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Defense Logistics Agency

Defense Supply Center Richmond

ADMINISTRATIVE RECORD COVER SHEET

AR File Number 1416-1

FINAL

ENGINEERING EVALUATION/COST ANALYSIS
NON-TIME CRITICAL REMOVAL ACTION
BUILDING 65
OPERABLE UNIT 8

DEFENSE SUPPLY CENTER-RICHMOND
ENVIRONMENTAL RESTORATION PROGRAM (ERP)

PREPARED FOR

Defense Logistics Agency

And

United States Army Corps of Engineers
Baltimore District

JUNE 2025

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Table of Contents

Table of Contents i
Executive Summary 1-1
1. Introduction 1-1
  1.1 Purpose 1-1
  1.2 Report Organization 1-1
2. Site Characterization 2-1
  2.1 Site Description and Background 2-1
  2.2 Physical and Environmental Setting 2-5
  2.3 Source Area and Nature and Extent of Contamination 2-9
  2.4 Nature and Extent of Groundwater Impacts 2-13
  2.5 Streamlined Risk Evaluation 2-13
3. Identification of Removal Action Objectives 3-1
  3.1 Statutory Limits on Removal Actions 3-1
  3.2 Remedial Action Objectives 3-1
  3.3 Removal Action Scope 3-1
  3.4 Schedule 3-1
  3.5 Planned Remedial Activities 3-1
  3.6 Cleanup Levels 3-1
  3.7 Applicable or Relevant and Appropriate Requirements 3-2
4. Identification and Evaluation of Removal Action Alternatives 4-1
  4.1 Identification of Potentially Applicable Remediation Technologies for Soil 4-1
  4.2 Identification and Screening of Technologies Types and Process Option 4-1
  4.3 Development of Remedial Alternatives 4-3
  4.4 Evaluation of Removal Action Alternatives 4-10
  4.5 Alternative 2 In Situ Treatment of Soil 4-12
  4.6 Alternative 3 Removal Action and Decommissioning 4-13
5. Comparative Analysis of Removal Action Alternatives 5-1
  5.1 Threshold Criteria 5-1
  5.2 Primary Balancing Criteria 5-1
6. Selected Remedial Alternative 6-1
7. References 7-1
Appendix A Supporting Information
  A.1 Soil Analytical Results Table
  A.2 Soil Cleanup Calculations
  A.2.1 Soil-Water Partitioning Analysis
  A.2.2 Calculation of SSL
  A.2 BDGR Record Drawings and Layout
Appendix B Cost Estimates

Figures

Figure 1-1 DSCR Site Layout 1-2
Figure 2-1 Building 65 Area Site Features 2-21
Figure 2-2 DSCR and Surrounding Area Land Use 2-22
Figure 2-3 Building 65 Source Investigation Soil Boring Locations (June 2020) 2-23
Figure 2-4 Lateral Distribution of PCE and TCE in Vadose Zone Soil (June 2020) 2-24
Figure 2-5 Vertical Distribution of PCE in Soil Parallel to Groundwater Flow (June 2020) 2-25
Figure 2-6 Vertical Distribution of PCE in Soil Perpendicular to Groundwater Flow (June 2020) 2-26
Figure 2-7 PCE Distribution in Soil and Groundwater 2-27
Figure 2-8 Building 65 Air and Soil Vapor Annual Sample Locations (2019-2024) 2-28
Figure 2-9 Lateral Distribution of PCE in Surficial Aquifer (April 2022) 2-29
Figure 2-10 Lateral Distribution of TCE in Surficial Aquifer (April 2022) 2-30
Figure 2-11 Lateral Distribution of cDCE in Surficial Aquifer (April 2022) 2-31
Figure 2-12 Lateral Distribution of VC in Surficial Aquifer (April 2022) 2-32
Figure 2-13 Lateral Distribution of PCE in Surficial Aquifer (October 2022) 2-33
Figure 2-14 Lateral Distribution of TCE in Surficial Aquifer (October 2022) 2-34
Figure 2-15 Lateral Distribution of cDCE in Surficial Aquifer (October 2022) 2-35
Figure 2-16 Lateral Distribution of VC in Surficial Aquifer October 2022) 2-36
Figure 4-1 Building 65 Alternative #2 - Former Tank and Waste Line Abandonment 4-16
Figure 4-2 Building 65 Alternative #2 – In-situ Treatment of Soil 4-17
Figure 4-3 Building 65 Alternative #2 Process Flow Diagram 4-18
Figure 4-4 Building 65 Alternative #3 – SSDS Decommissioning and Well Abandonment 4-19
Figure 4-5 Building 65 Alternative #3 - Structure Demolition Area 4-20
Figure 4-6 Building 65 Soil Remediation Area - Alternative #3 4-21

Exhibits

Exhibit 2-1 Data Distributions for PCE and TCE in Soil (June 2020 Data) 2-10

Tables

Table 2-1 Monthly Wind Data for Richmond Executive-Chesterfield County Airport 2-6
Table 2-2 OU 8 General Stratigraphy 2-7
Table 2-3 OU 8 Hydrostratigraphy 2-8
Table 2-4 Summary of Groundwater Measurement Data in F Bay 2-9
Table 2-5 PCE and TCE Distribution Areas and Volumes in Soil 2-10
Table 2-6 TOC Results for Soil (mg/kg) 2-11
Table 2-7 Site-Specific Soil Physical Properties 2-12
Table 2-8 Summary of PDI Calculated Soil SSLs for PCE (mg/kg, Soil to Groundwater) 2-12
Table 2-9 2022 Plume Areas and Maximum Concentrations 2-13
Table 2-10 Exposure Pathways and Receptors for Building 65 F Bay and Northern E Bay 2-15
Table 2-11 Human Health Soil Screening 2-16
Table 2-12 Soil to Groundwater Screening for SPLP Soil Samples 2-16
Table 2-13 Sub-Slab Vapor Screening F Bay Building 65 2-19
Table 2-14 Indoor and Ambient Air Screening Building 65 2-20
Table 3-1 Subsurface Soil Cleanup Levels in Building 65 Area 3-2
Table 3-2 Groundwater Cleanup Levels for COCs in Building 65 Area 3-2
Table 3-3 ARAR Elements 3-2
Table 3-4 ARAR Evaluation for Removal Action at Building 65 3-3
Table 4-1 Screening of Technologies and Process Options 4-2
Table 4-2 Assembly of Remedial Alternatives 4-3
Table 4-3 Alternative 2 Treatment Area Volume and SVE Pore Volume Calculations 4-6
Table 4-4 Evaluation Criteria for Alternatives Analysis 4-10
Table 4-5 Summary of Detailed Alternative Analysis 4-11
Table 4-6 Summary of Cost Estimate for Alternative 2 4-13

Table 4-7 Summary of Cost Estimate for Alternative 3 4-15
Table 5-1 Summary of Comparative Analysis of Remedial Alternatives 5-2
Table 5-2 Alternative Cost Comparison 5-3

Acronyms and Abbreviations

µg/L	micrograms per liter
2D	two dimensional
3D	three dimensional
ANP	acid neutralization pit
ARAR	applicable or relevant and appropriate requirements (ARARs)
ARC	Dervishian Army Reserve Center
BDGR	bio-enhanced directed groundwater recirculation
BCY	bank cubic yards
BGS	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cDCE	cis-1,2-dichloroethene
CF	cubic feet
COC	constituent of concern
COPC	constituent of potential concern
CSM	conceptual site model
DEQ	Virginia Department of Environmental Quality
DLA	Defense Logistics Agency
DPE	dual phase extraction
DPT	direct push technology
DSCR	Defense Supply Center Richmond
EE/CA	engineering evaluation/cost analysis
ESD	Explanation of Significant Differences
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
EVO	emulsified vegetable oil
FFA	Federal Facility Agreement
FFS	focused feasibility study
ft.	feet
HHRA	human health risk assessment
HRSC	high resolution site characterization
IC	institutional control
IRP	installation restoration program
ISB	in situ bioremediation
IWG	inches water gauge
LF	linear foot
LOD	limit of detection
LTM	long term monitoring
LUCIP	land use control implementation plan
Meadows	Meadows CMPG, Inc.
MCL	maximum contaminant level
mg/L	milligrams per liter
MNA	monitored natural attenuation
NCP	National Contingency Plan
NPL	National Priorities List
NTCRA	non-time critical removal action
OU	operable unit
PCE	tetrachloroethene
PDI	predesign investigation
RAO	remedial action objective
RASR	remedial action selection report
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
RSL	regional screening level
SCFM	standard cubic feet per minute
SF	square feet
SPLP	synthetic precipitation leaching procedure
SSDS	sub-slab depressurization system

SSL	soil screening level
SVE	soil vapor extraction
SVOC	semi-volatile organic compounds
TCE	trichloroethene
tDCE	trans-1,2-dichloroethene
TOC	total organic carbon
UE/UU	unrestricted exposure/unrestricted use
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
VC	vinyl chloride
VI	vapor intrusion
VMP	vapor monitoring point
VOC	volatile organic compound

Executive Summary

Remedy optimization at Operable Unit 8 at Defense Supply Center Richmond (DSCR) included preparation of a Remedial Action Selection Report (RASR) for Building 65 (AECOM-Meadows 2024). The RASR developed, screened, and evaluated three remedial alternatives for Building 65 to address residual source zones of chlorinated solvents identified in soil and groundwater beneath the northern portion of Building 65 (principally F Bay). The remedial alternatives for identified and evaluated for impacted soil included no action, soil vapor extraction, and a removal action.

From 1958 to early 1980s, operations in the northern area of Building 65 included cleaning (paint and rust removal) and repainting steel combat helmets, compressed gas cylinders and other metals items. These operations included a tank pit with a caustic tank and rinse tank and vitrified clay pipe waste lines. Wastewater from the Building 65 operations connected into two former concrete tanks (identified as acid neutralization pits) located to the west of Building 65. The chlorinated solvent impacts beneath Building 65 likely relate to use and/or improper disposal of solvents associated with thinning of paint prior to application and cleaning of paint equipment.

Defense Logistics Agency (DLA) has used the RASR to justify the need for preparation of an Engineering Evaluation/ Cost Analysis (EE/CA) to quantify and develop removal action alternatives for completion of a Non-Time Critical Removal Action (NTCRA). Remedial actions to date for the Building 65 have focused on engineered, in situ biological treatment (ISB) of groundwater and sub-slab vapor mitigation in F Bay using a sub-slab depressurization system (SSDS).

Section 104(c)(1) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) has $2,000,000 and 12-month limits for removal actions; however, that does not apply because this action is funded by a federal agency at a federal facility. Remedial action objectives (RAOs) established in the EE/CA include:

1. Address the high concentration source area in soil beneath F Bay that is the primary source for the VOC plume in groundwater and the source of subsurface vapor beneath Building 65.
2. Mitigate leaching of chlorinated VOCs from subsurface soil to groundwater to accelerate attainment of groundwater cleanup levels for the OU 8 plume.
3. Mitigate the need for active soil vapor mitigation measures in F Bay of Building 65.
4. Reduce groundwater constituent concentrations within the Building 65 area to meet established chemical specific Applicable or Relevant and Appropriate Requirements (ARARs) consisting of MCLs and reduce contaminant flux to downgradient areas.

The EE/CA develops, screens, and evaluates three removal action alternatives for Building 65 to address the residual source zones in soil and groundwater including:

1. Alternative 1 – No Action.
2. Alternative 2 – In situ Treatment of Soil.
3. Alternative 3 – Removal action.

Alternative 1 would consist of no actions. Alternative 2 would temporarily convert the Building 65 SSDS to SVE operations to address the residual source zone in soil. Additionally, this alternative would include in place abandonment of former tanks and waste lines beneath the floor slab of F Bay. SVE would include an upgraded blower and new extraction wells in F Bay connecting into the existing piping system. Alternative 2 assumes three years of SVE operations to attain RAO 1 followed by one year of sub-slab vapor and air monitoring to evaluate attainment of RAOs 2 and 3.

Alternative 3 would include well abandonments in F Bay, SSDS decommissioning of equipment, demolition of the F Bay superstructure foundation, floor slab, SSDS components in F Bay, and the adjacent covered structure, completion of a NTCRA for former tanks, waste lines, and VOC impacted soil in the F Bay area, and site restoration. Site restoration will include restoration design, E Bay exterior restoration, west dock gate restoration, well replacement, pavement design, pavement removal, and installation of new concrete pavement for heavy traffic.

Alternative 1 does not include any actions and would not achieve RAOs. The comparative analysis of the alternatives indicated that Alternative 3 had the highest degree of effectiveness and risk reduction because it achieved RAOs 1, 2, and 3 upon completion of the removal actions. Alternative 2 had a lower degree of effectiveness with a longer period required to achieve RAO 1 with uncertainties on the ability of SVE to achieve RAOs 2 and 3. The installation has indicated no significant constraints in implementing Alternatives 2 and 3. Alternative 2 would require less planning and building mitigation measures to implement than Alternative 3 because it uses existing infrastructure already in place with disturbance related to SVE well installation and in place decommissioning. Alternative 2 would not require the design and planning measures for demolition, soil excavation, and larger scale waste management that Alternative 3 would require.

Alternative 1 has no cost. Alternative 2 has an estimated total cost of $705,745 compared to an estimated total cost of $2,605,055 for the removal action component of Alternative 3. The cost difference of $1,889,310 reflects limited decommissioning and in situ treatment of soil for Alternative 2 compared to complete decommissioning, demolition, removal actions, and site restoration for the F Bay area for Alternative 3.

DLA and USACE have selected Alternative 3 as the preferred remedial alternative to address the residual VOC soil and groundwater source zone beneath Building 65 at OU 8. Alternative 3 has a higher degree of remedial effectiveness than Alternative 2 supporting more rapid attainment of groundwater cleanup levels and plume reduction while eliminating long-term monitoring and vapor mitigation costs associated with F Bay. The cost difference for Alternatives 2 and 3 is only associated with the immediate activities proposed within the Building 65 footprint and does not consider costs or actions for downgradient long-term monitoring and management activities.

1. Introduction

This document is the Engineering Evaluation/Cost Analysis (EE/CA) for a non-time critical removal action (NTCRA) at Building 65 located at Defense Supply Center Richmond (DSCR). This document is prepared under Contract W912DR22C0045 awarded by the United States Army Corps of Engineers (USACE) Baltimore District on September 19, 2022, to Meadows CMPG, Inc. (Meadows). Meadows and teaming partner AECOM have prepared the EE/CA according to the contract Performance Work Statement and requirements of Contract Line-Item Number 0034.

DSCR is the headquarters for Defense Logistics Agency (DLA) Aviation and home to a variety of other DLA, Department of Defense, and other federal organizations. Since 1990, DLA has implemented an environmental restoration program at DSCR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (NCP) (40 CFR Section 300.430(f)(4)(ii)), and the Federal Facility Agreement (FFA) between the DLA, the United States Environmental Protection Agency (EPA), and the Virginia Department of Environmental Quality (DEQ).

DLA used a previously completed Remedial Action Selection Report (RASR, Meadows-AECOM 2024) for Building 65 to justify the need for preparation of this EE/CA to quantify and develop removal action alternatives.

1.1 Purpose

Section 300.415(b)(4)(i) of the NCP requires an EE/CA for all non-time-critical removal actions. The EE/CA is intended to: 1) satisfy environmental review requirements for removal actions, 2) satisfy administrative record requirements for unproved documentation of removal action selection, and 3) provide a framework for evaluating and selecting alternative technologies.

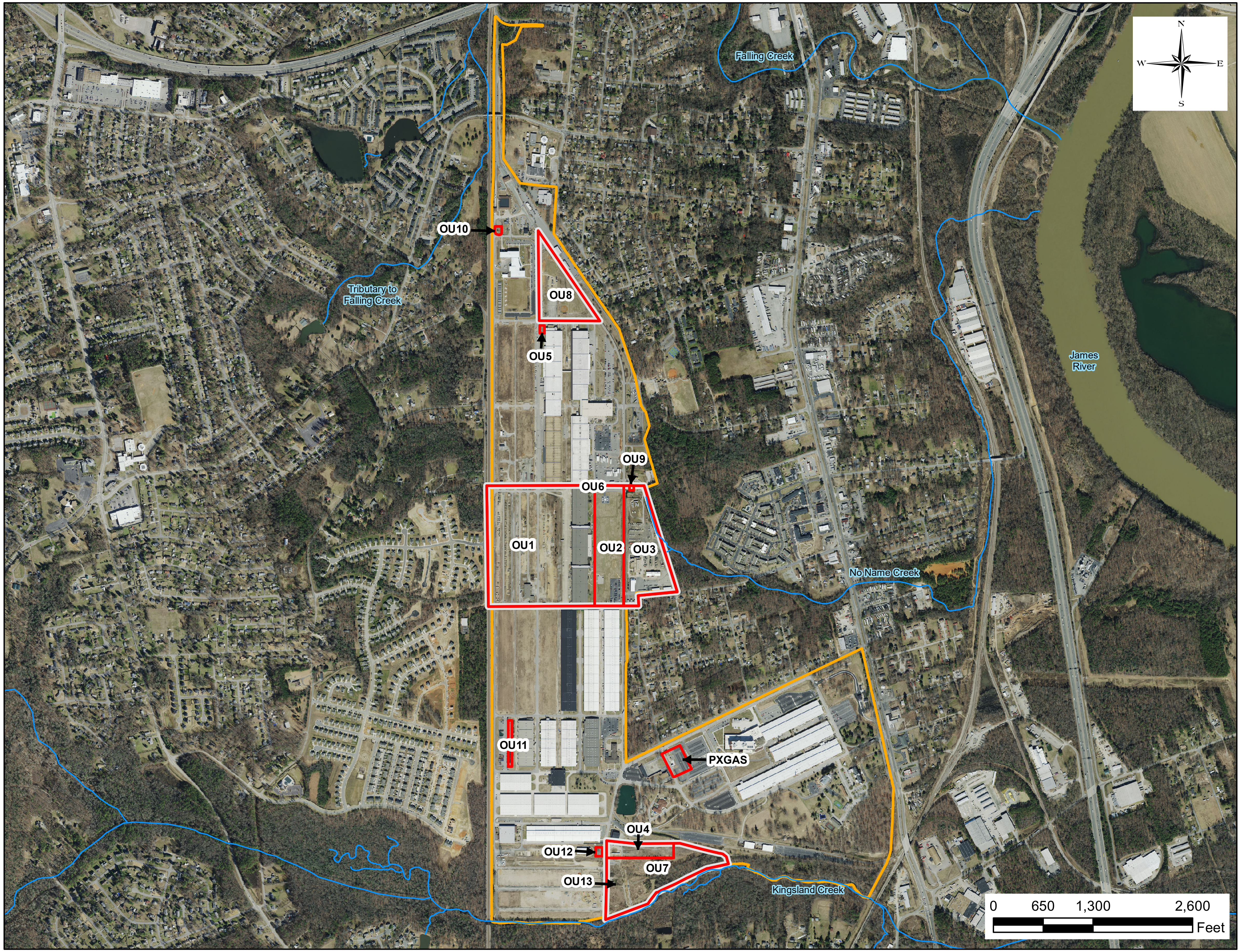
The EE/CA identifies the objectives of the NTCRA and analyzes the effectiveness, implementability, and cost of various alternatives that may satisfy those objectives. Results of the EE/CA and the EPA's response decision are summarized in an Action Memorandum.

1.2 Report Organization

The EE/CA has the following sections:

- Executive Summary
- Section 1 Introduction
- Section 2 Site Characterization
- Section 3 Identification of Removal Action Objectives
- Section 4 Identification and Analysis of Removal Action Alternatives
- Section 5 Comparative Analysis of Removal Action Alternatives
- Section 6 Recommended Removal Action Alternative

This document organization has Figures contained at the end of the section where initially referenced with tables included in line within the document text where first referenced. Exhibits occur in line within the document text where first referenced.



Legend

- Streams
- Operable Unit Boundaries
- OU 6; OU 7; OU 8 Boundaries
- Installation Boundary

Notes:
OU6 Includes Groundwater Impacts Beneath OU's 1, 2, & 3
OU7 Includes Groundwater Impacts Beneath OU 4
OU8 Includes Groundwater Impacts Beneath OU 5
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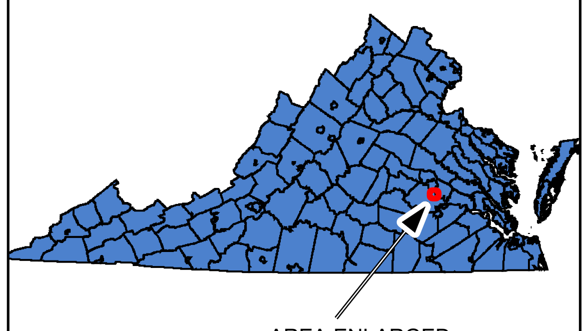

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AECOM

Figure 1-1
DSCR Site Layout

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 1,300'	Date: July 16, 2024

C:\Users\david.copen\AECOM\DSCR Bldg. 65 EA CA Report and Action Memorandum - General\Draft Bldg. 65 EE_CA Report\Figures\Figure 1-1 - DSCR Site Map.mxd

2. Site Characterization

Section 2 has site characterization information including a site description and background, previous removal actions, source information and nature and extent of contamination, analytical data, and streamlined risk evaluation.

2.1 Site Description and Background

Section 2.1 has a description of the site and background information.

2.1.1 Installation Description and Operational History

DSCR (the installation) is located approximately 8 miles south of the city of Richmond, Virginia, with an address of 6090 Strathmore Road, Richmond, Virginia (23237) in Chesterfield County. The installation consists of over 600 acres of land, approximately 1 mile wide (east to west) and 2 miles long (north to south) as shown in Figure 1-1. The property is L-shaped, and the southeastern section currently consists of primarily administrative, operations, maintenance, housing, daycare facilities, and recreational areas. The remaining areas include warehouses, open storage, and light industrial facilities. The current workforce at DSCR numbers more than 2,000. The area surrounding the installation is primarily residential and woodland with a lesser proportion of commercial/light industrial property. The installation, also known as DLA Aviation is the aviation demand and supply manager for Defense Logistics Agency and supports more than 1,800 major weapon systems.

The United States government purchased the land from private owners in 1941, and construction activities began in September of that year; activation occurred on January 1, 1942, as the Richmond Quartermaster Depot. In 1943, the installation became the Richmond Armed Service Forces Depot. The Army established the Quartermaster Branch Depot on-site in 1949, followed by the U.S. Army General Supply Center in 1958. DLA began overseeing operations in 1962 when the installation became known as the Defense General Supply Center. In 1996, the installation became DSCR.

Past industrial operations at the installation have resulted in the use, storage, management, inadvertent release, and/or disposal of hazardous materials, such as chlorinated solvents, petroleum products, and wastewater treatment sludge. Past storage operations at the installation have led to the accidental release of these and other hazardous materials, such as polycyclic aromatic hydrocarbons (PAHs), pesticides, petroleum hydrocarbons, polychlorinated biphenyls (PCBs), and metals.

In 1980, the Department of Defense placed DSCR in its Installation Restoration Program (IRP). The first phase of the IRP involved completion of Installation Assessment Report that indicated possible soil impacts at six locations and possible groundwater impacts at three (Army Chemical Systems Laboratory 1981). In 1982, the United States Army Environmental Hygiene Agency identified three additional areas of groundwater impact including the Area 50 Landfill, the Former Fire Training Area, and the National Guard Area. In 1984, EPA recommended placement of DSCR on the CERCLA National Priority List (NPL) with listing on the NPL occurring in 1987 based on Hazard Ranking System scoring performed for the installation based on conclusions of previous studies performed by the United States Army Environmental Hygiene Agency in the early 1980s. In 1986, the EPA issued a Corrective Action Permit pursuant to the Resource Conservation and Recovery Act (RCRA). The installation submitted three remedial investigation reports in 1989 with DLA, the installation, EPA, and DEQ entering into a FFA in September 1990.

2.1.2 Site Description and History

Figure 2-1 has Building 65 site features, shows adjacent areas, and identifies the overall location within the installation. Building 65 functions as a warehouse for DSCR and consists of six connected bays (A-F), with E Bay and F Bay located at the northern end. E Bay has dimensions of 200 feet (ft.) by 200 ft. An electronically operated full-size traffic door allows access from E Bay to F Bay. F Bay is the area targeted for the NTCRA and has overall dimensions of 120 ft. by 40 ft with external ramp access from the north with a locked, chain-linked gate across an opening at the northwest corner of the bay. This opening allows airflow between the exterior and interior of F Bay. An eastern ramp at the northeast corner of F Bay also provides access to the interior of this bay but this ramp currently is not used for this purpose. F Bay is no longer used for warehousing or storage. A covered area is located north of Building 65 and F Bay as shown in Figure 2-1. This covered area is no longer used for storage or operations with former uses including pallet storage, compressed gas storage, and sandblasting.

Historical operations in F Bay of Building 65 included cleaning (paint and rust removal) and repainting steel combat helmets compressed gas cylinders, and other metal items such as 55-gallon drums and 5-gallon metal gasoline cans. The operation used a series of dip tanks that removed paint by treating in boiling caustic (sodium hydroxide in water) followed by a hot water rinse drip. Rust removal operations involved treatment in a 20% hydrochloride acid solution followed by treatment with neutralization solution containing sodium hydroxide, surfactant, and sodium bicarbonate. Helmet painting operations in Building 65 used a water curtain type spray paint with paint sludges placed in 55-gallon drums stored in Open Storage Area 75 north of Building 65. These operations occurred from 1958 to the early 1980s.

A primary acid neutralization pit (ANP) received wastewater from the cleaning and repainting operations in F Bay through terracotta waste lines supplemented by a second ANP added in the late 1970s (see Figure 2-1). Initially, the primary ANP discharged wastewater to a storm sewer with the process later modified to flow through the secondary ANP with final discharge to a sanitary sewer. Solids accumulated in the bottom of the concrete settling pits and periodically the installation had the solids removed and disposed at the Chesterfield County landfill. Leaching procedure analysis of these solids performed in 1979 by the United States Army Environmental Hygiene Agency resulted in a determination of not considered hazardous (Dames & Moore 1989).

The Acid Neutralization Pits (ANPs) Source Area is designated as Operable Unit 5 (OU 5) for CERCLA response actions. OU 5 addresses the soil impacted by the ANPs. A Record of Decision (ROD) for OU 5 finalized in March 1992 selected vacuum extraction to address soils impacted by volatile organic compounds (VOCs). An Explanation of Significant Differences (ESD) issued in September 1995 documented a decision to eliminate the installation of a full-scale vacuum extraction system based on the results of information generated pilot scale operation and field explorations performed as part of the remedial design of OU 5.

Operable Unit 8 (OU 8) is the designation for Acid Neutralization Pits (ANPs) groundwater impacted by chlorinated VOCs attributed to the ANPs. A ROD dated February 2007 identified the selected remedy for OU 8 groundwater as monitored natural attenuation (MNA) and institutional controls (ICs) with a contingency remedy of in situ bioremediation (ISB). The ROD identified threshold levels and conditions for implementation of the contingency remedy including evidence of attenuation processes, plume stability, and potential for offsite migration. Remedial cleanup levels established by the ROD for constituents in groundwater consist of Federal maximum contaminant levels (MCLs). An ESD finalized in August 2011, specified implementation of the ISB contingency remedy identified in the OU 8 ROD (DSCR 2011). The ESD triggered preparation of remedial design/remedial action addendum to implement the contingency remedy. The OU 8 area of groundwater includes the northern Building 65 area.

2.1.3 Previous Investigations and Response Actions in Building 65 Area

Section 2.1.3 has a summary of previous investigations completed in the Building 65 area.

2.1.3.1 Remedial Investigation (1986-1987)

Initial investigations in the Building 65 area occurred during the RI for the ANP area (1986 and 1987) and included a soil gas investigation (VOCs) and installation of monitoring wells at locations west, north, and northeast of Building 65. The groundwater sampling program included target compound list VOCs, semi-volatile organic compounds (SVOCs), and pesticides with library scan and target analyte list inorganics. Soil gas samples collected between Building 65 and the ANPs had low level detections of tetrachloroethene (PCE) and trichloroethene (TCE) with higher concentrations detected northeast of Building 65. Two monitoring wells north and northeast of Building 65 (DMW-30A and DMW-31A) had detected PCE and TCE concentrations greater than MCLs with detections of 1,2-dichloroethene (total) and 1,2-dichloroethane also reported in the samples.

2.1.3.2 ANP Area Supplemental Remedial Investigation (1992-1993)

In 1992-1993, Law Environmental Inc. (Law) completed a supplemental RI for groundwater to the north and northeast of Building 65 that included installation of four monitoring wells designated MWANP-1, -2, -

3, and -4D. Law collected samples from these wells for analysis of VOCs, semi-volatile organic compounds, and target analyte list inorganics. Sample results from wells screened in the surficial aquifer, MWANP-1, -2, and -3, had concentrations of PCE and TCE greater than MCLs. The sample collected from well MWANP-4D screened in the confined aquifer did not have VOC detections (Law 1993).

2.1.3.3 Focused Feasibility Study (1998)

A focused feasibility study (FFS) completed for OU 8 included design and implementation of a dual phase extraction (DPE) system. This system operated from July 1997 until July 1998 and had 12 dual phase wells, 6 air injection wells, and an air stripper with operations occurring within an approximate 1.4-acre area north of the Building 65 area. DSCR continued system operations beyond the treatability test phase. The FFS evaluated several alternatives for remediation of groundwater and recommended DPE as the final alternative for implementation.

2.1.3.4 Dual Phase Extraction System (1997-2004)

DSCR operated the DPE and air injection system at OU 8 from July 1997 until January 2004 to address chlorinated VOCs in the surficial aquifer. During operation, the system created a hydraulic gradient toward the square grid of DPE wells to capture, treat, and discharge treated groundwater. Post DPE system shutdown sampling indicated apparent reductions in chlorinated VOC plume areas and concentrations with no significant rebound in concentrations observed after shutdown. DPE system decommissioning occurred in February 2008.

2.1.3.5 Remedial Action (2008)

AECOM prepared a RD/RA Work Plan finalized in September 2008 that outlined remedy elements for MNA and ICs (AECOM 2008). DSCR modified the Land Use Control Implementation Plan (LUCIP) to include OU 8-specific ICs. The OU 8 ICs included designation of the land use solely for non-residential purposes until conditions allow for unlimited use and unrestricted exposure to groundwater. The ICs also included the requirement for a pre-construction assessment before construction activities can occur at OU 8. DSCR finalized the LUCIP addendum in November 2007 (DSCR 2007).

The RD/RA outlined additional groundwater characterization activities to support implementation of MNA and long-term monitoring (LTM) for the remedy. AECOM implemented the additional characterization (2008-2009) and semi-annual monitoring of groundwater (beginning in 2009) and reported these activities in a Final Remedial Action Monitoring Report dated March 2011 (AECOM 2011). This report indicated limited evidence of natural biodegradation and rebound of plume concentrations in the former DPE area.

2.1.3.6 Remedial Action Addendum (2013)

AECOM prepared a remedial design/remedial action work plan addendum finalized in May 2013 (AECOM 2013). This work plan identified four ISB treatment areas with injection wells to distribute emulsified vegetable oil (EVO) as the carbon substrate to stimulate reductive dichlorination. AECOM completed treatability tests in 2011 to support the remedial design. The remedial design included installation of additional monitoring wells for remedy effectiveness and MNA evaluations with continued semi-annual groundwater monitoring.

AECOM implemented remedial actions at OU 8 in 2013 and 2014, which included well installation, ISB injections, vapor monitoring, semi-annual groundwater monitoring, and annual IC inspections. The modified remedy incorporated an expanded semi-annual monitoring program that included offsite locations along Strathmore Road beginning in 2012 and additional downgradient locations in 2014/2015.

In 2015, USACE completed an ISB pilot test north of Building 65 and began operating a single-well pumping test in the northern plume area at OU 8. This pumping test operated from May 2015 until October 2019. In 2016, Arcadis implemented a second single-well pumping test east of Building 66; this pumping test operated from May 2016 until February 2021.

2.1.3.7 Human Health Risk Assessment for Buildings 65 and 66

In 2014, AECOM completed a human health risk assessment (HHRA) to evaluate potential risks to indoor workers at Buildings 65 and 66 via inhalation of VOCs migrating from the OU 8 groundwater plume to indoor air (AECOM 2014). The risk assessment used the results of sub-slab vapor and indoor air samples collected at each building as part of the January 2014 subsurface vapor intrusion (VI) investigation conducted for OU 8.

The HHRA calculated risks and hazards for current indoor workers at Buildings 65 and 66 fell below the target risk and hazard levels. The HHRA included the sub-slab soil vapor analytical results from Building 65 to evaluate future worker risk. The HHRA estimated risks fell below the target risk and the estimated hazard exceeded the target hazard with PCE and TCE identified as constituents of concern (COCs). At Building 66 using sub-slab soil vapor results, the HHRA estimated risks and hazard for Building 66 fell below the target risk and hazard levels.

The results of this HHRA resulted in implementing VI mitigation measures in F Bay of Building 65 in 2014. A sub-slab depressurization system (SSDS) began operating in F Bay in 2014 with system upgrades completed in 2015 and 2018 to increase the level and extent of depressurization below the floor slab in F Bay. Annual air sampling and SSDS evaluations have indicated continued effectiveness of the SSDS mitigation measures.

2.1.3.8 Bio-Enhanced Directed Groundwater Recirculation System (2017-2021)

In February 2017, Arcadis implemented a bio-enhanced directed groundwater recirculation (BDGR) system at OU 8 as an enhanced ISB measure. The BDGR focused on the groundwater plume area extending from Building 65 to the former Building 75 area and had three (3) extraction wells and five (5) reinjection wells primarily along the northern interior wall of E Bay of Building 65 immediately upgradient of F Bay. This system operated from February 2017 until February 2021.

BDGR operations extracted groundwater from the diffuse plume area north and northeast of the source zone beneath Building 65 resulting in low rates of VOC mass removal. Because of the low flows, the BDGR had limited capture zones around the extraction wells and could not completely hydraulically contain the plume in the Building 65 area. System influent concentrations peaked shortly after system startup and decreased through the operational period. The system also had progressively lower flow and extraction rates over time, which required rehabilitation of extraction and injection wells to maintain continuous operations.

2.1.3.9 Remedial Action Addendum (2018)

Arcadis prepared a remedial action work plan finalized in July 2018 (Arcadis, 2018). This work plan addendum to the 2008 remedial action/remedial design identified additional ISB treatment beneath F Bay of Building 65 and expanded ISB treatment areas at existing downgradient injection well transects. Arcadis completed pre-design investigation (PDI) activities in 2016 and 2018 to support design and implementation of the ISB measures. PDI included completion of soil borings and high-resolution site characterization (HRSC) using direct push technology (DPT). These investigations confirmed the presence of a residual source zone of chlorinated VOCs in soil beneath the floor slab of F Bay in Building 65 and discovered the existence of the former tank pit (including a caustic tank and rinse tank), vitrified clay pipe waste lines, and impacted perched water beneath the floor slab in F Bay.

The scope of ISB included installation of six injection wells in F Bay and six additional injection wells at existing downgradient injection well transects. Arcadis implemented ISB injections in September 2018, which included soluble substrate (lactate) in the Building 65 area and semi-soluble substrate (EVO) in the downgradient locations.

2.1.3.10 Building 65 Investigation and Conceptual Site Model Update (2020)

AECOM-Meadows completed a soil investigation within F Bay and E Bay of Building 65 in June 2020 that delineated a residual chlorinated VOC source zone in soil beneath the building. The scope of work included completion of 17 soil borings inside of Building 65 to depths extending into the saturated zone of the surficial aquifer. Vertical profiling of soils at each boring included analysis for VOCs at three depth intervals, collection of eight soil samples for VOC leaching evaluation by the Synthetic Precipitation Leaching Procedure (SW846 Method 1312) and supporting analysis for total organic carbon (TOC) and physical soil properties.

This source zone consists of principally PCE and TCE contained within an approximate 4,300 square foot area primarily beneath F Bay extending into the northern portion of E Bay. A high concentration source zone remains beneath a former degreasing tank and drain line with the highest concentration near the saturated zone of the surficial aquifer. Soil concentrations exceed the calculated soil saturation limit for PCE (125.45 milligrams per kilogram (mg/kg)). The vertical extent of the residual source zone extends into the surficial aquifer.

AECOM-Meadows incorporated the Building 65 investigation into a higher resolution, digital conceptual site model (CSM) developed for the Building 65 area and OU 8 using a combination of historical and new data.

2.1.3.11 Remedial Action Addendum for Building 65 Area (2023)

AECOM-Meadows prepared a remedial action work plan addendum finalized in January 2023 that identified follow-up ISB treatment in and immediately around F Bay of Building 65 (AECOM-Meadows 2023). ISB targeted direct treatment of the residual chlorinated VOC source zone (groundwater), reduction of VOC flux from the source zone, and acceleration of plume degradation downgradient of this source zone. The remedy optimization completed in the Building 65 area in March 2023 consisted of ISB injections at 11 existing injection wells using EVO with bioaugmentation. Post-injection performance monitoring includes quarterly monitoring combined with semi-annual site-wide monitoring of groundwater at OU 8.

2.1.3.12 Remedial Action Selection Report (RASR)

AECOM-Meadows prepared a RASR for Building 65 finalized in 2024 to evaluate options to address the residual source zone of chlorinated VOC beneath the northern area of Building 65 (Meadows-AECOM 2024). The RASR presents details of the updated CSM for the Building 65 that included an integrated analysis of soil and groundwater conditions. This CSM update supported the development, screening, and evaluation of three remedial alternatives in the RASR to address residual source zones in soil and groundwater beneath the northern portion of Building 65. The RASR recommended a preferred alternative that included a removal action for soil beneath F Bay of Building 65 facilitated by demolition of F Bay and adjacent areas to the north as part of planned renovations to the larger warehouse area.

2.2 Physical and Environmental Setting

Section 2.2 describes the physical and environmental setting for the Building 65 area.

2.2.1 Land Use and Demographics

Land use in the Building 65 area is industrial and related to logistics, warehousing, and related administrative functions. Building 65 has active operations in A-E Bays with indoor workers in these areas with F Bay not used for active storage or operations. Development around Building 65 includes Building 66 and the Virginia National Guard Headquarters Building located 235 ft and 725 ft. east and northwest of Building 65, respectively. Both buildings have indoor workers.

The closest offsite area to the Building 65 area is approximately 700 ft. to the northeast and consists of the Bensley residential area (suburban) with single family homes. The residential area extends along the installation fence line with the designated OU 8 area. Bensley Elementary School is approximately 2000 ft. The greater Bensley community has a population of approximately 6,000 with a median home value of $175,100 and median household income of approximately $44,000[1]. The Bellwood community encompasses DSCR and areas south of Bensley and east of DSCR. This community has a population of approximately 7,800 with a median home value of $188,000 and median household income of approximately $50,000[2].

The Meadowbrook residential community is located west of DSCR separated from the installation by the CSX Transportation railroad and right-of-way. The closest residential area is 800 ft. west of the Building 65 area. The greater Meadowbrook community has a population of approximately 20,000 with a median home value of $239,000 and median household income of approximately $77,000[3].

[1] Demographic data for Bensley from https://www.niche.com/places-to-live/bensley-chesterfield-va/
[2] Demographic data for Bellwood from https://www.niche.com/places-to-live/bellwood-chesterfield-va/
[3] Demographic data for Meadowbrook from https://www.niche.com/places-to-live/meadowbrook-chesterfield-va/

Figure 2-2 has a map showing land use around the installation area. As of 2022, Chesterfield County had a population of 336,000 people with a median age of 38.9 years and a median household income of $95,757. Between 2021 and 2022, Chesterfield County had a 1.73% increase in population and with an 8.43% increase in household income. The largest ethnic groups in Chesterfield County are White (Non-Hispanic, 59.1%), Black or African American (Non-Hispanic, 23.2%), Other (Hispanic, 4.74%) Two+(Non-Hispanic, 3.63%), and Asian (Non-Hispanic, 3.48%). In 2022, residential property in Chesterfield had a median value of $306,500 with a county homeownership rate of 77.4%[4].

2.2.2 Climatic Data Summary

Chesterfield County's climate type is Modified Continental. Summers are warm and humid, and winters are generally mild. The 12-month average temperature for Chesterfield County, Virginia from May 1900 to April 2023 is 57.7 degrees Fahrenheit. Annual average precipitation for Chesterfield County, Virginia from May 1900 to April 2023 is 43.9 inches[5]. Table 2-1 has monthly wind data for the Richmond Executive-Chesterfield County Airport for September 2012-May 2024.

Table 2-1 Monthly Wind Data for Richmond Executive-Chesterfield County Airport

Prevailing Wind Direction											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
WNW	WNW	NW	SW	WSW	SW	SW	SSW	N	NW	WNW	W
Average Wind Speed and Gust (mph)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
8	8	9	9	7	7	7	7	7	7	7	7
22	22	22	21	20	20	21	20	19	20	20	20

Notes: WNW = west-northwest, NW = northwest, SW = southwest, WSW = west-southwest, N = north, W west, mph = miles per hour, Source https://www.windfinder.com/windstatistics/chesterfield_county_airport

2.2.3 Physical Setting

DSCR lies east of the Fall Line that separates the Atlantic Coastal Plain physiographic province to the east from the Piedmont physiographic province to the west. The Coastal Plain physiographic province has level to gently rolling terrain, broad stream valleys, and extensive wetlands. Piedmont areas have rolling terrain and higher elevations than the Coastal Plain with narrower stream valleys and less extensive non-tidal wetlands.

2.2.4 Topography and Surface Water Drainage

Ground surface elevations in the OU 8 area range from approximately 117 to 124 ft. (NAVD 1988). Site development has slightly altered the surface grade at OU 8. Surface water drainage is through overland flow to storm sewer drains within OU 8. OU 8 is in the Falling Creek Tributary watershed. Stormwater outfalls associated with OU 8 discharge to tributaries of Falling Creek. Falling Creek and tributaries are located north and northeast of DSCR, as shown on Figure 1-1. Falling Creek is 1,800 ft. northwest of the Building Area and No Name Creek is 2,900 ft. southeast of the Building 65 Area.

2.2.5 Geology

DSCR lies near the western edge of the Virginia Coastal Plain. General stratigraphy found beneath OU 8 includes four coastal plain formations present above the Petersburg Granite bedrock from youngest to oldest: the Eastover Formation, Calvert Formation, Aquia Formation, and Potomac Formation. Table 2-2 (page 2-7) provides general stratigraphy information for the OU 8 area.

[4] Chesterfield County demographic data from Data USA at *https://datausa.io/profile/geo/chesterfield-county-va#:~:text=The%205%20largest%20ethnic%20groups,%2DHispanic)%20(3.48%25).*
[5] Climatic data from the National Centers for Environmental Information at https://www.ncei.noaa.gov/pub/data/cirs/climdiv/

Table 2-2 OU 8 General Stratigraphy

Geologic Formation	Age	Origin	Approx. THK (ft)	Primary Lithology Types
Eastover	Pliocene	Alluvial	23-25 31-33[1]	(a) Clay (CL), clayey sand, and silty sand (SM) (b) Poorly graded sand with gravel (SP)
Calvert	Miocene	Marine	2.5-7 <2[1]	Clay (CH) and organic sand silt (OL)
Aquia	Paleocene Early Eocene	Marine	<3-12	Silty sand (SM)
Potomac	Cretaceous	Alluvial	20-35	(a) Clayey sand with gravel (SC) (b) Clayey sand with gravel, elastic silt with sand (MH), clayey sand with gravel (SC)
Petersburg Granite	Mississippian	Bedrock	--	Granite to Granodiorite Bedrock

Notes: THK = thickness, [1]For northern part of study area in northern Army Reserve Center

The Eastover Formation consists of reddish brown to yellowish brown, variable silty clay, and fine-to-medium silty sand, overlying a basal layer consisting of poorly graded sand (SP) with variable gravel. This formation is approximately 23 to 25 ft. thick in OU 8. In the Dervishian Army Reserve Center (ARC) northwest of OU 8 the Eastover thickness increases to 31 to 33 ft. The poorly graded sand with gravel lithologic unit ranges from 8 to 12 ft. thick.

The Calvert Formation is a dark gray highly plastic clay and organic sandy silt with a dry consistency. HRSC borings indicate variable thickness across OU 8. North of Building 65, the Calvert thickness is approximately 3.5 ft and decreases to 2.5 ft. along the northern fence line area. East and northeast of Building 66 the Calvert thickness averages 7 ft. near the fence line and decreases to approximately 3 ft. along the fence line in the southern ARC area. Near the northwest corner of the ARC, the Calvert thickness decreases to approximately 1 ft.

The Aquia Formation is a fining-upward, well sorted, dark green, glauconitic silty sand with a basal gravel stratum. HRSC borings performed in the northern OU 8 area indicated variable thickness of 6 to 12 ft. with an increase in thickness toward the north from Building 65.

Potomac Formation sediments at DSCR consist of an upper lithologic zone of greyish-green clayey sand with gravel ranging in thickness from 20 to 35 ft. and a lower lithologic zone of grayish-green, clayey sand with gravel with a texturally finer basal layer varying from elastic silt with sand to clayey sand. The thickness of the lower lithologic zone is variable.

Bedrock in the study area is the Petersburg Granite described by the United States Geological Survey (USGS) as chlorite rich granodiorite (USGS 1987).

2.2.6 Hydrostratigraphy

The updated CSM includes a refined hydrostratigraphy model developed by integrating the geologic model with existing hydrogeologic data and HRSC data. Table 2-3 (page 2-8) summarizes the refined hydrostratigraphy for OU 8 and associated hydraulic properties defined in the digital CSM.

Table 2-3 OU 8 Hydrostratigraphy

Hydrostratigraphic Unit	Type	Description	Relative Permeability	Estimated K (cm/sec)
Eastover	Aquifer	Unconfined (formerly designated upper water bearing unit)	High	1E-02 to 5.3E-02[2] 4.58E-02[1]
Calvert	Confining Zone	Leaky unit	Very Low	4.8E-08 to 1.8E-06[3]
Aquia	Aquifer	Semi-confined, bulk matrix of formation (formerly designed as part of confining unit)	Low-High	<1.0E-04 to 3.5E-02[2] 1.76E-06 to 1.55E-05[3]
Potomac	Aquifer	Semi-confined, bulk matrix of formation (formerly designated lower water bearing unit)	Very Low-Moderate	2.5E-03 to 6.5E-03[4] 2.3E-07 to 3.5E-05[5]
Bedrock	Aquifer	Confined in fractures	Not determined	

Notes [1]Pumping test performed by AECOM northeast of Building 66, [2]Field testing with hydraulic profiling tool, [3]Laboratory core testing at OU 6 (vertical), [4]Pumping test at OU 8 fence line by USGS in 1986, [5]Laboratory core testing (horizontal) at OU 6, K= hydraulic conductivity, cm/sec = centimeters per second,

The Eastover hydrostratigraphic unit corresponds to the Eastover Formation and groundwater within this unit is an unconfined water table. The surficial aquifer (also identified as UWBU for previous site work and investigations) is the principal unit monitored at OU 8. Depth to groundwater is 12 to 14 ft. below ground surface (BGS) with the saturated zone principally occurring in the poorly graded sand with variable gravel lithologic unit. Downhole hydraulic profile tool (HPT) data and pumping test data indicate that this lithologic unit has a high hydraulic conductivity as illustrated in Table 3-2.

The Calvert hydrostratigraphic unit corresponds to the Calvert Formation and is a leaky confining zone that ranges from 2.5 to 7 ft. thick, except in the northwestern ARC where the Calvert is less than 2 ft. thick. It has a low vertical hydraulic conductivity based on laboratory core testing (Table 3-2) and high HPT pressures (100-110 PSI). The Calvert separates the overlying Eastover hydrostratigraphic unit from the underlying Aquia and Potomac hydrostratigraphic units. At OU 6, vertical migration of VOCs from the surficial aquifer to the confined aquifer implies vertical groundwater flow through Calvert at DSCR.

The Aquia hydrostratigraphic unit corresponds to the Aquia Formation and is a semi-confined zone of groundwater that ranges from <3 to 12 ft. thick. HPT profiling indicates that the horizontal hydraulic conductivity of the Aquia varies by more than two orders of magnitudes (Table 3-2) with discrete zones having values greater than 1E-02 centimeters per second (cm/sec). For work at OU 6, the USGS and Remedial Investigation determined vertical hydraulic conductivities in the range of 3 to 4 orders of magnitude lower than horizontal conductivities (Table 3-2). Horizontal groundwater flow patterns and hydraulic gradient within the Aquia are similar to the underlying Potomac.

