site Work - Labor - Technicians	90	hr	$130.00				$11,700	$0	$0	$0	$11,700
6.6 Site Restoration - topsoil/seed	0	ls	$2,500.00				$0	$0	$0	$0	$0
7 POST CONSTRUCTION DOCUMENTS											
7.1 Completion Report	250	hr			$39.00		$0	$0	$9,750	$0	$9,750
Subtotal							$35,685	$13,250	$30,141	$2,750	$81,826
Overhead on Labor Cost @ 30%									$9,042		$9,042
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$3,569	$1,325	$3,014	$275	$8,183
Tax on Materials and Equipment @ 6%								$795		$165	$960
Total Direct Cost							$39,254	$15,370	$42,198	$3,190	$100,011
Indirects on Total Direct Cost @ 10%											$10,001
Profit on Total Direct Cost @ 10%											$10,001

Reinjection Year 15
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
Subtotal											$120,014
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$120,014
Contingency on Total Field Cost @ 20%											$24,003
Engineering on Total Field Cost @ 20%											$24,003
TOTAL COST											**$168,019**

Hawthorn WBZ Groundwater Alternative H-3: Land Use Controls, In-Situ Bio, Groundwater Monitoring, MNA
Operable Unit 4, NTC Orlando, Florida
Operation and Maintenance Costs per Year

	Item	Qty	Unit	Unit Cost	Subtotal Cost	Notes
1	Maintenance/Repair of Monitoring Wells	1	ls	$1,000.00	$1,000	
	Cost for One Year Operatior				$1,000	

Hawthorn WBZ Groundwater Alternative H-3: Land Use Controls, In-Situ Bio, Groundwater Monitoring, MNA
Operable Unit 4, NTC Orlando, Florida
Annual Cost

Item	Item Cost Years 1 - 5	Item Cost Years 6 - 30	Item Cost every 5 years	Notes
Site Inspection & Report	$3,200	$3,200		One-day visit to verify LUCs
Groundwater Water Sampling	$3,900	$1,950		Labor and supplies to collect samples from 9 wells, semi-annually years 1 through 5 & annually years 6 through 30.
Groundwater Analysis Annual Event	$2,700	$2,700		VOCs, MNA and Miscellaneous Parameters
Groundwater Analysis Semi-annual Event	$925			VOCs in 6 wells only
Sampling Reports	$8,000	$4,000		
Five-Year Review			$6,700	
Subtotal	$18,725	$11,850	$6,700	
Contingency @ 10%	$1,873	$1,185	$670	
TOTAL	**$20,598**	**$13,035**	**$7,370**	

Hawthorn WBZ Groundwater Alternative H-3: Land Use Controls, In-Situ Bio, Groundwater Monitoring, MNA
Operable Unit 4, NTC Orlando, Florida
Present Worth Analysis

Year	Capital Cost	Operation & Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.3%	Present Worth
0	$1,188,945			$1,188,945	1.000	$1,188,945
1		$1,000	$20,598	$21,598	0.978	$21,112
2		$1,000	$20,598	$21,598	0.956	$20,637
3		$1,000	$20,598	$21,598	0.934	$20,173
4		$1,000	$20,598	$21,598	0.913	$19,720
5	$246,303	$1,000	$27,968	$275,271	0.893	$245,687
6		$1,000	$13,035	$14,035	0.872	$12,245
7		$1,000	$13,035	$14,035	0.853	$11,970
8		$1,000	$13,035	$14,035	0.834	$11,701
9		$1,000	$13,035	$14,035	0.815	$11,438
10	$201,898	$1,000	$20,405	$223,303	0.797	$177,884
11		$1,000	$13,035	$14,035	0.779	$10,929
12		$1,000	$13,035	$14,035	0.761	$10,683
13		$1,000	$13,035	$14,035	0.744	$10,443
14		$1,000	$13,035	$14,035	0.727	$10,208
15	$168,019	$1,000	$20,405	$189,424	0.711	$134,679
16		$1,000	$13,035	$14,035	0.695	$9,754
17		$1,000	$13,035	$14,035	0.679	$9,535
18		$1,000	$13,035	$14,035	0.664	$9,321
19		$1,000	$13,035	$14,035	0.649	$9,111
20		$1,000	$20,405	$21,405	0.635	$13,583
21		$1,000	$13,035	$14,035	0.620	$8,706
22		$1,000	$13,035	$14,035	0.606	$8,510
23		$1,000	$13,035	$14,035	0.593	$8,319
24		$1,000	$13,035	$14,035	0.579	$8,132
25		$1,000	$20,405	$21,405	0.566	$12,123
26		$1,000	$13,035	$14,035	0.554	$7,770
27		$1,000	$13,035	$14,035	0.541	$7,596
28		$1,000	$13,035	$14,035	0.529	$7,425
29		$1,000	$13,035	$14,035	0.517	$7,258
30		$1,000	$20,405	$21,405	0.506	$10,820
					TOTAL PRESENT WORTH	**$2,056,420**