The Potomac hydrostratigraphic unit corresponds to the Potomac Formation. This unit is a semi-confined zone of groundwater with low to moderate permeability. Limited monitoring of this semi-confined aquifer occurs for vertical extent determinations in residual source zones. The USGS pumping test conducted at the OU 8 fence line indicated moderate permeability (see Table 3-2). This hydrostratigraphic unit has a dense bulk matrix with HPT profiling and testing indicating consistent maximum pressure responses of 110 PSI. Clean water injection testing and laboratory testing performed at OU 6 indicate low to very low permeability for the Potomac. Samples collected from monitoring wells installed into the confined aquifer (Potomac) at OU 8 do not have detectable VOCs.

2.2.7 Groundwater Flow

Overall, groundwater within the surficial aquifer flows laterally across OU 8 in a northerly direction from the building 65 area with variable flow directions from the Building 66 area toward the north, northeast, and east. The hydraulic gradient typically is low and in the range of 0.0015 to 0.0022 ft./ft. Using an average hydraulic conductivity of 90 ft./day[6], the above range for hydraulic gradient, and an assumed

[6] Hydraulic conductivity estimate based on the AECOM pumping test (2011) and HRSC data used in the digital CSM.

porosity of 0.25 for the sand and gravel unit within the surficial aquifer results in a calculated groundwater flow velocity in the range of 0.54 ft./day (197 ft./year) to 0.79 ft/day (289 ft./year).

Table 2-4 has a summary of groundwater measurement data for wells installed in F Bay of Building 65 (2019-2022). These flush mount wells have measurement point elevations of 123.52 to 123.62 ft[7]. Minimum depths to water for each well ranged from 12.27 to 12.40 ft. as measured from the monitoring well top of inner well casing. Maximum depths to water from each well ranged from 17.40 to 17.49 ft. Seasonal groundwater fluctuations observed in these wells for 2019-2022 averaged 2.5 to 2.9 ft between measurements obtained in April and October of each year. The elevation range observed for groundwater elevations at the three wells is 106.12 to 111.25 ft[7].

Table 2-4 Summary of Groundwater Measurement Data in F Bay

Location	Top of Inner Well Casing Elevation (ft. NAVD 88)	Water Depth (ft., Measured from Top of Inner Well Casing)			Groundwater Elevation (ft., NAVD 88)		
		Min	Max	Mean	Max	Min	Mean
OU8-MW-163	123.56	12.32	17.41	15.07	111.24	106.15	108.49
OU8-MW-164	123.52	12.27	17.40	14.99	111.25	106.12	108.53
OU8-MW-165	123.62	12.40	17.49	15.25	111.22	106.13	108.37

Notes: ft. = feet, NAVD 88 = North American Vertical Datum of 1988.

2.3 Source Area and Nature and Extent of Contamination

The assessment of the source area and nature and extent of contamination of soil within the area of Building 65 addressed by this EE/CA is based on the soil sampling performed beneath F Bay and E Bay in 2020. Figure 2-3 shows the boring locations for the 2020 soil investigation. PCE and TCE are the primary constituents impacting soil in the Building 65 area based on frequency of detection and concentrations detected relative to risk-screening levels for soil. The occurrence of TCE and other VOCs detected in soil is within the PCE impacted soil area. Appendix A has an analytical results table for the soil sampling performed at Building 65 in 2020.

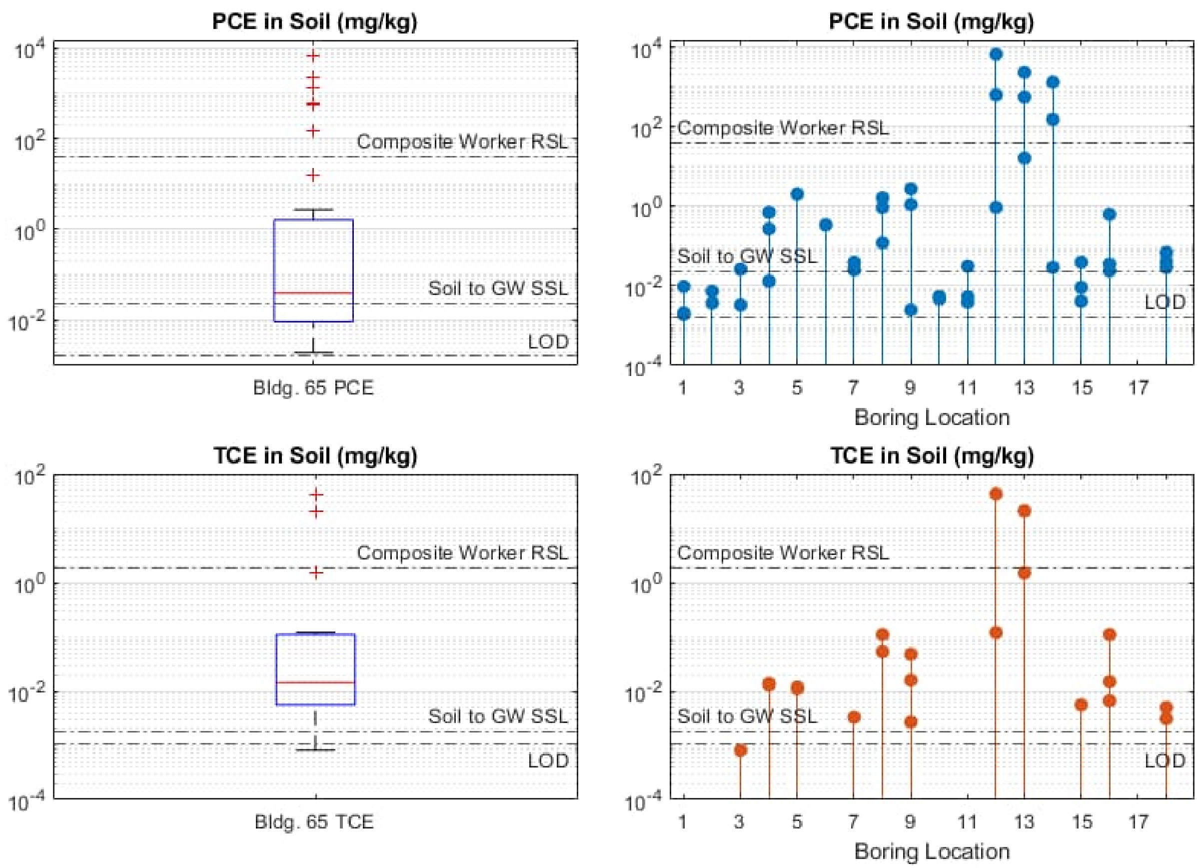
2.3.1 Data Distribution for PCE and TCE

Exhibit 2-1 (page 2-10) has box plots and stem plots showing data distributions for PCE and TCE in soil beneath F Bay and E Bay of Building 65. Data distributions for PCE and TCE have outliers with higher degree of positive skewness and high kurtosis reflecting a concentration hotspot in F Bay in the area of soil borings SB-12, SB-13, and SB-14. The box plots have reference lines used in the data assessment including the EPA composite worker regional screening level[8] (RSL), soil screening level (SSL) for the soil-to-groundwater pathway[9], and the average method limit of detection (LOD).

Figure 2-3 shows the location of soil borings SB-12, SB-13, and SB-14 along the former tank pit and waste line area. The highest concentrations of PCE and TCE in the vadose zone, above seasonally high groundwater levels, occur at depths of 13-14 ft. BGS in borings SB-12 (7,300 mg/kg) and SB-13 (74 mg/kg). The highest concentration of PCE at SB-14 (1,300 mg/kg) occurs within the sample interval of 18-19 ft. BGS.

[7] Measuring point for depth to groundwater is top of inner well casing. Elevation of Top of Casing Feet per National Vertical Datum of 1988.
[8] EPA Regional Screening Level for composite soil worker for a hazard quotient of 0.1 and target risk of 1E-06 included in the EPA November 2024 RSL table.
[9] EPA Soil Screening Level for the soil-to-groundwater pathway using a target concentration equal to the Federal maximum contaminant level that corresponds to the site cleanup levels for groundwater.

Exhibit 2-1 Data Distributions for PCE and TCE in Soil (June 2020 Data)



2.3.2 Spatial Distribution and Extent of PCE and TCE in Soil

Figure 2-4 shows the lateral distribution of PCE and TCE in soil beneath F Bay and E Bay of Building 65 within an approximate 100 ft. x 45 ft. area. The visualizations in Figure 2-4 project the maximum concentrations to a two-dimensional (2D) surface derived from geostatistical analysis (kriging) and volumetric modeling. Table 2-5 has a summary of volumetrically modeled areas for PCE and TCE in soil displayed on Figures 2-5 through Figure 2-7. For reference, the interior of F Bay has an area of 4,500 square ft.

Table 2-5 PCE and TCE Distribution Areas and Volumes in Soil

Parameter	≥0.1 mg/kg			≥1 mg/kg			≥10 mg/kg			≥100 mg/kg			≥1000 mg/kg		
	SF	BCF	BCY	SF	BCF	BCY	SF	BCF	BCY	SF	BCF	BCY	SF	BCF	BCY
Tetrachloroethene	3510	28759	1065	2042	14619	541	1164	8599	318	733	4269	158	312	1066	39.5
Trichloroethene	1343	11021	408	745	4156	154	270	616	22.8	--	--	--	--	--	--

Notes: mg/kg = milligrams per kilogram, SF = square feet, BCF = bank cubic feet, BCY = bank cubic yards

The lateral and volumetric extent of VOC impacted soil is defined by PCE with TCE and other detected VOC constituents occurring within the larger area for PCE. PCE also has the highest detected concentrations.

Figures 2-5 and 2-7 illustrate the vertical distribution of PCE below Building 65 in north-south and east-west cross-sectional views. Figure 2-5 shows the north-south cross-sectional view parallel to the direction of groundwater. Figure 2-6 shows the east-west cross-sectional view perpendicular to the direction of groundwater. The upper left panel of the figures display PCE concentrations and hydrostratigraphy and the lower left panels display the HPT data from previous site investigations. The color ramp for the HPT data displays low pressures as warm (light) and high pressures as cool (dark). Low pressures occur in the bulk matrix with higher hydraulic conductivity. High pressures occur in the bulk matrix with lower hydraulic conductivity. The cross-sectional views show the seasonal range of water table fluctuation measured in the Building 65 area.

The upper left panel of both figures shows the high concentration source zone extending into the upper saturated zone of the surficial aquifer. Vadose zone soil strata beneath the building have a lower hydraulic conductivity and primarily a clay/silt lithology where the residual VOC mass is sorbed to soil. Maximum PCE concentrations occur beneath the former degreasing tank pit and waste line within the center of contaminant mass located between borings SB-12 and SB-13 approximately 1.5 ft. above the seasonally high-water table. The saturated zone in the surficial aquifer below the soil source zone has a high hydraulic conductivity with a lithology consisting of sand with variable gravel.

Figure 2-7 illustrates the lateral and vertical distribution of PCE below Building 65 in north-south and east-west cross-sectional views and integrates soil and groundwater data. The right panel of this figure shows a plan view of the cross section transects with the north-south cross-sectional view parallel to the direction of groundwater and the east-west cross-sectional view perpendicular to the direction of groundwater. The left panels display cross-section views integrating PCE concentrations in soil/groundwater and shows boring/well locations and hydrostratigraphy.

A residual high concentration PCE source zone remains beneath F Bay of Building 65 with lower concentrations extending beneath the northern part of E Bay. PCE concentrations in soil exceed the soil saturation limit below the former degreasing tank pit and waste line area with the highest concentrations in the lower portion of the vadose zone. Volumetric modeling for PDI report calculated an estimated residual VOC contaminant mass of 338 pounds remaining in subsurface soil beneath F Bay and E Bay of Building 65. Volumetric modeling of the OU 8 groundwater VOC plume for the same period calculated a contaminant mass of approximately 2.3 pounds.

2.3.3 VOC Results for Soil Leachate

The 2020 soil investigation included collection of eight (8) samples for analysis of VOCs using the synthetic leaching procedure method (SPLP) to evaluate mobility of these constituents in soil within the source zone area. One or more soil samples had leachate concentrations greater than Federal MCLs for PCE, TCE, methylene chloride, and 1,2-dichloroethane. Appendix A has analysis results tables for SPLP soil samples.

2.3.4 TOC and Physical Soil Testing Results

Table 2-6 has a summary of the results for the eight (8) representative soil samples collected in the Building 65 source zone analyzed for TOC by the Lloyd Kahn method. The fraction of organic carbon (f_{oc}) is a parameter input used for soil-water partitioning analysis of a chemical substance. Soil samples have low levels of TOC at 0.1 percent or less by dry weight.

Table 2-6 TOC Results for Soil (mg/kg)

Parameter (mg/kg)	SB-06 (2-3)	SB-08 (4-5)	SB-12 (6-7)	SB-12 (13-14)	SB-13 (9-10)	SB-13 (18-19)	SB-14 (6-7)	SB-14 (11-12)
Total Organic Carbon	<98	1,800	<95	1,200	720	440	<100	2,600

Notes: TOC = total organic carbon, mg/kg = milligrams per kilogram, (2-3 = depth interval of samples below floor slab in feet.

Soil porosity and bulk density are additional parameter inputs for soil-water partitioning analysis used to evaluate leaching of VOCs from soil to groundwater. Physical soil testing performed by Integrated Geosciences Laboratory, LLC in Houston, Texas, included the following parameter analysis for four (4) representative site soil samples collected from the vadose zone beneath the floor slab in F Bay of Building 65:

- Total, air-filled, and water-filled porosity by API RP40.
- Moisture Content by ATSM D2216.
- Bulk density by ASTM D2937.

Table 2-7 identifies the sample locations and presents the results of the physical soil testing. Sample locations and depths represent the soil types present in the VOC source zone. Parameter inputs for data evaluations completed for the Building 65 PDI Technical Memorandum (AECOM-Meadows 2020) used an arithmetic average (mean) value for dry bulk density and porosity values calculated from the four samples.

Table 2-7 Site-Specific Soil Physical Properties

Sample ID	Moisture Content (% dry weight)	Dry Bulk Density (g/cc)	Total Porosity (%)	Air-Filled Porosity (%)	Water-Filled Porosity (%)
BLDG65-SB-04 (9-10)	24.6	1.39	47.2	12.6	34.6
BLDG65-SB-07 (11-12)	24.7	1.48	44.6	7.8	36.8
BLDG65-SB-09 (9-10)	42.0	1.10	59.3	10.0	49.3
BLDG65-SB-09 (19-20)	28.7	1.41	46.7	13.9	32.9
Mean:	Not Applicable	1.34	49.4	11.1	38.4

Notes: g/cc = grams per cubic centimeter, porosity is percent of bulk volume

2.3.5 Previously Calculated Soil Screening Levels (Soil to Groundwater)

The Building 65 PDI Technical Memorandum developed preliminary soil screening levels (SSLs) for the soil to groundwater pathway using the data collected from the 2020 investigation (AECOM-Meadows 2020). The two methods used to calculate SSLs included the soil-water partitioning equation[10] (EPA 1996) and the leach test[11].

2.3.5.1 Calculated Soil Saturation Limit

The soil saturation limit represents chemical-physical limits in soil. The limit occurs when a chemical completely fills the soil air and water pore spaces. Parameters controlling the soil saturation limit are chemical solubility in water, chemical partitioning between aqueous and gas phases, and in situ bulk soil properties. The PDI report used chemical properties and site-specific properties for soil input into Equation 9 from page 28 of the 1996 EPA SSL Soil Screening Guidance (EPA 1996) to calculate a soil saturation limit of 125.45 mg/kg.

2.3.5.2 Calculated SSLs for Soil to Groundwater

Table 2-8 has a summary of calculated SSLs from the PDI Report (AECOM-Meadows 2020) with target soil leachate concentrations equal to the PCE MCL of 0.005 milligrams per liter (mg/L). SSLs calculated using a dilution attenuation factor of 1 ranged from 0.003 to 0.243 mg/kg. SSLs proportionally increased when applying dilution attenuation factors greater than 1. The PDI report calculated a site-specific dilution attenuation factor of 6.9 using Equation 11 from of the 1996 EPA SSL Soil Screening Guidance (EPA 1996).

Table 2-8 Summary of PDI Calculated Soil SSLs for PCE (mg/kg, Soil to Groundwater)

Method	DAF 1	DAF 2	DAF 3	Site Calculated DAF = 6.9
Soil-Water Partitioning using K_{oc} for K_d	0.003	0.006	0.009	0.020
Soil-Water Partitioning using SPLP for K_d[1]	0.144	0.229	0.434	0.997
Direct Leach Method[1]	0.243	0.486	0.729	1.68

Notes: mg/kg = milligrams per kilogram, DAF = dilution attenuation factor, K_{oc} = soil organic carbon/water partition coefficient, K_d = soil-water partitioning coefficient, [1]Used total lowest concentration PCE leach sample (0.243 mg/kg) with a non-negative, calculated soil-water partitioning coefficient of 28.6 liters per kilogram.

[10] EPA 1996 SSL Guidance p. 29 (Equation 10)
[11] EPA 1996 SSL Guidance p. 31

Investigation findings indicated that PCE impacts in soil extend into the saturated zone of the surficial aquifer with the highest concentrations occurring near the soil-groundwater interface. The high concentration area has PCE levels that exceed the calculated soil saturation limit (125.45 mg/kg) with SPLP leachate results of 5 and 81 mg/L at depths proximate to groundwater.

2.4 Nature and Extent of Groundwater Impacts

Primary COCs in groundwater in OU 8 that have concentrations greater than MCLs include PCE and biodegradation products TCE, cDCE, and vinyl chloride (VC). Figures 2-9 through 2-16 illustrate the lateral distributions of these COCs in groundwater for the April and October 2022 sampling events.

Table 2-9 has constituent plume areas and maximum concentrations detected for the 2022 semi-annual monitoring events. This table identifies the well locations of the maximum concentrations, which included wells in the Building 65 area (MW-164, MW-51, and MW-72), Open Storage Area 75 (MW-106), and Building 66 area (MWANP-3).

Table 2-9 2022 Plume Areas and Maximum Concentrations

	Plume Area (Acres)		Maximum Concentration (µg/L)			
Constituent	April	October	April		October	
Tetrachloroethene	2.38	2.42	170	MW-164	38	MW-106
Trichloroethene	3.59	2.88	87	MWANP-3	160	MWANP-3
cis-1,2-dichloroethene	0.06	0.34	140	MW-51	180	MWANP-3
Vinyl chloride	0.27	0.09	22	MW-51	25	MW-72

Notes: µg/L = micrograms per liter

Limited and separate PCE and TCE plume areas remain in the surficial aquifer at OU 8 in the area of Buildings 65/75 and in the area of Building 66. The highest PCE concentration (170 micrograms per liter, µg/L) occurred in April 2022 at well MW-164 that monitors groundwater beneath the residual soil source zone in F Bay of Building 65. Well MW-106 in the former Building 75 area had the highest PCE concentration (38 µg/L) for the October 2022 event. The highest TCE concentrations for both semi-annual monitoring events occurred at well MWANP-3 located north of Building 66. The aggregate total of the TCE plume areas exceeds the PCE plume areas by 50 percent for the April event and by 19 percent for the October event.

Limited and separate cDCE plumes occur within recent ISB injection areas at former Building 75 area (April) and in the Building 66 area (April and October). The highest cDCE concentration (180 µg/L) occurred at well MWANP-3 located north of Building 66. Limited and separate VC plumes occur at the north end of Building 65 and the recent ISB injection area in the former Building 75 area. The highest VC concentration occurred at well MW-72 located in the covered area north of Building 65.

2.5 Streamlined Risk Evaluation

Section 2.5 has a streamlined risk evaluation for the proposed NTCRA at Building 65.

2.5.1 Exposure Pathways and Receptors

In 2014, AECOM completed a HHRA for subsurface VI at Building 65 as summarized in Section 2.1.3.7. The HHRA calculated risks and hazards for current indoor workers at Buildings 65 and 66 fell below the target risk and hazard levels. At Building 65 using the sub-slab vapor results for future worker risk evaluation, the HHRA estimated risks fell below the target risk and the estimated hazard exceeded the target hazard for PCE and TCE.

Section 2.3 describes the physical characteristics and use of Building 65. Workers in Building 65 use propane-fired or electrical vehicles as conveyance throughout the building and to access materials in upper shelving storage units (E Bay). E Bay connects to F Bay via a full-size traffic door with access limited to F Bay by a locked, chain-linked gate. A building manager coordinates access to Building 65 including F Bay and E Bay.

Bay C of Building 65 has office space separated from the main warehouse by walls, separate foundation, doors, and access hallway. The groundwater plume and residual soil source zone area is more than 450 ft. north of this office area. No enclosed office space is within 100 ft. of this plume area or residual soil source zone. Warehouse building doors opened in the summer months provide for ventilation and traffic flow. A steam heating system maintains the warehouse space near 65 degrees Fahrenheit for the heating season. A non-occupied boiler room in the northeast portion of F Bay provides the building heat. F Bay has two-foot diameter open roof vents and has the duct work of former forced ventilation systems that penetrate the roof on the southern side of F Bay and penetrate the exterior northern wall. These forced air exhaust systems do not operate but function as passive air exchange conduits.

Building occupants work 8 hours per day for 5 days a week in the main warehouse area (A-E Bays). No permanent workers occupy F Bay with intermittent worker access between E Bay and the outside area to the north of Building 65. An SSDS currently operates in the F Bay area to mitigate potential future risk to indoor workers from intrusion of subsurface VI from beneath the floor slab into the indoor air of F Bay.

Table 2-10 (page 2-15) identifies the exposure pathways and receptors for F Bay and northern E Bay of Building 65.

2.5.2 Human Health Risk Screening for Soil

Table 2-11 (page 2-16) has a risk screening (human health) for soil beneath the floor slab of F Bay and the northernmost portion of E Bay. The risk screening for commercial worker (current and future) compares detected results to EPA RSLs for composite worker with a hazard quotient of 0.1 and target carcinogenic risk of 1E-06. This screening has identified the following constituents of potential concern (COPCs):

- PCE – 7 of 60 samples had detected concentrations greater than the RSL of 38.9 mg/kg. The screening exceedances occurred at soil borings SB-12, SB-13, and SB-14 at depths ≥ 6 ft. beneath the floor slab in F Bay.
- TCE – 8 of 58 samples had detected concentrations greater than the RSL of 1.87 mg/kg. For left censored data, the screening conservatively used a concentration equal to one half of the LOD and identified five (5) samples at borings SB-12, SB-13, and SB-14 with corresponding levels greater than the RSL.
- VC – 6 of 58 samples had detections of VC with concentrations than the RSL of 1.68 mg/kg. Six samples with left censored data at borings SB-12, SB-13, and SB-14 had screening values greater than the RSL.
- 1,1,1,2-tetrachloroethane – 1 of 57 samples had a detection of 1,1,1,2-tetrachloroethane with a concentration less than the RSL of 8.75 mg/kg. Two samples with left censored data at borings SB-SB-13 and SB-14 had screening values greater than the RSL.
- 1,2-dichloroethane – 6 of 59 samples had detections of 1,2-dichloethane with concentrations less than the RSL of 2.04 mg/kg. Eight samples with left censored data at borings SB-12, SB-13, and SB-14 had screening values greater than the RSL.

2.5.3 Screening for Soil to Groundwater Pathway

Table 2-11 (page 2-16) has a risk screening for the soil to groundwater pathway at Building 65 using the EPA MCL-based SSL. Cleanup levels for groundwater at OU 8 are Federal MCLs. This screening identified the following COPCs for the soil-to-groundwater pathway:

- PCE – 50 of 60 samples had detected concentrations greater than the MCL-based SSL.

Table 2-10 Exposure Pathways and Receptors for Building 65 F Bay and Northern E Bay

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Soil	Indoor Air	Vapors in Indoor Air in Building 65	Indoor Worker	Adult	Inhalation	Quantitative	Chlorinated VOC impacted soil underlies the building slab in F Bay and the northernmost portion of E Bay. Indoor air sampling in F Bay detected VOCs in indoor air. A current, indoor worker may have potential exposure to contaminants via inhalation of VOCs in indoor air due to subsurface VI. An SSDS operates in F Bay as a VI mitigation measure.
Current	Groundwater	Indoor Air	Vapors in Indoor Air in Building 65	Indoor Worker	Adult	Inhalation	Quantitative	OU 8 groundwater plume of chlorinated VOCs underlies F Bay and a portion of E Bay. Indoor air sampling in F Bay detected VOCs in indoor air. A current indoor worker may have potential exposure to contaminants via inhalation of VOCs in indoor air due to subsurface VI. An SSDS operates in F Bay as a VI mitigation measure.
Future	Soil	Indoor Air	Vapors in Indoor Air in Building 65	Indoor Worker	Adult	Inhalation	Quantitative	Chlorinated VOC impacted soil underlies the building slab in F Bay and the northernmost portion of E Bay. Indoor air sampling in F Bay detected VOCs in indoor air. A future, indoor worker may have potential exposure to contaminants via inhalation of VOCs in indoor air due to subsurface VI. An SSDS operates in F Bay as a VI mitigation measure.
Future	Groundwater	Indoor Air	Vapors in Indoor Air in Building 65	Indoor Worker	Adult	Inhalation	Quantitative	OU 8 groundwater plume of chlorinated VOCs underlies F Bay and a portion of E Bay. Indoor air sampling in F Bay detected VOCs in indoor air. A future, indoor worker may have potential exposure to contaminants via inhalation of VOCs in indoor air due to subsurface vapor intrusion. An SSDS operates in F Bay as a vapor intrusion mitigation measure.
Future	Groundwater	Groundwater	Groundwater and Vapors in Construction Trench	Construction Worker	Adult	Ingestion, Dermal Absorption, Inhalation	Quantitative	Included in ROD for OU 8 groundwater. A future construction worker in trench may have exposure through incidental ingestion of groundwater, dermal contact with groundwater, and vapor emissions.
Future	Soil	Subsurface Soil	Subsurface Soil	Construction Worker	Adult	Ingestion, Dermal Absorption	Quantitative	Chlorinated VOC impacted soil underlies the building slab in F Bay and the northernmost portion of E Bay. A future construction worker could contact ingest/contact subsurface soil (≤10-foot depth) from the site if future construction involved disturbance of subsurface soil beneath the building slab in F Bay.

Notes: VOC = volatile organic compound, VI = vapor intrusion.

Table 2-11 Human Health Soil Screening

Constituent	BUILDING 65 SOIL SAMPLING RESULTS (JUNE 2020, mg/kg)								RSL CW SOIL 0.1			MCL BASED SSL 1.0			RISK BASED SSL 0.1			APR 2024 SEMI-ANNUAL GW MONITORING RESULTS FOR DETECTED VOCS IN Soil (ug/L)							FEDERAL MCL			RSL TAP WATER 0.1		
	Matrix	No. Results	Unit	Min	Max	No. > LOD	% > LOD	Max Loc	No. >	% >	Action Level	No. >	% >	SSL	No. >	% >	SSL	No. of Results	Unit	Min	Max	No. > LOD	% > LOD	Max Loc	No. >	% >	MCL	No. >	% >	RSL
1,1,1,2-Tetrachloroethane	SO	57	mg/kg	<0.0027	0.013	1	2	SB-13	1	2	8.75E+00	-	-	-	1	2	2.19E-04	96	ug/L	<0.36	<0.36	0	0	-	-	-	-	0	0	5.74E-01
1,1-Dichloroethene	SO	58	mg/kg	<0.0016	0.014	2	3	SB-13	0	0	2.00E+00	2	3	2.51E-03	2	3	2.90E-04	96	ug/L	<0.33	0.62	11	11	DMW-30A	0	0	7.00E+00	0	0	2.85E+01
1,2,4-Trimethylbenzene	SO	58	mg/kg	<0.0016	0.038	4	7	SB-13	0	0	1.77E+02	-	-	-	4	7	8.08E-03	96	ug/L	<0.53	3	4	4	DP-6	0	0	7.00E+01	4	4	3.99E-01
1,2-Dichloroethane	SO	59	mg/kg	<0.0016	0.16	6	10	SB-13	6	10	2.04E+00	6	10	1.42E-03	6	10	4.84E-05	96	ug/L	<0.25	8.6	14	15	MW-163	2	2	5.00E+00	14	15	1.71E-01
1,3,5-Trimethylbenzene	SO	58	mg/kg	<0.0027	0.017	3	5	SB-13	0	0	1.51E+02	-	-	-	3	5	8.66E-03	96	ug/L	<0.28	1.1	2	2	DP-6	-	-	-	0	0	6.03E+00
Acetone	SO	58	mg/kg	<15	0.092	50	86	SB-07	0	0	1.05E+05	-	-	-	0	0	3.68E-01	96	ug/L	<3.7	1800	5	5	MW-163	-	-	-	1	1	1.80E+03
Carbon disulfide	SO	58	mg/kg	<0.0016	0.0024	4	7	SB-15	0	0	3.47E+02	-	-	-	0	0	2.40E-02	96	ug/L	<0.43	4.3	7	7	DP-6	-	-	-	0	0	8.11E+01
Chloroform	SO	58	mg/kg	<0.0016	0.0026	3	5	SB-13	0	0	1.38E+00	0	0	2.22E-02	3	5	6.12E-05	96	ug/L	<0.27	1.4	5	5	MW-115	0	0	8.00E+01	5	5	2.21E-01
cis-1,2-Dichloroethene	SO	59	mg/kg	<0.0025	0.7	20	34	SB-13	0	0	3.69E+01	16	27	2.06E-02	20	34	7.41E-04	96	ug/L	<0.25	270	55	57	MW-163	2	2	7.00E+01	29	30	2.52E+00
Ethylbenzene	SO	58	mg/kg	<0.0027	0.0047	1	2	SB-13	0	0	2.54E+01	0	0	7.85E-01	1	2	1.68E-03	96	ug/L	<0.2	0.63	2	2	DP-6	0	0	7.00E+02	0	0	1.50E+00
Methylene chloride	SO	58	mg/kg	<0.0013	160	9	16	SB-13	0	0	3.16E+02	8	14	1.28E-03	8	14	2.72E-03	96	ug/L	<3.2	4.4	1	1	MW-165	0	0	5.00E+00	0	0	1.07E+01
Naphthalene	SO	58	mg/kg	<0.0016	0.12	21	36	SB-09	0	0	8.57E+00	-	-	-	11	19	3.85E-04	96	ug/L	<0.014	3.3	3	3	MWANP-27, 7	-	-	-	96	95	1.17E-01
n-Butylbenzene	SO	58	mg/kg	<0.0027	0.0032	2	3	SB-09, SB-13	0	0	5.84E+03	-	-	-	0	0	3.23E-01	96	ug/L	<0.52	2	3	3	DP-6	-	-	-	0	0	1.00E+02
n-Propylbenzene	SO	58	mg/kg	<0.0027	0.005	1	2	SB-13	0	0	2.43E+03	-	-	-	0	0	1.22E-01	96	ug/L	<0.41	1.2	4	4	DP-6	-	-	-	0	0	6.56E+01
o-Xylene	SO	58	mg/kg	<0.0016	0.011	3	5	SB-13	0	0	2.79E+02	-	-	-	1	2	1.91E-02	96	ug/L	<0.26	0.54	3	3	DP-6	-	-	-	0	0	1.93E+01
tert-Butyl methyl ether (MTBE)	SO	58	mg/kg	<0.0016	0.0012	6	10	SB-11, SB-14	0	0	2.05E+02	-	-	-	0	0	3.22E-03	96	ug/L	<0.81	8.1	7	7	DP-11	-	-	-	0	0	1.43E+01
Tetrachloroethene (PCE)	SO	60	mg/kg	<0.0043	7300	52	87	SB-13	7	12	3.89E+01	50	83	2.27E-03	52	87	1.84E-03	96	ug/L	<0.35	85	58	60	DP-2	12	13	5.00E+00	15	16	4.06E+00
Toluene	SO	58	mg/kg	<0.00082	8.7	8	14	SB-13	0	0	4.68E+03	7	12	6.92E-01	7	12	7.62E-02	96	ug/L	<0.25	0.85	15	16	MW-124	0	0	1.00E+03	0	0	1.10E+02
trans-1,2-Dichloroethene	SO	58	mg/kg	<0.00082	0.011	7	12	SB-13	0	0	3.02E+01	7	12	3.13E-02	13	22	2.12E-03	96	ug/L	<0.34	1.2	11	11	DP-2	0	0	1.00E+02	0	0	6.78E+00
Trichloroethene (TCE)	SO	58	mg/kg	<0.0025	74	24	41	SB-13	8	14	1.87E+00	24	41	1.79E-03	24	41	1.01E-04	96	ug/L	<0.2	88	68	71	DP-2	14	15	5.00E+00	66	69	2.83E-01
Vinyl chloride	SO	58	mg/kg	<0.0016	0.075	6	10	SB-13	6	10	1.68E+00	6	10	6.90E-04	6	10	6.47E-06	96	ug/L	<0.4	7.8	24	25	MW-165	9	9	2.00E+00	96	100	1.88E-02
Xylene (Total)	SO	58	mg/kg	<0.0016	0.036	3	5	SB-13	0	0	2.49E+02	0	0	9.90E+00	3	5	1.91E-02	96	ug/L	<0.49	1.3	1	1	DP-6	0	0	1.00E+04	0	0	1.93E+01

Notes: mg/kg = milligrams per kilogram, SO = soil, No. = number, % = percent, LOD = limit of detection, Max = maximum, Loc = location, MCL = maximum contaminant level, RSL = EPA Regional Screening Level for composite soil worker for a hazard quotient of 0.1 and target risk of 1E-06 included in the EPA May 2024 RSL table, SSL = soil screening level for soil to groundwater based on MCLs and risk-based tap water RSL with hazard quotient of 0.1 and target carcinogenic risk of 1E-06 included in the EPA May 2024 RSL table. Detailed soil analytical results are included in Appendix B.3 of the Final Technical Memorandum for Results of Building 65 Area Soil Investigation for Operable Unit 8 Remediation Optimization, dated September 10, 2021. ug/L = micrograms per liter. Concentration greater than EPA Composite Worker RSL 0.1. Concentration greater than MCL Based SSL 1.0, Concentration greater than risk-based SSL 0.1, Concentration greater than Federal MCL, and Concentration greater than RSL Tap Water 0.1.

Table 2-12 Soil to Groundwater Screening for SPLP Soil Samples

Constituent	BUILDING 65 SOIL SAMPLING RESULTS for SPLP (JUNE 2020, mg/L)								FEDERAL MCL			RSL TAP WATER 0.1		
	Matrix	No. Results	Unit	Min	Max	# > LOD	% > LOD	Max Loc	No. >	% >	MCL	No. >	% >	RSL
1,2,4-Trimethylbenzene	SL	8	mg/L	<0.00047	0.012	3	38	SB-12	-	-	-	2	25	5.57E-03
1,2-Dichloroethane	SL	8	mg/L	<0.0005	0.015	4	50	SB-12	2	25	5.00E-03	8	100	1.71E-04
1,2-Dichloroethene, Total	SL	8	mg/L	<0.00075	0.048	3	38	SB-12	-	-	-	-	-	-
1,3,5-Trimethylbenzene	SL	8	mg/L	<0.00031	0.0038	2	25	SB-12	-	-	-	1	13	6.03E-03
Acetone	SL	8	mg/L	<0.35	0.019	7	88	SB-14	-	-	-	0	0	1.80E+00
cis-1,2-Dichloroethene	SL	8	mg/L	<0.00041	0.047	4	50	SB-12	0	0	7.00E-02	4	50	2.52E-03
Ethylbenzene	SL	8	mg/L	<0.00033	0.0022	2	25	SB-12	0	0	7.00E-01	2	25	1.50E-03
m+p-Xylenes	SL	8	mg/L	<0.00035	0.012	4	50	SB-12	-	-	-	-	-	-
Methylene chloride (DCM)	SL	8	mg/L	0.0068	0.17	8	100	SB-13	8	100	5.00E-03	3	38	1.07E-02
Naphthalene	SL	8	mg/L	<0.0025	0.023	4	50	SB-12	-	-	-	4	50	1.17E-04
n-Butylbenzene	SL	8	mg/L	<0.00047	0.00053	1	13	SB-12	-	-	-	0	0	1.00E-01
n-Propylbenzene	SL	8	mg/L	<0.00038	0.0011	1	13	SB-12	-	-	-	0	0	6.56E-02
o-Xylene	SL	8	mg/L	<0.00023	0.0041	4	50	SB-12	-	-	-	0	0	1.93E-02
p-Isopropyltoluene	SL	8	mg/L	<0.00048	0.0045	2	25	SB-12	-	-	-	1	13	2.09E-03
tert-Butyl methyl ether (MTBE)	SL	8	mg/L	<0.015	0.00047	7	88	SB-13	-	-	-	0	0	1.43E-02
Tetrachloroethene (PCE)	SL	8	mg/L	0.0021	81	8	100	SB-12	7	88	5.00E-03	7	88	4.06E-03
Toluene	SL	8	mg/L	<0.00048	0.0023	4	50	SB-14	0	0	1.00E+00	0	0	1.10E-01
trans-1,2-Dichloroethene	SL	8	mg/L	<0.00037	0.00097	1	13	SB-12	0	0	1.00E-01	0	0	6.78E-03
Trichloroethene (TCE)	SL	8	mg/L	0.00081	0.99	8	100	SB-12	5	63	5.00E-03	8	100	2.83E-04
Xylene (Total)	SL	8	mg/L	<0.00023	0.016	4	50	SB-12	0	0	1.00E+01	0	0	1.93E-02

Notes: mg/L= milligrams per liter, SL = soil leachate, No. = number, % = percent, Max = maximum, Loc = location, LOD = limit of detection, MCL = maximum contaminant level, RSL = EPA Regional Screening Level for tap water with a hazard quotient of 0.1 and target risk of 1E-06 included in the EPA May 2024 RSL table. Concentration greater than Federal MCL and Concentration greater than RSL Tap Water 0.1.

- TCE – 24 of 58 samples had detected concentrations greater than the MCL-based SSL.
- cDCE – 16 of 59 samples had detected concentrations greater than the MCL-based SSL.
- trans-1,2-dichloroethene (tDCE) – 7 of 58 samples had detected concentrations greater than the MCL-based SSL.
- VC – 6 of 58 samples had detected concentrations greater than the MCL-based SSL Thirty nine (39) samples with left-censored data had screening values greater than the MCL-based SSL.
- 1,1-dichloroethene – 2 of 58 samples had detected concentrations greater than the MCL-based SSL. Seven (7) samples with left-censored data had screening values greater than the MCL-based SSL.
- 1,2-dichloroethane – 6 of 59 samples had detected concentrations greater than the MCL-based SSL. Eight (8) samples with left-censored data had screening values greater than the MCL-based SSL.
- Methylene chloride – 8 of 58 samples had detected concentrations greater than the MCL-based SSL. Four (4) samples with left-censored data had screening values greater than the MCL-based SSL.
- Toluene – 7 of 58 samples had detected concentrations greater than the MCL-based SSL.

For constituents detected in soil, Table 2-11 screens groundwater sample data for OU 8 from April 2024 relative to MCLs (cleanup levels). The screening results identified the following groundwater COPCs with detections in groundwater at concentrations greater than MCLs:

- PCE – 12 of 96 samples had detected concentrations greater than the MCL. This included locations monitoring groundwater beneath F Bay (MW-165) and north of Building 65.
- TCE - 14 of 96 samples had detected concentrations greater than the MCL. This included locations monitoring groundwater beneath F Bay (MW-165) and north of Building 65.
- cDCE - 2 of 96 samples had detected concentrations greater than the MCL. This included locations monitoring groundwater beneath F Bay (MW-163) and north of Building 65 (DMW-30A).
- VC - 9 of 96 samples had detected concentrations greater than the MCL. This included locations monitoring groundwater beneath F Bay (MW-163 and MW-165) and north of Building 65.
- 1,2-dichloroethane – 2 of 96 samples had detected concentrations greater than the MCL. This included locations monitoring groundwater beneath F Bay (MW-163 and MW-165).

For constituents detected in soil, Table 2-11 also screens groundwater sample data for OU 8 from April 2024 relative to tap water RSLs. The screening results identified the following additional soil COPCs with detections in groundwater at concentrations greater than RSLs:

- 1,2,4-trimethylbenzene– 4 of 96 samples had detected concentrations greater than the RSL. This included three locations monitoring groundwater north of Building 65.
- Acetone - 1 of 96 samples had detected concentrations greater than the RSL at well MW-163 in F Bay. Acetone is ketone by-product that temporarily forms in ISB injection areas.

Table 2-12 (page 2-16) has a screening for detected VOC constituents for SPLP leachate testing and identified the following COPCs for this measure of the soil to groundwater pathway:

- PCE – 7 of 8 samples had concentrations greater than the MCL with 8 of 8 samples having concentrations greater than the RSL.
- TCE – 5 of 8 samples had concentrations greater than the MCL with 8 of 8 samples having concentrations greater than the RSL.
- cDCE – 4 of 8 samples had detected concentrations greater than the RSL.
- tDCE– 1 of 8 samples had a detected concentration greater than the RSL.
- 1,2-dichloroethane – 2 of 8 samples had concentrations greater than the MCL with 4 of 8 samples having concentrations > tap water RSL Four samples with left-censored data had screening values > RSL.
- 1,2,4-trimethylbenzene – 2 of 8 samples had detected concentrations greater than the RSL.

- 1,3,5-trimethylbenzene – 1 of 8 samples had detected concentrations greater than the RSL.
- Ethylbenzene – 2 of 8 samples had detected concentrations greater than the RSL.
- Naphthalene – 4 of 8 samples had detected concentrations greater than the RSL with four samples with left-censored data had screening values greater than the RSL.
- Methylene chloride – 8 of 8 samples had concentrations greater than MCL with 3 of 8 samples having concentrations greater than the RSL.
- p-Isopropyltoluene – 1 of 8 samples had concentrations greater than the RSL.

The maximum soil leachate concentrations reported for PCE and TCE at SB-12 are four (4) and two (2) orders of magnitude greater than MCLs, respectively.

2.5.4 Building 65 F Bay Sub-Slab Vapor Risk Screening

Figure 2-8 shows sample locations in F Bay Building 65 for annual sub-slab vapor sampling. Table 2-13 (page 2-19) has a risk screening for sub-slab vapor data in F Bay of Building 65 using EPA Vapor Intrusion Screening Levels for a commercial scenario with a target hazard quotient of 0.1 and target risk of 1E-06. The VOC data is from June 2023 collected as part of annual monitoring at Building 65 for sub-slab soil gas and indoor air/ambient air. The screening results identified the following COPCs with detections in sub-slab soil gas at concentrations greater than VISLs:

- PCE – 2 of 4 samples had detected concentrations greater than the VISL.
- TCE – 3 of 4 samples had detected concentrations greater than the VISL.
- cDCE - 1 of 4 samples had detected concentrations greater than the VISL.

The COPCs for sub-slab vapor correlate to the COPCs for soil beneath F Bay of Building 65. The Building 65 SSDS currently operates to depressurize and remove VOCs in soil vapor beneath the floor slab of F Bay.

2.5.5 Building 65 Indoor Air and Ambient Air Risk Screening

Figure 2-8 shows sample locations in the Building 65 area for annual sampling of indoor air and ambient air. Annual sampling at these locations began in 2019. Table 2-14 (page 2-20) has a risk screening for indoor air in F Bay of Building and ambient air outside of Building 65 using EPA RSLs for a composite worker (air) with a target hazard quotient of 0.1 and target risk of 1E-05. The VOC air data is from June 2023 collected as part of annual monitoring at Building 65 for sub-slab soil gas and indoor air/ambient air. The screening results indicated detected VOC concentrations < VISLs.

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Table 2-13 Sub-Slab Vapor Screening F Bay Building 65

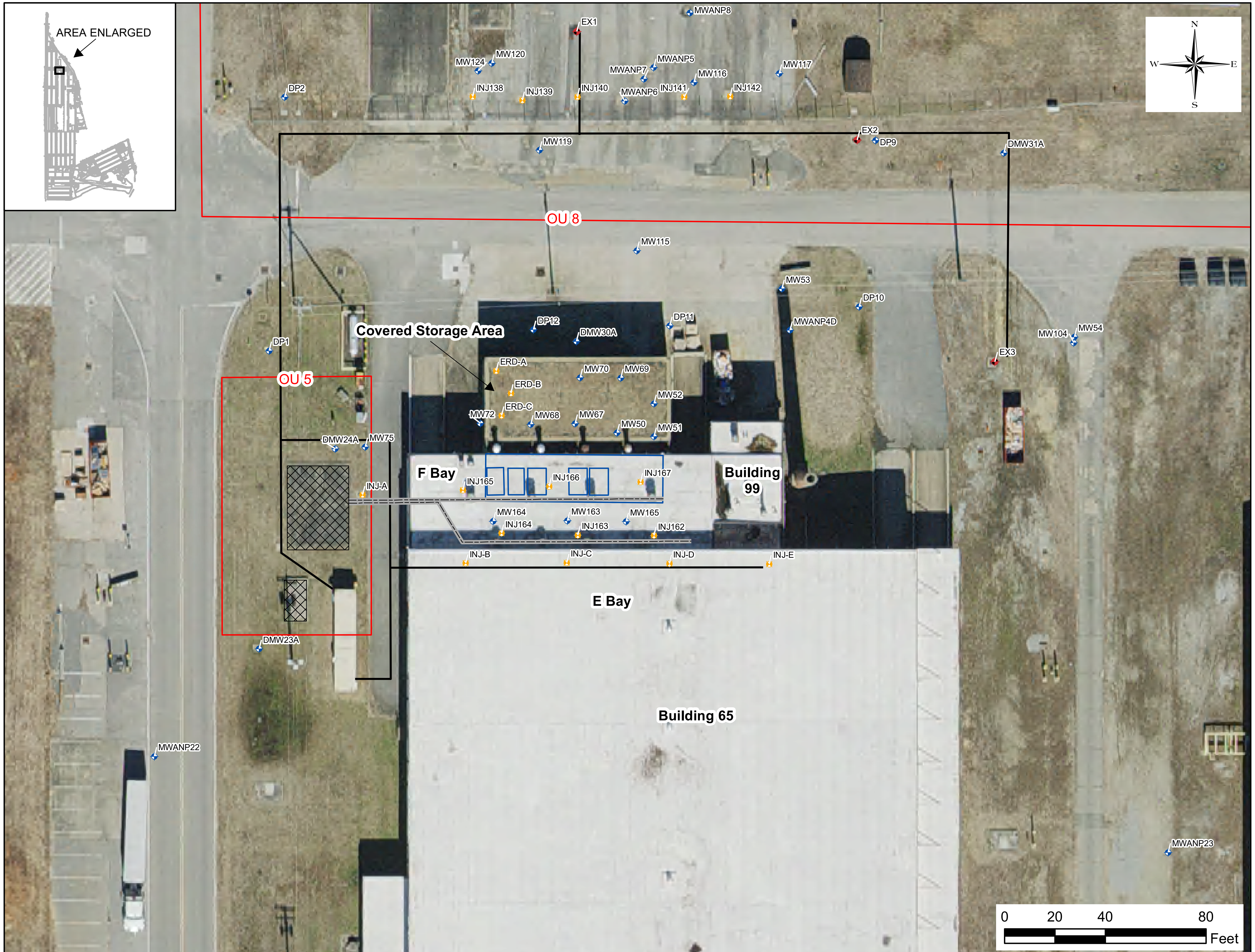
Constituent	Matrix	No. Results	Unit	Min	Max	No. > LOD	% > LOD	Max Loc	VISL COMM SS NSSG 0.1		
									No. >	% >	VISL
1,1-Dichloroethene	GS	4	ug/m3	<0.13	0.16	1	25	VMP-87	0	0	2.92E+03
1,2,4-Trimethylbenzene	GS	4	ug/m3	<25	2	3	75	VMP-86	0	0	8.76E+02
1,2-Dichloroethane	GS	4	ug/m3	<0.1	0.61	1	25	VMP-87	0	0	1.57E+01
2,2,4-Trimethylpentane	GS	4	ug/m3	<0.17	1.8	1	25	VMP-192	-	-	-
2-Butanone (MEK)	GS	4	ug/m3	<54	200	3	75	VMP-86	0	0	7.30E+04
2-Hexanone	GS	4	ug/m3	<58	11	3	75	VMP-86	0	0	4.38E+02
4-Ethyltoluene	GS	4	ug/m3	<26	0.74	3	75	VMP-86	-	-	-
4-Methyl-2-pentanone (MIBK)	GS	4	ug/m3	<0.57	1	1	25	VMP-87	0	0	4.38E+04
Acetone	GS	4	ug/m3	<340	200	3	75	VMP-86	-	-	-
Benzene	GS	4	ug/m3	<11	6.4	3	75	VMP-192	0	0	5.24E+01
Butane	GS	4	ug/m3	<51	110	3	75	VMP-87	-	-	-
Carbon disulfide	GS	4	ug/m3	<27	4.1	3	75	VMP-192	0	0	1.02E+04
Carbon tetrachloride	GS	4	ug/m3	<20	0.34	3	75	VMP-87	0	0	6.81E+01
Chlorodifluoromethane	GS	4	ug/m3	<20	1	3	75	VMP-192	0	0	7.30E+05
Chloroform	GS	4	ug/m3	<0.18	1.5	2	50	VMP-86	0	0	1.78E+01
cis-1,2-Dichloroethene	GS	4	ug/m3	0.69	9000	4	100	VMP-191	1	25	5.84E+02
Cyclohexane	GS	4	ug/m3	<0.32	0.75	2	50	VMP-192	0	0	8.76E+04
Dichlorodifluoromethane	GS	4	ug/m3	<18	1.2	3	75	VMP-192, 86, 87	0	0	1.46E+03
Ethylbenzene	GS	4	ug/m3	<15	0.44	3	75	VMP-87	0	0	1.64E+02
Hexane	GS	4	ug/m3	<23	18	3	75	VMP-87	0	0	1.02E+04
Isopropyl alcohol	GS	4	ug/m3	<60	2	3	75	VMP-192	0	0	2.92E+03
m+p-Xylenes	GS	4	ug/m3	<32	1.5	3	75	VMP-192	-	-	-
Methyl chloride (Chloromethane)	GS	4	ug/m3	<34	0.93	3	75	VMP-192	0	0	1.31E+03
Methylene chloride	GS	4	ug/m3	1.4	120	4	100	VMP-191	0	0	8.76E+03
n-Heptane	GS	4	ug/m3	<15	17	3	75	VMP-87	0	0	5.84E+03
n-Propylbenzene	GS	4	ug/m3	<0.24	0.33	2	50	VMP-86	0	0	1.46E+04
o-Xylene	GS	4	ug/m3	<17	0.87	3	75	VMP-87	0	0	1.46E+03
Tert Butyl Alcohol	GS	4	ug/m3	<26	4.2	3	75	VMP-86	0	0	7.30E+04
Tetrachloroethene (PCE)	GS	4	ug/m3	100	1500	4	100	VMP-191	2	50	5.84E+02
Tetrahydrofuran	GS	4	ug/m3	<0.53	0.6	1	25	VMP-87	0	0	2.92E+04
Toluene	GS	4	ug/m3	<22	1.5	3	75	VMP-192	0	0	7.30E+04
trans-1,2-Dichloroethene	GS	4	ug/m3	<0.13	160	3	75	VMP-191	0	0	5.84E+02
Trichloroethene (TCE)	GS	4	ug/m3	2.7	1700	4	100	VMP-191	3	75	2.92E+01
Trichlorofluoromethane	GS	4	ug/m3	<16	1	3	75	VMP-192, 86, 87	-	-	-
Trichlorotrifluoroethane (Freon 113)	GS	4	ug/m3	<19	0.48	3	75	VMP-86	0	0	7.30E+04
Vinyl chloride	GS	4	ug/m3	<0.17	1.5	1	25	VMP-87	0	0	9.29E+01
Xylene (Total)	GS	4	ug/m3	<17	2.3	3	75	VMP-87	0	0	1.46E+03

Notes: ug/m3 = micrograms per meter cubed, GS = soil gas matrix, No. = number, % = percent, LOD = limit of detection, VISL COMM SS = United States Environmental Protection Agency Vapor Intrusion Screening Level for sub-slab and near source soil gas concentration for a commercial/industrial scenario with a target hazard quotient of 0.1 and target carcinogenic risk of 1E-06 using VISL calculator and May 2024 toxicity data. A site-specific groundwater temperature of 18.20 degrees Celsius is used for the calculations. Concentration greater than VISL.

Table 2-14 Indoor and Ambient Air Screening Building 65

Constituent	Matrix	No. Results	Unit	Min	Max	# > LOD	% > LOD	Max Loc	RSL CW AIR 0.1		
									No. >	% >	RSL
2,2,4-Trimethylpentane	AA	6	ug/m3	0.24	0.26	6	100	AA-2, IA1	-	-	-
2-Butanone (MEK)	AA	6	ug/m3	1.2	4.7	6	100	IA3	0	0	2.19E+03
2-Hexanone	AA	6	ug/m3	<0.57	0.62	1	17	IA3	0	0	1.31E+01
4-Methyl-2-pentanone (MIBK)	AA	6	ug/m3	<0.57	0.75	4	67	IA3	0	0	1.31E+03
Acetone	AA	6	ug/m3	12	57	6	100	IA3	-	-	-
Benzene	AA	6	ug/m3	0.74	0.85	6	100	AA-1	0	0	1.57E+00
Butane	AA	6	ug/m3	0.96	1.1	6	100	AA-2, IA1, IA2, IA3, IA4	-	-	-
Carbon disulfide	AA	6	ug/m3	<0.27	1.2	4	67	AA-1	0	0	3.07E+02
Carbon tetrachloride	AA	6	ug/m3	0.35	0.4	6	100	AA-2	0	0	2.04E+00
Chlorodifluoromethane	AA	6	ug/m3	1.1	1.7	6	100	AA-2	0	0	2.19E+04
cis-1,2-Dichloroethene	AA	6	ug/m3	<0.099	0.13	1	17	AA-2	0	0	1.75E+01
Dichlorodifluoromethane	AA	6	ug/m3	1.1	1.3	6	100	IA4	0	0	4.38E+01
Ethylbenzene	AA	6	ug/m3	0.2	0.25	6	100	IA1, IA4	0	0	4.91E+00
Hexane	AA	6	ug/m3	0.26	0.35	6	100	AA-1	0	0	3.07E+02
Isopropyl alcohol	AA	6	ug/m3	0.74	1.9	6	100	IA3	0	0	8.76E+01
m+p-Xylenes	AA	6	ug/m3	0.45	0.62	6	100	AA-1	-	-	-
Methyl chloride (Chloromethane)	AA	6	ug/m3	1.5	2.7	6	100	AA-2	0	0	3.94E+01
Methylene chloride	AA	6	ug/m3	1.6	3.7	6	100	AA-1	0	0	2.63E+02
n-Heptane	AA	6	ug/m3	0.16	0.32	6	100	IA3	0	0	1.75E+02
o-Xylene	AA	6	ug/m3	0.19	0.31	6	100	IA4	0	0	4.38E+01
Tert Butyl Alcohol	AA	6	ug/m3	<0.25	1.6	3	50	IA3	0	0	2.19E+03
Tetrachloroethene (PCE)	AA	6	ug/m3	<0.2	0.38	4	67	AA-2	0	0	1.75E+01
Toluene	AA	6	ug/m3	0.63	0.72	6	100	AA-1	0	0	2.19E+03
Trichlorofluoromethane	AA	6	ug/m3	1.1	1.2	6	100	AA-1	-	-	-
Trichlorotrifluoroethane (Freon 113)	AA	6	ug/m3	0.46	0.52	6	100	AA-1	0	0	2.19E+03
Xylene (Total)	AA	6	ug/m3	0.64	0.91	6	100	IA4	0	0	4.38E+01

Notes: ug/m3 = micrograms per meter cubed, AA = ambient air matrix, No. = number, % = percent, LOD = limit of detection, MCL = maximum contaminant level, RSL = EPA Regional Screening Level for composite worker air with a hazard quotient of 0.1 and target risk of 1E-06 included in the EPA May 2024 RSL table.



Legend

- Monitoring Well
- Extraction Well
- Injection Well
- Pumping Well
- Piezometer
- Former ANPs
- Former Waste Lines
- Former Tank Pit
- BDGR Conveyance Piping
- OU Boundary

Notes:
Orthoimagery Source: VGIN (2021)

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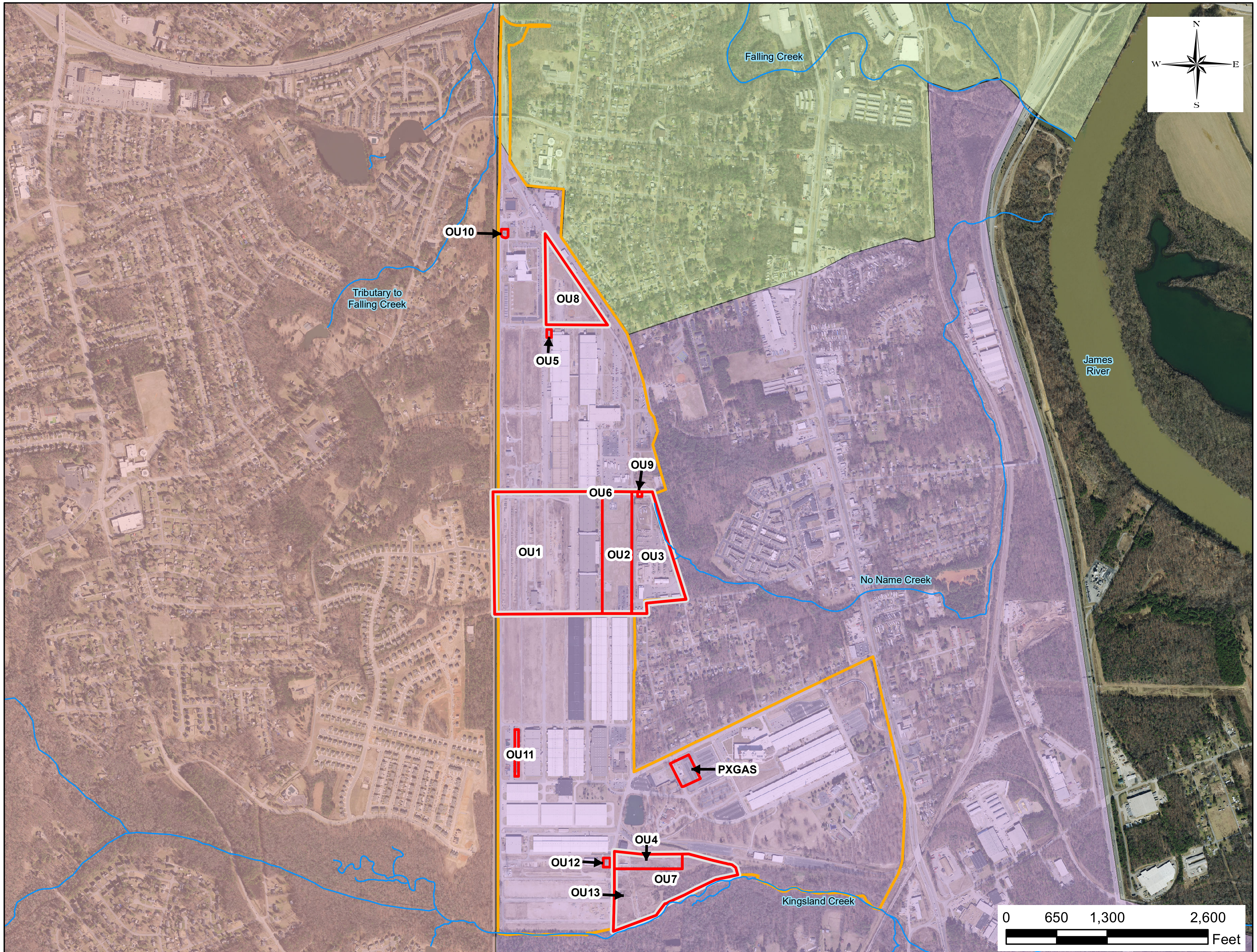
Figure 2-1
Building 65 Area Site Features

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 40'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-1 - BLDG 65 Layout.mxd



Legend

- Streams
- Operable Unit Boundaries
- OU 6; OU 7; OU 8 Boundaries
- Installation Boundary
- Bellwood Suburb
- Bensley Suburb
- Meadowbrook Suburb

Notes:
OU6 Includes Groundwater Impacts Beneath OU's 1, 2, & 3
OU7 Includes Groundwater Impacts Beneath OU 4
OU8 Includes Groundwater Impacts Beneath OU 5
Orthoimagery Source: VGIN (2021)

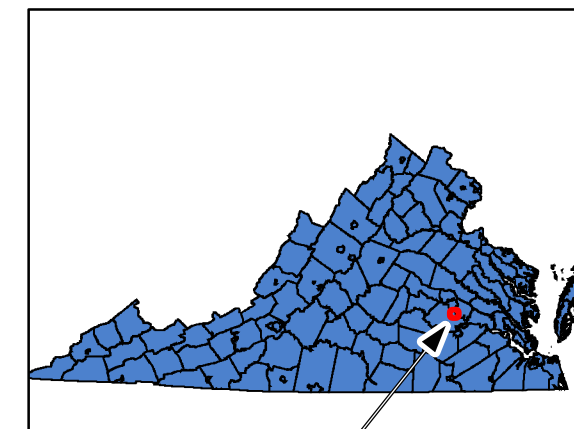


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Figure 2-2
DSCR and Surrounding Area Land Use

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 1,300'	Date: July 16, 2024

C:\Users\david.copen\AECOM\DSCR Bldg. 65 EA CA Report and Action Memorandum - General\Draft Bldg. 65 EE_CA Report\Figures\Figure 2-2 - DSCR and Surrounding Land Use.mxd

Legend

- Building 65 Soil Source Investigation Boring
- Former Waste Lines
- Former Tank Pit
- Former ANPs
- OU Boundary

Notes:
Orthoimagery Source: VGIN (2021)

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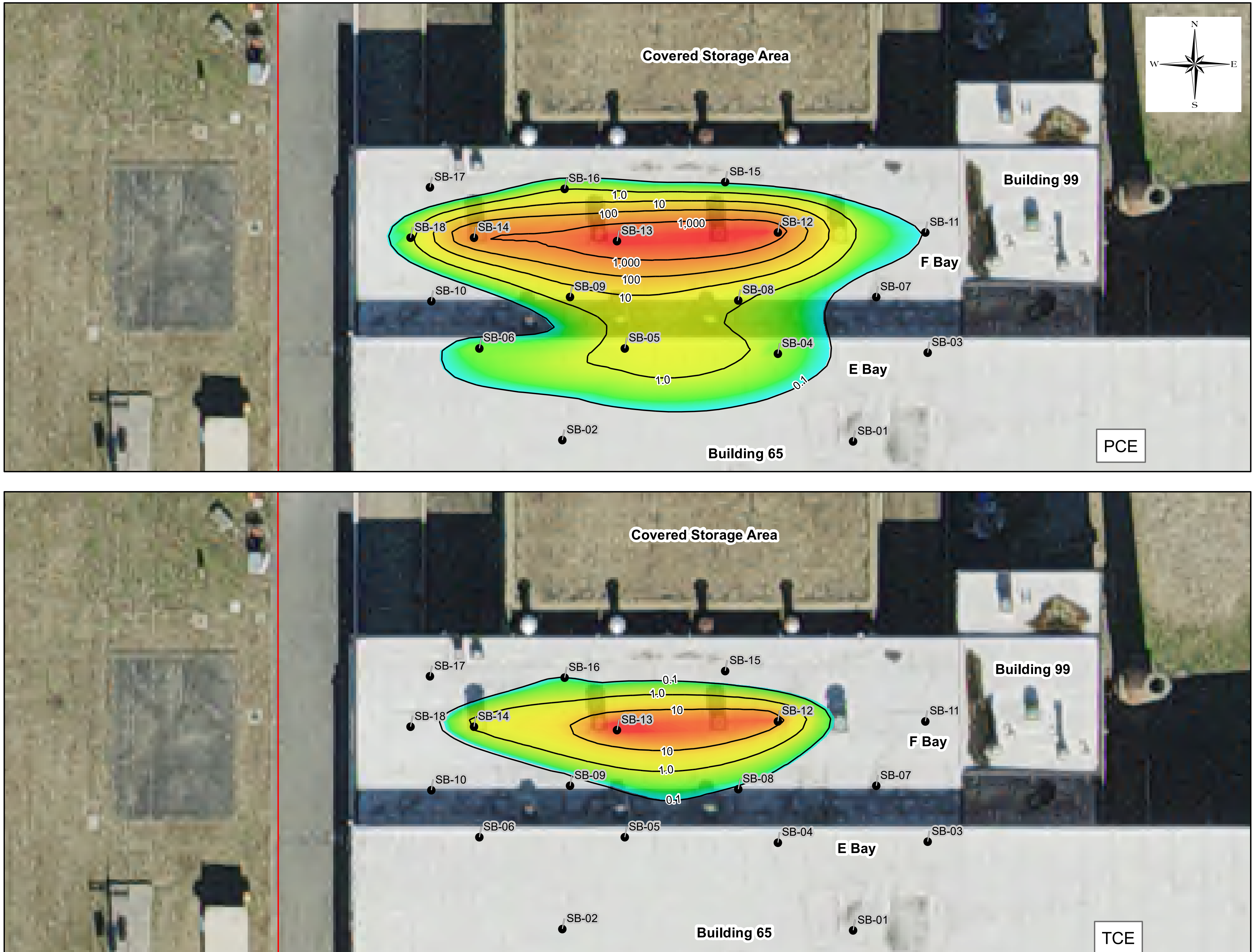
Figure 2-3
Building 65 Source Investigation
Soil Boring Locations
(June 2020)

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 30'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-3 - BLDG 65 SB Locs.mxd



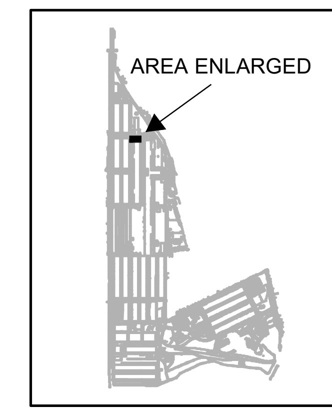
Legend

- Building 65 Soil Source Investigation Boring
- Isoconcentration Line
- OU Boundary

Soil Concentration (mg/kg)

0.0002 0.001 0.01 0.1 1 10 100 1,000 7,300

Notes:
Orthoimagery Source: VGIN (2021)
Migration to GW SSL = 1.156 mg/kg
Csat = 5,782.33 mg/kg
mg/kg = milligrams per kilogram



0 10 20 40
Feet

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Figure 2-4
Lateral Distribution of PCE and TCE in Vadose Zone Soil (June 2020)

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 20'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-4 - Lateral Distribution of PCE and TCE in VZ Soil above 100PPB.mxd

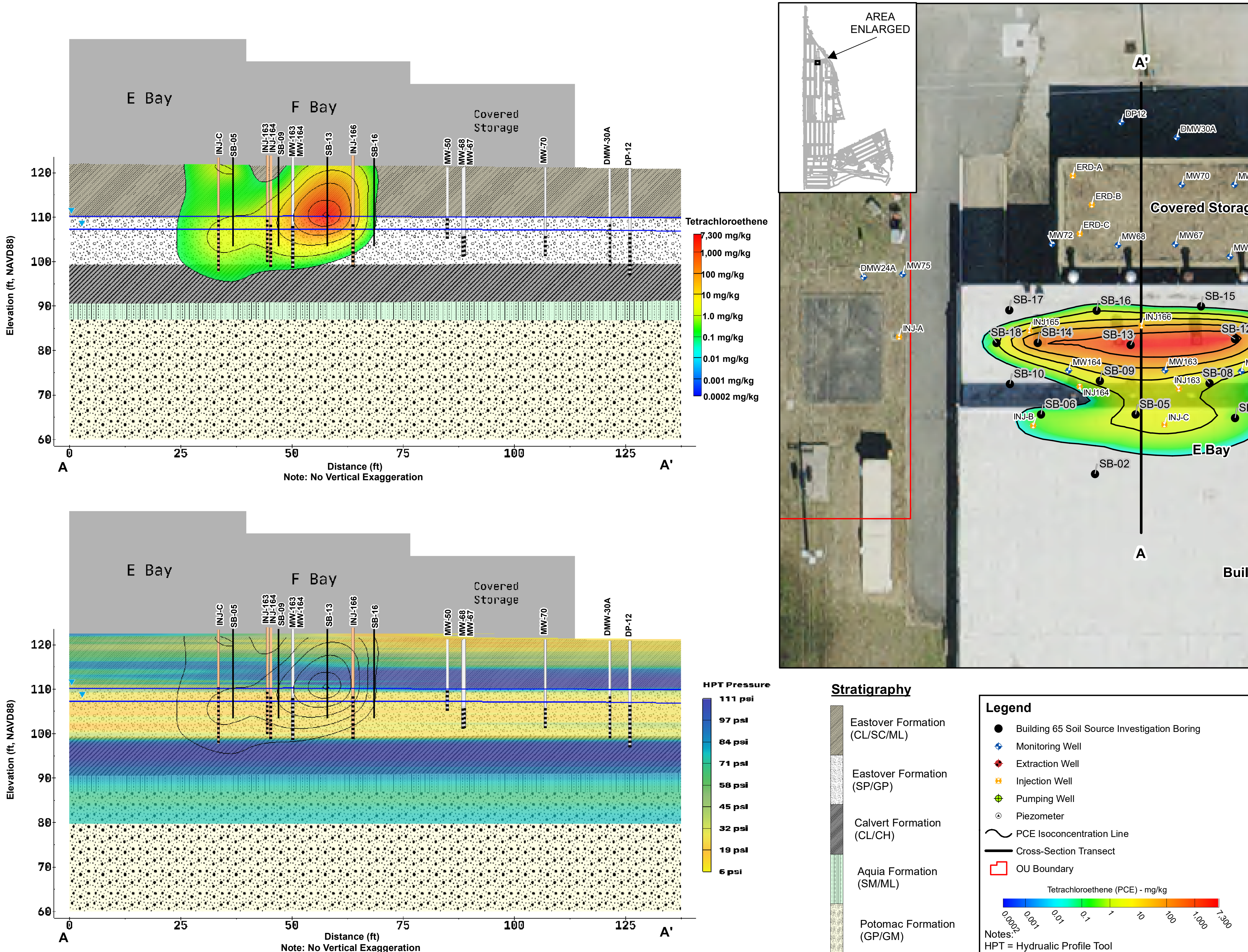

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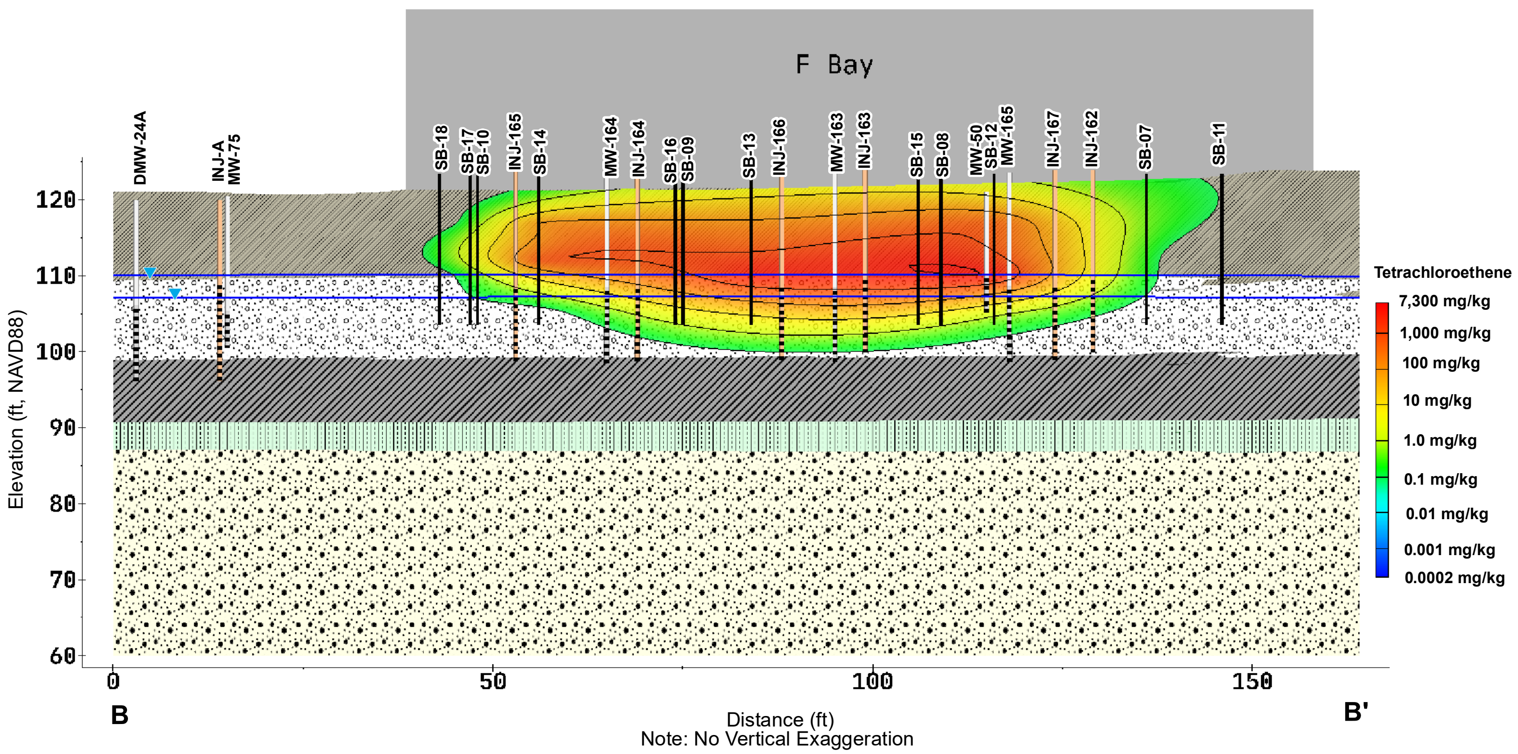
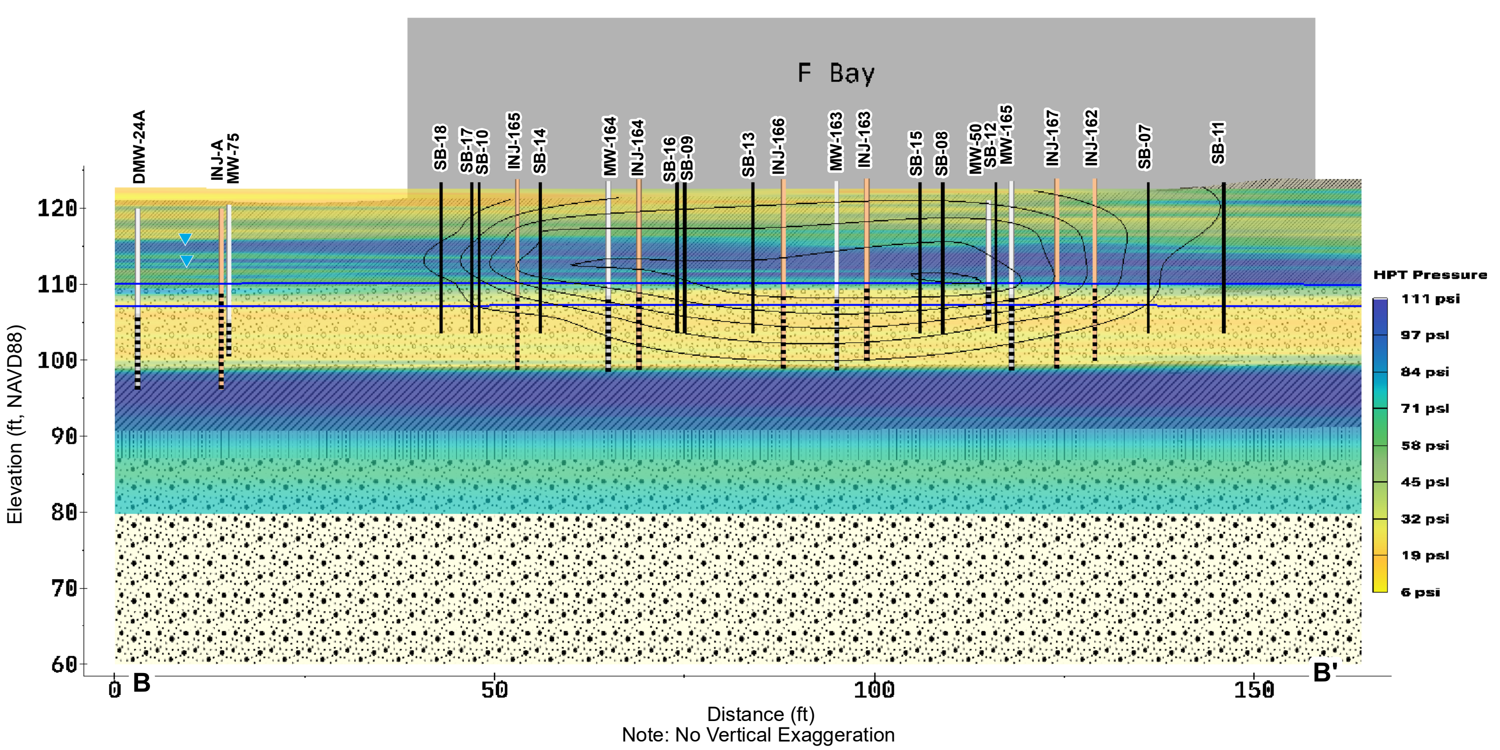
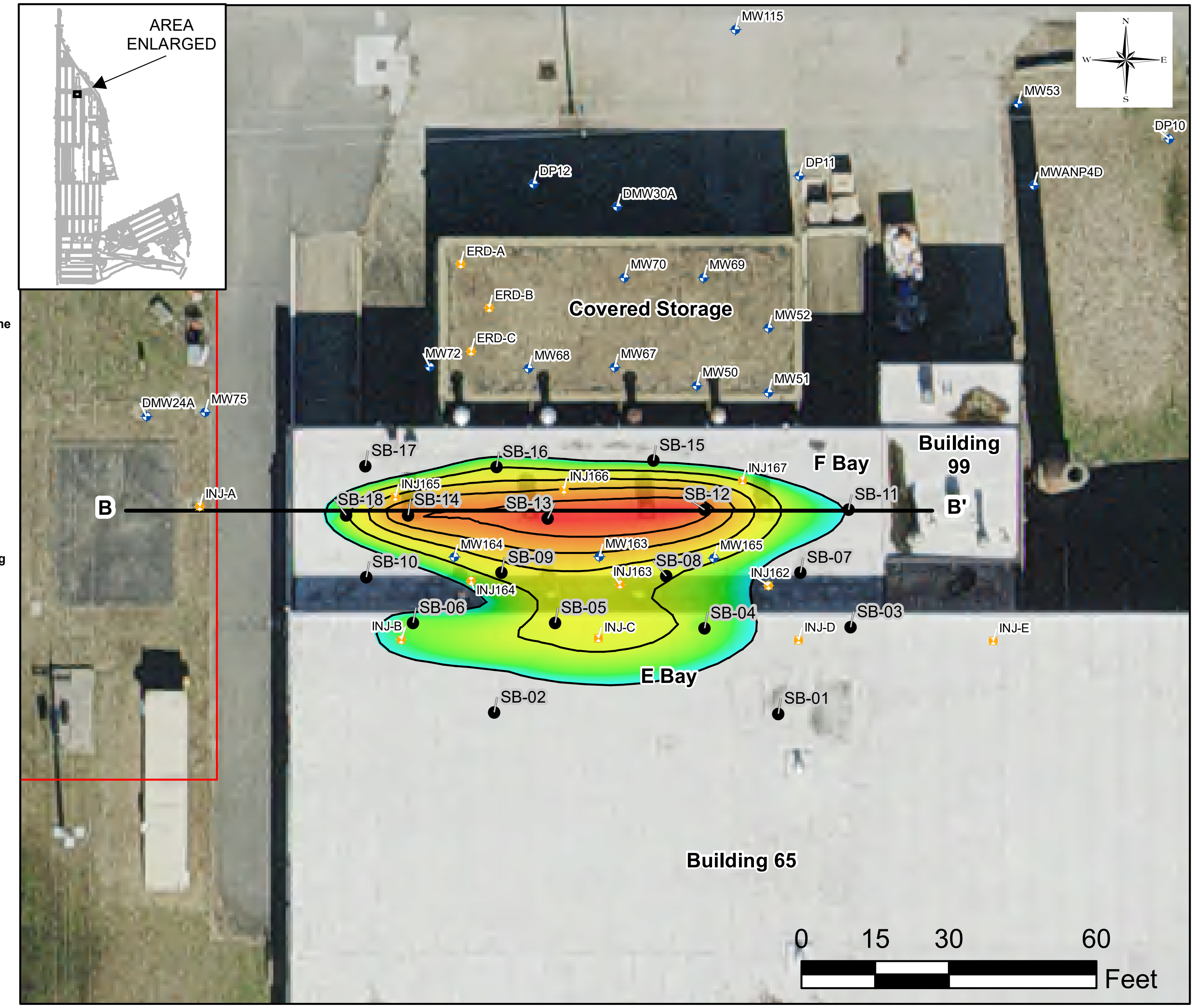
Figure 2-5
Vertical Distribution of PCE in Soil Parallel to Groundwater Flow (June 2020)

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1 " = 30 '	Date: January 10, 2025







Stratigraphy

- Eastover Formation (CL/SC/ML)
- Eastover Formation (SP/GP)
- Calvert Formation (CL/CH)
- Aquia Formation (SM/ML)
- Potomac Formation (GP/GM)

Legend

- Building 65 Soil Source Investigation Boring
- Monitoring Well
- Extraction Well
- Injection Well
- Pumping Well
- Piezometer
- PCE Isoconcentration Line
- Cross-Section Transect
- OU Boundary

Tetrachloroethene (PCE) - mg/kg: 0.0002, 0.001, 0.01, 0.1, 1, 10, 100, 1,000, 7,300

Notes:
HPT = Hydraulic Profile Tool
Orthoimagery Source: VGIN (2021)

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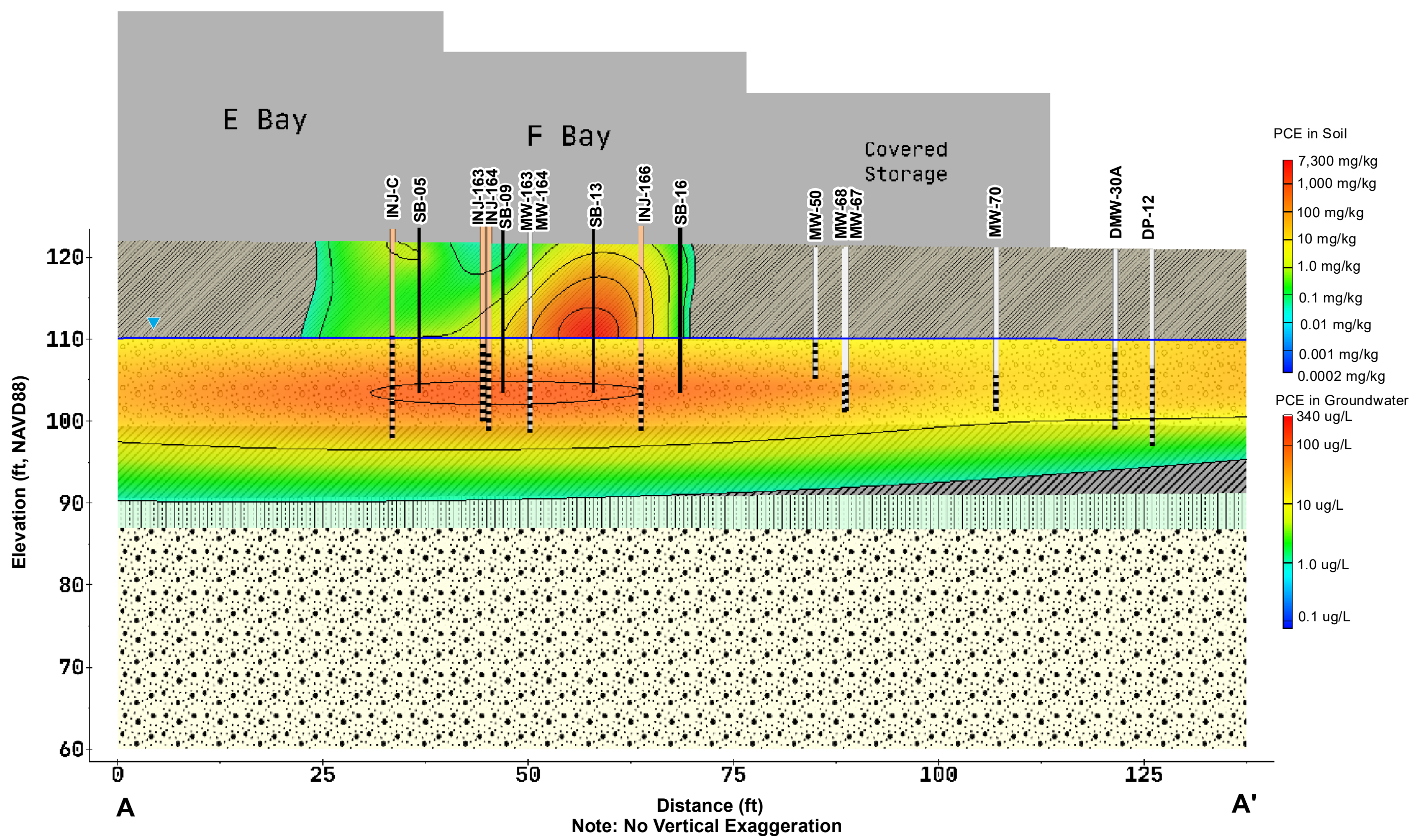
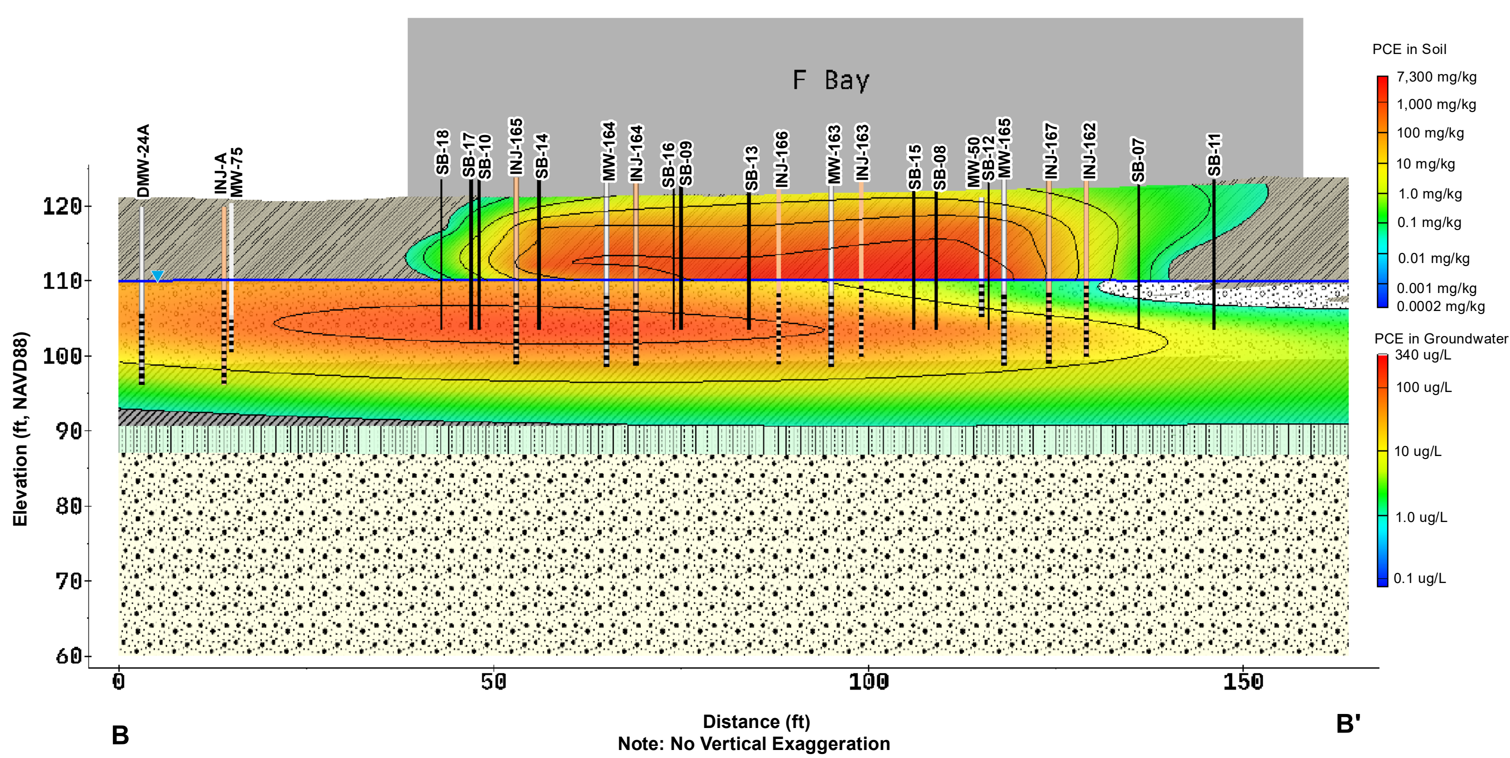
Figure 2-6
Vertical Distribution of PCE in Soil Perpendicular to Groundwater Flow (June 2020)

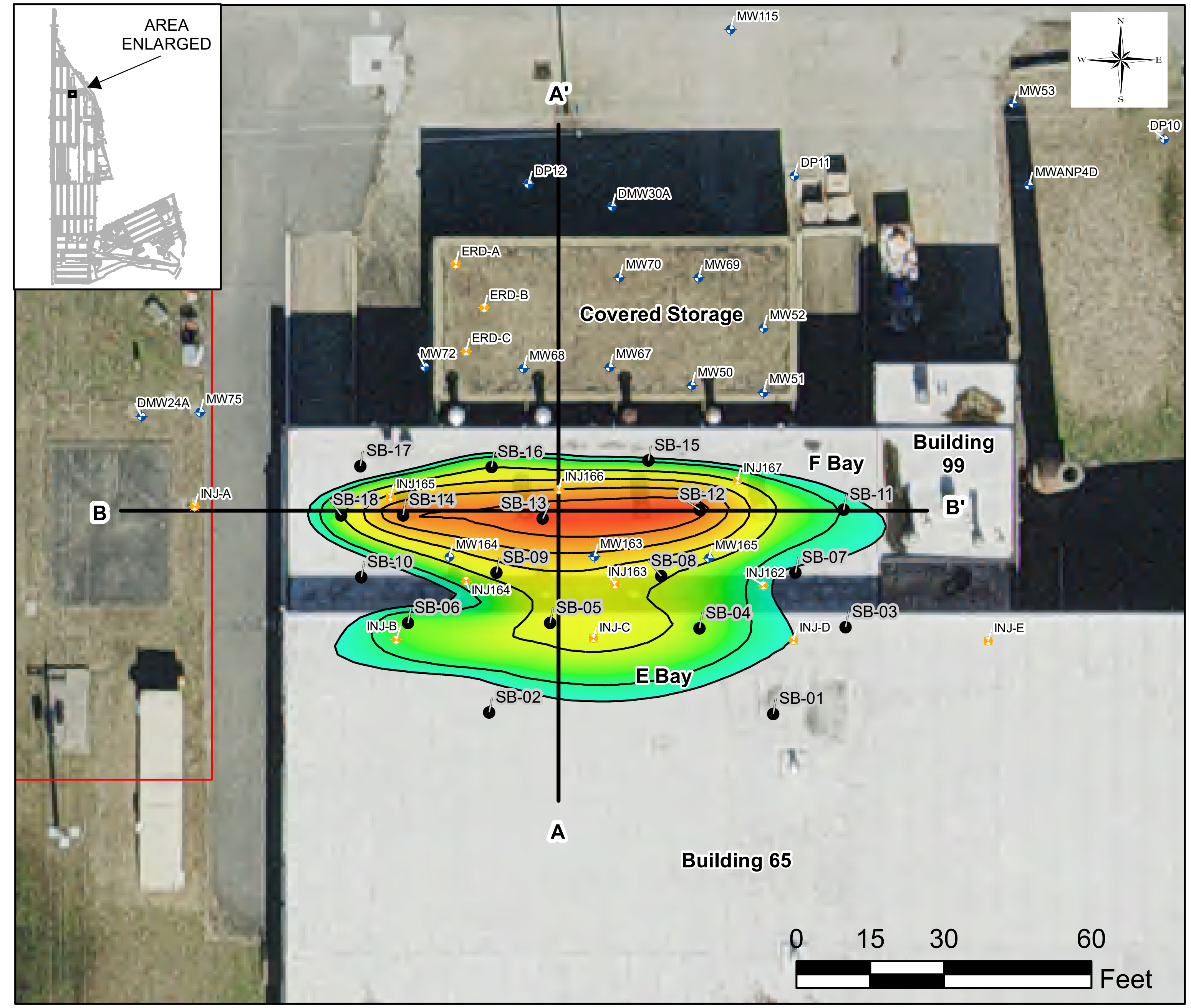
Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1 " = 30 '	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-6 - Vertical Dist PCE Perp to GW.mxd







Stratigraphy

- Eastover Formation (CL/SC/ML)
- Eastover Formation (SP/GP)
- Calvert Formation (CL/CH)
- Aquia Formation (SM/ML)
- Potomac Formation (GP/GM)

Legend

- Building 65 Soil Source Investigation Boring
- Monitoring Well
- Extraction Well
- Injection Well
- Pumping Well
- Piezometer
- PCE Isoconcentration Line
- Cross-Section Transect
- OU Boundary

Tetrachloroethene (PCE) - mg/kg

0.0002 0.001 0.01 0.1 1 10 100 1,000 7,300

Notes:
HPT = Hydraulic Profile Tool
Orthoimagery Source: VGIN (2021)

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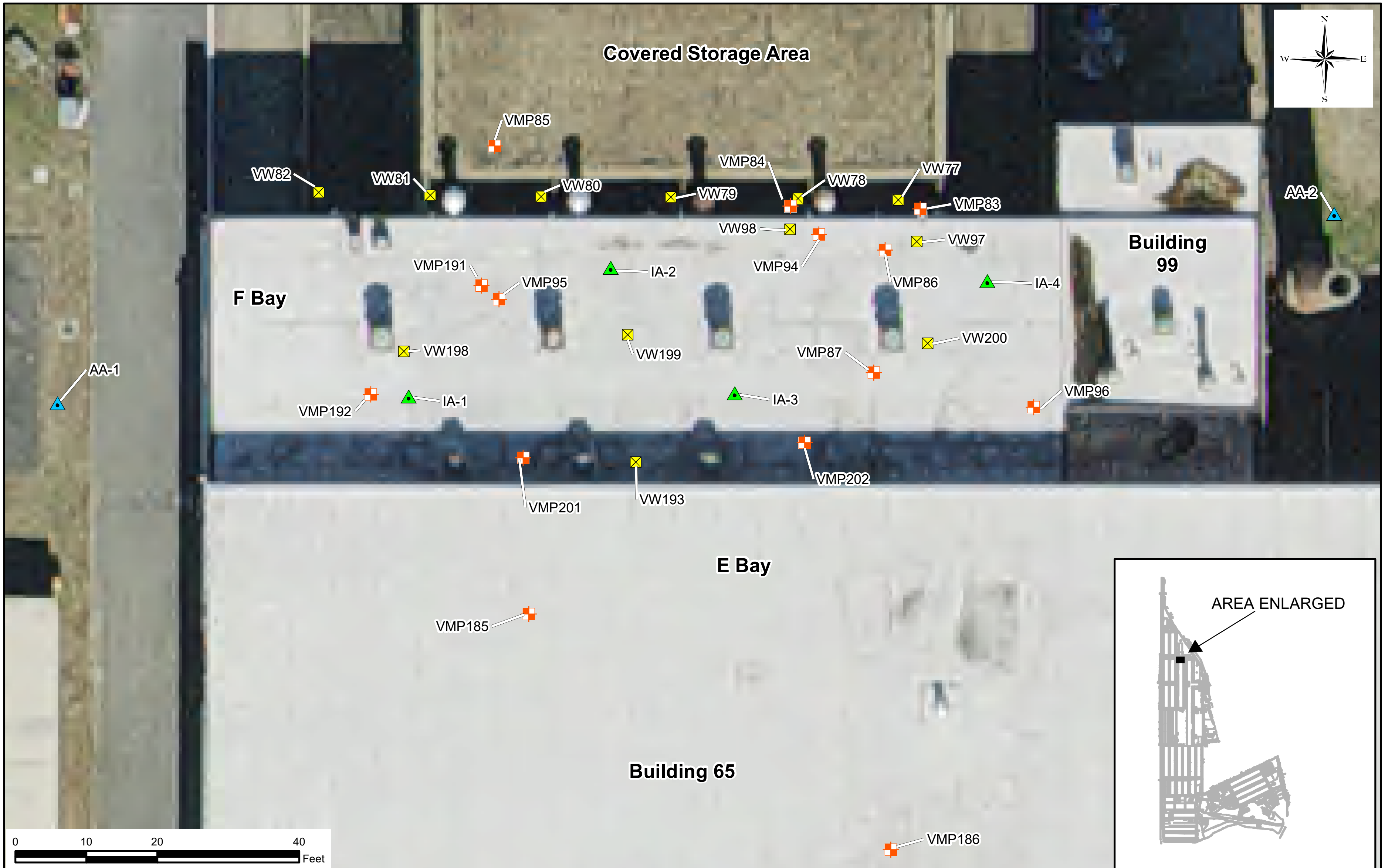
Figure 2-7
PCE Distribution in Soil and Groundwater (June 2020)

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1 " = 30 '	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-7 - PCE SOandGW.mxd



Legend

- Vapor Monitoring Point
- Vent Well Location
- OU8 Boundary
- Indoor Air Sample Location
- Ambient Air Sample Location

Notes:
Orthoimagery Source: VGIN (2021)

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Prepared By:
DBC

Reviewed By:
JOS

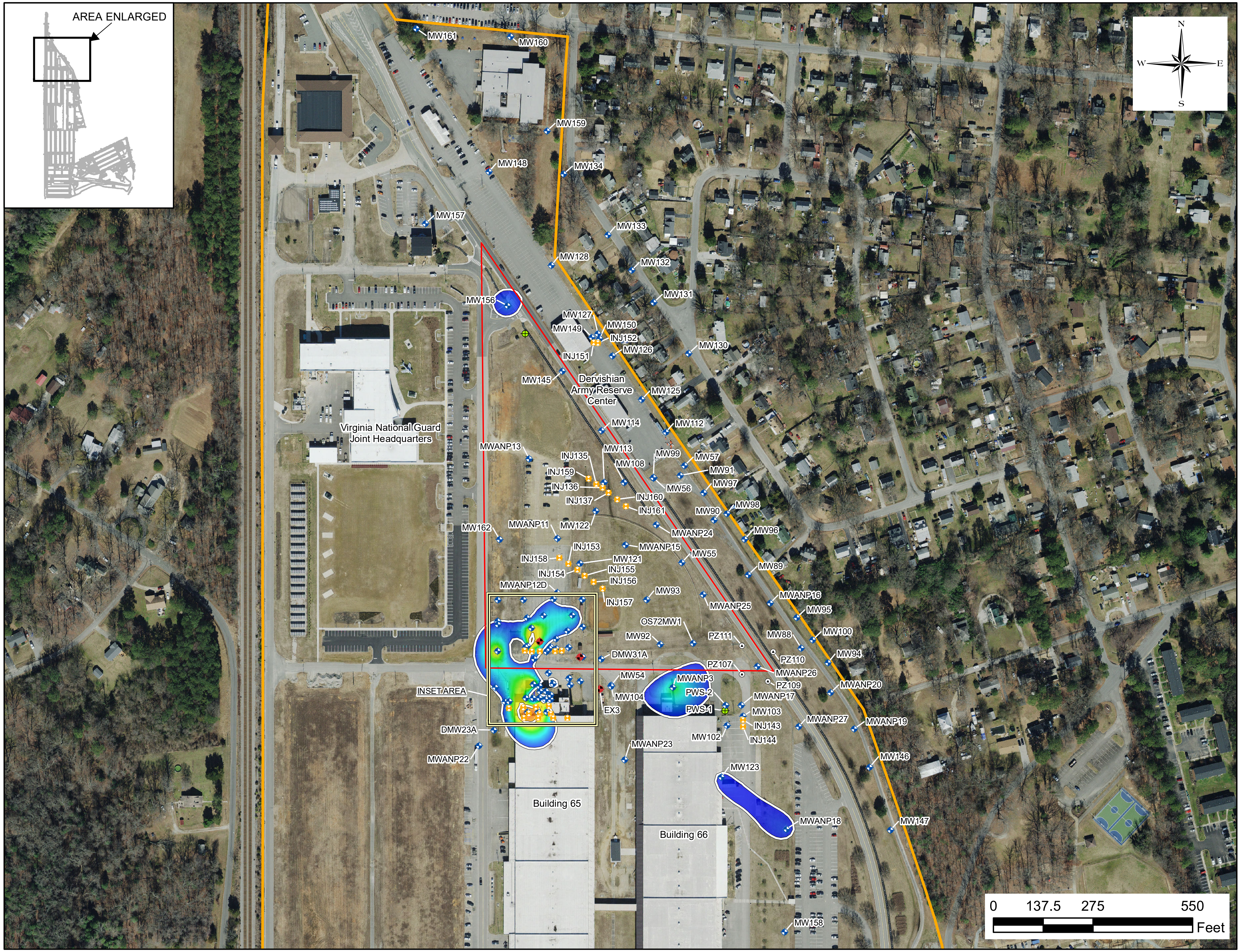
Scale:
1 " = 20 '

Date:
January 10, 2025

Figure 2-8
Building 65 Air and Soil Vapor Annual Sample Locations

Defense Supply Center Richmond
Richmond, VA

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-8 - Bldg 65 Air and Vapor Locations.mxd



Legend

- Monitoring Well
- Extraction Well
- Injection Well
- Pumping Well
- Piezometer
- OU8 Boundary
- Installation Boundary
- PCE Isoconcentration Line

PCE Concentration (ug/L)

5 10 30 100 170

Notes:
Orthoimagery Source: VGIN (2021)

INSET

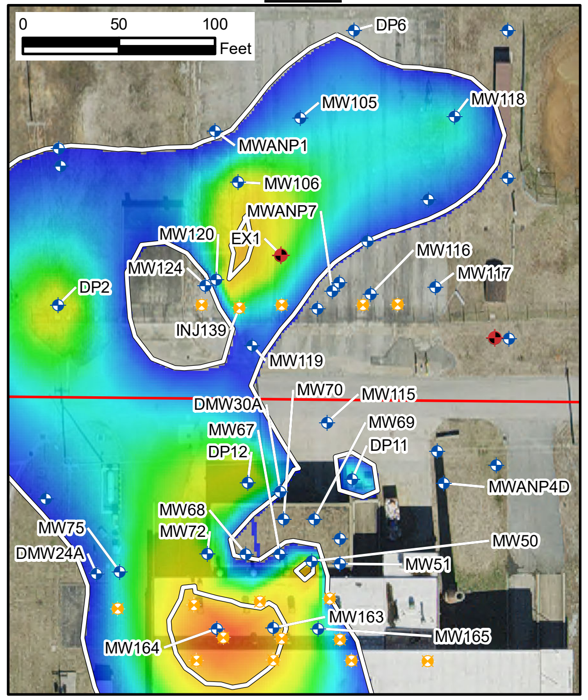


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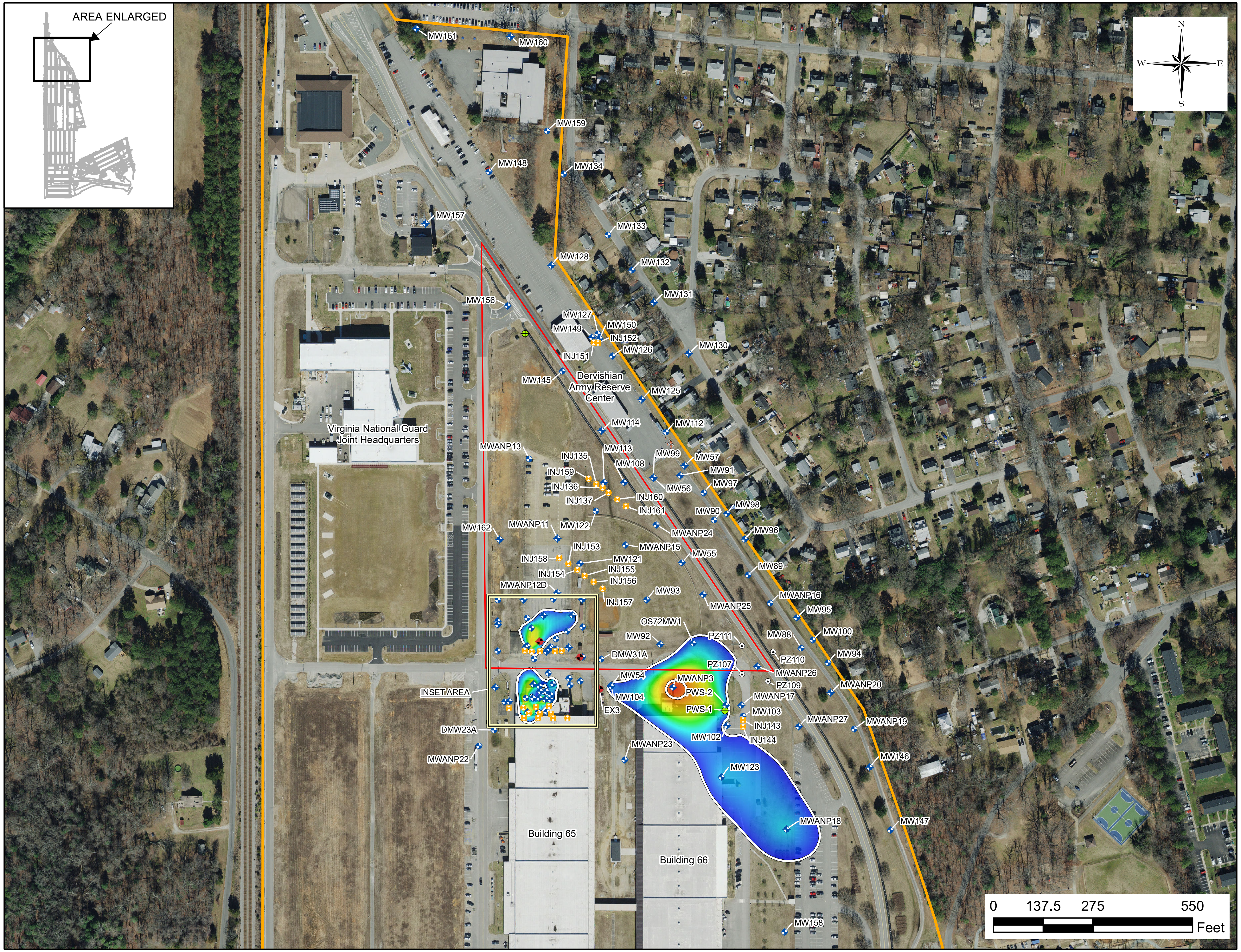
Figure 2-9
Lateral Distribution of PCE in Surficial Aquifer (April 2022)

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 275'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-9 - Lateral Distribution of PCE in Surficial (April 2022).mxd



Legend

- Monitoring Well
- Extraction Well
- Injection Well
- Pumping Well
- Piezometer
- OU8 Boundary
- Installation Boundary
- TCE Isoconcentration Line

TCE Concentration (ug/L)

5 10 30 87

Notes:
Orthoimagery Source: VGIN (2021)

INSET

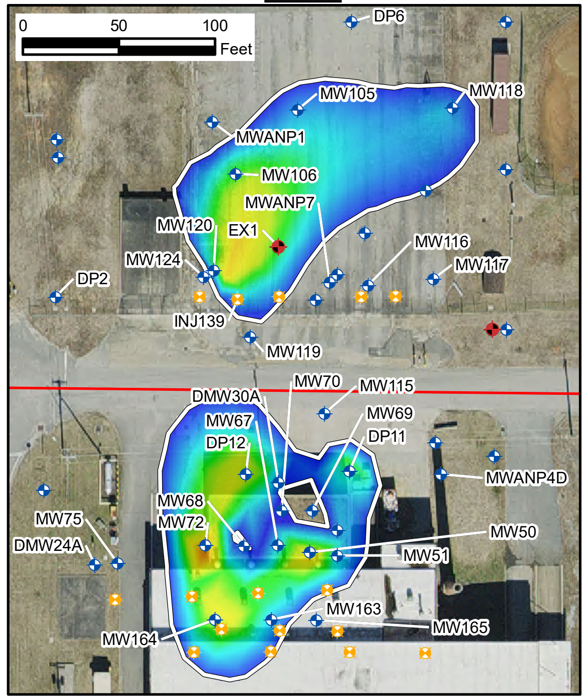


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Figure 2-10
Lateral Distribution of TCE
in Surficial Aquifer (April 2022)

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 275'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-10 - Lateral Distribution of TCE in Surficial (April 2022).mxd

Legend

- Monitoring Well
- Extraction Well
- Injection Well
- Pumping Well
- Piezometer
- OU8 Boundary
- Installation Boundary
- cDCE Isoconcentration Line

cis-1,2 DCE Concentration (ug/L)

70 | 100 | 140

Notes:
Orthoimagery Source: VGIN (2021)

INSET

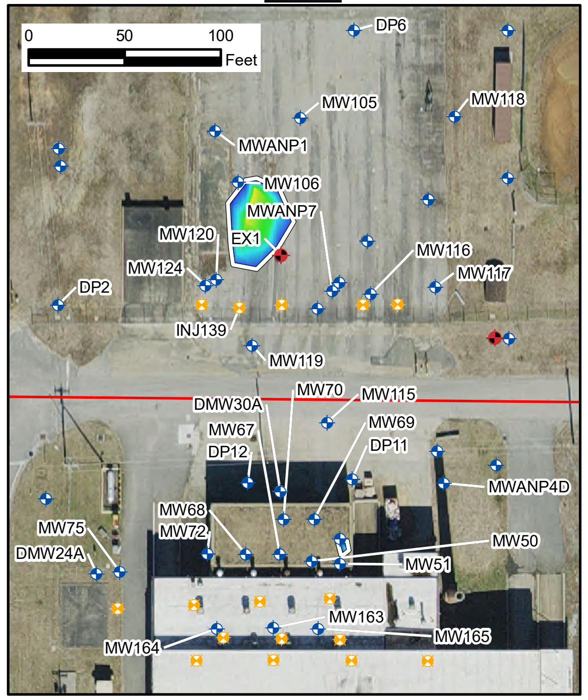

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Figure 2-11
Lateral Distribution of cDCE
in Surficial Aquifer (April 2022)

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 275'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-11 - Lateral Distribution of cDCE in Surficial (April 2022).mxd

Legend

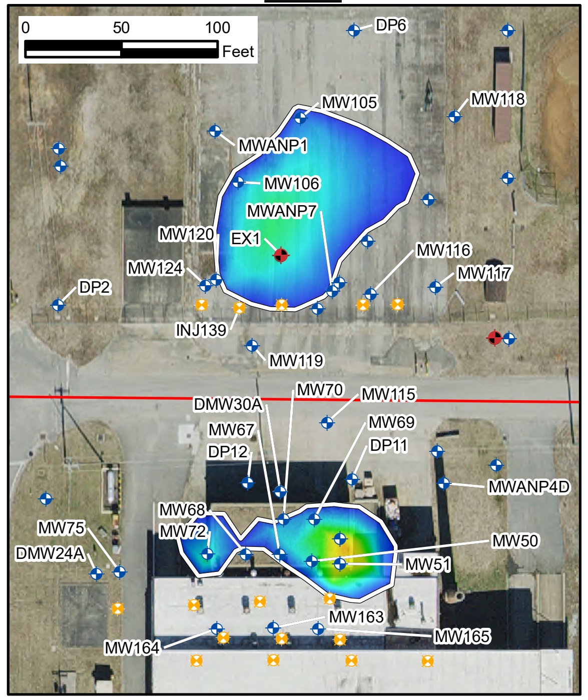
- Monitoring Well
- Extraction Well
- Injection Well
- Pumping Well
- Piezometer
- OU8 Boundary
- Installation Boundary
- VC Isoconcentration Line

Vinyl Chloride Concentration (ug/L)

2 3 10 22

Notes:
Orthoimagery Source: VGIN (2021)

INSET



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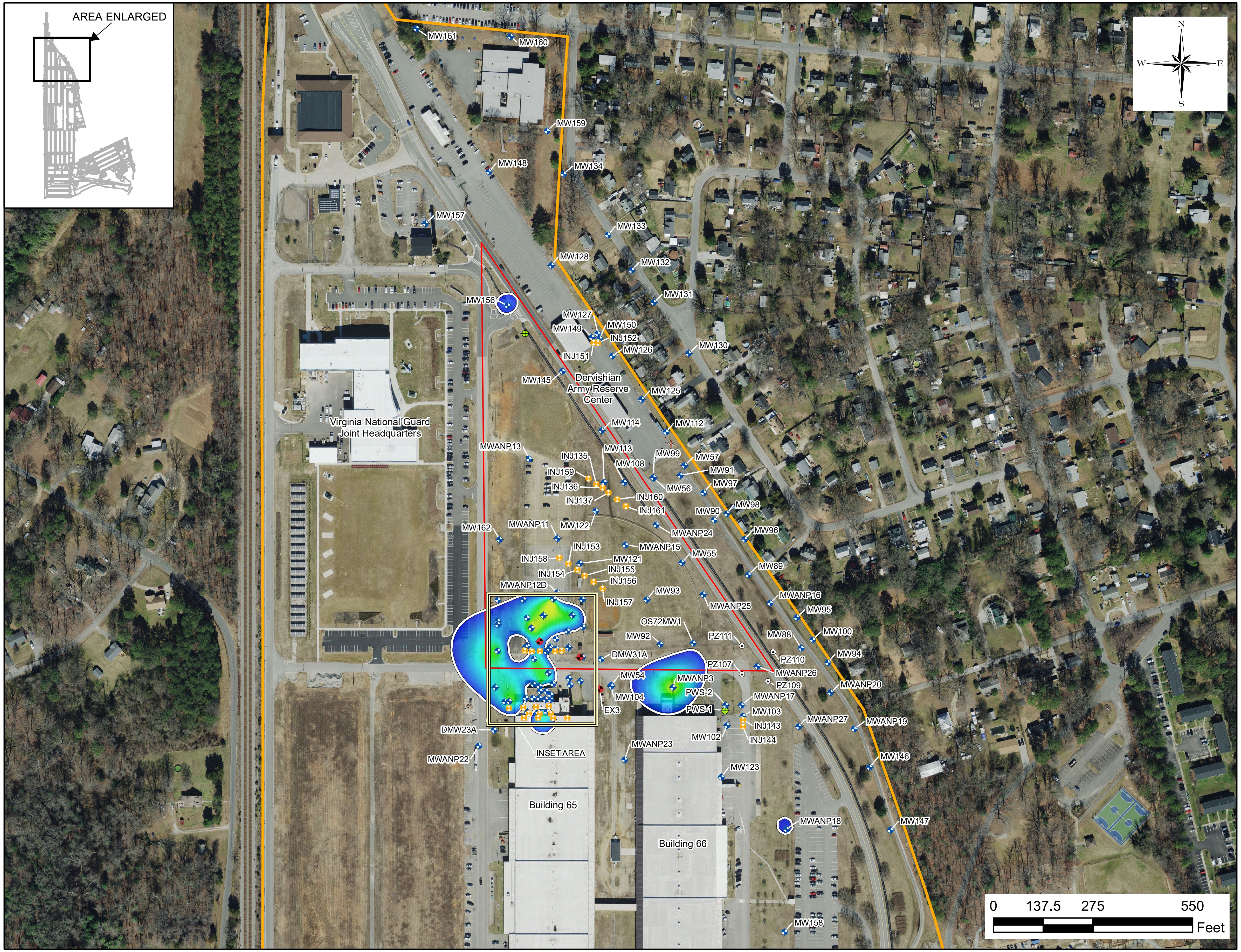
AECOM

Figure 2-12
Lateral Distribution of VC in Surficial Aquifer (April 2022)

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 275'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-12 - Lateral Distribution of VC in Surficial (April 2022).mxd



Legend

- Monitoring Well
- Extraction Well
- Injection Well
- Pumping Well
- Piezometer
- PCE Isoconcentration Line
- OU8 Boundary
- Installation Boundary

PCE Concentration (ug/L)

5 10 30 100 170

Notes:
Orthoimagery Source: VGIN (2021)

INSET

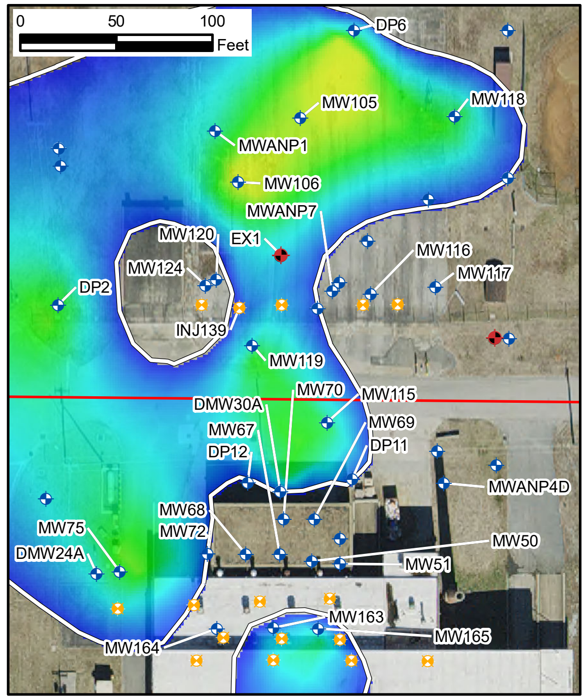


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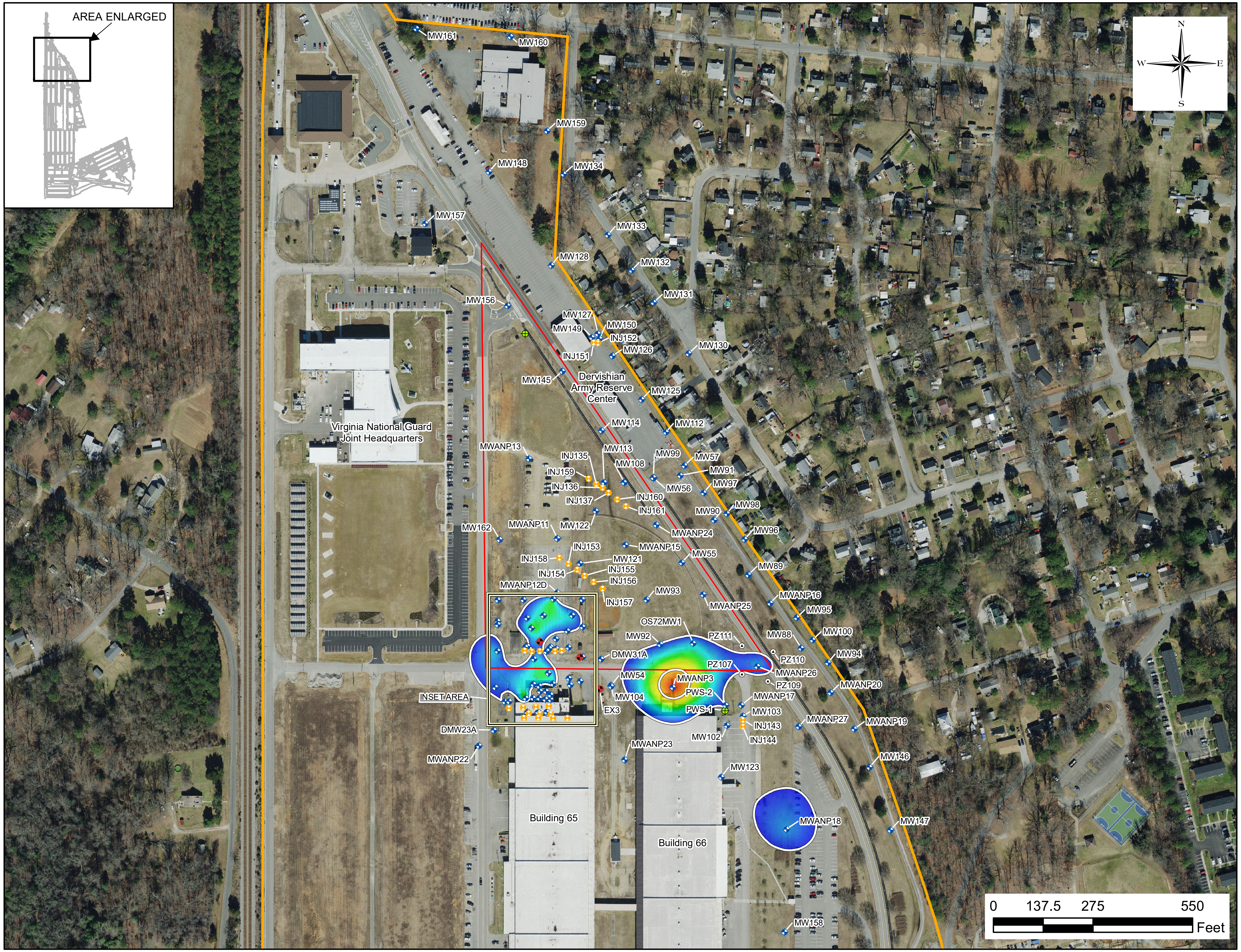
Figure 2-13
Lateral Distribution of PCE
in Surficial Aquifer (October 2022)

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 275'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-13 - Lateral Distribution of PCE in Surficial (October 2022).mxd



Legend

- Monitoring Well
- Extraction Well
- Injection Well
- Pumping Well
- Piezometer
- TCE Isoconcentration Line
- OU8 Boundary
- Installation Boundary

TCE Concentration (ug/L)

5 10 30 100 160

Notes:
Orthoimagery Source: VGIN (2021)

INSET

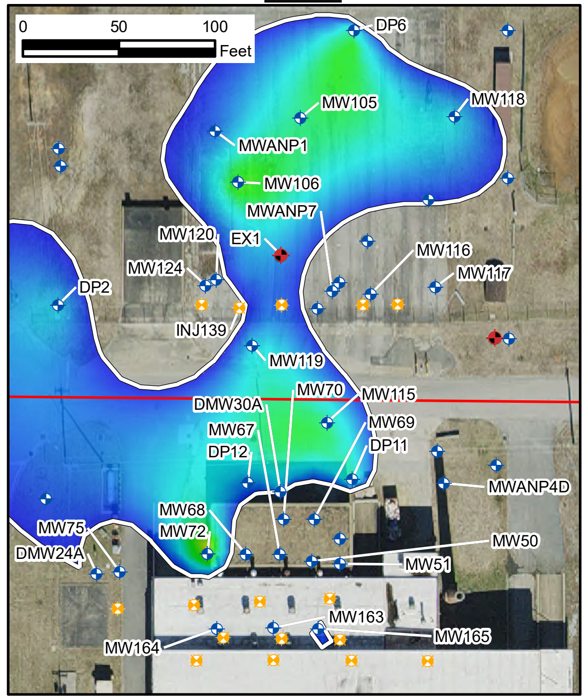


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Figure 2-14
Lateral Distribution of TCE in Surficial Aquifer (October 2022)

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 275'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-14 - Lateral Distribution of TCE in Surficial (October 2022).mxd

Legend

- Monitoring Well
- Extraction Well
- Injection Well
- Pumping Well
- Piezometer
- cDCE Isoconcentration Line
- OU8 Boundary
- Installation Boundary

cis-1,2 DCE Concentration (ug/L)

70 — 100 — 180

Notes:
Orthoimagery Source: VGIN (2021)

INSET

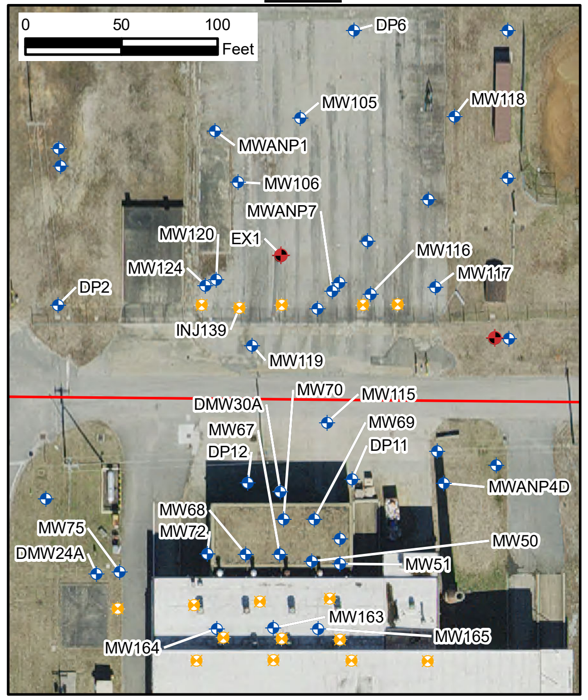

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Figure 2-15
Lateral Distribution of cDCE
in Surficial Aquifer (October 2022)

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 275'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-15 - Lateral Distribution of cDCE in Surficial (October 2022).mxd

Legend

- Monitoring Well
- Extraction Well
- Injection Well
- Pumping Well
- Piezometer
- VC Isoconcentration Line
- OU8 Boundary
- Installation Boundary

Vinyl Chloride Concentration (ug/L)

2 3 10 25

Notes:
Orthoimagery Source: VGIN (2021)

INSET

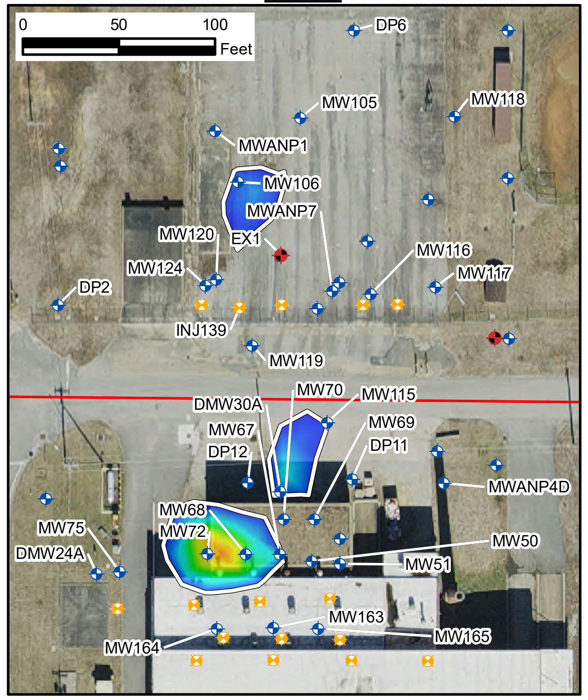

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Figure 2-16
Lateral Distribution of VC
in Surficial Aquifer (October 2022)

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 275'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 2-16 - Lateral Distribution of VC in Surficial (October 2022).mxd

3. Identification of Removal Action Objectives

Section 3 considers the statutory limits on NTCRA funding for removal actions and identifies removal action objectives, scope, and schedule, and planned activities.

3.1 Statutory Limits on Removal Actions

Section 104 (c)(1) of CERCLA has $2,000,000 and 12-month limits for removal actions; however, that does not apply, because this action is funded by a federal agency at a federal facility.

3.2 Remedial Action Objectives

Remedial action objectives (RAOs) for the removal action include the following:

1. Address the high concentration source area in soil beneath F Bay that is the primary source for the VOC plume in groundwater and the source of subsurface vapor beneath Building 65.
2. Mitigate leaching of chlorinated VOCs from subsurface soil to groundwater to accelerate attainment of groundwater cleanup levels for the OU 8 plume.
3. Mitigate the need for active soil vapor mitigation measures in F Bay of Building 65.
4. Reduce groundwater constituent concentrations within the Building 65 area to meet established chemical specific Applicable or Relevant and Appropriate Requirements (ARARs) consisting of MCLs and reduce contaminant flux to downgradient areas.

3.3 Removal Action Scope

The scope of the removal action at Building 65 will address the soil source zone and residual infrastructure beneath F Bay of Building 65. This scope will include decommissioning and demolition activities as part of the removal action.

3.4 Schedule

The general schedule for removal activities is implementation in calendar year 2026 with the expected 6-months or less field duration to perform the removal action scope of work.

3.5 Planned Remedial Activities

Planned remedial activities will include:

- Decommissioning activities to support the removal action in F Bay at Building 65 including decommissioning of the SSDS, and well/monitoring infrastructure in F Bay.
- Demolition of F Bay of Building 65 including building structure, foundations, ramp, and adjoining covered structure north of F Bay.
- Removal of impacted soil and remaining infrastructure beneath the F Bay area.
- Offsite disposal of demolition debris.
- Offsite treatment and disposal of removed wastes including soil, liquid residuals, and other contaminated media.
- Site restoration of the removal action area including installation of replacement monitoring locations in F Bay, concrete re-pavement for heavy traffic, and restoration of the external north building face of E Bay.

3.6 Cleanup Levels

This EE/CA contains cleanup levels established for soil in the RASR and reflecting the RAOs identified in Section 3.2. PCE is the primary COC for subsurface soil beneath the floor slab in Building 65 with other COCs more infrequently detected at lower concentrations and contained within the highest concentration area of PCE. The RASR established a single cleanup level for soil using PCE to define the volumetric areas for remedial action. Table 3-1 has cleanup levels for PCE and TCE in soil. Appendix A.2 has supporting information and detailed calculations.

Table 3-1 Subsurface Soil Cleanup Levels in Building 65 Area

Constituent	Medium	Cleanup Level	Basis
PCE	Subsurface Soil	1.0 mg/kg	Calculated site-specific SSL for the soil to groundwater pathway using site-specific soil properties, a soil partitioning coefficient calculated from SPLP leaching test, target leachate concentration = tetrachloroethene MCL, and a site calculated DAF = 6.9. Soil area defined by this cleanup level also has the elevated sub-slab soil vapor concentrations for PCE and TCE. The cleanup level is also less than the EPA composite worker RSL of 38.9 mg/kg for soil.
TCE	Subsurface Soil	1.0 mg/kg	Calculated site-specific SSL for the soil to groundwater pathway using site-specific soil properties, a soil partitioning coefficient calculated from SPLP leaching test, target leachate concentration = trichloroethene MCL, and a site calculated DAF = 6.9. The cleanup level is also less than the EPA composite worker RSL of 1.87 mg/kg for soil.

Notes: mg/kg = milligrams per kilogram, PCE = tetrachloroethene, TCE = trichloroethene, DAF = dilution attenuation factor, MCL = maximum contaminant

Cleanup levels established in the OU 8 ROD for groundwater consist of primary MCLs under the Safe Drinking Water Act. Table 3-2 identifies MCL based cleanup levels for site COCs in groundwater within the Building 65 area that have exceeded MCLs for LTM performed in 2021-2023.

Table 3-2 Groundwater Cleanup Levels for COCs in Building 65 Area

Constituent	Medium	Cleanup Level (µg/L)	Basis
Tetrachloroethene	Groundwater	5	OU 8 ROD Chemical-Specific ARAR (MCL)
Trichloroethene	Groundwater	5	OU 8 ROD Chemical-Specific ARAR (MCL)
cis-1,2-Dichloroethene	Groundwater	70	OU 8 ROD Chemical-Specific ARAR (MCL)
Vinyl Chloride	Groundwater	2	OU 8 ROD Chemical-Specific ARAR (MCL)

Notes: µg/L= micrograms per liter, ROD = Record of Decision, ARAR = Applicable or Relevant and Appropriate Requirement, MCL = maximum contaminant level

3.7 Applicable or Relevant and Appropriate Requirements

CERCLA requires the selection of a remedial action for a site that is protective of human health and the environment and complies with “applicable or relevant and appropriate requirements” (ARARs). Table 3-3 describes the elements of ARARs.

Table 3-3 ARAR Elements

Element	Description
Applicable requirements	Cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under Federal environmental or state environmental or facility siting laws that directly and fully address a hazardous substance, pollutant, contaminant, action being taken, location, or other circumstance found at a site.
Relevant and Appropriate Requirements	Cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or state environmental or facility siting laws that while not applicable to a hazardous substance, pollutant, contaminant, action, location, or other circumstances at a site address similar problems or situations to those encountered at a site.

Table 3-4 identifies ARARs determined for the alternatives for the NTCRA at Building 65 based on chemical-specific requirements, location-specific requirements, and action-specific requirements.

3.7.1 Chemical Specific ARARs

Remedial alternatives for the NTCRA at Building 65 address the soil source area with RAOs established to address the soil-to-groundwater migration pathway and accelerate attainment of cleanup levels for groundwater in the ROD for OU 8. Cleanup levels in the ROD for groundwater are based on a future unlimited exposure and unrestricted use (UE/UU) scenario for DSCR and consist of the following chemical-specific ARARs.

- National Primary Drinking Water Regulations, MCLs contained in the Code of Federal Regulations (CFR) Title 40 Protection of the Environment Part 141 Subpart B.

The National Primary Drinking Water Regulations are legally enforceable primary standards and treatment techniques that apply to public water systems.

3.7.2 Location-Specific ARARs

Location-specific ARARs relate to restrictions placed on the concentrations of constituents or activities that may occur because the site is located in a special location; such locations may include floodplains, wetlands, historic places, or areas with sensitive ecosystems or habitats. There are no location specific ARARs for the Building 65 Site based on project information and environmental reviews completed for the project where actions will target soil beneath F Bay of Building 65. Remedial alternatives for the NTCRA at Building 65 developed for current and reasonably expected future receptors and land use will target PCE and other VOCs in soil beneath the F Bay area.

3.7.3 Action-Specific ARARs

Action-specific ARARs relate to technology or activity-based requirements or limitations on proposed remedial actions at the site. Action-specific ARARs depend on the proposed remedial actions at the site. Table 3-4 identifies action-specific ARARs for the removal action.

Table 3-4 ARAR Evaluation for Removal Action at Building 65

ARAR Type	ARAR	Response Action/Notes	Applicability
Chemical Specific	40 CFR Part 141 Subpart B – National Primary Drinking Water Regulations, Maximum Contaminant Levels (MCLs)	Record of Decision (ROD) for Operable Unit 8 (OU 8) has MCLs as cleanup levels for groundwater.	Applicable for groundwater.
Location Specific	None identified	Not applicable	Not applicable
Action Specific	Virginia Erosion and Sediment Control Regulations 9VAC 25-840-10 to 110	Potential ARAR related to land disturbance. Land disturbance/Virginia Stormwater Management permit is required in Chesterfield County for land disturbance > 2,500 square ft.	Not applicable, disturbance will not exceed threshold
	40 CFR Part 261 Identification and Listing of Hazardous Waste	Identifies standards applicable to generators of hazardous waste. Applicable if actions result in generation of hazardous waste.	Applicable if actions result in generation of hazardous waste.
	40 CFR Part 268, Land Disposal Restrictions, Subpart D Treatment Standards (§268.40)	Identifies hazardous wastes that are restricted from land disposal. Applicable if actions result in generation of characteristic waste such as D039 and D040 (toxicity characteristics for tetrachloroethene and trichloroethene).	Applicable if actions result in generation of characteristic hazardous waste such as D039 and D040

4. Identification and Evaluation of Removal Action Alternatives

Section 4 identifies, screens, develops, and evaluates removal action alternatives potentially applicable for the RAOs established in Section 3 for soil at Building 65 addressed by the EE/CA.

4.1 Identification of Potentially Applicable Remediation Technologies for Soil

Soil remediation technologies identified for consideration to achieve soil RAOs for Building 65 include:

- No action.
- Containment.
- Collection.
- Treatment.
- Removal and Disposal. No Action

No action consists of no activity toward cleanup or risk mitigation.

4.1.1 Containment

Containment includes remedial actions intended to minimize the migration of contaminants in soil and soil vapor. The existing concrete floor slab in Building 65 represents surface containment preventing direct contact with soil and preventing vertical infiltration of water into the soil. A vapor barrier can mitigate the upward migration of subsurface vapor into indoor building areas.

4.1.2 Collection

Collection can include subsurface soil gas or vapor collection using active or passive methods. An SSDS has operated at Building 65 using an active collection and treatment system.

4.1.3 Treatment

Treatment reduces contaminant concentrations and mass in soil, and it would reduce the potential risks for exposure. Treatment can occur in situ or ex-situ using biological, chemical, and physical processes. The ROD for OU 8 includes in situ treatment of groundwater consisting of ISB.

4.1.4 Removal and Disposal

Removal and disposal could include demolition, excavation, and offsite disposal. Demolition consists of the process of dismantling of building and structures by pre-planned and controlled methods. For the Building 65 area, demolition could include dismantling of building and structural components for F Bay and the adjoining covered area, and offsite recycling and/or disposal of demolished materials. Excavation involves the removal of contaminated media and transport of media to a permitted offsite treatment and/or disposal facility. For Building 65, excavation could include soil and/or remanent components of the metals cleaning tank system beneath the floor slab in F Bay.

4.2 Identification and Screening of Technologies Types and Process Option

Table 4-1 (page 4-2) identifies and screens remedial technologies and process options for general response actions. Remedial technology refers to categories of technologies such as in situ biological treatment. Technology process options refer to specific processes within each technology type. For example, process options for in situ biological treatment include ISB and MNA. In general, the identification and screening process follows the EPA guidance document for conducting remedial investigations and feasibility studies (EPA 1988a). The primary factor for the screening evaluation in Table 4-5 is technical implementability at the site with respect to COC characteristics, site characteristics, ability and to time required to achieve RAOs, and development status of the technology.

The screening has retained no action, soil vapor extraction (SVE) with off-gas treatment controls, building and structure demolition, and soil excavation/offsite disposal as technologies and process options for development of removal action alternatives.

Table 4-1 Screening of Technologies and Process Options

General Response Action	Remedial Technology	Process Option	Description	Screening and Comment	Retained
No Action	None	Not applicable	No activity toward cleanup or risk mitigation.	Baseline, retained.	Yes
Containment	Horizontal barrier	Vapor barrier	Sub-slab vapor membrane that prevents intrusion of VOCs from subsurface soil and groundwater into indoor building areas.	Typically process option for new construction before installation of foundation slab. Not retained as process option because removal of entire slab is not feasible.	No
Treatment	In situ physical/chemical treatment	Bioventing	Anaerobic bioventing delivers nitrogen gas and an electron donor (e.g., hydrogen) to the subsurface for stimulating anaerobic degradation of CVOCs present in unsaturated soil. The process uses a blower to inject gas/electron donor and would require vapor extraction within building areas.	Bioremediation process consistent with selected remedy in OU 8 ROD/ESD. Limited to vadose zone soil. Not commonly applied for in situ treatment of CVOCs. Anerobic bioventing can require several years for in situ treatment. Would require installation of injection points and monitoring points. Would require bench testing/field testing for feasibility/implementation. Vapor control/recovery required in application area such as existing SSDS and/or enhanced vapor recovery wells with off gas treatment. Not retained as process option based on projected treatment time required to meet RAOs.	No
		In Situ Soil Mixing	In situ soil mixing for shallow depths would use an excavator potentially modified with a rotary blender system to stabilize soil often using a cement-based liquid grout. Amendments for a stabilization approach could include sodium persulfate (ISCO) activated by the Portland cement.	Not retained as a process option because of limited workspace, residual subsurface infrastructure remaining beneath the building slab, and treatment effectiveness for CVOCs.	No
		Thermal treatment	In situ thermal treatment for CVOCs most often involves using electrical resistance heating (ERH) sometimes augmented with steam enhanced extraction (SEE) to co-boil vaporize or steam strip CVOCs from in situ soils and groundwater. The system recovers vapors in the subsurface for aboveground treatment of recovered gaseous and liquid phases.	ERH would require the installation of electrical infrastructure, treatment equipment, and a dense network of electrodes, wiring, piping, and vapor extraction wells inside Building 65. ERH processes dry the soil and alter soil properties and may cause ground subsidence because of the thick clay beneath the building area. Excessive heating would adversely impact microbial colonies responsible for ongoing biodegradation processes. Would require air permitting evaluations and pollution controls. Subsurface obstructions may impede implementation. Not retained because of ISB effectiveness/remedial progress for groundwater and limited soil source zone area/mass area.	No
		Soil vapor extraction (SVE)	Soil vapor extraction (SVE) involves the application of a vacuum in the vadose zone to induce the controlled flow of air and removal of VOCs from the subsurface. SVE recovers vapor from the subsurface through extraction wells with aboveground treatment to recover or destroy the contaminants.	Would use existing equipment (SVE type blower) and convert from the SSDS to an SVE process using SVE wells. Vadose zone clay soils with lower permeability and higher moisture content may require a higher applied vacuum and potential longer duration for treatment because of lower extraction rates related to lower soil permeability and moisture content. EPA presumptive and preferred remedy for VOCs in soil. Retained as process option.	Yes
	Ex situ physical/chemical treatment	SVE with Vapor-phase granular activated carbon absorption	Carbon adsorption uses one or more vessels containing granular activated carbon to adsorb organic contaminants contained in extracted process vapor/gas. Replacement of the activated carbon occurs when concentrations in the discharge exceed determined limits. The treated vapor would discharge would through a vertical stack.	Process option for treatment that is in use for the existing SSDS system at Building 65. Retained as process option for treatment related to retained in situ soil remediation process options (bioventing and SVE).	Yes
Removal and Disposal	Demolition	Building and structure demolition	Involves the process of dismantling of the F Bay portion of Building 65 and the adjacent covered storage area by pre-planned and controlled methods. This would include removal of the building, structural elements, floor slab, ramp, and covered structure extending north of the building area. Demolished materials management would include recycling and/or offsite disposal at a permitted disposal facility. Would include decommissioning and removal of the Building 65 SSDS components.	Considered a removal action under CERCLA separate from OU 8 remedy under the ROD and ESD. Would eliminate the need for implementation of vapor mitigation measures for F Bay of Building 65. Retained as process option.	Yes
	Excavation	Soil excavation and offsite disposal	Involves excavation of contaminated soil beneath floor slab of Building 65 and offsite disposal of contaminated soil at permitted treatment and/or disposal facility. Additional materials removed from the excavation could include concrete tank and clay pipe remnants.	Considered a removal action under CERCLA separate from OU 8 remedy under the ROD and ESD. Retained as process option. Excavation would require implementation of limited engineering measures to mitigate potential structural impacts to building from excavation near building foundations associated with the northern wall of E Bay.	Yes
	Restoration	Well replacement, structural pavement, and building restoration	Restoration consists of other activities performed to support response actions that involve restoration of site conditions or elements impacted or changed by the response actions.	Retained as a process option because removal actions would require additional site restoration elements beyond backfilling the excavation.	Yes

Notes: CVOCs = chlorinated volatile organic compounds, RAO = remedial action objective, SVE = soil vapor extraction, LAC = liquid activated carbon, ROD = record of decision, ESD = explanation of significant differences, SSDS = sub-slab depressurization system, SEE = steam-enhanced extraction, ERH = electrical resistivity heating, LAC = liquid-activated carbon, ISB = in situ bioremediation.

4.3 Development of Remedial Alternatives

Section 4.3 assembles and describes three removal action developed for Building 65 soil. The alternatives assembled include no action and two removal action alternatives that address established RAOs using different approaches to address the soil source zone beneath Building 65. Excluding no action, the remedial alternatives emphasize:

- Protection of human health and the environment.
- Use permanent solutions/treatment technologies to the extent practicable.
- Supporting attaining of RAOs and reducing remedy duration.
- Lifecycle cost effectiveness.

Table 4-2 shows the assembly of the three (3) removal action alternatives using the remedial technologies and process options retained from the screening including:

- Alternative 1 – No Action.
- Alternative 2 – In Situ Treatment of Soil.
- Alternative 3 – Removal Action.

Table 4-2 Assembly of Remedial Alternatives

General Response Action	Remedial Technology	Technology Process Option	Media	Alternative 1 No Action	Alternative 2 In Situ Treatment of Soil	Alternative 3 Removal Action
No Action	None	None	None	X		
Treatment	In situ physical/chemical treatment	Soil vapor extraction (SVE)	Soil		X	
	Ex situ physical/chemical treatment	Vapor-phase granular activated carbon absorption	Soil Vapor		X	
Removal and Disposal	Decommissioning and removal	Equipment and related infrastructure	Equipment and materials		X	X
	Demolition	Building and structure demolition, and equipment removal	Building and structural elements			X
	Excavation	Soil excavation and offsite disposal	Soil, Residuals			X
	Restoration	Well replacement, structural pavement, and building restoration	Groundwater, pavement, building exterior			X

4.3.1 Alternative 1 No Action

A no action alternative provides a baseline for evaluating other alternatives. This alternative has no activity toward cleanup or risk mitigation.

4.3.2 Alternative 2 In Situ Treatment of Soil

Alternative 2 consists of decommissioning activities and in situ treatment of soil.

4.3.2.1 Decommissioning Activities

Alternative 2 would include abandonment of remaining tanks and waste lines beneath the floor slab of F Bay. Abandonment of remaining tanks would include cutting access points in the floor slab and each tank, gauging the tanks for fluids, recovery of any fluids, filling the tanks and access points with flowable fill, and slab restoration. Abandonment of the waste lines would consist of cutting access points in the floor slab, grouting the lines in place, recovery of any remaining liquids, and slab restoration. Figure 4-1 shows the former tank and waste line areas for abandonment.

4.3.2.2 In Situ Treatment of Soil

Alternative 2 would include targeted in situ treatment of soil in F Bay and E Bay where PCE and TCE concentrations ≥ 1 mg/kg as identified in Figure 2-4. The three-dimensional (3D) volumetric model estimates this area as 2,042 square feet (SF) with a volume of 14,619 cubic feet (CF) and contaminant mass less than 340 pounds.

SVE would induce a vacuum in the subsurface to extract vapor (VOCs) using vertical wells installed in the targeted treatment area. The vertical extraction wells would have screened intervals across the soil vadose zone beneath the floor slab in F Bay. Figure 4-3 has a process flow diagram from the SSDS modified to conceptually show SVE operation. Existing SVE equipment housed in a metal shed in the covered area includes a 3-horsepower regenerative blower, inlet vacuum filter and silencer, moisture separator, valves, and gauges. The metal shed has a convection heater with thermostat and exhaust fan with actuated louvres. A single inlet line enters the shed from F Bay for vapor processing and moisture separation. An outlet line from the shed connects to two (2) 55-gallon granular activated carbon units for vapor treatment with atmospheric discharge through a vertical stack.

Figure 4-2 has a generalized, conceptual layout for Alternative 2 soil treatment used as an input for the development of rough order of magnitude (ROM) costs. This layout includes seven (7) SVE wells and eight (8) vapor monitoring points (VMPs). New SVE wells would connect to existing system piping in F Bay.

Site clay/silty soils targeted for remediation at Building 65 have lower air permeability, higher moisture content with lower air-filled porosity. Capillary forces in this soil type can retain water and constrain both air flow and mass removal processes. Soil conditions found at the site would require an SVE blower capable of higher vacuum operation to overcome lower air permeability, higher moisture content and capillary forces. AECOM experience with SVE in similar soil types has shown gas flow extraction rates in the range of 0.25 to 0.50 standard cubic feet per minute per linear foot (SCFM/LF) of SVE well screen with SVE well spacing of 15 to 20 ft. Conceptually for the site, this would translate to SVE system flows in the range of 21 to 40 SCFM for seven (7) wells with 12 ft. screens. These flows fall below the existing SSDS blower performance curve, which has a minimum flow of 60 SCFM with a corresponding maximum vacuum of 73 inches water gauge (IWG). The EE/CA assumes that SVE operations would require an equipment upgrade to a blower with an optimal performance curve that can operate at higher vacuum and lower flow. The SSDS blower manufacturer has a higher-pressure model with a performance curve that has a minimum flow of 18 SCFM with a maximum vacuum of 190 IWG with a vacuum of 150 IWG at a flow of 40 SCFM. Field testing with the existing SSDS and the network of SVE wells would confirm the need for a blower upgrade.

Pre-Implementation Activities

The EE/CA assumes development and submission of a RA Work Plan Addendum to EPA and DEQ to obtain concurrence to implement decommissioning activities and conversion of SSDS operations to SVE for soil treatment. This document would follow established formats and processes.

Subsurface disturbance will require layout of disturbance areas and locations and marking for utility clearance following the DSCR dig permit process. This process involves DSCR utility scans and marking and Virginia One Call Center (811) notification supplemented by a third-party professional underground utility locator. Reconfiguration of the SSDS will not alter installed equipment or the electrical service and will not require a permit. Remediation and monitoring will require regulatory approval through work plan review with no permitting required.

Field Implementation of SVE Soil Treatment

Field implementation for soil treatment would include the layout of SVE well and VMP locations, subsurface utility scans, and well/VMP installation using a compact drill rig. System piping modifications in F Bay would connect SVE wells to existing SSDS piping with individual valves at each well to control flow. Each well would have gauges or ports to measure differential pressure and a sampling port.

Initial field testing for SVE with the existing SSDS equipment (blower) and the network of SVE wells would determine the need for a blower upgrade. This testing would measure system flow and applied vacuum relative to the blower performance curve. Pressure measurements at SVE wells and VMPs for SVE and SSDS during field testing will measure the system radius of influence and the induced vacuum area relative to the target remediation area. System sampling for VOCs will measure constituent concentrations and mass removal rates when combined with flow measurements. Follow-up testing would occur using an upgraded blower following the same process before moving to continuous SVE operations.

SVE operations would include inspection and maintenance of system components, process monitoring, and sampling similar to the Building 65 SSDS. The EE/CA assumes monthly inspection, maintenance, monitoring, and sampling of the SVE system for purposes of the alternative ROM cost estimate.

The EE/CA assumes collection of process samples for laboratory analysis VOCs by EPA Method TO-15 at system locations SP-2, SP-3, and SP-4 shown in Figure 4-3. This would allow for the determination of mass removal rates, treatment efficiency, and timing of GAC maintenance.

Performance Monitoring and Effectiveness Sampling

Performance monitoring in the Building 65 area would evaluate the effectiveness of soil treatment measures. Performance monitoring for SVE would include the process monitoring and sampling described in Section 4.3.2.2. Primary metrics for remedial progress would include mass removal relative to the VOC mass indicated by the CSM and changes in vapor levels over time. The EE/CA assumes that remedial effectiveness sampling would occur after attainment of asymptotic levels for mass removal and soil vapor measurements at SVE and VMPs or at the prescribed operational duration. Remedial effectiveness sampling would confirm attainment of RAOs and the PCE and TCE cleanup levels for the soil-to-groundwater pathway (≤ 1 mg/kg).

The EE/CA assumes one year of post-SVE operation performance monitoring (quarterly) of sub-slab vapor and indoor air to confirm mitigation of the need for active soil vapor mitigation measures in F Bay of Building 65 (RAO). Assumed quarterly sampling would include nine VMPs, two established indoor air locations, and two established ambient air locations for VOCs by EPA Method TO-15.

4.3.2.3 Reporting

A remedial action completion report would document actions taken, results of performance monitoring and effectiveness sampling, data evaluations performed, status of RAO attainment, and resultant conclusions and recommendations. Interim reporting of results during completion of the remedial action would occur during regulatory planning team meetings held with EPA and DEQ with updates presented at Restoration Advisory Board meetings.

4.3.2.4 Remediation Time Frame

Remediation time frames for SVE for mass removal typically range from 1 to 3 years (FRTR, 2023). Pore volume exchanges typically govern the remediation time frame for SVE with 1,000 to 1,500 pore volume exchanges considered a good estimate of required exchanges for sites where initial concentrations are not high or cleanup levels are not low (USACE 2002). Factors influencing SVE extraction rates and pore volume exchanges include air permeability influenced by lithology, moisture content, porosity (air-filled and water-filled), and volume of soil for treatment.

Table 4-3 (page 4-5) has the calculated soil volume for treatment (26,831 CF) using the surface area of the target treatment area (2,042 SF) from the 3D model and a vadose zone thickness of 14.5 ft. subtracted by the volume of the former tanks in this area (2,778 CF). Pore volume exchange rates assume sufficient applied vacuum to achieve a minimum flow rate of 21 CFM from seven SVE wells

(.0.25 SCFM/LF for SVE well screens). The analysis in Table 4-3 assumes three years of operation and subdivides the calculations by year assuming incremental increases in air-filled pore volumes and flow rates through SVE processes that reduce soil moisture content. Calculated pore volume exchanges in Table 4-3 assumes 90 percent runtime for the SVE during each one-year operational period.

Table 4-3 Alternative 2 Treatment Area Volume and SVE Pore Volume Calculations

Year	Soil Volume (CF)	Total Porosity[3]	Water Filled Porosity[3]	Air Filled Porosity[3]	Air Filled Pore Volume (CF)	Blower Flow[1] (CFM)	Extraction Volume per Day (CF)	Pore Volumes per Day	Pore Volumes Per Year[2]
1	26,831	50.4%	40.3%	10.1%	2,710	21	30,240	11.2	3,666
2	26,831	50.4%	36.0%	14.4%	3,864	23	33,120	8.6	2,816
3	26,831	50.4%	32.5%	17.9%	4,803	25	36,000	7.5	2,462
								Total	8,944

Notes: mg/kg = milligrams per kilogram, CF = cubic feet, CFM = cubic feet per minute, [1]assumes blower flow applied to SVE wells excluding dilution area flow with extraction rate of 0.25 cubic feet per minute per linear foot of SVE extraction screen, [2]assumes 90% operational period for one year, [3]average calculated porosity for 3 physical soil samples collected from vadose zone beneath F Bay.

The EE/CA for purposes of alternative evaluation and cost estimating assumes three years of SVE operations at Building 65 based on site characteristics and the analysis presented in Section 4.3.2.4.

4.3.3 Alternative 3 Removal Action

Alternative 3 consists of decommissioning, building and structure demolition, and removal action in the Building F Bay area, and site restoration.

4.3.3.1 Decommissioning Activities

Alternative 3 will include well decommissioning and SSDS decommissioning.

Well Decommissioning

Alternative 3 would include well decommissioning in F Bay of Building 65 before structure demolition and completion of the removal action at the following locations:

- Monitoring wells MW-163, MW-164, and MW-165.
- Injection wells INJ-162, INJ-163, INJ-164, INJ-165, INJ-166, and INJ-167.

SSDS Decommissioning

Alternative 3 would include decommissioning of the SSDS components in the covered area structure north of Building 65 including completing electrical disconnects for SSDS and removal of the SSDS blower shed, equipment, vapor phase carbon units, and process piping (see Figure 4-4).

Demolition of Building F Bay and Covered Area

Alternative 3 would include demolition of F Bay and the covered area structure north of F Bay as shown in Figure 4-5. Demolition would include the following elements:

- Decommissioning of electrical service to demolition areas.
- Protection of monitoring and injection wells in and adjacent to the covered area before demolition using steel plates or other protective surface covering. These wells shown in the inset of Figure 2-1 include: ERD-A, ERD-B, ERD-C, DP-11, DP-12, DMW-30A, MW-50, MW-51, MW-52, MW-68, MW-69, MW-72, and MW-115.
- Covered Area structure demolition, leaving existing concrete pavement in place.
- F Bay demolition including superstructure, foundations and floor slab, SSDS infrastructure inside F Bay including piping, vent wells, and vapor monitoring points, and external western building ramp.
- E Bay exterior restoration.

- Assumed offsite disposal of demolition material at permitted construction and debris (C&D) facility.

4.3.3.2 Removal Action

Alternative 3 would include a removal action in the F Bay area implemented as an NTCRA. The scope of the removal action would include demolition of the F Bay foundations and floor slab, demolition and removal of the former tanks and waste lines beneath the F Bay floor slab, contaminated soil removal, and offsite disposal.

Figure 4-6 shows the approximate 3,805 SF removal area for contaminated soil that includes the former tanks and waste lines. This soil removal area encompasses the lateral extent of PCE impacted soil in F Bay shown on Figure 2-4. The assumed depth of excavation is 15 ft. below the floor slab elevation with total soil excavation volume of 2,182 BCY with an equivalent weight of 3,491 tons. The EE/CA makes the following additional assumptions for Alternative 3 for development of the rough order of magnitude cost estimate:

- Concrete disposal as non-hazardous C&D material at a permitted facility.
- Removal of any residual contents from the former tanks and waste line, containerization of residuals, and assumed offsite disposal as D039 hazardous waste (PCE) and D040 hazardous waste (TCE).
- Excavation plans would require geotechnical and structural evaluations to develop mitigating measures for excavation adjacent to E Bay and Building 99 (boiler room). The assumed mitigation measure would consist of sequenced excavation that would incrementally replace excavation material with rapid placement, engineered, flowable fill.
- Excavation would require designed vapor and dust mitigation measures in the work area for the duration of excavation work, soil handling, and backfilling.
- Geotechnical/structural oversight for excavation area adjacent to E Bay.
- Assumed proportional work performed will occur under personal protection equipment (PPE) Levels D and C.
- Collection of confirmatory excavation samples for analysis of VOCs by SW846 Method 8260.
- Waste characterization sampling for disposal would include composite samples tested for VOCs, full TCLP analysis, paint filter testing, pH, and ignitability by SW846 methods.
- 480 tons (300 BCY) of excavated soil for disposal that would classify as hazardous waste (D039 and D040) with composite samples having a combined PCE and TCE concentration less than 10 times the universal treatment standard of 6 mg/kg for PCE and TCE contained in 40 CFR § 268.48.
- 480 tons (300 BCY) of excavated soil for treatment and disposal that would classify as hazardous waste (D039 and D040) with composite samples having a combined PCE and TCE concentration equal to or greater than 10 times the universal treatment standard and total a VOC concentration less than 500 mg/kg.
- 2,531 tons (1582 BCY) of excavated soil for disposal that would classify as non-hazardous waste.
- Soil handling and loading would occur immediately north of F Bay and assumes demolition of aboveground covered area infrastructure prior to removal actions. This would include temporary stockpiling of excavated soil in the concrete covered area within the demolished superstructure area. This area would have a bottom liner, runoff controls.
- Loading of hazardous soil into dump trailers (22 tons per load) for transport to treatment/disposal facility.
- Loading of non-hazardous soil into trucks for transport to treatment/disposal facility.
- 2,396 CY of compacted backfill to planned subgrade elevation established for pavement restoration (see Section 4.3.3.3 for restoration activities).
- Soil handling and waste management procedures for the removal would comply with policy and guidance found at the following EPA website: https://www.epa.gov/superfund/superfund-waste-management. Site activities including temporary soil handling for excavation and loading of soil would

not constitute treatment, storage, or disposal of hazardous waste or involve the use waste piles as defined in 40 CFR Part 264 Subpart L.

4.3.3.3 Restoration Activities

Restoration activities for Alternative 3 will include design and implementation of the following restoration elements:

- Repairs and refinishing of the front face of E Bay This assumes 4,000 SF of masonry pointing to repair any damage to the face of the building from the F-Bay removal action.
- Site preparation elements for new heavy duty concrete pavement within a 1,111 square yard (10,000 SF) area shown in Figure 4-5 assuming:
    - Preparation for new concrete pavement with saw cutting of 300 LF of existing pavement to create a joint between existing and new pavement.
    - Rough and fine grading of the 1,111 square yard restoration area to a final grade 6-inches below base of the concrete pavement.
    - Placement and compaction of 6-inches of VDOT 21-A crushed stone as a subbase for the new concrete pavement.
    - Heavy duty concrete pavement placement including formwork, placement of a double mat of rebar consisting of 5/8-inch rebar at 12-inches on center each way top and bottom, placement of an 8-inch concrete pad consisting of a 5,000-psi concrete mix. Concrete will have expansion joints installed on 20 ft. spacings each way filled with an elastomeric sealant.
- Restoration of the western dock gate in E Bay including the installation of a locking mechanism.
- Installation of four replacement monitoring wells (flush mount) in the former F-Bay area with similar construction to wells MW-163, MW-164, and MW-165 for surface completion and screened intervals.

Pre-Implementation Activities

The EE/CA assumes implementation of removal action as an NTCRA that would include development and submission of an Action Memorandum to EPA and DEQ to document a NTCRA to implement the removal actions under Alternative 3. Alternative 3 would have a technical memorandum work plan for proposed decommissioning activities to implement the NTCRA and installation of replacement monitoring wells in the F Bay decommissioned to implement the NTCRA. The process to administratively support implementing the NTCRA would involve preparing an engineer evaluation/cost analysis (EE/CA), a public participation component, and EE/CA Approval Memorandum.

Subsurface disturbance will require layout of disturbance areas and locations and marking for utility clearance following the DSCR dig permit process. This process involves DSCR utility scans and marking and Virginia One Call Center (811) notification supplemented by a third-party professional underground utility locator. BDGR and SSDS decommissioning and demolition activities will require coordination with the installation and final service disconnections may require permitting. According to DLA Installation Management Richmond, permits are not required from Chesterfield County for building and structure demolition at the installation. DSCR has an EPA identification number with large quantity generator status for hazardous waste and therefore, the installation would not need to change generator status if the removal action generates excavated soil characterized as hazardous waste.

Pre-implementation activities for the removal action would include:

- Preparation of a work plan for the removal action.
- Completion of building surveys for hazardous materials and demolition as applicable.
- Completion of geotechnical and structural assessments for the soil removal action.
- Pre-planning and coordination with identified treatment and disposal facilities, transporters, and waste coordinators for soil excavation implementation. This will support identifying waste profiling, containerization, handling, and transport requirements and procedures for expected waste types.

Field Implementation of Well Decommissioning

Field implementation for well decommissioning would include mobilization of materials, equipment, and personnel for well decommissioning and completion of well decommissioning. Well decommissioning would include pressure grouting of wells in-place, removal of surface completions, and restoration to match existing surfaces.

Field Implementation of SSDS Decommissioning

Field implementation would include mobilization of materials, equipment, and personnel for SSDS decommissioning and removal activities located north of Building 65 in the covered area. The general phases of work would include abandonment of vent wells and vapor monitoring points north of F Bay, electrical system decommissioning, and removal of aboveground equipment and piping.

Field Implementation of Building and Structure Demolition

Field implementation for demolition would include mobilization materials, equipment, and personnel to the site for demolition actions. Contractor setup would establish work areas, routes of equipment, staging areas for demolition debris management, and safety measures. Demolition actions would follow the established sequence and methods of work in the project work plan.

Field Implementation of Removal Action

Field implementation for the removal action initially would include layout of the excavation area and subsurface utility scans. The next phase of field implementation would include the mobilization of materials, equipment, and personnel to the site for the removal action. Contractor setup would establish work areas, routes for equipment, staging and loading areas for soil, decontamination facilities, and safety measures. Safety measures would include engineered measures for vapor and dust control and setup of environmental monitoring instrumentation.

The removal action would follow the established sequence and methods of work in the Action Memorandum and related engineering design. Removal actions would include foundation and slab removal, cleanout of former concrete tanks and waste lines before mass soil excavation to targeted depths. The contractor will segregate material types for containerization and disposal. Confirmatory soil sampling would occur after completion of the excavation with subsequent placement and compaction of select offsite backfill in the excavation area to proposed finished subgrade. The purpose of this sampling is to confirm removal of soils impacted above the cleanup levels following excavation to targeted limits. Sampling would occur at the bottom and sidewalls of the excavation area with an assumed 22 confirmatory samples from the excavation bottom and 22 confirmatory samples from the excavation sidewalls[12].

Field Implementation of Site Restoration

Site restoration of the area would include repairs and refinishing of the front face of E Bay, restoration of the western dock gate at E Bay including the installation of a locking mechanism, subgrade preparation and installation of heavy concrete pavement across the 1,111 square yard restoration area.

Site restoration would also include installation of replacement monitoring wells in the former F Bay area for OU 8 remedy monitoring. The EE/CA assumes the installation of four monitoring wells with similar construction and elevation as MW-163, MW-164, and MW-165.

4.3.3.4 Reporting

A removal action complete report would document demolition and removal actions completed, material management, characterization, transportation, and disposal, confirmatory soil sample results, and site restoration. This report would also include final designs and schematics, associated with refacing, resurfacing for E Bay including the western dock gate, and concrete re-pavement of the area.

[12] Sampling rate for excavation is assumed 1 per 175 square ft. for excavation bottom and 1 per 15 ft. linear ft. of excavation sidewall.

4.3.3.5 Remediation Time Frame

The estimated remediation time frame for Alternative 3 would correspond to the duration required to complete the demolition, removal action, and site restoration. The EE/CA assumes a time frame of six months for completion from initiation of activities after site mobilization.

4.4 Evaluation of Removal Action Alternatives

Section 4.4 has an evaluation analysis of the three alternatives developed for this RASR.

4.4.1 Evaluation Criteria

Table 4-4 has descriptions of the evaluation criteria used for analysis of alternatives.

Table 4-4 Evaluation Criteria for Alternatives Analysis

Effectiveness

1. Overall protection of human health and the environment: *remedy must be protective of human health and the environment as defined by site remedial action objectives (RAOs).*
2. Compliance with ARARs: *remedy must comply with state and federal regulatory, or a waiver of noncompliance must be obtained.*
3. Long-term effectiveness and permanence: *assesses the magnitude of residual risk and adequacy of physical and administrative components of the remedy to provide long-term risk reduction after RAOs are met: (1) magnitude of residual risk posed by treatment residuals or untreated wastes, and (2) adequacy and reliability of controls including continued protection from residuals, and assessment of the need to replace technical components of the alternative.*
4. Reduction of toxicity, mobility, and volume of contaminants through treatment: *assesses the degree to which the remedy will reduce the toxicity, mobility, and volume of the principal hazards through treatment: (1) treatment process used and materials treated, (2) amount of hazardous materials destroyed or treated, (3) degree of expected reductions into toxicity, mobility, and volume, (4) degree to which treatment is irreversible, and (5) type and quantity of residuals remaining after treatment.*
5. Short-term effectiveness*: assesses the protection of workers, community, and impacts to the environment while the remedy is implemented. Time required to achieve RAOs.*

Implementability

6. Assesses how technical, administrative, or resource requirements effect implementation of the remedy: (1) ability to construct and operate the technology, (2) reliability of the technology, (3) ability to monitor effectiveness of remedy, (4) ability to obtain approvals from other agencies, (5) coordination with other agencies, (6) availability of offsite, treatment, storage, and disposal services, (7) availability of necessary equipment and specialists, and (8) availability of technologies

Cost

7. Cost: assesses the capital, operating, and maintenance costs, and net present value of the remedy throughout its operational period.

Note: The evaluation criteria are detailed in the EPA document: *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988).

Table 4-5 (page 4-9) has a summary of the detailed alternatives analysis presented in Section 4.

Table 4-5 Summary of Detailed Alternative Analysis

Alternative	Overall Protection of Homan Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume	Short-Term Effectiveness	Implementability	Cost
1. No Action	Alternative 1 consists of no action and would not protect human health and the environment.	Alternative 1 consists of no action and would not protect human health and the environment.	Alternative 1 consists of no actions and would not reduce long-term risks.	Alternative 1 consists of no actions and would not reduce toxicity, mobility, or volume of contaminants.	Alternative 1 consists of no actions and would not achieve RAOs.	Alternative 1 has no actions to implement.	No cost for this alternative.
2. In Situ Treatment of Soil	The OU 8 remedy has ICs in place that control human health and environmental exposure. ICs for OU 8 include access restrictions, notice of land use restrictions, lease and property transfer restrictions, zoning restrictions, preconstruction assessments, maintenance, and monitoring, and well restrictions. Alternative 2 would accelerate the process of achieving RAOs 1 and 3 for Building 65. There is uncertainty related to the effectiveness of SVE measures to completely mitigate risk of subsurface VI into F Bay (RAO 2). If SVE measures do not mitigate VI risks, SSDS operations would need to continue at Building 65 until future building demolition occurs or mitigation measures reduce subsurface vapor to acceptable levels.	Alternative 2 would comply with established OU 8 ARARs (chemical specific) for groundwater through a combination of soil source zone reduction (treatment) and ISB measures performed in the Building 65 area in 2023. The adaptive remedy optimization plan for OU 8 has two additional ISB injection events planned for 2025-2026 to support overall compliance with ARARs.	The combination of decommissioning and soil source zone treatment for Alternative 2 represents a permanent remedy. These actions would not generate treatment residuals that would pose a long-term risk to human health or the environment. Decommissioning would remove any solid or liquid residuals from the former tanks and waste lines for offsite treatment and disposal. SVE treatment would reduce contaminant mass and transfer that mass to carbon absorbers. Offsite treatment of the carbon would remove contaminant mass and recycle the carbon. There is uncertainty related to effectiveness of SVE measures to completely mitigate risk of subsurface VI into F Bay (RAO 2).	Alternative 2 would use in situ physical/ex-situ chemical processes to reduce toxicity, mobility, and volume of soil VOCs. Projected reductions would exceed 95% for soil. Alternative 2 addresses an estimated 1,595 BCY of soil with a VOC mass of more than 330 pounds.	Site work that could affect site workers includes indoor work in F Bay related to drilling of SVE wells, in-place decommissioning of former tanks and waste lines, and monitoring/sampling activities. Well-established safeguards would protect workers, the community, and the environment during implementation. The estimated time to achievement of RAO 1 for soil is 3 yrs. There is uncertainty if SVE can achieve RAO 2 for subsurface soil vapor for an operation period of 3 years.	Alternative 2 is implementable at Building 65. Conversion of the existing SSDS to SVE operations would likely require modification of the process equipment (change in blower). A change in process equipment would potentially require air permitting evaluations. Previous work in F Bay and the adjacent outside areas has established procedures for utility clearance, drilling, and waste management. Multiple contractors in the region can provide the services, equipment and materials required for this alternative. F Bay is on the list of surplus building areas for future demolition with an estimated timeline of 5 years. Demolition actions could impact SVE system operations if demolition occurs within the soil remedy implementation period.	**Alternative 2** Total: $705,745 2026: $258,644 2027: $124,249 2028: $124,249 2029: $117,778 2030: $62,444
3. Removal Action	The OU 8 remedy has ICs in place that control human health and environmental exposure. ICs for OU 8 include access restrictions, notice of land use restrictions, lease and property transfer restrictions, zoning restrictions, preconstruction assessments, maintenance, and monitoring, and well restrictions. Alternative 3 would achieve RAOs 1 and 2 upon completion of the removal action. Alternative 3 would accelerate the process of achieving RAO 3 (ARARs) in combination with ISB injections performed in the Building 65 area in 2023 and future ISB actions at OU 8.	Alternative 3 would comply with established OU 8 ARARs (chemical specific) for groundwater through a combination of a complete soil removal action and ISB measures performed in the Building 65 area in 2023. The adaptive remedy optimization plan for OU 8 has two additional ISB injection events planned for 2025-2026 to support overall compliance with ARARs.	The combination of demolition, decommissioning, and complete removal action represents a permanent remedy. The removal action would excavate the delineated VOC soil area beneath F Bay with PCE concentrations ≥ 1 mg/kg. These actions would not generate treatment residuals or untreated waste that would potentially pose long-term risks to human health or the environment.	Alternative 3 would use a complete removal action to reduce toxicity, mobility, and volume of soil VOCs. Projected reductions would exceed 99% for soil. Alternative 3 addresses an estimated 2,182 BCY of soil with a VOC mass of approximately 338 pounds. The removal action does not address the limited soil area with PCE concentrations ≥1 mg/kg beneath the northern edge of F Bay (estimated area of 360 SF).	Site work that could affect site workers include demolition work, excavation, and handling of VOC soil. Well-established safeguards would protect workers, the community, and the environment during implementation. These safeguards would include development of project health and safety plans, performance of task hazard assessments, use of control measures, and personal protective equipment. Soil RAO achievement would occur at the completion of the removal action.	Alternative 3 is implementable as NTCRA with the installation confirming the feasibility of demolition of F Bay within the prescribed timelines of implementing the selected alternative (2026). Demolition activities would not require permits from local or state government agencies. The removal action would require conventional mitigation measures for dust, vapor, and excavation adjacent to the E Bay foundation. Another element of the removal action relates to potential generation of hazardous waste (D039) related to PCE impacted soil; this would require additional planning, sampling, and administrative requirements. The restoration program at DSCR has established procedures for utility clearance and drilling. Multiple contractors in the region can provide the services, equipment and materials required for demolition, decommissioning, the removal action, and site restoration.	**Alternative 3** Removal Action Total: $2,605,055 Removal Action 2026: $2,605,055

4.4.2 Long-Term Effectiveness and Permanence

Alternative 1 consists of no actions and would not reduce long-term risks.

4.4.3 Reduction of Toxicity, Mobility, and Volume of Contaminants through Treatment

Alternative 1 consists of no actions and would not reduce toxicity, mobility, or volume of contaminants.

4.4.4 Short-Term Effectiveness

Alternative 1 consists of no actions and would not achieve RAOs.

4.4.5 Implementability

Alternative 1 has no actions to implement.

4.4.6 Cost

Alternative has no actions or cost.

4.5 Alternative 2 In Situ Treatment of Soil

Alternative 2 would consist of decommission activities and in situ soil treatment using SVE.

4.5.1 Overall Protection of Human Health and the Environment

The OU 8 remedy has ICs in place that control human health and environmental exposure. ICs for OU 8 include access restrictions, notice of land use restrictions, lease and property transfer restrictions, zoning restrictions, preconstruction assessments, maintenance, and monitoring, and well restrictions.

Alternative 2 would use SVE to reduce VOC concentrations and mass in soil to mitigate leaching of COCs from subsurface soil to groundwater to accelerate attainment of groundwater cleanup levels for the OU 8 plume (RAO 1). Alternative 2 addresses soils in F Bay and E Bay with concentrations ≥ 1 mg/kg (cleanup level).

Attainment of RAO 3 would occur through a combination of SVE operations to achieve RAO 1 and ISB actions implemented in the Building 65 area in February 2023. As of July 2023, ISB actions have reduced PCE and TCE concentrations in monitored wells to concentrations ≤ 25 µg/L. Several wells in the Building 65 area have COC concentrations less than ARARs.

There is uncertainty related to the effectiveness of SVE measures to completely mitigate risk of subsurface VI into F Bay (RAO 2). If SVE measures do not mitigate VI risks, SSDS operations would need to continue at Building 65 until future building demolition occurs or mitigation measures reduce subsurface vapor to acceptable levels.

4.5.2 Compliance with ARARs

Alternative 2 would comply with established OU 8 ARARs (chemical specific) for groundwater through a combination of soil source zone reduction (treatment) and groundwater treatment. Groundwater treatment would target reduction of concentrations to attain cleanup levels consisting of Federal MCLs.

The adaptive remedy optimization plan for OU 8 has two additional ISB injection events planned for 2025-2026 to support overall compliance with ARARs.

4.5.3 Long-Term Effectiveness and Permanence

Abandonment of the former tanks and waste lines would involve removal of any solid or liquid residuals from the former tanks and waste lines for offsite treatment disposal and then filling of the empty tanks and waste lines with flowable fill inert material. These actions represent a permanent remedy that would not generate treatment residuals or untreated waste that potentially pose long-term risks to human health and the environment.

SVE treatment would reduce contaminant mass and transfer that mass to carbon absorbers. Offsite treatment of the carbon would remove contaminant mass and recycle the carbon. In situ biological treatment of groundwater would reduce COCs in situ to non-toxic end products.

There is uncertainty related to effectiveness of SVE measures to completely mitigate risk of subsurface VI into F Bay (RAO 2).

4.5.4 Reduction of Toxicity, Mobility, and Volume of Contaminants through Treatment

Alternative 2 would use in situ physical/ex-situ chemical processes to reduce toxicity, mobility, and volume of soil VOCs. Projected reductions would exceed 95% for soil. The estimated volume of VOC impacted soil addressed by Alternative 2 is 1,595 BCY with a VOC mass of more than 330 pounds.

4.5.5 Short-Term Effectiveness

Site work that could affect site workers include indoor work in F Bay related to drilling of SVE wells in-place decommissioning of former tanks and waste lines, and monitoring/sampling activities. Well-established safeguards implemented would protect workers, the community, and the environment during implementation. These safeguards would include development of project health and safety plans, performance of task hazard assessments, use of control measures, and personal protective equipment.

The estimated time to achievement of RAO 1 for soil is 3 yrs. There is uncertainty if SVE can achieve RAO 2 for subsurface soil vapor for an operation period of 3 years.

4.5.6 Implementability

Alternative 2 is implementable at Building 65. Conversion of the existing SSDS to SVE operations would likely require modification of process equipment (change in blower). A change in process equipment would potentially require air permitting evaluations. Previous work in F Bay and the adjacent outside areas has established procedures for utility clearance, drilling, and waste management. Multiple contractors in the region can provide the services, equipment and materials required for this alternative. F Bay is on the list of surplus building areas for future demolition with an estimated timeline of 5 years. Demolition actions could impact SVE system operations if demolition occurs within the soil remedy implementation period.

4.5.7 Cost

Appendix B has the ROM cost estimate for Alternative 2 summarized below. The total estimated cost of Alternative 2 is $774,144.

Table 4-6 Summary of Cost Estimate for Alternative 2

Year	Total Cost	Alternative Elements
2026	$258,644.0	Decommissioning tanks/waste lines, SVE implementation, and 6 months OM&M
2027	$124,249.0	SVE OM&M (12 months)
2028	$124,249.0	SVE OM&M (12 months)
2029	$92,415.5	SVE OM&M (6 months), confirmatory soil sampling
2030	$106,187.5	Post SVE subsurface vapor/air monitoring, decommissioning of SVE system
Total	$705,745.0	

Notes: SVE = soil vapor extraction, OM&M = operation, maintenance, and monitoring.

4.6 Alternative 3 Removal Action and Decommissioning

Alternative 3 would consist of decommissioning, building and structure demolition, and removal action in the Building F Bay area.

4.6.1 Overall Protection of Human Health and the Environment

The OU 8 remedy has ICs in place that control human health and environmental exposure. ICs for OU 8 include access restrictions, notice of land use restrictions, lease and property transfer restrictions, zoning restrictions, preconstruction assessments, maintenance, and monitoring, and well restrictions.

Alternative 3 would include demolition of F Bay that would eliminate a potential future complete pathway for VI into F Bay thereby achieving RAO 2. A complete removal action for former tanks, waste lines, and soil would remove the remaining residual VOC source zone from beneath F Bay thereby achieving RAO 1. The removal action does not address a limited area of PCE soil (estimated at 360 SF) beneath the northern edge of E Bay with PCE concentrations ≥ 1 mg/kg.

Alternative 3 would accelerate the process of achieving RAO 3 (ARARs) in combination with ISB injections performed in the Building 65 area in 2023 and future plan ISB actions at OU 8.

4.6.2 Compliance with ARARs

Alternative 3 would comply with established OU 8 ARARs (chemical specific) for groundwater through a combination of complete removal action and ISB measures performed in the Building 65 area in 2023. The adaptive remedy optimization plan for OU 8 has two additional ISB injection events planned for 2025-2026 to support overall compliance with ARARs.

4.6.3 Long-Term Effectiveness and Permanence

The combination of decommissioning, soil removal action and treatment for the soil source zone, and groundwater treatment for Alternative 3 represents a permanent remedy. Decommissioning would remove any solid or liquid residuals from the former tanks and waste lines for offsite treatment and disposal. The removal action would excavate the delineated VOC soil area beneath F Bay with PCE and TCE concentrations ≥ 1 mg/kg. These actions would not generate treatment residuals or untreated waste that would potentially pose long-term risks to human health or the environment.

4.6.4 Reduction of Toxicity, Mobility, and Volume of Contaminants through Treatment

Alternative 3 would use a complete removal action to reduce the toxicity, mobility, and volume of soil VOCs through offsite treatment and disposal. Projected reductions would exceed 99% for soil Alternative 3 addresses an estimated 2,182 BCY of soil with a VOC mass of approximately 338 pounds.

4.6.5 Short-Term Effectiveness

Site work that could affect site workers include demolition work, decommissioning of former tanks and waste lines, excavation and handling of VOC impacted soil. Well-established safeguards would protect workers, the community, and the environment during implementation. These safeguards would include development of project health and safety plans, performance of task hazard assessments, use of control measures, and personal protective equipment. Soil RAO achievement would occur at the completion of the removal action.

4.6.6 Implementability

Alternative 3 is implementable with the installation as an NTCRA confirming the feasibility of demolition of F Bay within the prescribed timelines of implementing the selected alternative (2026). Demolition activities would not require permitting with local or state government agencies. The removal action would require conventional mitigation measures for dust, vapor, and excavation adjacent to the E Bay foundation.

Another element of the removal action relates to potential generation of hazardous waste (D039 and D040) related to PCE and TCE impacted soil; this would require additional planning, sampling, and administrative requirements.

The restoration program at DSCR has established procedures for utility clearance and drilling. Multiple contractors in the region can provide the services, equipment and materials required for demolition, decommissioning, and the removal action.

4.6.7 Cost

Appendix B has the ROM cost estimate for Alternative 3 summarized below. The total estimated cost of Alternative 3 is $2,605,055.

Table 4-7 Summary of Cost Estimate for Alternative 3

Year	Total Cost	Alternative Elements
2026	$2,065,799	Removal Action
2026	$539,256	Site Restoration
2026	$2,605,055	Removal Action and Site Restoration

Legend

- Monitoring Well
- Injection Well
- Former Tank Pit
- Former Waste Lines
- Former ANPs
- OU Boundary

Notes:
Orthoimagery Source: VGIN (2021)

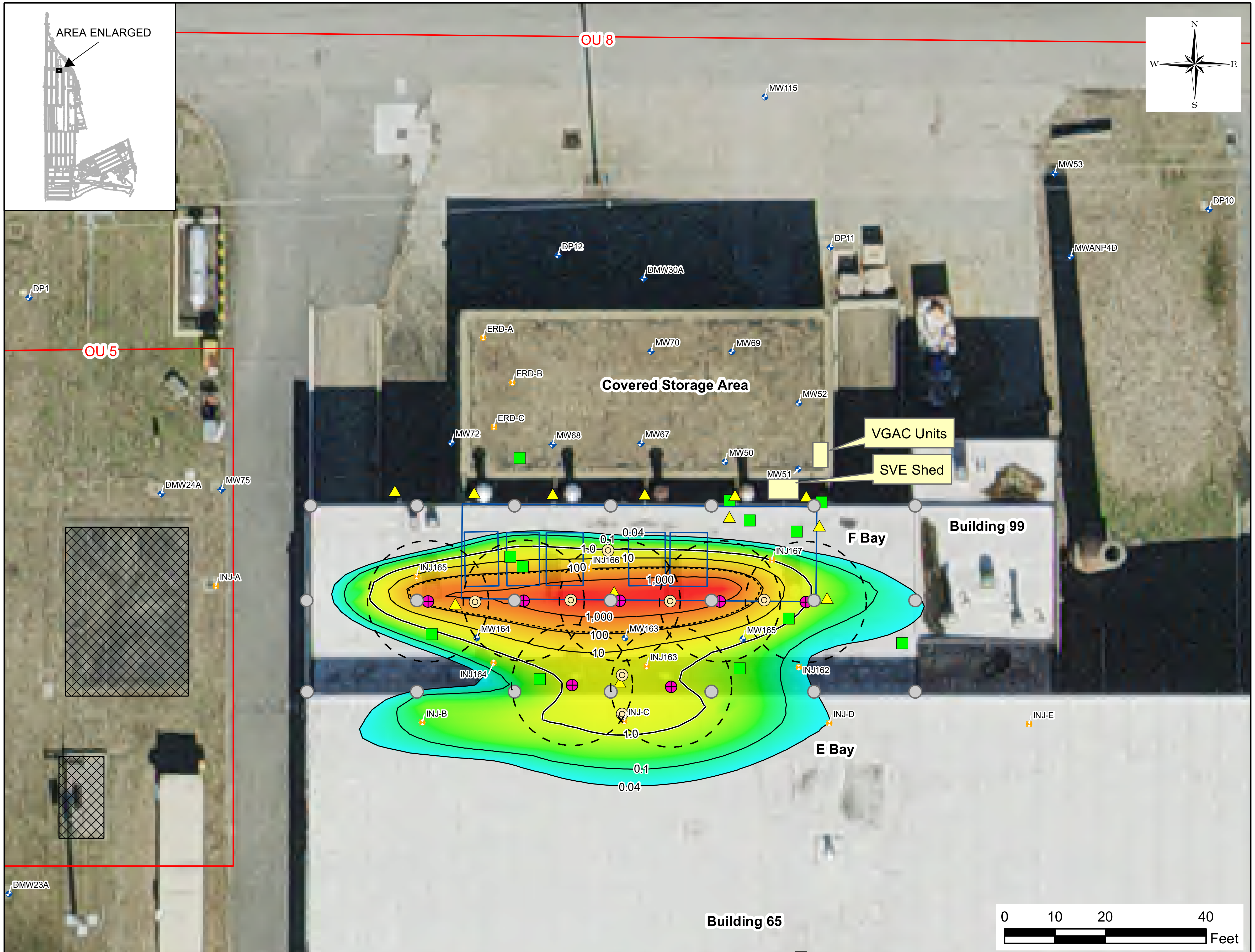
MEADOWS CONSULTING | MANAGEMENT | PLANNING   AECOM

Figure 4-1
Building 65 - Alternative #2
Former Tank and
Waste Line Abandonment

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 20'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 4-1 - Tank and Line Abandonment.mxd



Legend

- Approximate Column Location
- SVE Vapor Monitoring Point
- SVE Extraction Well
- Conceptual Estimated Radius of Influence
- SSDS Vent Wells
- Sub-Slab Vapor Monitoring Point
- Former Tank Pit
- PCE Csat Isoconcentration Line
- PCE Isoconcentration Line
- PCE Remedial Area
- Former ANPs
- OU Boundary

Tetrachloroethene (PCE) - mg/kg

0.0002, 0.001, 0.01, 0.1, 1, 10, 100, 1,000, 7,300

Notes:
Orthoimagery Source: VGIN (2021)
Migration to GW SSL = 0.04 mg/kg
Csat (Soil Saturation Limit for PCE) = 125.45 mg/kg
mg/kg = milligrams per kilogram
PCE Remedial Area = Concentration Greater than or Equal to 1.0 mg/kg

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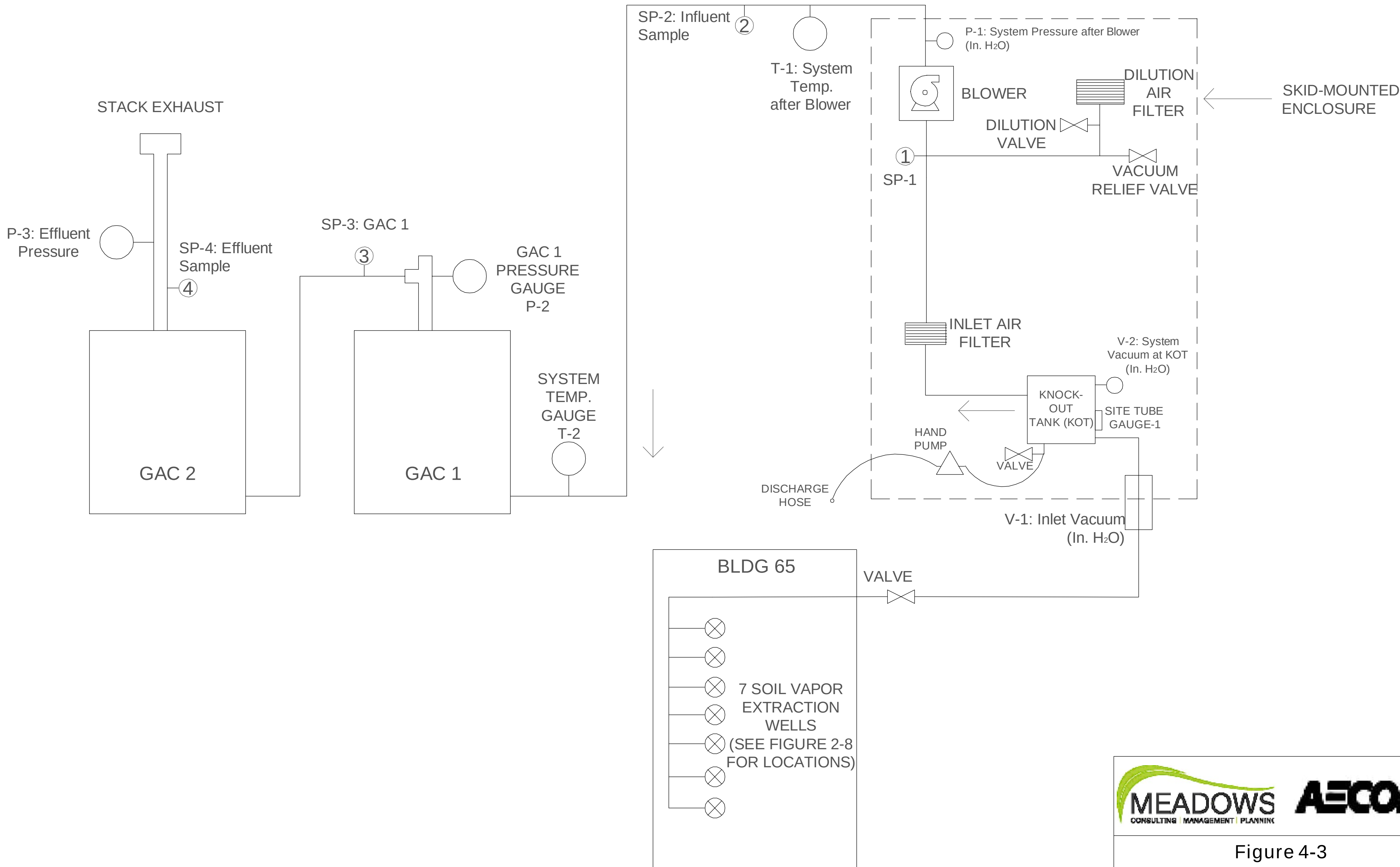
Figure 4-2
Building 65 - Alternative #2
In-situ Treatment of Soil

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 20'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 4-2 - SoilAlt2.mxd



GAC = GRANULAR ACTIVATED CARBON
SVE = SOIL VAPOR EXTRACTION WELL
→ = AIR FLOW DIRECTION
1 = QUARTERLY SYSTEM AIR SAMPLING LOCATIONS
SP = SAMPLE PORT
(H_2O) = INCHES OF WATER

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Figure 4-3
Building 65 Alternative #2
Process Flow Diagram

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: N.T.S.	Date: May 15, 2024

L:\DCS\PROJECTS\ENV\60692954 DLA RICHMOND ERP 23\500-DELIVERABLES\547-CLIN0034 EE_CA RPT\FIGURES\FIGURE 4-3 BLDG 65 ALT2 PFD.DWG

Legend

- Injection Well
- Former Injection Well Proposed for Decommissioning
- Monitoring Well
- Former Monitoring Wells Proposed for Decommissioning
- SSDS Vent Wells
- Sub-Slab Vapor Monitoring Point
- Former Tank Pit
- Former ANPs
- OU Boundary

Notes:
- Orthoimagery Source: VGIN (2021)
- Vent Wells and Vapor Monitoring Points in F Bay will be addressed by F Bay demolition

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Figure 4-4
Building 65 - Alternative #3
SSDS Decommissioning and
Well Abandonment

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 15'	Date: January 10, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 4-4 - SSDS Decommissioning.mxd

Legend

Former ANPs

OU Boundary

Proposed Demolition and Restoration Area

Notes:
Orthoimagery Source: VGIN (2021)

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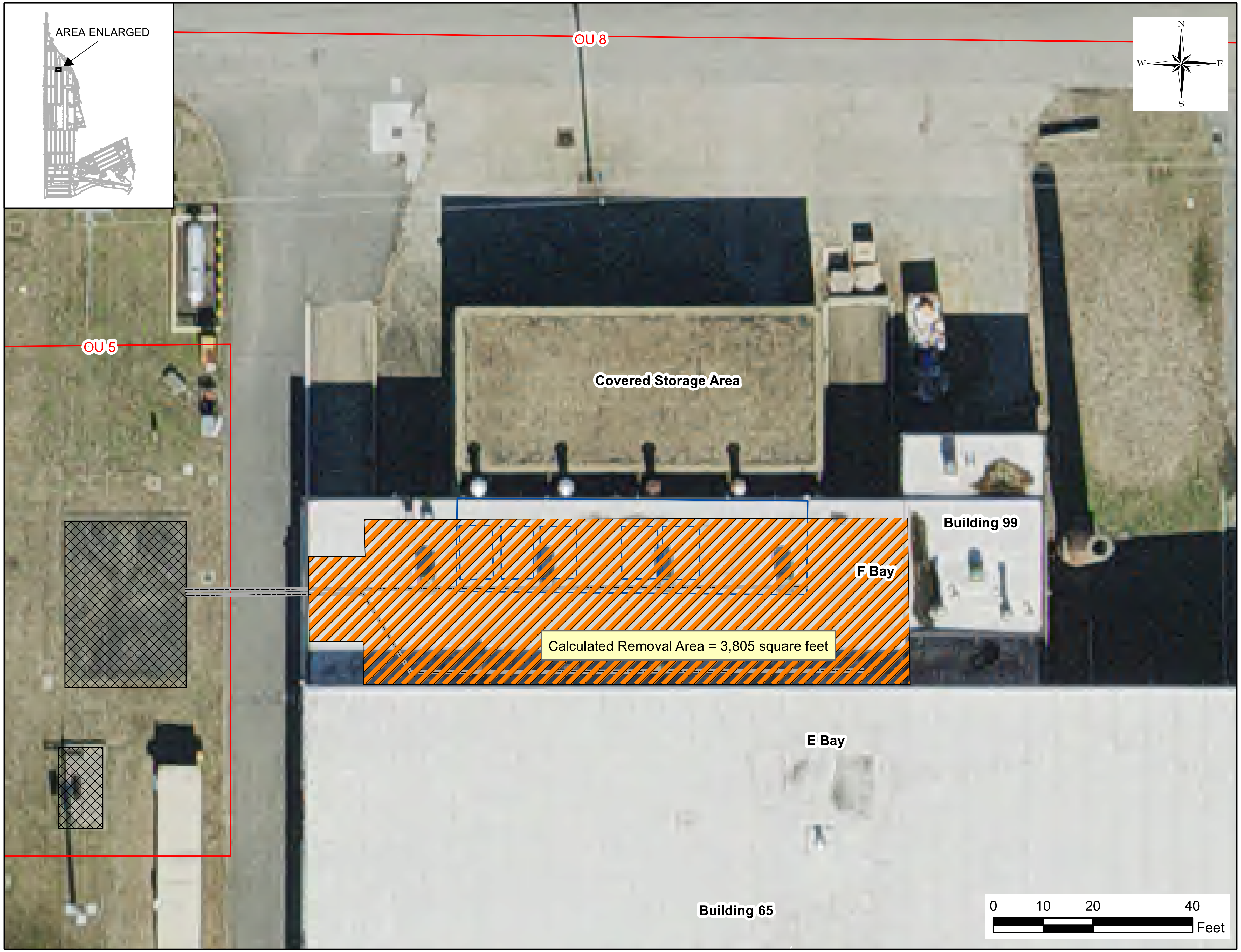
Figure 4-5
Building 65 - Alternative #3
Structure Demolition Area

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 20'	Date: May 14, 2025

L:\DCS\Projects\ENV\60692954 DLA Richmond ERP 23\500-Deliverables\547-CLIN0034 EE_CA Rpt\Figures\Figure 4-5 - StrucDemoArea_rev.mxd



Legend

- Former ANPs
- OU Boundary
- Proposed Removal

Notes:
Orthoimagery Source: VGIN (2021)

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Figure 4-6
Building 65 - Soil Remediation Area
- Alternative #3

Defense Supply Center Richmond
Richmond, VA

Prepared By: DBC	Reviewed By: JOS
Scale: 1" = 20'	Date: January 10, 2025

5. Comparative Analysis of Removal Action Alternatives

Section 5 of the EE/CA presents a comparison of the three removal action alternatives presented and evaluated in Section 4. The purpose of the comparative analysis is to weigh the relative performance of each alternative against established criteria and to determine which alternative performs consistently well or consistently better in relation to criteria of interest. Evaluation criteria for the comparative analysis from Table 4-1 include:

- Threshold criteria
  - Overall protection of human health and the environment
  - Compliance with ARARs
- Primary balancing criteria
  - Long-term effectiveness and permanence
  - Reduction in toxicity, mobility, or volume
  - Short-term effectiveness
  - Implementability
  - Cost

The EE/CA has retained the “No Action” alternative as a baseline for comparison with other alternatives; it involves taking no additional actions and implies no active management of the site or expectation of RAO attainment. Table 5-1 (page 5-2) presents a summary of the comparative analysis of the three removal action alternatives detailed in Section 4.

5.1 Threshold Criteria

Section 5.1 compares the three alternatives relative to threshold criteria.

5.1.1 Overall Protection of Human Health and the Environment

Alternative 1 would not protect human health or the environment. Alternative 2 would have a lower degree of overall protection of human health and the environment than Alternative 3. Alternative 2 would require a longer duration to achieve RAO 1 than Alternative 3, which would remove the source of groundwater contamination rather than the Alternative 2 approach of treating this source in place over a longer period. There is uncertainty related to the effectiveness of Alternative 2 to completely mitigate risk of subsurface VI into F Bay (RAO 2). This contrasts with Alternative 3 that would achieve RAOs 1 and 2 upon completion of the removal action.

5.1.2 Compliance with ARARs

Alternative 1 would not comply with ARARs. Alternative 2 would support compliance with ARARs for groundwater but require more time to reduce contaminant flux to groundwater than Alternative 3. Alternative 2 would treat the source in place over time contrasting with rapid removal of the source for Alternative 3.

Both Alternatives 2 and 3 would synergistically support ISB actions implemented in February 2023 for groundwater in the Building 65 area and future planned ISB actions at OU 8 that would occur under existing contracts outside of removal actions.

5.2 Primary Balancing Criteria

Section 5.2 compares the three alternatives relative to primary balancing criteria.

Table 5-1 Summary of Comparative Analysis of Remedial Alternatives

Screening Criteria	Alternative 1: No Action	Alternative 2: In Situ Treatment of Soil	Alternative 3: Removal Action
Overall Protection of Human Health and the Environment	Alternative 1 would not protect human health or the environment.	Alternative 2 would have a lower degree of overall protection of human health and the environment than Alternative 3. Alternative 2 would require a longer duration to achieve RAO 1 than Alternative 3. There is uncertainty related to the effectiveness of Alternative 2 to completely mitigate risk of subsurface VI into F Bay (RAO 2). This contrasts with Alternative 3 that would achieve RAOs 1 and 2 upon completion of the removal action.	Alternative 3 would have a higher degree of overall protection of human health and the environment than Alternative 2 achieving both RAOs 1 and 2 upon completion of the removal action. There is uncertainty related to the effectiveness of Alternative 2 to completely mitigate risk of subsurface VI into F Bay (RAO 2).
Compliance with ARARs	Alternative 1 would not comply with ARARs.	Alternative 2 would support compliance with ARARs for groundwater but require more time to reduce contaminant flux to groundwater than Alternative 3. Alternative 2 would treat the source in place over time contrasting with rapid removal of the source for Alternative 3. Both Alternatives 2 and 3 would synergistically support ISB actions implemented in February 2023 for groundwater in the Building 65 area and future planned ISB actions at OU 8.	The removal action for Alternative 3 would support more rapid compliance with established OU 8 ARARs (chemical specific) for groundwater than Alternative 2. Alternative 3 would remove the source of groundwater contamination rather than the Alternative 2 approach of treating this source in place over a longer period. Both Alternatives 3 and 2 would synergistically support ISB actions implemented in February 2023 for groundwater in the Building 65 area and future planned ISB actions at OU 8.
Long-Term Effectiveness and Permanence	Alternative 1 with no action would have no long-term risk reduction.	Alternative 2 would have a lower degree of long-term effectiveness and permanence than Alternative 3. Alternative 2 would require a longer duration to achieve RAO 1 (estimated 3 years) than Alternative 3 (< 6 months). There is uncertainty related to effectiveness of Alternative 2 to completely mitigate risk of subsurface VI in F Bay (RAO 2); this may require continuing vapor mitigation measures for F Bay after SVE reaches asymptotic mass removal rates. Alternative 2 relies on in situ treatment to reduce soil concentrations to achieve RAOs contrasting with Alternative 3 that completely removes the source zone beneath F Bay within the vadose zone.	Alternative 3 would have a higher degree of long-term effectiveness and permanence than Alternative 2 achieving both RAOs 1 and 2 upon completion. Alternative 3 would eliminate the potential VI pathway into Building 65 upon completion of building demolition and removal action thereby attaining RAO 2. There is uncertainty related to effectiveness of Alternative 2 to completely mitigate risk of subsurface VI into F Bay (RAO 2); this may require continuing vapor mitigation measures for F Bay after SVE reaches asymptotic mass removal rates. Alternative 3 would completely remove the source zone beneath F Bay within the vadose zone with Alternative 2 relying on in situ treatment to reduce soil concentrations to achieve RAOs.
Reduction in Toxicity, Mobility, or Volume	Alternative 1 has no action or treatment and would not reduce toxicity, mobility, or volume of contaminants.	Alternative 2 would address a smaller area, volume, and mass of VOC impacted soil than Alternative 3. The area and volume of soil addressed by Alternative 2 is 2,671 SF and 1,331 BCY compared to 3,805 SF and 2,182 BCY for Alternative 3. Alternative 2 would reduce VOC mass and volume through in situ treatment with estimated reductions in mass and volume of 95 percent. Alternative would use a removal action to address the extent of the VOC impacted soil area in F Bay.	The removal action for Alternative 3 would address a larger area, volume, and mass of VOC impacted soil than Alternative 2. The area and volume of soil addressed by Alternative 3 is 3,805 SF and 2,182 BCY compared to 2,671 SF and 1,331 BCY for Alternative 3. Alternative 3 would completely address the target area, volume, and mass in F Bay by removal with Alternative 2 reducing VOC mass and volume through in situ treatment with estimated reductions in mass and volume of 95%.
Short-Term Effectiveness	Alternative 1 involves no action and would not achieve RAOs.	Alternative 2 would require protective measures for workers in F Bay for drilling and assessment/sampling activities contrasted with Alternative 3 that would demolish F Bay before completion of remedial actions. Alternatives 2 and 3 would both require protective measures related to dust and vapors. Alternative 2 would require more time to achieve ROA 1 (estimated 3 years) than Alternative 3 (< 6 months). There is uncertainty that Alternative 2 would achieve RAO 2 contrasted with Alternative 3 that would achieve RAO 2 upon completion of the removal action.	Alternative 3 would demolish F Bay before the removal action eliminating the need for protective measures for workers at F Bay contrasting with Alternative 2 that would require indoor protective measures for workers implementing remedial actions inside F Bay (tank and waste line in-place decommissioning, drilling, sampling, and monitoring). Alternatives 3 and 2 would both require protective measures related to dust and vapors. Alternative 3 would achieve RAOs 1 and 2 upon completion of the removal action (< 6 months) contrasting with Alternative 2 that would have a longer duration to achieve RAO 1 (estimated 3 years) and uncertainty in achieving RAO 2. Alternative 3 would have higher degree of short-term effectiveness than Alternative 2.
Implementability	Alternative 1 has no action to implement.	The installation has indicated no significant constraints in implementing Alternatives 2 and 3. Alternative 2 would require less planning and building mitigation measures to implement than Alternative 3 because it uses existing infrastructure already in place with disturbance related to SVE well installation and in place decommissioning. Alternative 2 would not require the design measures for excavation that Alternative 3 would require. Planned future demolition of F Bay could impact system operation for Alternative 2 if demolition within the SVE operational period. Multiple contractors in the region can provide the services, equipment and materials required for Alternatives 2 and 3.	The installation has indicated no significant constraints in implementing Alternatives 3 and 2. Alternative 3 would require more planning and building mitigation measures to implement than Alternative 2 because of demolition, decommissioning, removal actions, and potential offsite disposal of hazardous waste. Multiple contractors in the region can provide the services, equipment and materials required for Alternatives 3 and 2.
Cost	$0	**Alternative 2** Total: $705,745.0 2026: $258,644.0 2027: $124,249.0 2028: $124,249.0 2029: $92,415.5 2030: $106,187.5	**Alternative 3 Removal Action** Total: $2,605,055 2026: $2,605,055

5.2.1 Long-Term Effectiveness and Permanence

Alternative 1 with no action would have no long-term risk reduction. Alternative 2 would have a lower degree of long-term effectiveness and permanence than Alternative 3. Alternative 2 would require a longer duration to achieve RAO 1 (estimated 3 years) than Alternative 3 (6 months or less). There is uncertainty related to effectiveness of Alternative 2 to completely mitigate risk of subsurface VI in F Bay (RAO 2); this may require continuing vapor mitigation measures for F Bay after SVE reaches asymptotic mass removal rates.

Alternative 3 would completely remove the source zone beneath F Bay within the vadose zone with Alternative 2 relying on in situ treatment to reduce soil concentrations to achieve RAOs.

5.2.2 Reduction of Toxicity, Mobility, and Volume of Contaminants through Treatment

Alternative 1 has no action or treatment and would not reduce toxicity, mobility, or volume of contaminants. Alternative 2 would address a smaller area, volume, and mass of VOC impacted soil than Alternative 3. The area and volume of soil addressed by Alternative 2 is 2,671 SF and 1,331 BCY compared to 3,805 SF and 2,182 BCY for Alternative 3. Alternative 2 would reduce VOC mass and volume through in situ treatment with estimated reductions in mass and volume of 95 percent. Alternative would use a removal action to address the extent of the VOC impacted soil area beneath F Bay.

5.2.3 Short-Term Effectiveness

Alternative 1 involves no action and would not achieve RAOs. Alternative 2 would require protective measures for workers in F Bay for in-place decommissioning, drilling, and assessment/sampling activities contrasted with Alternative 3 that would demolish F Bay before completion of remedial actions. Alternatives 2 and 3 would both require protective measures related to dust and vapors. Alternative 3 would achieve RAOs 1 and 2 upon completion of the removal action (< 6 months) contrasting with Alternative 2 that would have a longer duration to achieve RAO 1 (estimated 3 years) and uncertainty in achieving RAO 2. Alternative 3 would have a higher degree of short-term effectiveness than Alternative 2.

5.2.4 Implementability

Alternative 1 has no action to implement. The installation has indicated no significant constraints in implementing Alternatives 2 and 3. Alternative 2 would require less planning and building mitigation measures to implement than Alternative 3 because it uses existing infrastructure already in place with disturbance related to SVE well installation and in place decommissioning. Alternative 2 would not require the design and planning measures for demolition, soil excavation, and larger scale waste management that Alternative 3 would require. Planned future demolition of F Bay could impact system operation for Alternative 2 if demolition within the SVE operational period.

5.2.5 Cost

Table 5-2 has a cost comparison for the three alternatives. Alternative 1 has no cost. Alternative 2 has an estimated total cost of $705,745 compared to an estimated total cost of $2,605,055 for the removal action and site restoration for Alternative 3. The cost difference of $1,889,310 reflects limited decommissioning and in situ treatment of soil for Alternative 2 compared to complete decommissioning, demolition, removal actions, and restoration for Alternative 3. The cost difference for Alternative 2 and Task 3 of Alternative 3 is only associated actions related to Building 65 and does not consider costs or actions for downgradient long-term monitoring and management activities.

Table 5-2 Alternative Cost Comparison

Year	Alternative 1	Alternative 2	Alternative 3 Removal Action
2026	$0.0	$258,644.0	$2,605,055
2027	$0.0	$124,249.0	$0.0
2028	$0.0	$124,249.0	$0.0
2029	$0.0	$92,415.5	$0.0
2030	$0.0	$106,187.5	$0.0

Year	Alternative 1	Alternative 2	Alternative 3 Removal Action
Total	$0.0	$705,745.0	$2,605,055

6. Selected Remedial Alternative

DLA and USACE have selected Alternative 3 as the preferred remedial alternative to address the residual VOC soil and groundwater source zone beneath Building 65 at OU 8. Alternative 3 has a higher degree of remedial effectiveness than Alternative 2 supporting more rapid attainment of groundwater cleanup levels and plume reduction while eliminating LTM and vapor mitigation costs associated with F Bay.

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Appendix A Supporting Information

A.1 Soil Analytical Results Table

Appendix A.1
Summary of VOC Results
Building 65 Soil Investigation

	Boring ID	BLDG65-SB-01	BLDG65-SB-01	BLDG65-SB-01	BLDG65-SB-02	BLDG65-SB-02	BLDG65-SB-02	BLDG65-SB-03	BLDG65-SB-03	BLDG65-SB-03	BLDG65-SB-04	BLDG65-SB-04	BLDG65-SB-04	BLDG65-SB-05	BLDG65-SB-05	BLDG65-SB-05
	Sample Depth (ft bgs)	2-3	10-11	15-16	4-5	9-10	15-16	3-4	11-12	15-16	6-7	13-14	17-18	3-4	14-15	18-19
	Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	Sample Date	06/10/2020	06/10/2020	06/10/2020	06/10/2020	06/10/2020	06/10/2020	06/10/2020	06/10/2020	06/10/2020	06/12/2020	06/12/2020	06/12/2020	06/12/2020	06/12/2020	06/12/2020
Parameter	CAS #															
VOCs - 8260B (ug/kg)																
Acetone	67-64-1	42 J	41 J	62	35 J	24 J	86	42	43 J	27 J	17 JQ	50 JQ	20 JQ	22 JQ	21 JQ	< 6600 U
Benzene	71-43-2	< 0.85 U	< 0.61 U	< 0.62 U	< 0.63 U	< 0.77 U	< 0.77 U	< 0.46 U	< 0.88 U	< 0.64 U	< 0.72 U	< 1.2 U	< 0.72 U	< 0.60 U	< 0.74 U	< 440 U
Bromobenzene	108-86-1	< 2.0 U	< 1.4 U	< 1.4 U	< 1.5 U	< 1.8 U	< 1.8 U	< 1.1 U	< 2.0 U	< 1.5 U	< 1.7 U	< 2.9 U	< 1.7 U	< 1.4 U	< 1.7 U	< 1000 U
Bromochloromethane	74-97-5	< 3.8 U	< 2.8 U	< 2.8 U	< 2.8 U	< 3.5 U	< 3.5 U	< 2.1 U	< 4.0 U	< 2.9 U	< 3.2 UQ	< 5.6 UQ	< 3.2 UQ	< 2.7 UQ	< 3.3 UQ	< 2000 U
Bromodichloromethane	75-27-4	< 1.1 U	< 0.81 U	< 0.82 U	< 0.84 U	< 1.0 U	< 1.0 U	< 0.60 U	< 1.2 U	< 0.85 U	< 0.95 U	< 1.6 U	< 0.95 U	< 0.80 U	< 0.98 U	< 580 U
Bromoform	75-25-2	< 1.7 U	< 1.3 U	< 1.3 U	< 1.3 U	< 1.6 U	< 1.6 U	< 0.94 U	< 1.8 U	< 1.3 U	< 1.5 UQ	< 2.5 UQ	< 1.5 UQ	< 1.2 UQ	< 1.5 UQ	< 900 U
Bromomethane (Methyl bromide)	74-83-9	< 1.7 U	< 1.3 U	< 1.3 U	< 1.3 U	< 1.6 U	< 1.6 U	< 0.94 U	< 1.8 U	< 1.3 U	< 1.5 U	< 2.5 U	< 1.5 U	< 1.2 U	< 1.5 U	< 900 U
2-Butanone (MEK)	78-93-3	< 2.8 U	< 2.0 U	< 2.0 U	< 2.1 U	< 2.5 U	< 2.5 U	< 1.5 U	< 2.9 U	< 2.1 U	< 2.4 UQ	< 4.1 UQ	< 2.4 UQ	< 2.0 UQ	< 2.4 UQ	< 1400 U
n-Butylbenzene	104-51-8	< 2.8 U	< 2.0 U	< 2.0 U	< 2.1 U	< 2.5 U	< 2.5 UQ	< 1.5 U	< 2.9 U	< 2.1 U	< 2.4 U	< 4.1 U	< 2.4 U	< 2.0 U	< 2.4 U	< 1400 U
sec-Butylbenzene	135-98-8	< 2.4 U	< 1.8 U	< 1.8 U	< 1.8 U	< 2.2 U	< 2.2 UQ	< 1.3 U	< 2.5 U	< 1.8 U	< 2.1 U	< 3.5 U	< 2.1 U	< 1.7 U	< 2.1 U	< 1300 U
tert-Butylbenzene	98-06-6	< 2.1 U	< 1.5 U	< 1.5 U	< 1.6 U	< 1.9 U	< 1.9 U	< 1.1 U	< 2.2 U	< 1.6 U	< 1.8 UQ	< 3.0 UQ	< 1.8 UQ	< 1.5 UQ	< 1.8 UQ	< 1100 U
Carbon disulfide	75-15-0	< 1.3 U	< 0.92 U	< 0.93 U	< 0.95 U	< 1.2 U	< 1.2 U	< 0.69 U	< 1.3 U	< 0.96 U	< 1.1 UQ	< 1.9 UQ	< 1.1 UQ	< 0.91 UQ	< 1.1 UQ	< 660 U
Carbon tetrachloride	56-23-5	< 0.97 U	< 0.69 U	< 0.70 U	< 0.72 U	< 0.87 U	< 0.88 U	< 0.52 U	< 1.0 U	< 0.73 U	< 0.82 UQ	< 1.4 UQ	< 0.81 UQ	< 0.69 UQ	< 0.84 UQ	< 500 U
Chlorobenzene	108-90-7	< 1.1 U	< 0.80 U	< 0.81 U	< 0.83 U	< 1.0 U	< 1.0 U	< 0.60 U	< 1.2 U	< 0.84 U	< 0.94 U	< 1.6 U	< 0.94 U	< 0.79 U	< 0.97 U	< 580 U
Chloroethane	75-00-3	< 3.1 U	< 2.3 U	< 2.3 U	< 2.3 U	< 2.8 U	< 2.8 U	< 1.7 U	< 3.2 U	< 2.4 U	< 2.7 U	< 4.6 U	< 2.6 U	< 2.2 U	< 2.7 U	< 1600 U
Chloroform	67-66-3	< 1.3 U	< 0.92 U	< 0.93 U	< 0.95 U	< 1.2 U	< 1.2 UM	< 0.69 U	< 1.3 U	< 0.96 U	< 1.1 U	< 1.9 U	< 1.1 U	< 0.91 U	< 1.1 U	< 660 U
Chloromethane (Methyl chloride)	74-87-3	< 1.2 U	< 0.84 U	< 0.85 U	< 0.86 U	< 1.0 U	< 1.1 UQ	< 0.62 U	< 1.2 U	< 0.87 U	< 0.98 U	< 1.7 U	< 0.98 U	< 0.83 U	< 1.0 U	< 600 U
2-Chlorotoluene	95-49-8	< 2.3 U	< 1.7 U	< 1.7 U	< 1.7 U	< 2.1 U	< 2.1 U	< 1.2 U	< 2.4 U	< 1.7 U	< 2.0 U	< 3.4 U	< 2.0 U	< 1.7 U	< 2.0 U	< 1200 U
4-Chlorotoluene	106-43-4	< 2.0 U	< 1.4 U	< 1.4 U	< 1.5 U	< 1.8 U	< 1.8 U	< 1.1 U	< 2.0 U	< 1.5 U	< 1.7 U	< 2.9 U	< 1.7 U	< 1.4 U	< 1.7 U	< 1000 U
Dibromochloromethane	124-48-1	< 2.0 U	< 1.4 U	< 1.4 U	< 1.5 U	< 1.8 U	< 1.8 U	< 1.1 U	< 2.0 U	< 1.5 U	< 1.7 U	< 2.9 U	< 1.7 U	< 1.4 U	< 1.7 U	< 1000 U
1,2-Dibromo-3-chloropropane	96-12-8	< 5.1 U	< 3.7 U	< 3.7 U	< 3.8 U	< 4.6 U	< 4.6 U	< 2.7 U	< 5.3 U	< 3.8 U	< 4.3 U	< 7.4 U	< 4.3 U	< 3.6 U	< 4.4 U	< 2600 U
Dibromomethane (Methylene bromide)	74-95-3	< 2.0 U	< 1.4 U	< 1.4 U	< 1.5 U	< 1.8 U	< 1.8 U	< 1.1 U	< 2.0 U	< 1.5 U	< 1.7 U	< 2.9 U	< 1.7 U	< 1.4 U	< 1.7 U	< 1000 U
1,2-Dichlorobenzene	95-50-1	< 1.5 U	< 1.1 U	< 1.1 U	< 1.1 U	< 1.4 U	< 1.4 U	< 0.81 U	< 1.6 U	< 1.1 U	< 1.3 U	< 2.2 U	< 1.3 U	< 1.1 U	< 1.3 U	< 780 U
1,3-Dichlorobenzene	541-73-1	< 1.9 U	< 1.3 U	< 1.4 U	< 1.4 U	< 1.7 U	< 1.7 U	< 1.0 U	< 1.9 U	< 1.4 U	< 1.6 U	< 2.7 U	< 1.6 U	< 1.3 U	< 1.6 U	< 960 U
1,4-Dichlorobenzene	106-46-7	< 0.86 U	< 0.62 U	< 0.63 U	< 0.64 U	< 0.78 U	< 0.78 U	< 0.46 U	< 0.89 U	< 0.65 U	< 0.73 U	< 1.3 U	< 0.73 U	< 0.61 U	< 0.75 U	< 450 U
Dichlorodifluoromethane	75-71-8	< 1.1 U	< 0.79 U	< 0.79 U	< 0.81 U	< 0.99 U	< 0.99 UQ	< 0.59 U	< 1.1 U	< 0.82 U	< 0.92 UQ	< 1.6 UQ	< 0.92 UQ	< 0.78 UQ	< 0.95 UQ	< 570 U
1,1-Dichloroethane	75-34-3	< 1.3 U	< 0.92 U	< 0.93 U	< 0.95 U	< 1.2 U	< 1.2 U	< 0.69 U	< 1.3 U	< 0.96 U	< 1.1 U	< 1.9 U	< 1.1 U	< 0.91 U	< 1.1 U	< 660 U
1,2-Dichloroethane	107-06-2	< 1.3 U	< 0.92 UM	< 0.93 UM	< 0.95 UM	< 1.2 UM	< 1.2 U	< 0.69 UM	< 1.3 U	< 0.96 UM	< 1.1 UMQ	< 1.9 UMQ	< 1.1 UMQ	< 0.91 UQ	< 1.1 UMQ	< 660 UM
1,1-Dichloroethene	75-35-4	< 1.7 U	< 1.3 U	< 1.3 U	< 1.3 U	< 1.6 U	< 1.6 U	< 0.94 U	< 1.8 U	< 1.3 U	< 1.5 U	< 2.5 U	< 1.5 U	< 1.2 U	< 1.5 U	< 900 U
1,2-Dichloroethene, Total	540-59-0	< 0.73 U	< 0.53 U	< 0.53 U	< 0.54 U	< 0.66 U	< 0.66 U	< 0.39 U	< 0.76 U	< 0.55 U	< 0.62 U	2.4 J	< 0.62 U	3.1 J	< 0.64 U	< 380 U
cis-1,2-Dichloroethene	156-59-2	< 1.6 U	< 1.2 U	< 1.2 U	< 1.2 U	< 1.5 U	< 1.5 U	< 0.87 U	< 1.7 U	< 1.2 U	< 1.4 U	2.4 J	< 1.4 U	2.7 J	< 1.4 U	< 840 U
trans-1,2-Dichloroethene	156-60-5	< 0.73 U	< 0.53 U	< 0.53 U	< 0.54 U	< 0.66 U	< 0.66 U	< 0.39 U	< 0.76 U	< 0.55 U	< 0.62 U	< 1.1 U	< 0.62 U	< 0.52 U	< 0.64 U	< 380 U
1,2-Dichloropropane	78-87-5	< 1.0 U	< 0.72 U	< 0.73 U	< 0.74 U	< 0.90 U	< 0.91 U	< 0.54 U	< 1.0 U	< 0.75 U	< 0.85 U	< 1.5 U	< 0.84 U	< 0.71 U	< 0.87 U	< 520 U
1,3-Dichloropropane	142-28-9	< 2.1 U	< 1.5 U	< 1.5 U	< 1.6 U	< 1.9 U	< 1.9 U	< 1.1 U	< 2.2 U	< 1.6 U	< 1.8 U	< 3.0 U	< 1.8 U	< 1.5 U	< 1.8 U	< 1100 U
2,2-Dichloropropane	594-20-7	< 1.3 U	< 0.92 U	< 0.93 U	< 0.95 U	< 1.2 U	< 1.2 U	< 0.69 U	< 1.3 U	< 0.96 U	< 1.1 U	< 1.9 U	< 1.1 U	< 0.91 U	< 1.1 U	< 660 U
1,1-Dichloropropene	563-58-6	< 1.1 U	< 0.79 U	< 0.80 U	< 0.82 U	< 1.0 U	< 1.0 U	< 0.59 U	< 1.1 U	< 0.83 U	< 0.93 U	< 1.6 U	< 0.93 U	< 0.79 U	< 0.96 U	< 570 U
cis-1,3-Dichloropropene	10061-01-5	< 0.97 U	< 0.69 U	< 0.70 U	< 0.72 U	< 0.87 U	< 0.88 U	< 0.52 U	< 1.0 U	< 0.73 U	< 0.82 U	< 1.4 U	< 0.81 U	< 0.69 U	< 0.84 U	< 500 U
trans-1,3-Dichloropropene	10061-02-6	< 1.0 U	< 0.73 U	< 0.74 U	< 0.75 U	< 0.91 U	< 0.92 U	< 0.54 U	< 1.0 U	< 0.76 U	< 0.86 U	< 1.5 U	< 0.85 U	< 0.72 U	< 0.88 U	< 520 U
Ethylbenzene	100-41-4	< 1.5 U	< 1.1 UM	< 1.1 U	< 1.1 U	< 1.4 U	< 1.4 U	< 0.81 U	< 1.6 U	< 1.1 UM	< 1.3 U	< 2.2 UM	< 1.3 U	< 1.1 UM	< 1.3 UM	< 780 UM
Hexachlorobutadiene	87-68-3	< 3.6 U	< 2.6 U	< 2.6 U	< 2.7 U	< 3.3 U	< 3.3 UQ	< 1.9 U	< 3.7 U	< 2.7 U	< 3.0 U	< 5.2 U	< 3.0 U	< 2.6 U	< 3.1 U	< 1900 U
2-Hexanone	591-78-6	< 3.8 UQ	< 2.8 UQ	< 2.8 UQ	< 2.8 UQ	< 3.5 UQ	< 3.5 U	< 2.1 UQ	< 4.0 UQ	< 2.9 UQ	< 3.2 U	< 5.6 U	< 3.2 U	< 2.7 U	< 3.3 U	< 2000 U
Isopropylbenzene (Cumene)	98-82-8	< 2.2 U	< 1.6 U	< 1.6 U	< 1.6 U	< 2.0 U	< 2.0 U	< 1.2 U	< 2.3 U	< 1.7 U	< 1.9 UQ	< 3.2 UQ	< 1.9 UQ	< 1.6 UQ	< 1.9 UQ	< 1100 U
4-Isopropyltoluene	99-87-6	< 2.6 U	< 1.8 U	< 1.9 U	< 1.9 U	< 2.3 U	< 2.3 UQ	< 1.4 U	< 2.6 U	< 1.9 U	< 2.2 U	< 3.7 U	< 2.2 U	< 1.8 U	< 2.2 U	< 1300 U
Methylene chloride	75-09-2	< 1.1 U	< 0.82 U	< 0.83 U	< 0.85 U	< 1.0 U	< 1.0 UQ	< 0.61 U	< 1.2 U	< 0.86 U	< 0.96 U	< 1.7 U	< 0.96 U	< 0.81 U	< 0.99 U	< 590 U
4-Methyl-2-pentanone (MIBK)	108-10-1	< 4.9 U	< 3.5 U	< 3.6 U	< 3.6 U	< 4.4 U	< 4.4 U	< 2.6 U	< 5.1 U	< 3.7 U	< 4.1 U	< 7.1 U	< 4.1 U	< 3.5 U	< 4.2 U	< 2500 U
tert-Butyl methyl ether (MTBE)	1634-04-4	< 1.2 U	< 0.84 U	< 0.85 U	< 0.86 U	< 1.0 U	< 1.1 UM	< 0.62 U	< 1.2 U	< 0.87 U	< 0.98 UQ	< 1.7 UQ	< 0.98 UQ	< 0.83 UMQ	< 1.0 UQ	< 600 U
Naphthalene	91-20-3	< 1.4 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.3 U	< 1.3 U	< 0.75 U	< 1.4 U	< 1.0 U	< 1.2 U	< 2.0 U	< 1.2 U	1.5 J	< 1.2 U	< 720 U
n-Propylbenzene	103-65-1	< 3.1 U	< 2.3 U	< 2.3 U	< 2.3 U	< 2.8 U	< 2.8 UQ	< 1.7 U	< 3.2 U	< 2.4 U	< 2.7 U	< 4.6 U	< 2.6 U	< 2.2 U	< 2.7 U	< 1600 U
Styrene	100-42-5	< 1.1 U	< 0.78 U	< 0.79 U	< 0.80 U	< 0.98 U	< 0.98 U	< 0.58 U	< 1.1 U	< 0.81 U	< 0.91 U	< 1.6 U	< 0.91 U	< 0.77 U	< 0.94 U	< 560 U
1,1,1,2-Tetrachloroethane	630-20-6	< 2.8 U	< 2.0 U	< 2.0 U	< 2.1 U	< 2.5 U	< 2.5 U	< 1.5 U	< 2.9 U	< 2.1 U	< 2.4 UQ	< 4.1 UQ	< 2.4 UQ	< 2.0 UQ	< 2.4 UQ	< 1400 U
1,1,2,2-Tetrachloroethane	79-34-5	< 1.9 U	< 1.3 U	< 1.4 U	< 1.4 U	< 1.7 U	< 1.7 U	< 1.0 U	< 1.9 U	< 1.4 U	< 1.6 UQ	< 2.7 UQ	< 1.6 UQ	< 1.3 UQ	< 1.6 UQ	< 960 U
Tetrachloroethene (PCE)	127-18-4	9.6	2.1 J	1.9 J	< 1.6 U	3.7 J	7.3 BQ	26	< 2.3 U	3.3 J	13	270	700 H	2000	2000	2000 J
Toluene	108-88-3	< 0.98 U	< 0.70 U	< 0.71 U	< 0.73 U	< 0.88 U	< 0.89 UM	0.63 J	< 1.0 U	< 0.73 U	< 0.83 UM	< 1.4 U	< 0.82 U	< 0.70 U	< 0.85 UM	< 510 U

Summary of VOC Results
Building 65 Soil Investigation

	Boring ID	BLDG65-SB-01	BLDG65-SB-01	BLDG65-SB-01	BLDG65-SB-02	BLDG65-SB-02	BLDG65-SB-02	BLDG65-SB-03	BLDG65-SB-03	BLDG65-SB-03	BLDG65-SB-04	BLDG65-SB-04	BLDG65-SB-04	BLDG65-SB-05	BLDG65-SB-05	BLDG65-SB-05
	Sample Depth (ft bgs)	2-3	10-11	15-16	4-5	9-10	15-16	3-4	11-12	15-16	6-7	13-14	17-18	3-4	14-15	18-19
	Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	Sample Date	06/10/2020	06/10/2020	06/10/2020	06/10/2020	06/10/2020	06/10/2020	06/10/2020	06/10/2020	06/10/2020	06/12/2020	06/12/2020	06/12/2020	06/12/2020	06/12/2020	06/12/2020
Parameter	CAS #															
1,2,3-Trichlorobenzene	87-61-6	< 1.9 U	< 1.3 U	< 1.4 U	< 1.4 U	< 1.7 U	< 1.7 U	< 1.0 U	< 1.9 U	< 1.4 U	< 1.6 U	< 2.7 U	< 1.6 U	< 1.3 U	< 1.6 U	< 960 U
1,2,4-Trichlorobenzene	120-82-1	< 1.0 U	< 0.74 U	< 0.75 U	< 0.77 U	< 0.93 U	< 0.94 U	< 0.55 U	< 1.1 U	< 0.78 U	< 0.88 U	< 1.5 U	< 0.87 U	< 0.74 U	< 0.90 U	< 540 U
1,1,1-Trichloroethane	71-55-6	< 0.69 U	< 0.49 U	< 0.50 U	< 0.51 U	< 0.62 U	< 0.62 U	< 0.37 U	< 0.71 U	< 0.52 U	< 0.58 U	< 1.0 U	< 0.58 U	< 0.49 U	< 0.60 U	< 350 U
1,1,2-Trichloroethane	79-00-5	< 1.5 U	< 1.1 U	< 1.1 U	< 1.1 U	< 1.4 U	< 1.4 U	< 0.81 UM	< 1.6 U	< 1.1 U	< 1.3 UQ	< 2.2 UMQ	< 1.3 UMQ	< 1.1 UMQ	< 1.3 UMQ	< 780 U
Trichloroethene (TCE)	79-01-6	< 1.5 U	< 1.1 U	< 1.1 U	< 1.1 U	< 1.4 U	< 1.4 U	0.81 J	< 1.6 U	< 1.1 U	< 1.3 U	13	14	11	12	< 780 U
Trichlorofluoromethane	75-69-4	< 1.4 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.3 U	< 1.3 U	< 0.75 U	< 1.4 U	< 1.0 U	< 1.2 U	< 2.0 U	< 1.2 U	< 0.99 U	< 1.2 U	< 720 U
1,2,3-Trichloropropane	96-18-4	< 2.8 U	< 2.0 U	< 2.0 U	< 2.1 U	< 2.5 U	< 2.5 U	< 1.5 U	< 2.9 U	< 2.1 U	< 2.4 UQ	< 4.1 UQ	< 2.4 UQ	< 2.0 UQ	< 2.4 UQ	< 1400 U
1,2,4-Trimethylbenzene	95-63-6	< 1.6 U	< 1.2 U	< 1.2 U	< 1.2 U	< 1.5 U	< 1.5 U	< 0.87 U	< 1.7 U	< 1.2 U	< 1.4 U	< 2.4 U	< 1.4 U	< 1.2 U	< 1.4 U	< 840 U
1,3,5-Trimethylbenzene	108-67-8	< 2.0 U	< 1.4 U	< 1.4 U	< 1.5 U	< 1.8 U	< 1.8 UQ	< 1.1 U	< 2.0 U	< 1.5 U	< 1.7 U	< 2.9 U	< 1.7 U	< 1.4 U	< 1.7 U	< 1000 U
Vinyl acetate	108-05-4	< 2.9 U	< 2.1 U	< 2.1 U	< 2.2 U	< 2.6 U	< 2.6 U	< 1.6 U	< 3.0 U	< 2.2 U	< 2.5 UQ	< 4.2 UQ	< 2.5 UQ	< 2.1 UQ	< 2.5 UQ	< 1500 U
Vinyl chloride	75-01-4	< 1.7 U	< 1.3 U	< 1.3 U	< 1.3 U	< 1.6 U	< 1.6 UQ	< 0.94 U	< 1.8 U	< 1.3 U	< 1.5 U	< 2.5 U	< 1.5 U	< 1.2 U	< 1.5 U	< 900 U
m+p-Xylenes	179601-23-1	< 3.0 U	< 2.2 U	< 2.2 U	< 2.2 U	< 2.7 U	< 2.7 U	< 1.6 U	< 3.1 U	< 2.3 U	< 2.6 U	< 4.4 U	< 2.6 U	< 2.2 U	< 2.6 U	< 1600 U
o-Xylene	95-47-6	< 1.3 U	< 0.92 U	< 0.93 U	< 0.95 U	< 1.2 U	< 1.2 U	< 0.69 U	< 1.3 U	< 0.96 U	< 1.1 U	< 1.9 U	< 1.1 U	< 0.91 U	< 1.1 U	< 660 U
Xylene (Total)	1330-20-7	< 1.3 U	< 0.92 U	< 0.93 U	< 0.95 U	< 1.2 U	< 1.2 U	< 0.69 U	< 1.3 U	< 0.96 U	< 1.1 U	< 1.9 U	< 1.1 U	< 0.91 U	< 1.1 U	< 660 U

Notes:
CAS# = Chemical Abstract Service number
FD = field duplicate
ft bgs = feet below ground surface
N = normal or primary sample
ug/kg = micrograms per kilogram
VOCs = volatile organic compounds
Bold font = detected result

Laboratory Qualifiers:
B = Blank Contamination
D = The reported value is from a dilution
H = Sample was prepped or analyzed beyond the specified holing time
J = Estimated. The analyte was positively identified; the quantitation is an estimation
J1 = Estimated. The quantitation is an estimation due to discrepancies in meeting certain analyte-sfecific quality control criteria.
M = Manual integrated compound
Q = One or more quality control criteria failed
U = Undetected at limit of detection

Appendix A.1
Summary of VOC Results
Building 65 Soil Investigation

	Boring ID	BLDG65-SB-06	BLDG65-SB-06	BLDG65-SB-06	BLDG65-SB-07	BLDG65-SB-07	BLDG65-SB-07	BLDG65-SB-08	BLDG65-SB-08	BLDG65-SB-08	BLDG65-SB-09	BLDG65-SB-09	BLDG65-SB-09	BLDG65-SB-09	BLDG65-SB-10	BLDG65-SB-10	BLDG65-SB-10	BLDG65-SB-10
	Sample Depth (ft bgs)	2-3	13-14	15-16	4-5	14-15	18-19	4-5	14-15	19-20	5-6	16-17	18-19	18-19	5-6	14-15	14-15	18-19
	Sample Type	N	N	N	N	N	N	N	N	N	N	N	FD	N	N	N	FD	N
	Sample Date	06/10/2020	06/10/2020	06/10/2020	06/11/2020	06/11/2020	06/11/2020	06/12/2020	06/12/2020	06/12/2020	06/11/2020	06/11/2020	06/11/2020	06/11/2020	06/10/2020	06/10/2020	06/10/2020	06/10/2020
Parameter	CAS #																	
VOCs - 8260B (ug/kg)																		
Acetone	67-64-1	66	49 JJ1	20 J	67 Q	92 Q	39 JQ	32 JQ	17 JQ	21 JQJ1	22 JQ	75 Q	65	27 JQ	30 J	37 J	40 J	28 J
Benzene	71-43-2	< 0.62 U	< 0.85 U	< 0.76 U	< 0.59 U	< 0.71 U	< 0.70 U	< 0.53 U	< 0.73 U	< 0.69 U	< 0.72 U	< 0.86 U	< 0.81 U	< 0.84 U	< 0.74 U	< 0.76 U	< 0.87 U	< 0.64 U
Bromobenzene	108-86-1	< 1.4 U	< 2.0 U	< 1.8 U	< 1.4 U	< 1.7 U	< 1.6 U	< 1.2 U	< 1.7 U	< 1.6 UJ1	< 1.7 U	< 2.0 U	< 1.9 U	< 2.0 U	< 1.7 U	< 1.8 U	< 2.0 U	< 1.5 U
Bromochloromethane	74-97-5	< 2.8 U	< 3.9 UJ1	< 3.4 U	< 2.7 U	< 3.2 U	< 3.2 U	< 2.4 UQ	< 3.3 UQ	< 3.1 UQJ1	< 3.2 U	< 3.9 U	< 3.7 U	< 3.8 U	< 3.4 U	< 3.4 U	< 3.9 U	< 2.9 U
Bromodichloromethane	75-27-4	< 0.82 U	< 1.1 UJ1	< 1.0 U	< 0.78 U	< 0.95 U	< 0.93 U	< 0.70 U	< 0.97 U	< 0.92 U	< 0.95 U	< 1.1 U	< 1.1 U	< 1.1 U	< 0.98 U	< 1.0 U	< 1.2 U	< 0.86 U
Bromoform	75-25-2	< 1.3 U	< 1.8 UJ1	< 1.6 U	< 1.2 U	< 1.5 U	< 1.4 U	< 1.1 UQ	< 1.5 UQ	< 1.4 UQJ1	< 1.5 U	< 1.8 U	< 1.7 U	< 1.7 U	< 1.5 U	< 1.6 U	< 1.8 U	< 1.3 U
Bromomethane (Methyl bromide)	74-83-9	< 1.3 U	< 1.8 UJ1	< 1.6 U	< 1.2 UQ	< 1.5 UQ	< 1.4 UQ	< 1.1 U	< 1.5 U	< 1.4 UJ1	< 1.5 UQ	< 1.8 UQ	< 1.7 U	< 1.7 UQ	< 1.5 U	< 1.6 U	< 1.8 U	< 1.3 U
2-Butanone (MEK)	78-93-3	< 2.0 U	< 2.8 UJ1	< 2.5 U	< 1.9 U	< 2.4 U	< 2.3 U	< 1.7 UQ	< 2.4 UQ	< 2.3 UQ	< 2.4 U	< 2.8 U	< 2.7 U	< 2.8 U	< 2.4 U	< 2.5 U	< 2.9 U	< 2.1 U
n-Butylbenzene	104-51-8	< 2.0 U	< 2.8 U	< 2.5 U	< 1.9 UQ	< 2.4 UQ	< 2.3 UQ	< 1.7 U	< 2.4 U	< 2.3 U	< 2.4 UQ	3.2 JQM	< 2.7 UQ	< 2.8 UQ	< 2.4 U	< 2.5 U	< 2.9 U	< 2.1 U
sec-Butylbenzene	135-98-8	< 1.8 U	< 2.5 U	< 2.2 U	< 1.7 UQ	< 2.1 UQ	< 2.0 UQ	< 1.5 U	< 2.1 U	< 2.0 UJ1	< 2.1 UQ	< 2.5 UQ	< 2.3 UQ	< 2.4 UQ	< 2.1 U	< 2.2 U	< 2.5 U	< 1.9 U
tert-Butylbenzene	98-06-6	< 1.5 U	< 2.1 U	< 1.9 U	< 1.5 U	< 1.8 U	< 1.7 U	< 1.3 UQ	< 1.8 UQ	< 1.7 UQJ1	< 1.8 U	< 2.1 U	< 2.0 U	< 2.1 U	< 1.8 U	< 1.9 U	< 2.1 U	< 1.6 U
Carbon disulfide	75-15-0	< 0.93 U	< 1.3 U	< 1.1 U	< 0.89 UQ	< 1.1 UQ	< 1.1 UQ	< 0.80 UQ	< 1.1 UQ	< 1.0 UQJ1	< 1.1 UQ	< 1.3 UQ	1.5 JM	< 1.3 UQ	< 1.1 U	< 1.1 U	< 1.3 U	< 0.97 U
Carbon tetrachloride	56-23-5	< 0.70 U	< 0.97 U	< 0.86 U	< 0.67 UQ	< 0.81 UQ	< 0.80 UQ	< 0.60 UQ	< 0.83 UQ	< 0.79 UQJ1	< 0.81 UQ	< 0.98 UQ	< 0.92 U	< 0.96 UQ	< 0.84 U	< 0.86 U	< 0.99 U	< 0.73 U
Chlorobenzene	108-90-7	< 0.81 U	< 1.1 U	< 0.99 U	< 0.78 U	< 0.94 U	< 0.92 U	< 0.70 U	< 0.96 U	< 0.91 U	< 0.94 U	< 1.1 U	< 1.1 U	< 1.1 U	< 0.97 U	< 1.0 U	< 1.1 U	< 0.85 U
Chloroethane	75-00-3	< 2.3 U	< 3.2 UJ1	< 2.8 U	< 2.2 UQ	< 2.6 UQ	< 2.6 UQ	< 2.0 U	< 2.7 U	< 2.6 UJ1	< 2.6 UQ	< 3.2 UQ	< 3.0 U	< 3.1 UQ	< 2.7 U	< 2.8 U	< 3.2 U	< 2.4 U
Chloroform	67-66-3	< 0.93 U	< 1.3 U	< 1.1 U	< 0.89 U	< 1.1 U	< 1.1 U	0.87 J	< 1.1 UM	< 1.0 UJ1	< 1.1 U	< 1.3 U	< 1.2 U	< 1.3 U	< 1.1 U	< 1.1 U	< 1.3 U	< 0.97 U
Chloromethane (Methyl chloride)	74-87-3	< 0.85 U	< 1.2 U	< 1.0 U	< 0.81 UMQ	< 0.98 UQ	< 0.96 UQ	< 0.73 UM	< 1.0 UM	< 0.95 UJ1	< 0.98 UQ	< 1.2 UQ	< 1.1 UQ	< 1.2 UQ	< 1.0 U	< 1.0 U	< 1.2 U	< 0.88 U
2-Chlorotoluene	95-49-8	< 1.7 U	< 2.3 U	< 2.1 U	< 1.6 U	< 2.0 U	< 1.9 U	< 1.5 U	< 2.0 U	< 1.9 UJ1	< 2.0 U	< 2.4 U	< 2.2 U	< 2.3 U	< 2.0 U	< 2.1 U	< 2.4 U	< 1.8 U
4-Chlorotoluene	106-43-4	< 1.4 U	< 2.0 U	< 1.8 U	< 1.4 U	< 1.7 U	< 1.6 U	< 1.2 U	< 1.7 U	< 1.6 UJ1	< 1.7 U	< 2.0 U	< 1.9 U	< 2.0 U	< 1.7 U	< 1.8 U	< 2.0 U	< 1.5 U
Dibromochloromethane	124-48-1	< 1.4 UM	< 2.0 UJ1	< 1.8 U	< 1.4 U	< 1.7 U	< 1.6 U	< 1.2 U	< 1.7 U	< 1.6 UMJ1	< 1.7 U	< 2.0 U	< 1.9 U	< 2.0 UM	< 1.7 U	< 1.8 U	< 2.0 U	< 1.5 U
1,2-Dibromo-3-chloropropane	96-12-8	< 3.7 U	< 5.1 UJ1	< 4.6 U	< 3.6 U	< 4.3 U	< 4.2 U	< 3.2 UM	< 4.4 U	< 4.2 UJ1	< 4.3 U	< 5.2 U	< 4.9 U	< 5.1 UM	< 4.5 U	< 4.6 U	< 5.2 U	< 3.9 U
Dibromomethane (Methylene bromide)	74-95-3	< 1.4 U	< 2.0 UJ1	< 1.8 U	< 1.4 U	< 1.7 U	< 1.6 U	< 1.2 U	< 1.7 U	< 1.6 U	< 1.7 U	< 2.0 U	< 1.9 U	< 2.0 U	< 1.7 U	< 1.8 U	< 2.0 U	< 1.5 U
1,2-Dichlorobenzene	95-50-1	< 1.1 U	< 1.5 UJ1	< 1.3 U	< 1.1 U	< 1.3 U	< 1.2 U	< 0.94 U	< 1.3 U	< 1.2 U	< 1.3 U	< 1.5 U	< 1.4 U	< 1.5 U	< 1.3 U	< 1.3 U	< 1.5 U	< 1.1 U
1,3-Dichlorobenzene	541-73-1	< 1.4 U	< 1.9 U	< 1.7 U	< 1.3 U	< 1.6 U	< 1.5 U	< 1.2 U	< 1.6 U	< 1.5 U	< 1.6 U	< 1.9 U	< 1.8 U	< 1.8 U	< 1.6 U	< 1.7 U	< 1.9 U	< 1.4 U
1,4-Dichlorobenzene	106-46-7	< 0.63 U	< 0.87 U	< 0.77 U	< 0.60 U	< 0.72 U	< 0.71 U	< 0.54 U	< 0.74 U	< 0.70 U	< 0.72 U	< 0.87 U	< 0.82 U	< 0.85 U	< 0.75 U	< 0.77 U	< 0.88 U	< 0.65 U
Dichlorodifluoromethane	75-71-8	< 0.80 U	< 1.1 U	< 0.97 U	< 0.76 U	< 0.92 U	< 0.90 U	< 0.68 UQ	< 0.94 UQ	< 0.89 UQJ1	< 0.92 U	< 1.1 U	< 1.0 UQ	< 1.1 U	< 0.95 U	< 0.97 U	< 1.1 U	< 0.83 U
1,1-Dichloroethane	75-34-3	< 0.93 U	< 1.3 U	< 1.1 U	< 0.89 UQ	< 1.1 UQ	< 1.1 UQ	< 0.80 U	< 1.1 U	< 1.0 UJ1	< 1.1 UQ	< 1.3 UQ	< 1.2 U	< 1.3 UQ	< 1.1 U	< 1.1 U	< 1.3 U	< 0.97 U
1,2-Dichloroethane	107-06-2	< 0.93 UM	< 1.3 UMJ1	< 1.1 UM	< 0.89 U	< 1.1 U	< 1.1 U	0.89 JQ	2.4 JQ	4.2 JQ	< 1.1 U	< 1.3 U	< 1.2 U	< 1.3 U	< 1.1 UM	< 1.1 UM	< 1.3 UM	< 0.97 UM
1,1-Dichloroethene	75-35-4	< 1.3 U	< 1.8 U	< 1.6 U	< 1.2 UQ	< 1.5 UQ	< 1.4 UQ	< 1.1 U	< 1.5 U	< 1.4 UJ1	< 1.5 UQ	< 1.8 UQ	< 1.7 U	< 1.7 UQ	< 1.5 U	< 1.6 U	< 1.8 U	< 1.3 U
1,2-Dichloroethene, Total	540-59-0	< 0.53 U	< 0.74 U	< 0.65 U	1.5 JQ	< 0.62 UQ	< 0.60 UQ	14	15	37 J1	< 0.62 UQ	5.2 JQ	8.3 J	27 Q	< 0.64 U	< 0.65 U	< 0.75 U	< 0.56 U
cis-1,2-Dichloroethene	156-59-2	< 1.2 U	< 1.6 U	< 1.4 U	1.5 JQ	< 1.4 UQ	< 1.3 UQ	12	15	37 J1	< 1.4 UQ	5.2 JQ	8.3	27 Q	< 1.4 U	< 1.5 U	< 1.7 U	< 1.2 U
trans-1,2-Dichloroethene	156-60-5	< 0.53 U	< 0.74 U	< 0.65 U	< 0.51 UQ	< 0.62 UQ	< 0.60 UQ	2.2 J	< 0.63 U	< 0.60 UJ1	< 0.62 UQ	< 0.74 UQ	< 0.70 U	< 0.73 UQ	< 0.64 U	< 0.65 U	< 0.75 U	< 0.56 U
1,2-Dichloropropane	78-87-5	< 0.73 U	< 1.0 U	< 0.89 U	< 0.69 U	< 0.84 U	< 0.82 U	< 0.62 U	< 0.86 U	< 0.82 U	< 0.84 U	< 1.0 U	< 0.95 U	< 0.99 U	< 0.87 U	< 0.89 U	< 1.0 U	< 0.76 U
1,3-Dichloropropane	142-28-9	< 1.5 U	< 2.1 UJ1	< 1.9 U	< 1.5 U	< 1.8 U	< 1.7 U	< 1.3 U	< 1.8 U	< 1.7 UJ1	< 1.8 U	< 2.1 U	< 2.0 U	< 2.1 U	< 1.8 U	< 1.9 U	< 2.1 U	< 1.6 U
2,2-Dichloropropane	594-20-7	< 0.93 U	< 1.3 U	< 1.1 U	< 0.89 U	< 1.1 U	< 1.1 U	< 0.80 U	< 1.1 U	< 1.0 UJ1	< 1.1 U	< 1.3 U	< 1.2 U	< 1.3 U	< 1.1 U	< 1.1 U	< 1.3 U	< 0.97 U
1,1-Dichloropropene	563-58-6	< 0.81 U	< 1.1 U	< 0.98 U	< 0.77 U	< 0.93 U	< 0.91 U	< 0.69 U	< 0.95 U	< 0.90 UJ1	< 0.93 U	< 1.1 U	< 1.1 U	< 1.1 U	< 0.96 U	< 0.99 U	< 1.1 U	< 0.84 U
cis-1,3-Dichloropropene	10061-01-5	< 0.70 U	< 0.97 U	< 0.86 U	< 0.67 U	< 0.81 U	< 0.80 U	< 0.60 U	< 0.83 U	< 0.79 U	< 0.81 U	< 0.98 U	< 0.92 U	< 0.96 U	< 0.84 U	< 0.86 U	< 0.99 U	< 0.73 U
trans-1,3-Dichloropropene	10061-02-6	< 0.74 U	< 1.0 UJ1	< 0.90 U	< 0.70 U	< 0.85 U	< 0.83 U	< 0.63 U	< 0.87 U	< 0.83 U	< 0.85 U	< 1.0 U	< 0.96 U	< 1.0 U	< 0.88 U	< 0.90 U	< 1.0 U	< 0.77 U
Ethylbenzene	100-41-4	< 1.1 UM	< 1.5 UM	< 1.3 UM	< 1.1 U	< 1.3 U	< 1.2 UM	< 0.94 UM	< 1.3 UM	< 1.2 U	< 1.3 U	< 1.5 UM	< 1.4 UM	< 1.5 U	< 1.3 UM	< 1.3 UM	< 1.5 UM	< 1.1 UM
Hexachlorobutadiene	87-68-3	< 2.6 U	< 3.6 U	< 3.2 U	< 2.5 UQ	< 3.0 UQ	< 3.0 UQ	< 2.3 U	< 3.1 U	< 2.9 U	< 3.0 UQ	< 3.7 UQ	< 3.4 UQ	< 3.6 UQ	< 3.1 U	< 3.2 U	< 3.7 U	< 2.7 U
2-Hexanone	591-78-6	< 2.8 UQ	< 3.9 UQJ1	< 3.4 UQ	< 2.7 UQ	< 3.2 UQ	< 3.2 UQ	< 2.4 U	< 3.3 U	< 3.1 UJ1	< 3.2 UQ	< 3.9 UQ	< 3.7 U	< 3.8 UQ	< 3.4 UQ	< 3.4 UQ	< 3.9 UQ	< 2.9 UQ
Isopropylbenzene (Cumene)	98-82-8	< 1.6 U	< 2.2 U	< 2.0 U	< 1.5 U	< 1.9 U	< 1.8 U	< 1.4 UQ	< 1.9 UQ	< 1.8 UMQJ1	< 1.9 U	< 2.2 U	< 2.1 U	< 2.2 U	< 1.9 U	< 2.0 U	< 2.3 U	< 1.7 U
4-Isopropyltoluene	99-87-6	< 1.9 U	< 2.6 U	< 2.3 U	< 1.8 U	< 2.2 U	< 2.1 U	< 1.6 U	< 2.2 U	< 2.1 U	< 2.2 U	< 2.6 U	< 2.4 UQ	< 2.5 U	< 2.2 U	< 2.3 U	< 2.6 U	< 1.9 U
Methylene chloride	75-09-2	< 0.83 U	< 1.1 UJ1	< 1.0 U	< 0.79 UQ	< 0.96 UQ	< 0.94 UQ	3.8 B	< 0.98 U	< 0.93 UJ1	< 0.96 UQ	< 1.2 UQ	< 1.1 UQ	< 1.1 UQ	< 1.0 U	< 1.0 U	< 1.2 U	< 0.86 U
4-Methyl-2-pentanone (MIBK)	108-10-1	< 3.6 U	< 4.9 UJ1	< 4.3 U	< 3.4 U	< 4.1 U	< 4.0 U	< 3.1 U	< 4.2 U	< 4.0 UJ1	< 4.1 U	< 5.0 U	< 4.7 U	< 4.8 U	< 4.3 U	< 4.4 U	< 5.0 U	< 3.7 U
tert-Butyl methyl ether (MTBE)	1634-04-4	< 0.85 U	< 1.2 UJ1	< 1.0 U	0.84 JQ	1.1 JQ	1.0 JQ	< 0.73 UQ	< 1.0 UQ	< 0.95 UQJ1	< 0.98 UQ	< 1.2 UQ	< 1.1 U	< 1.2 UQ	< 1.0 U	< 1.0 U	< 1.2 U	< 0.88 U
Naphthalene	91-20-3	< 1.0 U	< 1.4 UJ1	< 1.2 U	< 0.97 U	< 1.2 U	12	3.2 J	1.3 J	< 1.1 U	< 1.2 U	120	72	8.7	< 1.2 U	26	16	2.3 J
n-Propylbenzene	103-65-1	< 2.3 U	< 3.2 U	< 2.8 U	< 2.2 U	< 2.6 U	< 2.6 U	< 2.0 U	< 2.7 U	< 2.6 UJ1	< 2.6 U	< 3.2 U	< 3.0 UQ	< 3.1 U	< 2.7 U	< 2.8 U	< 3.2 U	< 2.4 U
Styrene	100-42-5	< 0.79 U	< 1.1 U	< 0.96 U	< 0.75 U	< 0.91 U	< 0.89 U	< 0.68 U	< 0.93 U	< 0.88 UJ1	< 0.91 U	< 1.1 U	< 1.0 U	< 1.1 U	< 0.94 U	< 0.96 U	< 1.1 U	< 0.82 U
1,1,1,2-Tetrachloroethane	630-20-6	< 2.0 U	< 2.8 U	< 2.5 U	< 1.9 U	< 2.4 U	< 2.3 U	< 1.7 UQ	< 2.4 UQ	< 2.3 UQJ1	< 2.4 U	< 2.8 U		< 2.8 U	< 2.4 U	< 2.5 U	< 2.9 U	< 2.1 U
1,1,2,2-Tetrachloroethane	79-34-5	< 1.4 U	< 1.9 UJ1	< 1.7 U	< 1.3 U	< 1.6 U	< 1.5 U	< 1.2 UQ	< 1.6 UQ	< 1.5 UQJ1	< 1.6 U	< 1.9 U	< 1.8 U	< 1.8 U	< 1.6 U	< 1.7 U	< 1.9 U	< 1.4 U
Tetrachloroethene (PCE)	127-18-4	340 BQ	< 2.2 UJ1	< 2.0 U	39 Q	25 Q	26 Q	120 J	920	1600	2.5 JQ	2700 BQ	1200	1100 BQ	< 1.9 U	4.7 J	4.5 J	5.4
Toluene	108-88-3	< 0.71 U	< 0.98 U	< 0.87 U	< 0.68 U	< 0.82 U	< 0.81 U	0.69 J	< 0.84 U	< 0.80 U	< 0.82 U	< 0.99 U	< 0.93 UM	< 0.97 U	< 0.85 U	< 0.87 U	< 1.0 U	< 0.74 U

Appendix A.1
Summary of VOC Results
Building 65 Soil Investigation

	Boring ID	BLDG65-SB-06	BLDG65-SB-06	BLDG65-SB-06	BLDG65-SB-07	BLDG65-SB-07	BLDG65-SB-07	BLDG65-SB-08	BLDG65-SB-08	BLDG65-SB-08	BLDG65-SB-09	BLDG65-SB-09	BLDG65-SB-09	BLDG65-SB-09	BLDG65-SB-10	BLDG65-SB-10	BLDG65-SB-10	BLDG65-SB-10
	Sample Depth (ft bgs)	2-3	13-14	15-16	4-5	14-15	18-19	4-5	14-15	19-20	5-6	16-17	18-19	18-19	5-6	14-15	14-15	18-19
	Sample Type	N	N	N	N	N	N	N	N	N	N	N	FD	N	N	N	FD	N
	Sample Date	06/10/2020	06/10/2020	06/10/2020	06/11/2020	06/11/2020	06/11/2020	06/12/2020	06/12/2020	06/12/2020	06/11/2020	06/11/2020	06/11/2020	06/11/2020	06/10/2020	06/10/2020	06/10/2020	06/10/2020
Parameter	CAS #																	
1,2,3-Trichlorobenzene	87-61-6	< 1.4 U	< 1.9 UJ1	< 1.7 U	< 1.3 U	< 1.6 U	< 1.5 U	< 1.2 U	< 1.6 U	< 1.5 U	< 1.6 U	< 1.9 UM	< 1.8 UM	< 1.8 U	< 1.6 U	< 1.7 U	< 1.9 U	< 1.4 U
1,2,4-Trichlorobenzene	120-82-1	< 0.75 U	< 1.0 UJ1	< 0.92 U	< 0.72 U	< 0.87 U	< 0.85 U	< 0.65 U	< 0.89 U	< 0.84 U	< 0.87 U	< 1.1 U	< 0.99 U	< 1.0 U	< 0.90 U	< 0.92 U	< 1.1 U	< 0.78 U
1,1,1-Trichloroethane	71-55-6	< 0.50 U	< 0.69 U	< 0.61 U	< 0.48 U	< 0.58 U	< 0.57 U	< 0.43 U	< 0.59 U	< 0.56 UJ1	< 0.58 U	< 0.70 U	< 0.65 U	< 0.68 U	< 0.60 U	< 0.61 U	< 0.70 U	< 0.52 U
1,1,2-Trichloroethane	79-00-5	< 1.1 UM	< 1.5 UJ1	< 1.3 U	< 1.1 U	< 1.3 U	< 1.2 U	< 0.94 UMQ	< 1.3 UMQ	< 1.2 UMQ	< 1.3 UM	< 1.5 UM	< 1.4 UM	< 1.5 UM	< 1.3 U	< 1.3 U	< 1.5 U	< 1.1 U
Trichloroethene (TCE)	79-01-6	< 1.1 U	< 1.5 U	< 1.3 U	3.3 J	< 1.3 U	< 1.2 U	110	53	110	2.7 J	16	14	48	< 1.3 U	< 1.3 U	< 1.5 U	< 1.1 U
Trichlorofluoromethane	75-69-4	< 1.0 U	< 1.4 U	< 1.2 U	< 0.97 UQ	< 1.2 UQ	< 1.2 UQ	< 0.87 U	< 1.2 U	< 1.1 UJ1	< 1.2 UQ	< 1.4 UQ	< 1.3 U	< 1.4 UQ	< 1.2 U	< 1.2 U	< 1.4 U	< 1.1 U
1,2,3-Trichloropropane	96-18-4	< 2.0 U	< 2.8 UJ1	< 2.5 U	< 1.9 U	< 2.4 U	< 2.3 U	< 1.7 UQ	< 2.4 UQ	< 2.3 UMQJ1	< 2.4 U	< 2.8 U	< 2.7 U	< 2.8 U	< 2.4 U	< 2.5 U	< 2.9 U	< 2.1 U
1,2,4-Trimethylbenzene	95-63-6	< 1.2 U	< 1.6 U	< 1.4 U	< 1.1 U	< 1.4 U	< 1.3 U	< 1.0 U	< 1.4 U	< 1.3 UJ1	< 1.4 U	2.0 J	< 1.6 U	< 1.6 U	< 1.4 U	< 1.5 U	< 1.7 U	< 1.2 U
1,3,5-Trimethylbenzene	108-67-8	< 1.4 U	< 2.0 U	< 1.8 U	< 1.4 U	< 1.7 U	< 1.6 U	< 1.2 U	< 1.7 U	< 1.6 UJ1	< 1.7 U	< 2.0 U	< 1.9 UQ	< 2.0 U	< 1.7 U	< 1.8 U	< 2.0 U	< 1.5 U
Vinyl acetate	108-05-4	< 2.1 U	< 2.9 UJ1	< 2.6 U	< 2.0 U	< 2.4 U	< 2.4 U	< 1.8 UQ	< 2.5 UQ	< 2.4 UQJ1	< 2.4 U	< 2.9 U	< 2.8 U	< 2.9 U	< 2.5 U	< 2.6 U	< 3.0 U	< 2.2 U
Vinyl chloride	75-01-4	< 1.3 U	< 1.8 U	< 1.6 U	< 1.2 U	< 1.5 U	< 1.4 U	< 1.1 U	< 1.5 U	< 1.4 UJ1	< 1.5 U	< 1.8 U	< 1.7 UQ	< 1.7 U	< 1.5 U	< 1.6 U	< 1.8 U	< 1.3 U
m+p-Xylenes	179601-23-1	< 2.2 U	< 3.0 U	< 2.7 U	< 2.1 U	< 2.5 U	< 2.5 U	< 1.9 U	< 2.6 U	< 2.5 U	< 2.5 U	< 3.1 U	< 2.9 UM	< 3.0 U	< 2.6 U	< 2.7 U	< 3.1 U	< 2.3 U
o-Xylene	95-47-6	< 0.93 U	< 1.3 U	< 1.1 U	< 0.89 U	< 1.1 U	< 1.1 U	< 0.80 U	< 1.1 U	< 1.0 UJ1	< 1.1 U	< 1.3 U	< 1.2 U	< 1.3 U	< 1.1 U	< 1.1 U	< 1.3 U	< 0.97 U
Xylene (Total)	1330-20-7	< 0.93 U	< 1.3 U	< 1.1 U	< 0.89 U	< 1.1 U	< 1.1 U	< 0.80 U	< 1.1 U	< 1.0 U	< 1.1 U	< 1.3 U	< 1.2 U	< 1.3 U	< 1.1 U	< 1.1 U	< 1.3 U	< 0.97 U

Notes:
CAS# = Chemical Abstract Service number
FD = field duplicate
ft bgs = feet below ground surface
N = normal or primary sample
ug/kg = micrograms per kilogram
VOCs = volatile organic compounds
Bold font = detected result

Laboratory Qualifiers:
B = Blank Contamination
D = The reported value is from a dilution
H = Sample was prepped or analyzed beyond the specified holing time
J = Estimated. The analyte was positively identified; the quantitation is an estimation
J1 = Estimated. The quantitation is an estimation due to discrepancies in meeting certain analyte-sfecific quality control criteria.
M = Manual integrated compound
Q = One or more quality control criteria failed
U = Undetected at limit of detection

Appendix A.1
Summary of VOC Results
Building 65 Soil Investigation

	Boring ID	BLDG65-SB-11	BLDG65-SB-11	BLDG65-SB-11	BLDG65-SB-12	BLDG65-SB-12	BLDG65-SB-12	BLDG65-SB-13	BLDG65-SB-13	BLDG65-SB-13	BLDG65-SB-13	BLDG65-SB-14	BLDG65-SB-14	BLDG65-SB-14	BLDG65-SB-15	BLDG65-SB-15	BLDG65-SB-15
	Sample Depth (ft bgs)	8-9	11-12	18-19	6-7	13-14	18-19	9-10	13-14	13-14	18-19	6-7	11-12	18-19	6-7	9-10	14-15
	Sample Type	N	N	N	N	N	N	N	N	FD	N	N	N	N	N	N	N
	Sample Date	06/11/2020	06/11/2020	06/11/2020	06/11/2020	06/11/2020	06/11/2020	06/12/2020	06/12/2020	06/12/2020	06/12/2020	06/11/2020	06/11/2020	06/11/2020	06/11/2020	06/11/2020	06/11/2020
Parameter	CAS #																
VOCs - 8260B (ug/kg)																	
Acetone	67-64-1	41 JQ	25 J	65	< 54000 U	< 57000 U	26 JQ	19 JQ	< 110000 U	36 JQ	27 JQ	< 79000 U	< 11 U	< 140000 U	36 J	54	74 Q
Benzene	71-43-2	< 0.78 U	< 0.86 U	< 0.77 U	< 3600 U	< 3800 U	< 0.74 U	< 0.69 U	< 7500 U	< 0.81 U	< 0.63 U	< 5200 U	< 0.70 U	< 9400 U	< 0.62 U	< 0.77 U	< 0.40 UQ
Bromobenzene	108-86-1	< 1.8 U	< 2.0 U	< 1.8 U	< 8400 U	< 8800 U	< 1.7 U	< 1.6 U	< 18000 U	< 1.9 U	< 1.5 U	< 12000 U	< 1.6 U	< 22000 U	< 1.4 U	< 1.8 U	< 0.93 U
Bromochloromethane	74-97-5	< 3.5 U	< 3.9 U	< 3.5 U	< 16000 U	< 17000 U	< 3.3 U	< 3.1 UQ	< 34000 U	< 3.7 UQ	< 2.9 UQ	< 24000 U	< 3.2 U	< 42000 U	< 2.8 U	< 3.5 U	< 1.8 UQ
Bromodichloromethane	75-27-4	< 1.0 U	< 1.1 U	< 1.0 U	< 4800 U	< 5000 U	< 0.98 U	< 0.91 U	< 10000 U	< 1.1 U	< 0.84 U	< 6900 U	< 0.93 U	< 12000 U	< 0.82 U	< 1.0 U	< 0.53 UQ
Bromoform	75-25-2	< 1.6 U	< 1.8 U	< 1.6 U	< 7400 U	< 7800 U	< 1.5 U	< 1.4 UQ	< 15000 U	< 1.7 UQ	< 1.3 UQ	< 11000 U	< 1.4 U	< 19000 U	< 1.3 U	< 1.6 U	< 0.82 U
Bromomethane (Methyl bromide)	74-83-9	< 1.6 UQ	< 1.8 U	< 1.6 U	< 7400 U	< 7800 U	< 1.5 UQ	< 1.4 U	< 15000 U	< 1.7 U	< 1.3 U	< 11000 U	< 1.4 U	< 19000 U	< 1.3 U	< 1.6 U	< 0.82 UQ
2-Butanone (MEK)	78-93-3	< 2.6 U	< 2.8 U	< 2.5 UM	< 12000 U	< 12000 U	< 2.4 U	< 2.3 UQ	< 25000 U	< 2.7 UQ	< 2.1 UQ	< 17000 U	< 2.3 U	< 31000 U	< 2.0 U	< 2.5 U	< 1.3 UQ
n-Butylbenzene	104-51-8	< 2.6 UQ	< 2.8 UQ	< 2.5 UQ	< 12000 UQ	< 12000 UQ	< 2.4 UQ	< 2.3 U	< 25000 U	3.2 J	< 2.1 UM	< 17000 UQ	< 2.3 UQ	< 31000 U	< 2.0 UQ	< 2.5 UQ	< 1.3 UQ
sec-Butylbenzene	135-98-8	< 2.2 UQ	< 2.5 UQ	< 2.2 UQ	< 10000 UQ	< 11000 UQ	< 2.1 UQ	< 2.0 U	< 22000 U	< 2.3 U	< 1.8 U	< 15000 UQ	< 2.0 UQ	< 27000 U	< 1.8 UQ	< 2.2 UQ	< 1.2 UQ
tert-Butylbenzene	98-06-6	< 1.9 U	< 2.1 U	< 1.9 U	< 8900 U	< 9300 U	< 1.8 U	< 1.7 UQ	< 19000 U	< 2.0 UQ	< 1.6 UQ	< 13000 U	< 1.7 U	< 23000 U	< 1.5 U	< 1.9 U	< 0.99 U
Carbon disulfide	75-15-0	< 1.2 UQ	< 1.3 U	< 1.2 U	< 5400 U	< 5700 U	< 1.1 UQ	< 1.0 UMQ	< 11000 U	1.2 JQ	< 0.96 UQ	< 7900 U	< 1.1 U	< 14000 U	2.4 J	< 1.2 U	< 0.60 UQ
Carbon tetrachloride	56-23-5	< 0.89 UQ	< 0.97 U	< 0.88 U	< 4100 U	< 4300 U	< 0.84 UQ	< 0.78 UQ	< 8600 U	< 0.92 UQ	< 0.72 UQ	< 5900 U	< 0.79 U	< 11000 U	< 0.70 U	< 0.88 U	< 0.46 UQ
Chlorobenzene	108-90-7	< 1.0 U	< 1.1 U	< 1.0 U	< 4700 U	< 5000 U	< 0.97 U	< 0.90 U	< 9900 U	< 1.1 U	< 0.83 U	< 6900 U	< 0.92 U	< 12000 U	< 0.81 U	< 1.0 U	< 0.53 U
Chloroethane	75-00-3	< 2.9 UQ	< 3.2 U	< 2.9 U	< 13000 U	< 14000 U	< 2.7 UQ	< 2.5 U	< 28000 U	< 3.0 U	< 2.3 U	< 19000 U	< 2.6 U	< 35000 U	< 2.3 U	< 2.8 U	< 1.5 UQ
Chloroform	67-66-3	< 1.2 U	< 1.3 U	< 1.2 U	< 5400 UM	< 5700 U	< 1.1 U	1.1 J	< 11000 U	2.6 J	< 0.96 U	< 7900 UM	< 1.1 UM	< 14000 U	< 0.93 U	< 1.2 U	< 0.60 UQ
Chloromethane (Methyl chloride)	74-87-3	< 1.1 UJ1Q	< 1.2 UQ	< 1.1 UQ	< 4900 UQ	< 5200 UQ	< 1.0 UQ	< 0.94 U	< 10000 U	< 1.1 U	< 0.87 U	< 7100 UQ	< 0.95 UQ	< 13000 U	< 0.85 UQ	< 1.1 UMQ	< 0.55 UQ
2-Chlorotoluene	95-49-8	< 2.1 U	< 2.3 U	< 2.1 U	< 9800 U	< 10000 U	< 2.0 U	< 1.9 U	< 21000 U	< 2.2 UM	< 1.7 U	< 14000 U	< 1.9 U	< 26000 U	< 1.7 U	< 2.1 U	< 1.1 U
4-Chlorotoluene	106-43-4	< 1.8 U	< 2.0 U	< 1.8 U	< 8400 U	< 8800 U	< 1.7 U	< 1.6 U	< 18000 U	< 1.9 U	< 1.5 U	< 12000 U	< 1.6 U	< 22000 U	< 1.4 U	< 1.8 U	< 0.93 U
Dibromochloromethane	124-48-1	< 1.8 U	< 2.0 U	< 1.8 U	< 8400 U	< 8800 U	< 1.7 U	< 1.6 U	< 18000 U	< 1.9 UM	< 1.5 U	< 12000 U	< 1.6 U	< 22000 U	< 1.4 U	< 1.8 U	< 0.93 UQ
1,2-Dibromo-3-chloropropane	96-12-8	< 4.7 UJ1	< 5.2 U	< 4.6 UM	< 22000 U	< 23000 U	< 4.5 U	< 4.1 U	< 45000 U	< 4.9 UM	< 3.8 U	< 31000 U	< 4.2 U	< 56000 U	< 3.7 U	< 4.6 U	< 2.4 U
Dibromomethane (Methylene bromide)	74-95-3	< 1.8 U	< 2.0 U	< 1.8 U	< 8400 U	< 8800 U	< 1.7 U	< 1.6 U	< 18000 U	< 1.9 U	< 1.5 U	< 12000 U	< 1.6 U	< 22000 U	< 1.4 U	< 1.8 U	< 0.93 UQ
1,2-Dichlorobenzene	95-50-1	< 1.4 U	< 1.5 U	< 1.4 U	< 6400 U	< 6700 U	< 1.3 U	< 1.2 U	< 13000 U	< 1.4 U	< 1.1 U	< 9300 U	< 1.2 U	< 17000 U	< 1.1 U	< 1.4 U	< 0.71 U
1,3-Dichlorobenzene	541-73-1	< 1.7 U	< 1.9 U	< 1.7 U	< 7900 U	< 8300 U	< 1.6 U	< 1.5 U	< 17000 U	< 1.8 U	< 1.4 U	< 11000 U	< 1.5 U	< 21000 U	< 1.4 U	< 1.7 U	< 0.88 U
1,4-Dichlorobenzene	106-46-7	< 0.79 U	< 0.87 U	< 0.78 U	< 3600 U	< 3800 U	< 0.75 U	< 0.70 U	< 7600 U	< 0.82 U	< 0.64 U	< 5300 U	< 0.71 U	< 9500 U	< 0.63 U	< 0.78 U	< 0.41 U
Dichlorodifluoromethane	75-71-8	< 1.0 UJ1	< 1.1 UQ	< 0.99 UQ	< 4600 UQ	< 4900 UQ	< 0.95 U	< 0.88 UQ	< 9700 U	< 1.0 UQ	< 0.82 UQ	< 6700 UQ	< 0.90 UQ	< 12000 UM	< 0.80 UQ	< 0.99 UQ	< 0.52 UQ
1,1-Dichloroethane	75-34-3	< 1.2 UQ	< 1.3 U	< 1.2 U	< 5400 U	< 5700 U	< 1.1 UQ	< 1.0 U	< 11000 U	< 1.2 U	< 0.96 U	< 7900 U	< 1.1 U	< 14000 U	< 0.93 U	< 1.2 U	< 0.60 UQ
1,2-Dichloroethane	107-06-2	< 1.2 U	< 1.3 U	< 1.2 U	< 5400 U	< 5700 U	94	120 Q	< 11000 UM	< 6300 UM	160 Q	< 7900 U	< 1.1 U	< 14000 UM	< 0.93 U	< 1.2 U	< 0.60 UQ
1,1-Dichloroethene	75-35-4	< 1.6 UQ	< 1.8 U	< 1.6 U	< 7400 U	< 7800 U	< 1.5 UQ	4.7	< 15000 U	14	< 1.3 UM	< 11000 U	< 1.4 U	< 19000 U	< 1.3 U	< 1.6 U	< 0.82 UQ
1,2-Dichloroethene, Total	540-59-0	< 0.67 UQ	< 0.74 U	< 0.67 U	< 3100 U	< 3300 U	81 J	700 J1	< 6500 U	< 3600 U	140	< 4500 U	< 0.60 U	< 8100 U	2.0 J	1.3 J	9.8
cis-1,2-Dichloroethene	156-59-2	< 1.5 UQ	< 1.6 U	< 1.5 U	< 6900 U	< 7300 U	81 J	700 J1	< 14000 U	< 8000 U	140	< 10000 U	< 1.3 U	< 18000 U	2.0 J	< 1.5 UM	9.8 Q
trans-1,2-Dichloroethene	156-60-5	< 0.67 UQ	< 0.74 U	< 0.67 U	< 3100 U	< 3300 U	1.3 JQ	8.1	< 6500 U	11	1.3 JM	< 4500 U	< 0.60 U	< 8100 U	< 0.53 U	< 0.66 U	< 0.35 UQ
1,2-Dichloropropane	78-87-5	< 0.92 U	< 1.0 U	< 0.91 U	< 4200 U	< 4500 U	< 0.87 U	< 0.81 U	< 8900 U	< 0.96 U	< 0.75 U	< 6100 U	< 0.82 U	< 11000 U	< 0.73 U	< 0.91 U	< 0.47 UQ
1,3-Dichloropropane	142-28-9	< 1.9 UJ1	< 2.1 U	< 1.9 U	< 8900 U	< 9300 U	< 1.8 U	< 1.7 U	< 19000 U	< 2.0 U	< 1.6 U	< 13000 U	< 1.7 U	< 23000 U	< 1.5 U	< 1.9 U	< 0.99 UQ
2,2-Dichloropropane	594-20-7	< 1.2 UJ1	< 1.3 U	< 1.2 U	< 5400 U	< 5700 U	< 1.1 U	< 1.0 U	< 11000 U	< 1.2 U	< 0.96 U	< 7900 U	< 1.1 U	< 14000 U	< 0.93 U	< 1.2 U	< 0.60 UQ
1,1-Dichloropropene	563-58-6	< 1.0 U	< 1.1 U	< 1.0 U	< 4700 U	< 4900 U	< 0.96 U	< 0.89 U	< 9800 U	< 1.1 U	< 0.83 U	< 6800 U	< 0.91 U	< 12000 U	< 0.80 U	< 1.0 U	< 0.52 UQ
cis-1,3-Dichloropropene	10061-01-5	< 0.89 U	< 0.97 U	< 0.88 U	< 4100 U	< 4300 U	< 0.84 U	< 0.78 U	< 8600 U	< 0.92 U	< 0.72 U	< 5900 U	< 0.79 U	< 11000 U	< 0.70 U	< 0.88 U	< 0.46 UQ
trans-1,3-Dichloropropene	10061-02-6	< 0.93 U	< 1.0 U	< 0.92 U	< 4300 U	< 4500 U	< 0.88 U	< 0.82 U	< 9000 U	< 0.97 U	< 0.76 U	< 6200 U	< 0.83 U	< 11000 U	< 0.74 U	< 0.92 U	< 0.48 UQ
Ethylbenzene	100-41-4	< 1.4 U	< 1.5 U	< 1.4 U	< 6400 U	< 6700 U	< 1.3 U	< 1.2 U	< 13000 UM	4.7 J	< 1.1 U	< 9300 UM	< 1.2 U	< 17000 UM	< 1.1 U	< 1.4 U	< 0.71 U
Hexachlorobutadiene	87-68-3	< 3.3 UQ	< 3.6 UQ	< 3.3 UQ	< 15000 UQ	< 16000 UQ	< 3.1 UQ	< 2.9 U	< 32000 U	< 3.4 U	< 2.7 U	< 22000 UQ	< 3.0 UQ	< 40000 U	< 2.6 UQ	< 3.3 UQ	< 1.7 UQ
2-Hexanone	591-78-6	< 3.5 UJ1Q	< 3.9 U	< 3.5 U	< 16000 U	< 17000 U	< 3.3 UQ	< 3.1 U	< 34000 U	< 3.7 U	< 2.9 U	< 24000 U	< 3.2 U	< 42000 U	< 2.8 U	< 3.5 U	< 1.8 UQ
Isopropylbenzene (Cumene)	98-82-8	< 2.0 U	< 2.2 U	< 2.0 U	< 9300 U	< 9900 U	< 1.9 U	< 1.8 UQ	< 20000 U	< 2.1 UQ	< 1.7 UQ	< 14000 U	< 1.8 U	< 24000 U	< 1.6 U	< 2.0 U	< 1.0 U
4-Isopropyltoluene	99-87-6	< 2.3 U	< 2.6 UQ	< 2.3 UQ	< 11000 UQ	< 11000 UQ	< 2.2 U	< 2.1 U	< 23000 U	2.4 J	< 1.9 UM	< 16000 UQ	< 2.1 UQ	< 28000 U	< 1.9 UMQ	< 2.3 UQ	< 1.2 UQ
Methylene chloride	75-09-2	< 1.0 UQ	< 1.1 UQ	< 1.0 UQ	51000 BQ	81000 BQ	25 Q	160000 HBQ	< 10000 U	< 5600 U	< 6000 U	110000 BQ	12 BQ	< 13000 U	< 0.83 UQ	< 1.0 UQ	0.82 JQB
4-Methyl-2-pentanone (MIBK)	108-10-1	< 4.5 UJ1	< 4.9 U	< 4.4 U	< 21000 U	< 22000 U	< 4.3 U	< 3.9 U	< 43000 U	< 4.7 U	< 3.7 U	< 30000 U	< 4.0 U	< 54000 U	< 3.6 U	< 4.4 U	< 2.3 UQ
tert-Butyl methyl ether (MTBE)	1634-04-4	< 1.1 UJ1Q	< 1.2 UM	1.2 JM	< 4900 UM	< 5200 UM	1.0 JQ	< 0.94 UQ	< 10000 U	< 1.1 UQ	< 0.87 UMQ	< 7100 UM	1.2 JM	< 13000 U	< 0.85 UM	< 1.1 U	< 0.55 UQ
Naphthalene	91-20-3	100 J1	3.0 J	16	< 5900 U	< 6200 U	1.5 J	4.7	< 12000 U	22	9.6	< 8600 U	< 1.1 U	< 15000 U	< 1.0 U	< 1.3 U	< 0.66 U
n-Propylbenzene	103-65-1	< 2.9 U	< 3.2 UQ	< 2.9 UQ	< 13000 UQ	< 14000 UQ	< 2.7 U	< 2.5 U	< 28000 U	5.0 J	< 2.3 U	< 19000 UQ	< 2.6 UQ	< 35000 U	< 2.3 UQ	< 2.8 UQ	< 1.5 UQ
Styrene	100-42-5	< 0.99 U	< 1.1 U	< 0.98 U	< 4600 U	< 4800 U	< 0.94 U	< 0.87 U	< 9600 U	< 1.0 UM	< 0.81 U	< 6600 U	< 0.89 U	< 12000 U	< 0.79 U	< 0.98 U	< 0.51 U
1,1,1,2-Tetrachloroethane	630-20-6	< 2.6 U	< 2.8 U	< 2.5 U	< 12000 U	< 12000 U	< 2.4 U	< 2.3 UQ	< 25000 U	13 Q	< 2.1 UQ	< 17000 U	< 2.3 U	< 31000 U	< 2.0 U	< 2.5 U	< 1.3 U
1,1,2,2-Tetrachloroethane	79-34-5	< 1.7 UJ1	< 1.9 U	< 1.7 U	< 7900 U	< 8300 U	< 1.6 U	< 1.5 UQ	< 17000 U	< 1.8 UMQ	< 1.4 UQ	< 11000 U	< 1.5 U	< 21000 U	< 1.4 UM	< 1.7 U	< 0.88 U
Tetrachloroethene (PCE)	127-18-4	31 Q	3.9 JBQ	5.3 BQ	620000 BQ	6500000 J1BQ	930 BQ	550000 H	2300000 DJ1	7300000 J1	16000 J	150000 BQ	29 BQ	1300000 D	9.1 BQ	4.1 JBQ	39 QB
Toluene	108-88-3	< 0.90 U	< 0.98 UM	< 0.89 UM	< 4100 UM	6700 JM	< 0.85 U	1.3 J	8700 JD	7.0	< 0.73 U	6800 JM	0.93 JM	< 11000 U	< 0.71 U	< 0.89 U	< 0.46 UQ

Appendix A.1
Summary of VOC Results
Building 65 Soil Investigation

Boring ID		BLDG65-SB-11	BLDG65-SB-11	BLDG65-SB-11	BLDG65-SB-12	BLDG65-SB-12	BLDG65-SB-12	BLDG65-SB-13	BLDG65-SB-13	BLDG65-SB-13	BLDG65-SB-13	BLDG65-SB-14	BLDG65-SB-14	BLDG65-SB-14	BLDG65-SB-15	BLDG65-SB-15	BLDG65-SB-15
Sample Depth (ft bgs)		8-9	11-12	18-19	6-7	13-14	18-19	9-10	13-14	13-14	18-19	6-7	11-12	18-19	6-7	9-10	14-15
Sample Type		N	N	N	N	N	N	N	N	FD	N	N	N	N	N	N	N
Sample Date		06/11/2020	06/11/2020	06/11/2020	06/11/2020	06/11/2020	06/11/2020	06/12/2020	06/12/2020	06/12/2020	06/12/2020	06/11/2020	06/11/2020	06/11/2020	06/11/2020	06/11/2020	06/11/2020
Parameter	CAS #																
1,2,3-Trichlorobenzene	87-61-6	< 1.7 U	< 1.9 U	< 1.7 U	< 7900 U	< 8300 U	< 1.6 U	< 1.5 U	< 17000 U	< 1.8 UM	< 1.4 U	< 11000 U	< 1.5 U	< 21000 U	< 1.4 U	< 1.7 U	< 0.88 U
1,2,4-Trichlorobenzene	120-82-1	< 0.95 U	< 1.0 U	< 0.94 U	< 4400 U	< 4600 U	< 0.90 U	< 0.84 U	< 9200 U	< 0.99 UM	< 0.77 UM	< 6400 U	< 0.85 U	< 11000 U	< 0.75 U	< 0.94 U	< 0.49 U
1,1,1-Trichloroethane	71-55-6	< 0.63 U	< 0.69 U	< 0.62 U	< 2900 U	< 3100 U	< 0.60 U	< 0.55 U	< 6100 U	< 0.66 U	< 0.51 U	< 4200 U	< 0.56 U	< 7600 U	< 0.50 U	< 0.62 U	< 0.32 UQ
1,1,2-Trichloroethane	79-00-5	< 1.4 UJ1	< 1.5 U	< 1.4 U	< 6400 UM	< 6700 UM	< 1.3 UM	< 1.2 UMQ	< 13000 UM	< 1.4 UMQ	< 1.1 UMQ	< 9300 U	< 1.2 U	< 17000 UM	< 1.1 U	< 1.4 U	< 0.71 UQ
Trichloroethene (TCE)	79-01-6	< 1.4 U	< 1.5 U	< 1.4 U	< 6400 U	43000	120	1500 J1	21000 JD	74000	< 8000 U	< 9300 U	< 1.2 U	< 17000 U	< 1.1 U	< 1.4 U	5.6 MQ
Trichlorofluoromethane	75-69-4	< 1.3 UQ	< 1.4 U	< 1.3 U	< 5900 U	< 6200 U	< 1.2 UQ	< 1.1 U	< 12000 U	< 1.3 U	< 1.0 U	< 8600 U	< 1.1 U	< 15000 U	< 1.0 U	< 1.3 U	< 0.66 UQ
1,2,3-Trichloropropane	96-18-4	< 2.6 UJ1	< 2.8 U	< 2.5 U	< 12000 U	< 12000 U	< 2.4 U	< 2.3 UMQ	< 25000 U	< 2.7 UMQ	< 2.1 UQ	< 17000 U	< 2.3 U	< 31000 U	< 2.0 U	< 2.5 U	< 1.3 U
1,2,4-Trimethylbenzene	95-63-6	< 1.5 U	< 1.6 U	< 1.5 U	< 6900 U	< 7300 U	< 1.4 U	11	< 14000 U	38	1.6 J	< 10000 U	< 1.3 U	< 18000 U	< 1.2 U	< 1.5 U	< 0.77 U
1,3,5-Trimethylbenzene	108-67-8	< 1.8 U	< 2.0 UQ	< 1.8 UQ	< 8400 UQ	< 8800 UQ	< 1.7 U	6.3	< 18000 U	17	< 1.5 U	< 12000 UQ	< 1.6 UQ	< 22000 U	1.6 JQ	< 1.8 UQ	< 0.93 UQ
Vinyl acetate	108-05-4	< 2.7 U	< 2.9 U	< 2.6 U	< 12000 U	< 13000 U	< 2.5 U	< 2.3 UQ	< 26000 U	< 2.8 UMQ	< 2.2 UQ	< 18000 U	< 2.4 U	< 32000 U	< 2.1 U	< 2.6 U	< 1.4 UQ
Vinyl chloride	75-01-4	< 1.6 UJ1	< 1.8 UQ	< 1.6 UQ	< 7400 UQ	< 7800 UQ	5.5	75	< 15000 U	50	7.1	< 11000 UQ	< 1.4 UQ	< 19000 U	< 1.3 UMQ	< 1.6 UQ	< 0.82 UQ
m+p-Xylenes	179601-23-1	2.8 J	< 3.0 U	< 2.7 U	< 13000 U	< 13000 UM	< 2.6 U	< 2.4 U	< 27000 U	25	< 2.3 U	< 19000 U	< 2.5 U	< 33000 U	< 2.2 U	< 2.7 U	< 1.4 U
o-Xylene	95-47-6	1.6 J	< 1.3 U	< 1.2 U	< 5400 U	< 5700 U	< 1.1 U	1.4 J	< 11000 U	11	< 0.96 U	< 7900 U	< 1.1 U	< 14000 U	< 0.93 U	< 1.2 U	< 0.60 U
Xylene (Total)	1330-20-7	4.4 J	< 1.3 U	< 1.2 U	< 5400 U	< 5700 U	< 1.1 U	1.4 J	< 11000 U	36	< 0.96 U	< 7900 U	< 1.1 U	< 14000 U	< 0.93 U	< 1.2 U	< 0.60 U

Notes:
CAS# = Chemical Abstract Service number
FD = field duplicate
ft bgs = feet below ground surface
N = normal or primary sample
ug/kg = micrograms per kilogram
VOCs = volatile organic compounds
Bold font = detected result

Laboratory Qualifiers:
B = Blank Contamination
D = The reported value is from a dilution
H = Sample was prepped or analyzed beyond the specified holing time
J = Estimated. The analyte was positively identified; the quantitation is an estimation
J1 = Estimated. The quantitation is an estimation due to discrepancies in meeting certain analyte-sfecific quality control criteria.
M = Manual integrated compound
Q = One or more quality control criteria failed
U = Undetected at limit of detection

Appendix A.1
Summary of VOC Results
Building 65 Soil Investigation

	Boring ID	BLDG65-SB-16	BLDG65-SB-16	BLDG65-SB-16	BLDG65-SB-17	BLDG65-SB-17	BLDG65-SB-17	BLDG65-SB-18	BLDG65-SB-18	BLDG65-SB-18
	Sample Depth (ft bgs)	6-7	11-12	17-18	5-6	14-15	18-19	6-7	13-14	17-18
	Sample Type	N	N	N	N	N	N	N	N	N
	Sample Date	06/12/2020	06/12/2020	06/12/2020	06/10/2020	06/10/2020	06/10/2020	06/12/2020	06/12/2020	06/12/2020
Parameter	CAS #									
VOCs - 8260B (ug/kg)										
Acetone	67-64-1	18 JQ	23 JQ	22 JQ	32 J	24 J	19 J	14 JQ	28 JQ	15 JQ
Benzene	71-43-2	< 0.93 U	< 1.3 U	< 0.82 U	< 0.98 U	< 0.65 U	< 0.67 U	< 0.70 U	< 0.71 U	< 0.67 U
Bromobenzene	108-86-1	< 2.2 U	< 3.0 U	< 1.9 U	< 2.3 U	< 1.5 U	< 1.5 U	< 1.6 U	< 1.7 U	< 1.6 U
Bromochloromethane	74-97-5	< 4.2 UQ	< 5.7 UQ	< 3.7 UQ	< 4.4 U	< 3.0 U	< 3.0 U	< 3.2 UQ	< 3.2 UQ	< 3.0 UQ
Bromodichloromethane	75-27-4	< 1.2 U	< 1.7 U	< 1.1 U	< 1.3 U	< 0.87 U	< 0.88 U	< 0.93 U	< 0.95 U	< 0.89 U
Bromoform	75-25-2	< 1.9 UQ	< 2.6 UQ	< 1.7 UQ	< 2.0 U	< 1.3 U	< 1.4 U	< 1.4 UQ	< 1.5 UQ	< 1.4 UQ
Bromomethane (Methyl bromide)	74-83-9	< 1.9 U	< 2.6 U	< 1.7 U	< 2.0 U	< 1.3 U	< 1.4 U	< 1.4 U	< 1.5 U	< 1.4 U
2-Butanone (MEK)	78-93-3	< 3.1 UQ	< 4.2 UQ	< 2.7 UQ	< 3.2 U	< 2.2 U	< 2.2 U	< 2.3 UQ	< 2.4 UQ	< 2.2 UQ
n-Butylbenzene	104-51-8	< 3.1 U	< 4.2 U	< 2.7 U	< 3.2 U	< 2.2 U	< 2.2 U	< 2.3 U	< 2.4 U	< 2.2 U
sec-Butylbenzene	135-98-8	< 2.7 U	< 3.7 U	< 2.4 U	< 2.8 U	< 1.9 U	< 1.9 U	< 2.0 U	< 2.1 U	< 1.9 U
tert-Butylbenzene	98-06-6	< 2.3 UQ	< 3.1 UQ	< 2.0 UQ	< 2.4 U	< 1.6 U	< 1.6 U	< 1.7 UQ	< 1.8 UQ	< 1.7 UQ
Carbon disulfide	75-15-0	< 1.4 UQ	< 1.9 UQ	1.4 JQ	< 1.5 U	< 0.99 U	< 1.0 U	< 1.1 UQ	< 1.1 UQ	< 1.0 UQ
Carbon tetrachloride	56-23-5	< 1.1 UQ	< 1.4 UQ	< 0.94 UQ	< 1.1 U	< 0.74 U	< 0.76 U	< 0.80 UQ	< 0.81 UQ	< 0.76 UQ
Chlorobenzene	108-90-7	< 1.2 U	< 1.7 U	< 1.1 U	< 1.3 U	< 0.86 U	< 0.87 U	< 0.92 U	< 0.94 U	< 0.88 U
Chloroethane	75-00-3	< 3.4 U	< 4.7 U	< 3.0 U	< 3.6 U	< 2.4 U	< 2.5 U	< 2.6 U	< 2.6 U	< 2.5 U
Chloroform	67-66-3	< 1.4 U	< 1.9 U	< 1.2 U	< 1.5 U	< 0.99 U	< 1.0 U	< 1.1 U	< 1.1 U	< 1.0 U
Chloromethane (Methyl chloride)	74-87-3	< 1.3 U	< 1.7 U	< 1.1 U	< 1.3 U	< 0.90 U	< 0.91 U	< 0.96 U	< 0.98 U	< 0.92 U
2-Chlorotoluene	95-49-8	< 2.6 U	< 3.5 U	< 2.3 U	< 2.7 U	< 1.8 U	< 1.8 U	< 1.9 U	< 2.0 U	< 1.8 U
4-Chlorotoluene	106-43-4	< 2.2 U	< 3.0 U	< 1.9 U	< 2.3 U	< 1.5 U	< 1.5 U	< 1.6 U	< 1.7 U	< 1.6 U
Dibromochloromethane	124-48-1	< 2.2 U	< 3.0 U	< 1.9 U	< 2.3 U	< 1.5 U	< 1.5 U	< 1.6 U	< 1.7 U	< 1.6 U
1,2-Dibromo-3-chloropropane	96-12-8	< 5.6 U	< 7.7 U	< 5.0 U	< 5.9 U	< 3.9 U	< 4.0 U	< 4.2 U	< 4.3 U	< 4.0 U
Dibromomethane (Methylene bromide)	74-95-3	< 2.2 U	< 3.0 U	< 1.9 U	< 2.3 U	< 1.5 U	< 1.5 U	< 1.6 U	< 1.7 U	< 1.6 U
1,2-Dichlorobenzene	95-50-1	< 1.7 U	< 2.3 U	< 1.5 U	< 1.7 U	< 1.2 U	< 1.2 U	< 1.2 U	< 1.3 U	< 1.2 U
1,3-Dichlorobenzene	541-73-1	< 2.0 U	< 2.8 U	< 1.8 U	< 2.1 U	< 1.4 U	< 1.5 U	< 1.5 U	< 1.6 U	< 1.5 U
1,4-Dichlorobenzene	106-46-7	< 0.94 U	< 1.3 U	< 0.83 U	< 0.99 U	< 0.66 U	< 0.67 U	< 0.71 U	< 0.72 U	< 0.68 U
Dichlorodifluoromethane	75-71-8	< 1.2 UQ	< 1.6 UQ	< 1.1 UQ	< 1.3 U	< 0.84 U	< 0.86 U	< 0.90 UQ	< 0.92 UQ	< 0.86 UQ
1,1-Dichloroethane	75-34-3	< 1.4 U	< 1.9 U	< 1.2 U	< 1.5 U	< 0.99 U	< 1.0 U	< 1.1 U	< 1.1 U	< 1.0 U
1,2-Dichloroethane	107-06-2	< 1.4 UMQ	< 1.9 UMQ	< 1.2 UMQ	< 1.5 UM	< 0.99 U	< 1.0 UM	< 1.1 UMQ	< 1.1 UMQ	< 1.0 UMQ
1,1-Dichloroethene	75-35-4	< 1.9 U	< 2.6 U	< 1.7 U	< 2.0 U	< 1.3 U	< 1.4 U	< 1.4 U	< 1.5 U	< 1.4 U
1,2-Dichloroethene, Total	540-59-0	120	7.0 J	66	< 0.85 U	< 0.57 U	4.3 J	< 0.60 U	11	14
cis-1,2-Dichloroethene	156-59-2	110	7.0 J	65	< 1.9 U	< 1.3 U	4.3 J	< 1.3 U	11	14
trans-1,2-Dichloroethene	156-60-5	2.8 J	< 1.1 U	1.0 J	< 0.85 U	< 0.57 U	< 0.57 U	< 0.60 U	< 0.62 U	< 0.58 U
1,2-Dichloropropane	78-87-5	< 1.1 U	< 1.5 U	< 0.97 U	< 1.2 U	< 0.77 U	< 0.78 U	< 0.82 U	< 0.84 U	< 0.79 U
1,3-Dichloropropane	142-28-9	< 2.3 U	< 3.1 U	< 2.0 U	< 2.4 U	< 1.6 U	< 1.6 U	< 1.7 U	< 1.8 U	< 1.7 U
2,2-Dichloropropane	594-20-7	< 1.4 U	< 1.9 U	< 1.2 U	< 1.5 U	< 0.99 U	< 1.0 U	< 1.1 U	< 1.1 U	< 1.0 U
1,1-Dichloropropene	563-58-6	< 1.2 U	< 1.7 U	< 1.1 U	< 1.3 U	< 0.85 U	< 0.87 U	< 0.91 U	< 0.93 U	< 0.87 U
cis-1,3-Dichloropropene	10061-01-5	< 1.1 U	< 1.4 U	< 0.94 U	< 1.1 U	< 0.74 U	< 0.76 U	< 0.80 U	< 0.81 U	< 0.76 U
trans-1,3-Dichloropropene	10061-02-6	< 1.1 U	< 1.5 U	< 0.98 U	< 1.2 U	< 0.78 U	< 0.79 U	< 0.83 U	< 0.85 U	< 0.80 U
Ethylbenzene	100-41-4	< 1.7 UM	< 2.3 U	< 1.5 U	< 1.7 UM	< 1.2 UM	< 1.2 UM	< 1.2 UM	< 1.3 U	< 1.2 U
Hexachlorobutadiene	87-68-3	< 4.0 U	< 5.4 U	< 3.5 U	< 4.2 U	< 2.8 U	< 2.8 U	< 3.0 U	< 3.0 U	< 2.8 U
2-Hexanone	591-78-6	< 4.2 U	< 5.7 U	< 3.7 U	< 4.4 UQ	< 3.0 UQ	< 3.0 UQ	< 3.2 U	< 3.2 U	< 3.0 U
Isopropylbenzene (Cumene)	98-82-8	< 2.4 UQ	< 3.3 UQ	< 2.1 UQ	< 2.5 U	< 1.7 U	< 1.7 U	< 1.8 UQ	< 1.9 UQ	< 1.7 UQ
4-Isopropyltoluene	99-87-6	< 2.8 U	< 3.8 UM	< 2.5 U	< 3.0 U	< 2.0 U	< 2.0 U	< 2.1 U	< 2.2 U	< 2.0 U
Methylene chloride	75-09-2	< 1.3 U	< 1.7 U	< 1.1 U	< 1.3 U	< 0.88 U	< 0.89 U	< 0.94 U	< 0.96 U	< 0.90 U
4-Methyl-2-pentanone (MIBK)	108-10-1	< 5.4 U	< 7.3 U	< 4.7 U	< 5.6 U	< 3.8 U	< 3.8 U	< 4.0 U	< 4.1 U	< 3.9 U
tert-Butyl methyl ether (MTBE)	1634-04-4	< 1.3 UQ	< 1.7 UQ	< 1.1 UQ	< 1.3 U	< 0.90 U	< 0.91 U	< 0.96 UQ	< 0.98 UQ	< 0.92 UQ
Naphthalene	91-20-3	< 1.5 U	< 2.1 U	< 1.4 U	< 1.6 U	< 1.1 U	1.8 J	2.5 J	1.5 J	2.6 J
n-Propylbenzene	103-65-1	< 3.4 U	< 4.7 U	< 3.0 U	< 3.6 U	< 2.4 U	< 2.5 U	< 2.6 U	< 2.6 U	< 2.5 U
Styrene	100-42-5	< 1.2 U	< 1.6 U	< 1.0 U	< 1.2 U	< 0.83 U	< 0.85 U	< 0.89 U	< 0.91 U	< 0.85 U
1,1,1,2-Tetrachloroethane	630-20-6	< 3.1 UQ	< 4.2 UQ	< 2.7 UQ	< 3.2 U	< 2.2 U	< 2.2 U	< 2.3 UQ	< 2.4 UQ	< 2.2 UQ
1,1,2,2-Tetrachloroethane	79-34-5	< 2.0 UQ	< 2.8 UQ	< 1.8 UQ	< 2.1 U	< 1.4 U	< 1.5 U	< 1.5 UQ	< 1.6 UQ	< 1.5 UQ
Tetrachloroethene (PCE)	127-18-4	620	24	35	< 2.5 U	< 1.7 U	< 1.7 U	29	41	69
Toluene	108-88-3	< 1.1 U	< 1.5 U	< 0.95 U	< 1.1 U	< 0.75 U	< 0.77 U	< 0.81 U	< 0.82 U	< 0.77 U

Appendix A.1
Summary of VOC Results
Building 65 Soil Investigation

Boring ID		BLDG65-SB-16	BLDG65-SB-16	BLDG65-SB-16	BLDG65-SB-17	BLDG65-SB-17	BLDG65-SB-17	BLDG65-SB-18	BLDG65-SB-18	BLDG65-SB-18
Sample Depth (ft bgs)		6-7	11-12	17-18	5-6	14-15	18-19	6-7	13-14	17-18
Sample Type		N	N	N	N	N	N	N	N	N
Sample Date		06/12/2020	06/12/2020	06/12/2020	06/10/2020	06/10/2020	06/10/2020	06/12/2020	06/12/2020	06/12/2020
Parameter	CAS #									
1,2,3-Trichlorobenzene	87-61-6	< 2.0 U	< 2.8 U	< 1.8 U	< 2.1 U	< 1.4 U	< 1.5 U	< 1.5 U	< 1.6 U	< 1.5 U
1,2,4-Trichlorobenzene	120-82-1	< 1.1 U	< 1.6 U	< 1.0 U	< 1.2 U	< 0.80 U	< 0.81 U	< 0.85 U	< 0.87 U	< 0.82 U
1,1,1-Trichloroethane	71-55-6	< 0.75 U	< 1.0 U	< 0.66 U	< 0.79 U	< 0.53 U	< 0.54 U	< 0.57 U	< 0.58 U	< 0.54 U
1,1,2-Trichloroethane	79-00-5	< 1.7 UMQ	< 2.3 UQ	< 1.5 UMQ	< 1.7 U	< 1.2 U	< 1.2 U	< 1.2 UMQ	< 1.3 UQ	< 1.2 UMQ
Trichloroethene (TCE)	79-01-6	110	6.6 J	15	< 1.7 U	< 1.2 U	< 1.2 U	< 1.2 U	3.1 J	5.0
Trichlorofluoromethane	75-69-4	< 1.5 U	< 2.1 U	< 1.4 U	< 1.6 U	< 1.1 U	< 1.1 U	< 1.2 U	< 1.2 U	< 1.1 U
1,2,3-Trichloropropane	96-18-4	< 3.1 UQ	< 4.2 UQ	< 2.7 UQ	< 3.2 U	< 2.2 U	< 2.2 U	< 2.3 UQ	< 2.4 UQ	< 2.2 UQ
1,2,4-Trimethylbenzene	95-63-6	< 1.8 U	< 2.4 U	< 1.6 U	< 1.9 U	< 1.3 U	< 1.3 U	< 1.3 U	< 1.4 U	< 1.3 U
1,3,5-Trimethylbenzene	108-67-8	< 2.2 U	< 3.0 U	< 1.9 U	< 2.3 U	< 1.5 U	< 1.5 U	< 1.6 U	< 1.7 U	< 1.6 U
Vinyl acetate	108-05-4	< 3.2 UQ	< 4.4 UQ	< 2.8 UQ	< 3.4 U	< 2.2 U	< 2.3 U	< 2.4 UQ	< 2.4 UQ	< 2.3 UQ
Vinyl chloride	75-01-4	65	< 2.6 U	18	< 2.0 U	< 1.3 U	< 1.4 U	< 1.4 U	< 1.5 U	< 1.4 U
m+p-Xylenes	179601-23-1	< 3.3 U	< 4.5 U	< 2.9 U	< 3.5 U	< 2.3 U	< 2.4 U	< 2.5 U	< 2.5 U	< 2.4 U
o-Xylene	95-47-6	< 1.4 U	< 1.9 U	< 1.2 U	< 1.5 U	< 0.99 U	< 1.0 U	< 1.1 U	< 1.1 U	< 1.0 U
Xylene (Total)	1330-20-7	< 1.4 U	< 1.9 U	< 1.2 U	< 1.5 U	< 0.99 U	< 1.0 U	< 1.1 U	< 1.1 U	< 1.0 U

Notes:
CAS# = Chemical Abstract Service number
FD = field duplicate
ft bgs = feet below ground surface
N = normal or primary sample
ug/kg = micrograms per kilogram
VOCs = volatile organic compounds
Bold font = detected result

Laboratory Qualifiers:
B = Blank Contamination
D = The reported value is from a dilution
H = Sample was prepped or analyzed beyond the specified holing time
J = Estimated. The analyte was positively identified; the quantitation is an estimation
J1 = Estimated. The quantitation is an estimation due to discrepancies in meeting certain analyte-sfecific quality control criteria.
M = Manual integrated compound
Q = One or more quality control criteria failed
U = Undetected at limit of detection

Appendix A.1
Summary of Synthetic Precipitation Leaching Procedure (SPLP) VOC Results
Building 65 Soil Investigation

	Boring ID	BLDG65-SB-06	BLDG65-SB-08	BLDG65-SB-12	BLDG65-SB-12	BLDG65-SB-13	BLDG65-SB-13	BLDG65-SB-14	BLDG65-SB-14
	Sample Depth (ft bgs)	2-3	4-5	6-7	13-14	9-10	18-19	6-7	11-12
	Sample Type	N	N	N	N	N	N	N	N
	Sample Date	06/10/2020	06/12/2020	06/11/2020	06/11/2020	06/12/2020	06/12/2020	06/11/2020	06/11/2020
Parameter	CAS #	Result	Result	Result	Result	Result	Result	Result	Result
VOCs - 1312/8260B (mg/L)									
Acetone	67-64-1	0.018 B	0.014 B	0.012 B	0.016 B	< 0.35 U	0.012 B	0.016 B	0.019 B
Benzene	71-43-2	< 0.00043 U	< 0.00043 U	< 0.00043 U	< 0.00043 U	< 0.022 U	< 0.00043 U	< 0.00043 U	< 0.00043 U
Bromobenzene	108-86-1	< 0.00050 U	< 0.00050 U	< 0.00050 U	< 0.00050 U	< 0.025 U	< 0.00050 U	< 0.00050 U	< 0.00050 U
Bromochloromethane	74-97-5	< 0.00045 U	< 0.00045 U	< 0.00045 U	< 0.00045 U	< 0.023 U	< 0.00045 U	< 0.00045 U	< 0.00045 U
Bromodichloromethane	75-27-4	< 0.00044 U	< 0.00044 U	< 0.00044 U	< 0.00044 U	< 0.022 U	< 0.00044 U	< 0.00044 U	< 0.00044 U
Bromoform	75-25-2	< 0.00043 U	< 0.00043 U	< 0.00043 U	< 0.00043 U	< 0.022 U	< 0.00043 U	< 0.00043 U	< 0.00043 U
Bromomethane (Methyl bromide)	74-83-9	< 0.0025 UQ	< 0.0025 UQ	< 0.0025 UQ	< 0.0025 UQ	< 0.13 UQ	< 0.0025 UQ	< 0.0025 UQ	< 0.0025 UQ
2-Butanone (MEK)	78-93-3	< 0.0034 U	< 0.0034 U	< 0.0034 U	< 0.0034 U	< 0.17 U	< 0.0034 U	< 0.0034 U	< 0.0034 U
n-Butylbenzene	104-51-8	< 0.00047 U	< 0.00047 U	< 0.00047 U	0.00053 J	< 0.024 U	< 0.00047 U	< 0.00047 U	< 0.00047 U
sec-Butylbenzene	135-98-8	< 0.00042 U	< 0.00042 U	< 0.00042 U	< 0.00042 U	< 0.021 U	< 0.00042 U	< 0.00042 U	< 0.00042 U
tert-Butylbenzene	98-06-6	< 0.00045 U	< 0.00045 U	< 0.00045 U	< 0.00045 U	< 0.023 U	< 0.00045 U	< 0.00045 U	< 0.00045 U
Carbon disulfide	75-15-0	< 0.00043 U	< 0.00043 U	< 0.00043 U	< 0.00043 U	< 0.022 U	< 0.00043 U	< 0.00043 U	< 0.00043 U
Carbon tetrachloride	56-23-5	< 0.00033 U	< 0.00033 U	< 0.00033 U	< 0.00033 U	< 0.017 U	< 0.00033 U	< 0.00033 U	< 0.00033 U
Chlorobenzene	108-90-7	< 0.00026 U	< 0.00026 U	< 0.00026 U	< 0.00026 U	< 0.013 U	< 0.00026 U	< 0.00026 U	< 0.00026 U
Chloroethane	75-00-3	< 0.0025 U	< 0.0025 UQ	< 0.0025 U	< 0.0025 U	< 0.13 UQ	< 0.0025 UQ	< 0.0025 U	< 0.0025 U
Chloroform	67-66-3	< 0.00050 U	< 0.00050 U	< 0.00050 U	< 0.00050 U	< 0.025 U	< 0.00050 U	< 0.00050 U	< 0.00050 U
Chloromethane (Methyl chloride)	74-87-3	< 0.00040 U	< 0.00040 U	< 0.00040 U	< 0.00040 U	< 0.020 U	< 0.00040 U	< 0.00040 U	< 0.00040 U
2-Chlorotoluene	95-49-8	< 0.00027 U	< 0.00027 U	< 0.00027 U	< 0.00027 U	< 0.014 U	< 0.00027 U	< 0.00027 U	0.00099 JM
4-Chlorotoluene	106-43-4	< 0.00045 U	< 0.00045 U	< 0.00045 U	< 0.00045 U	< 0.023 U	< 0.00045 U	< 0.00045 U	< 0.00045 UM
Dibromochloromethane	124-48-1	< 0.00032 U	< 0.00032 U	< 0.00032 U	< 0.00032 U	< 0.016 U	< 0.00032 U	< 0.00032 U	< 0.00032 U
1,2-Dibromo-3-chloropropane	96-12-8	< 0.0011 U	< 0.0011 U	< 0.0011 U	< 0.0011 U	< 0.055 U	< 0.0011 U	< 0.0011 U	< 0.0011 U
1,2-Dibromoethane	106-93-4	< 0.00044 U	< 0.00044 U	< 0.00044 U	< 0.00044 U	< 0.022 U	< 0.00044 U	< 0.00044 U	< 0.00044 U
Dibromomethane (Methylene bromide)	74-95-3	< 0.00035 U	< 0.00035 U	< 0.00035 U	< 0.00035 U	< 0.018 U	< 0.00035 U	< 0.00035 U	< 0.00035 U
1,2-Dichlorobenzene	95-50-1	< 0.00037 U	< 0.00037 U	< 0.00037 U	< 0.00037 U	< 0.019 U	< 0.00037 U	< 0.00037 U	< 0.00037 U
1,3-Dichlorobenzene	541-73-1	< 0.00043 U	< 0.00043 U	< 0.00043 U	< 0.00043 U	< 0.022 U	< 0.00043 U	< 0.00043 U	< 0.00043 U
1,4-Dichlorobenzene	106-46-7	< 0.00046 U	< 0.00046 U	< 0.00046 U	< 0.00046 U	< 0.023 U	< 0.00046 U	< 0.00046 U	< 0.00046 U
Dichlorodifluoromethane	75-71-8	< 0.00060 U	< 0.00060 UQ	< 0.00060 U	< 0.00060 U	< 0.030 UQ	< 0.00060 UQ	< 0.00060 U	< 0.00060 U
1,1-Dichloroethane	75-34-3	< 0.00038 U	< 0.00038 U	< 0.00038 U	< 0.00038 U	< 0.019 U	< 0.00038 U	< 0.00038 U	< 0.00038 U
1,2-Dichloroethane	107-06-2	< 0.00050 UM	< 0.00050 UM	0.00074 J	0.015	< 0.025 UM	0.0025	0.00066 J	< 0.00050 UM
1,1-Dichloroethene	75-35-4	< 0.00036 U	< 0.00036 U	< 0.00036 U	< 0.00036 U	< 0.018 U	< 0.00036 U	< 0.00036 U	< 0.00036 U
1,2-Dichloroethene, Total	540-59-0	< 0.00075 U	< 0.00075 U	0.0029	0.048	< 0.038 U	< 0.00075 U	0.0033	< 0.00075 U
cis-1,2-Dichloroethene	156-59-2	< 0.00041 U	< 0.00041 U	0.0029	0.047	< 0.021 U	0.00041 J	0.0033	< 0.00041 U
trans-1,2-Dichloroethene	156-60-5	< 0.00037 U	< 0.00037 U	< 0.00037 U	0.00097 J	< 0.019 U	< 0.00037 U	< 0.00037 U	< 0.00037 U
1,2-Dichloropropane	78-87-5	< 0.00065 U	< 0.00065 U	< 0.00065 U	< 0.00065 U	< 0.033 U	< 0.00065 U	< 0.00065 U	< 0.00065 U
1,3-Dichloropropane	142-28-9	< 0.00034 U	< 0.00034 U	< 0.00034 U	< 0.00034 U	< 0.017 U	< 0.00034 U	< 0.00034 U	< 0.00034 U
2,2-Dichloropropane	594-20-7	< 0.00037 U	< 0.00037 U	< 0.00037 U	< 0.00037 U	< 0.019 U	< 0.00037 U	< 0.00037 U	< 0.00037 U
1,1-Dichloropropene	563-58-6	< 0.00034 U	< 0.00034 U	< 0.00034 U	< 0.00034 U	< 0.017 U	< 0.00034 U	< 0.00034 U	< 0.00034 U
cis-1,3-Dichloropropene	10061-01-5	< 0.00040 U	< 0.00040 U	< 0.00040 U	< 0.00040 U	< 0.020 U	< 0.00040 U	< 0.00040 U	< 0.00040 U
trans-1,3-Dichloropropene	10061-02-6	< 0.00042 U	< 0.00042 U	< 0.00042 U	< 0.00042 U	< 0.021 U	< 0.00042 U	< 0.00042 U	< 0.00042 U
Ethylbenzene	100-41-4	< 0.00033 U	< 0.00033 U	< 0.00033 U	0.0022	< 0.017 U	< 0.00033 U	0.00048 J	< 0.00033 UM
Hexachlorobutadiene	87-68-3	< 0.0025 U	< 0.0025 U	< 0.0025 U	< 0.0025 U	< 0.13 U	< 0.0025 U	< 0.0025 U	< 0.0025 U
2-Hexanone	591-78-6	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.10 U	< 0.0020 U	< 0.0020 U	< 0.0020 U
Isopropylbenzene (Cumene)	98-82-8	< 0.00035 U	< 0.00035 U	< 0.00035 U	< 0.00035 U	< 0.018 U	< 0.00035 U	< 0.00035 U	< 0.00035 U
4-Isopropyltoluene	99-87-6	< 0.00048 U	< 0.00048 U	0.0019	0.0045	< 0.024 U	< 0.00048 U	< 0.00048 U	< 0.00048 U
Methylene chloride	75-09-2	0.0073 B	0.0098 B	0.0068 B	0.011 B	0.17 JDB	0.016 B	0.0096 B	0.0073 B
4-Methyl-2-pentanone (MIBK)	108-10-1	< 0.0021 U	< 0.0021 U	< 0.0021 U	< 0.0021 U	< 0.11 U	< 0.0021 U	< 0.0021 U	< 0.0021 U
tert-Butyl methyl ether (MTBE)	1634-04-4	0.00035 JM	0.00043 J	0.00031 JM	0.00030 JM	< 0.015 U	0.00047 J	0.00036 J	0.00041 JM
Naphthalene	91-20-3	0.0053	< 0.0025 U	0.0056	0.023	< 0.13 U	< 0.0025 U	< 0.0025 U	0.013
n-Propylbenzene	103-65-1	< 0.00038 U	< 0.00038 U	< 0.00038 UM	0.0011	< 0.019 U	< 0.00038 U	< 0.00038 U	< 0.00038 UM
Styrene	100-42-5	< 0.00027 U	< 0.00027 U	< 0.00027 U	< 0.00027 U	< 0.014 U	< 0.00027 U	< 0.00027 U	< 0.00027 U
1,1,1,2-Tetrachloroethane	630-20-6	< 0.00037 U	< 0.00037 U	< 0.00037 U	< 0.00037 U	< 0.019 U	< 0.00037 U	< 0.00037 U	< 0.00037 U
1,1,2,2-Tetrachloroethane	79-34-5	< 0.00060 U	< 0.00060 U	< 0.00060 U	< 0.00060 U	< 0.030 U	< 0.00060 U	< 0.00060 U	< 0.00060 U
Tetrachloroethene (PCE)	127-18-4	0.0070	0.015	2.0 D	81 D	2.4 D	0.0021	0.94 D	5.0 D
Toluene	108-88-3	< 0.00048 U	< 0.00048 U	0.0017	0.0020	< 0.024 U	< 0.00048 U	0.0023	0.0020
1,2,3-Trichlorobenzene	87-61-6	< 0.0025 U	< 0.0025 U	< 0.0025 U	< 0.0025 U	< 0.13 U	< 0.0025 U	< 0.0025 U	< 0.0025 U
1,2,4-Trichlorobenzene	120-82-1	< 0.0025 U	< 0.0025 U	< 0.0025 U	< 0.0025 U	< 0.13 U	< 0.0025 U	< 0.0025 U	< 0.0025 U
1,1,1-Trichloroethane	71-55-6	< 0.00037 U	< 0.00037 U	< 0.00037 U	< 0.00037 U	< 0.019 U	< 0.00037 U	< 0.00037 U	< 0.00037 U
1,1,2-Trichloroethane	79-00-5	< 0.00033 UM	< 0.00033 U	< 0.00033 UM	< 0.00033 UM	< 0.017 UM	< 0.00033 U	< 0.00033 UM	< 0.00033 UM
Trichloroethene (TCE)	79-01-6	0.0012	0.0013	0.015		0.026 JD	0.00081 J	0.015	0.0096
Trichlorofluoromethane	75-69-4	< 0.00042 U	< 0.00042 U	< 0.00042 U	< 0.00042 U	< 0.021 U	< 0.00042 U	< 0.00042 U	< 0.00042 U
1,2,3-Trichloropropane	96-18-4	< 0.00039 U	< 0.00039 U	< 0.00039 U	< 0.00039 U	< 0.020 U	< 0.00039 U	< 0.00039 U	< 0.00039 U
1,2,4-Trimethylbenzene	95-63-6	< 0.00047 UM	< 0.00047 U	0.00068 J	0.012	< 0.024 U	< 0.00047 U	< 0.00047 UM	0.0018
1,3,5-Trimethylbenzene	108-67-8	< 0.00031 U	< 0.00031 U	< 0.00031 U	0.0038	< 0.016 U	< 0.00031 U	< 0.00031 U	0.00047 J
Vinyl acetate	108-05-4	< 0.00080 U	< 0.00080 U	< 0.00080 U	< 0.00080 U	< 0.040 U	< 0.00080 U	< 0.00080 U	< 0.00080 U
Vinyl chloride	75-01-4	< 0.00050 U	< 0.00050 U	< 0.00050 U	< 0.00050 U	< 0.025 U	< 0.00050 U	< 0.00050 U	< 0.00050 U
m+p-Xylenes	179601-23-1	< 0.00035 U	< 0.00035 U	0.0010	0.012	< 0.018 U	< 0.00035 U	0.0021	0.0012
o-Xylene	95-47-6	< 0.00023 U	< 0.00023 U	0.00046 J	0.0041	< 0.012 U	< 0.00023 U	0.00099 J	0.00058 J
Xylene (Total)	1330-20-7	< 0.00023 U	< 0.00023 U	0.0015 J	0.016	< 0.012 U	< 0.00023 U	0.0031	0.0018 J

Notes:
CAS# = Chemical Abstract Service number
ft bgs = feet below ground surface
N = normal or primary sample
mg/L = micrograms per liter
VOCs = volatile organic compounds
Bold font = detected result

Laboratory Qualifiers:
B = Blank Contamination
D = The reported value is from a dilution
H = Sample was prepped or analyzed beyond the specified holing time
J = Estimated. The analyte was positively identified; the quantitation is an estimation
J1 = Estimated. The quantitation is an estimation due to discrepancies in meeting certain analyte-sfecific quality control criteria.
M = Manual integrated compound
Q = One or more quality control criteria failed
U = Undetected at limit of detection

A.2 Soil Cleanup Calculations

A.2.1 Soil-Water Partitioning Analysis

Equation 1 taken from the 1996 EPA SSL Soil Screening Guidance uses soil-water partitioning to calculate an SSL. Input parameters will vary depending on methods used to arrive at a soil-water partitioning coefficient (K_d) and target soil leachate concentration.

Equation 1: $SSL = C_w \left[K_d + \left(\frac{\theta_w + \theta_a H'}{\rho_b}\right)\right]$ EPA 1996 SSL Guidance p. 29 (Equation 10)

Where:

SSL = soil screening level (mg/kg)
C_w = target soil leachate concentration (mg/L) = MCL*Dilution Attenuation Factor
K_d = soil-water partitioning coefficient (L/kg)
θ_w = water-filled soil porosity
H'= contaminant Henry's law constant
ρ_b = dry soil bulk density (kg/L)
θ_a = air-filled soil porosity

For a given chemical, parameters that most influence the SSL include dilution factor for soil leachate and the soil-water partitioning coefficient (K_d). The SSL and dilution factor are directly proportional given a constant K_d. K_d can vary depending on the method of calculation and chemical-physical properties of soil.

Parameter Inputs for Physical Soil Properties and Chemical Constant

Fixed parameters used for physical soil properties and contaminant Henry's law constant for Equation 1 including the following:

- θ_w = 0.111 (average of site data in Table 6[13])
- H'= 0.754 (EPA 1996 SSL Guidance, Appendix C Table C.1)
- ρ_b = 1.34 Kg/L (average of site data in Table 6[10])
- θ_a = 0.384 (average of site data in Table 6[10])

Using site-specific physical data reduces the calculated value added to K_d in Equation 1 by approximately 10% compared to the EPA default values that use an assumed dry bulk density of 1.5 Kg/L.

Method to Estimate Target Soil Leachate Concentration (C_w)

The target soil leachate concentration parameter is the product of the site cleanup level for PCE (EPA MCL of 0.005 mg/L) and a dilution attenuation factor (DAF) to account for leachate mixing with groundwater. The DAF is the ratio of soil leachate concentration to receptor point concentration (groundwater for this assessment).

The calculated DAF for the site approximates the reduction of leached contaminant that occurs as infiltrating precipitation mixes with the saturated aquifer below. Equation 2 below taken from the 1996 EPA SSL Soil Screening Guidance is used as an input parameter in the migration to groundwater SSL:

Equation 2: $DAF = 1 + \frac{Kid}{IL}$ EPA 1996 SSL Guidance p. 31 (Equation 11 of guidance)

Where:

DAF = dilution attenuation factor
i = hydraulic gradient (m/m)

[13]AECOM and Meadows, 2021. Final Results of Building 65 Area Soil Investigation for Operable Unit 8 Remedy Optimization, Defense Supply Center Richmond, Technical Memorandum Prepared for Defense Logistics Agency and U.S. Army Corps of Engineers, Baltimore, September 10, 2021.

d = mixing zone depth (m)
I = infiltration rate (m/yr.)
L= length of area of concern parallel to groundwater flow (m)
K = aquifer hydraulic conductivity (m/yr)

Equation 3 below taken from the 1996 EPA SSL Soil Screening Guidance is used to calculate the mixing zone depth parameter (d) in Equation 2.

Equation 3: $$d = (0.0112\ L^2)^{0.5} + d_a \left\{1 - exp\left[\frac{-LI}{Kid_a}\right]\right\}$$ EPA 1996 SSL Guidance p. 31 (Equation 12 of guidance)

Where:

d = mixing zone depth (m), where $d \leq d_a$
L= length of area of concern parallel to groundwater flow (m)
d_a = aquifer thickness (m)
i = hydraulic gradient (m/m)
K = aquifer hydraulic conductivity (m/yr)
I = infiltration rate (m/yr.)

Input parameters for Equation 2 and 3:

i = 0.001335 (site value)
d_a = 3.5 m (site value)
I = 0.2794 m/yr. (value of 11 inches/year for Richmond, VA area)
L= 12.2 m (site value)
K = 11,125 m/yr. (average from previous site investigations)

Using Equation 3 calculated d = 1.3546
Using Equation 2 calculated DAF for site = 6.9

Estimate of Soil-Water Partitioning Coefficient (K_d): Leachate Method

The method uses Equation 4 to calculate a K_d for input into Equation 2.

Equation 4: $$K_d = \frac{(C_T M_S - C_{SPLP} V_L)/M_S}{C_{SPLP}}$$ SPLP: NJDEP 2013 Guidance Document for Remediation Standards[1]

Fixed

K_d = soil-water partitioning coefficient (L/kg)
C_T = total concentration of contaminant in the SPLP soil sample (mg/kg)
M_S = total weight of the soil sample submitted for SPLP analysis (kg)
C_{SPLP} = concentration of contaminant in the SPLP leachate (mg/L)
V_L = volume of the SPLP leachate (L)

Fixed parameters used as inputs for Equation 3 including the following:

M_S = 0.025 kg (required by method)
V_L = 0.5 L (required by method)

Table A-1 presents K_d values calculated for PCE for the eight (8) samples analyzed for total VOCs and SPLP leachate using Equation 4 and the fixed parameter inputs.

Table A-1 Summary of Sample Specific K_d Values for PCE at Building 65

Sample ID	Total Soil (mg/kg)	SPLP Leachate (mg/L)	K_d (L/kg)	Data Usability Notes
BLDG65-SB-06 (2-3)	0.340	0.007	28.6	Retained for K_d SSL derivation
BLDG65-SB-08 (4-5)	0.120	0.015	-12.0	Negative result outside range of valid values for K_d, excluded K_d value from SSL derivation
BLDG65-SB-12 (6-7)	620	2.0	290.0	Total soil results above soil saturation limit for PCE, excluded K_d value from SSL derivation
BLDG65-SB-12 (13-14)	6500	81	60.2	Total soil results above soil saturation limit for PCE, excluded K_d value from derivation of SSL
BLDG65-SB-13 (9-10)	550	2.4	209.2	Total soil results above soil saturation limit for PCE, excluded K_d value from SSL derivation
BLDG65-SB-13 (18-19)	16	0.0021	7,599.0	Sample collected from uppermost saturated zone and not representative of vadose zone soil, excluded K_d value from SSL derivation
BLDG65-SB-14 (6-7)	150	0.94	139.6	Total soil results above soil saturation limit for PCE, excluded K_d value from SSL derivation
BLDG65-SB-13 (11-12)	0.029	5.0	-20.0	Negative result outside range of valid values for K_d, excluded K_d value from SSL derivation

Notes: mg/kg = milligrams per kilogram, mg/L = milligrams per liter, L/kg = liters per kilogram, SPLP = synthetic precipitation leaching procedure

Table A-1 has data usability notes for the data distribution of calculated K_d values from total soil and SPLP leachate analysis. Based on distribution attributes and data usability, soil leaching evaluations use the minimum K_d value of 28.6 L/kg determined from SPLP testing as one the data lines for SSL development.

Minimum K_d calculated from SPLP tests = 28.6 L/kg

A.2.2 Calculation of SSL

Table A-2 presents the calculated SSL for PCE using the soil-water partitioning method and Equation 5. Input parameter used include the SPLP derived K_d, calculated site-specific DAF, and calculated C_w (MCL x DAF).

Equation 5:

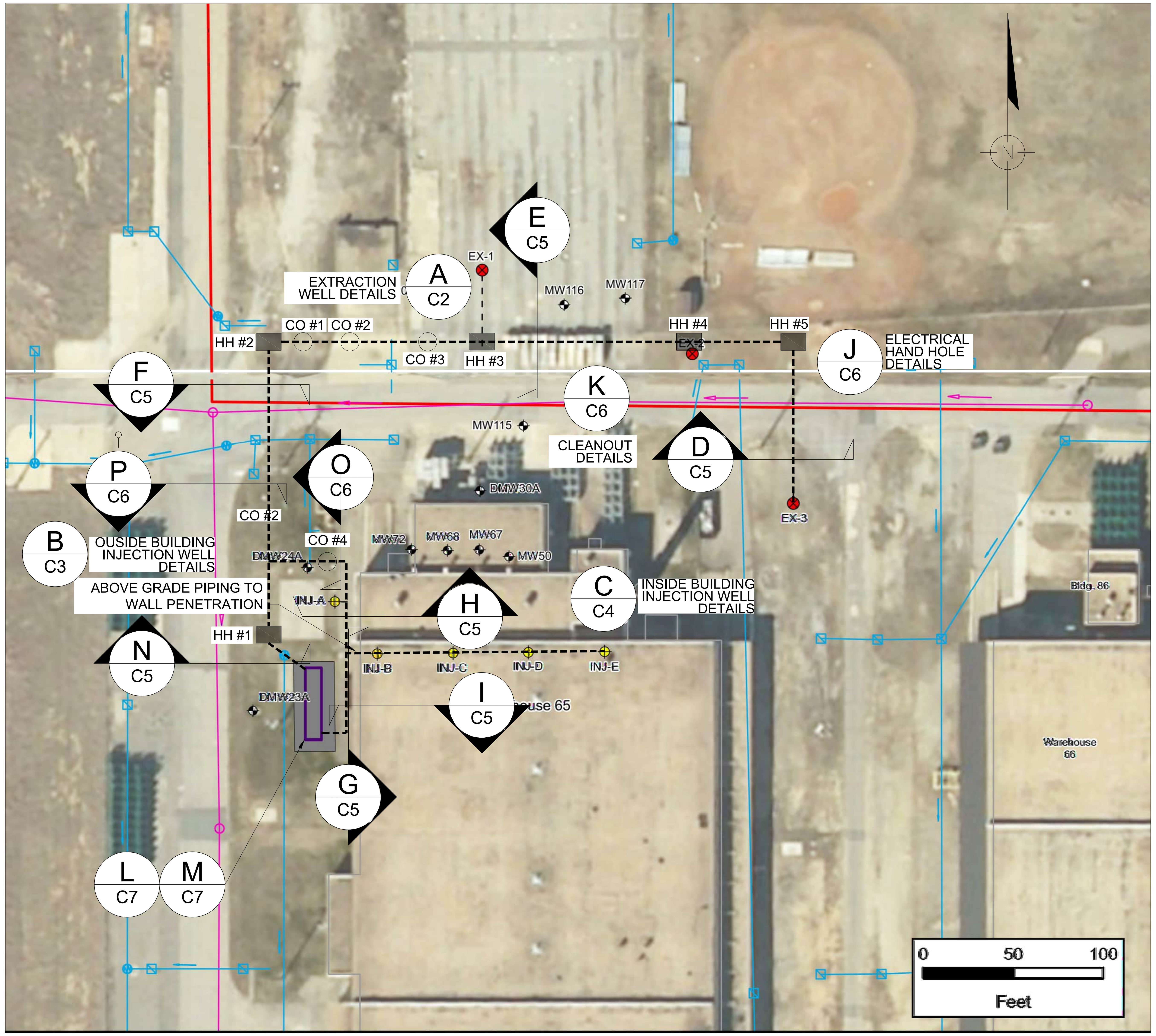
$$SSL = C_w \left[K_d + \left(\frac{\theta_w + \theta_a H'}{\rho_b}\right)\right]$$

Table A-2 Calculated SSLs Using Soil Partitioning Method

Method	Parameter	K_d (L/kg)	MCL (mg/L)	DAF	C_w mg/L	SSL (mg/kg)	Notes
Soil-Water Partitioning using SPLP for K_d (Equation 4)	PCE	28.6	0.005	6.9	0.0345	0.9970	Calculated Site DAF

Notes: K_d = soil-water partitioning coefficient, K_{oc} = soil organic carbon/water partition coefficient, MCL = maximum contaminant level, DAF = dilution attenuation factor, C_w = target soil leachate concentration, SSL = soil screening level, L/kg = liters per kilogram, mg/L = milligrams per liter, mg/kg = milligrams per kilogram, PCE = tetrachloroethene

A.2 BDGR Record Drawings and Layout



Legend

- OU-8
- Monitoring Well
- CO #1 Cleanout
- HH #1 Electrical Hand Hole

OU8 Remedy Features

- Remediation System
- Extraction Well
- Injection Well
- Conveyance Piping Utilities and Electrical Conduit
- Sanitary Sewer Line
- Storm Sewer Line

NOTES:
1. CLEANOUTS WERE SPACED 200-250 FEET.
2. ELECTRICAL HAND HOLES WERE SPACED AT A MAXIMUM OF 300 FEET.
3. PIPING CAME ABOVE GROUND OUTSIDE OF BUILDING AND ENTERED BUILDING THROUGH WALL PENETRATION TO REACH INJECTION WELLS INSIDE OF BUILDING (TYPICAL OF 3). ABOVE GROUND PIPING WAS HEAT-TRACED AND INSULATED.
4. MAP SOURCES INCLUDE AECOM, GIS DATA, ESRI, ARCGIS ONLINE AND AERIAL IMAGERY. COORDINATE SYSTEM: VA STATE PLANE, SOUTH. DATUM : NAD 83. UNITS: FEET.

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SEALS

DATE:	FEBRUARY, 2018
PROJECT NO.:	02118201.0001.00300
FILE NAME:	C1 - TRENCH LAYOUT REV2
DESIGNED BY:	CS
DRAWN BY:	MK
CHECKED BY:	XX

8000 JEFFERSON DAVIS HWY, RICHMOND, VA 23297

DEFENSE SUPPLY CENTER

BIO-ENHANCED DIRECTED GROUNDWATER RECIRCULATION PILOT TEST

ARCADIS PROJ. NO. 02118201.0001.00300

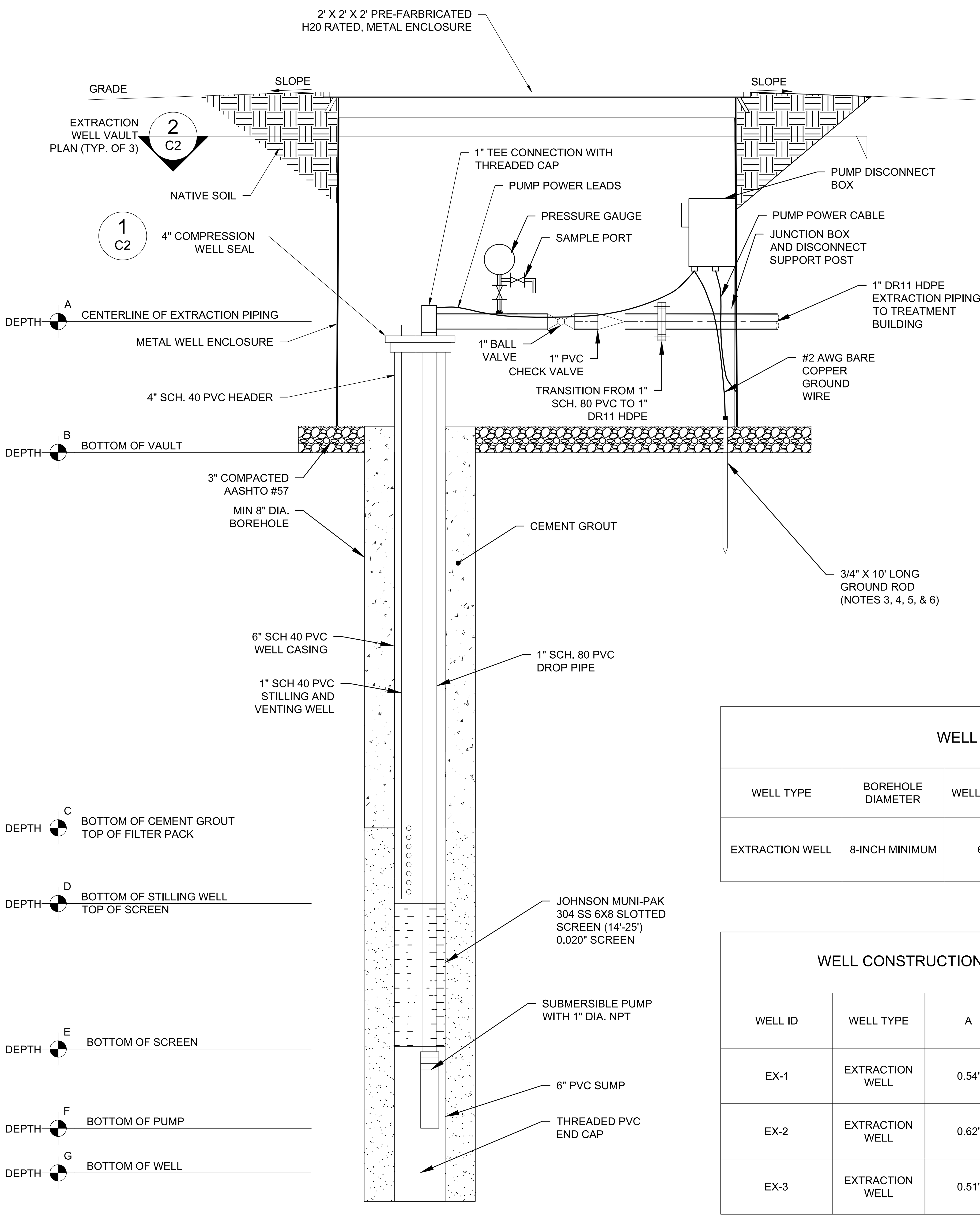
SHEET TITLE

SITE PIPING LAYOUT

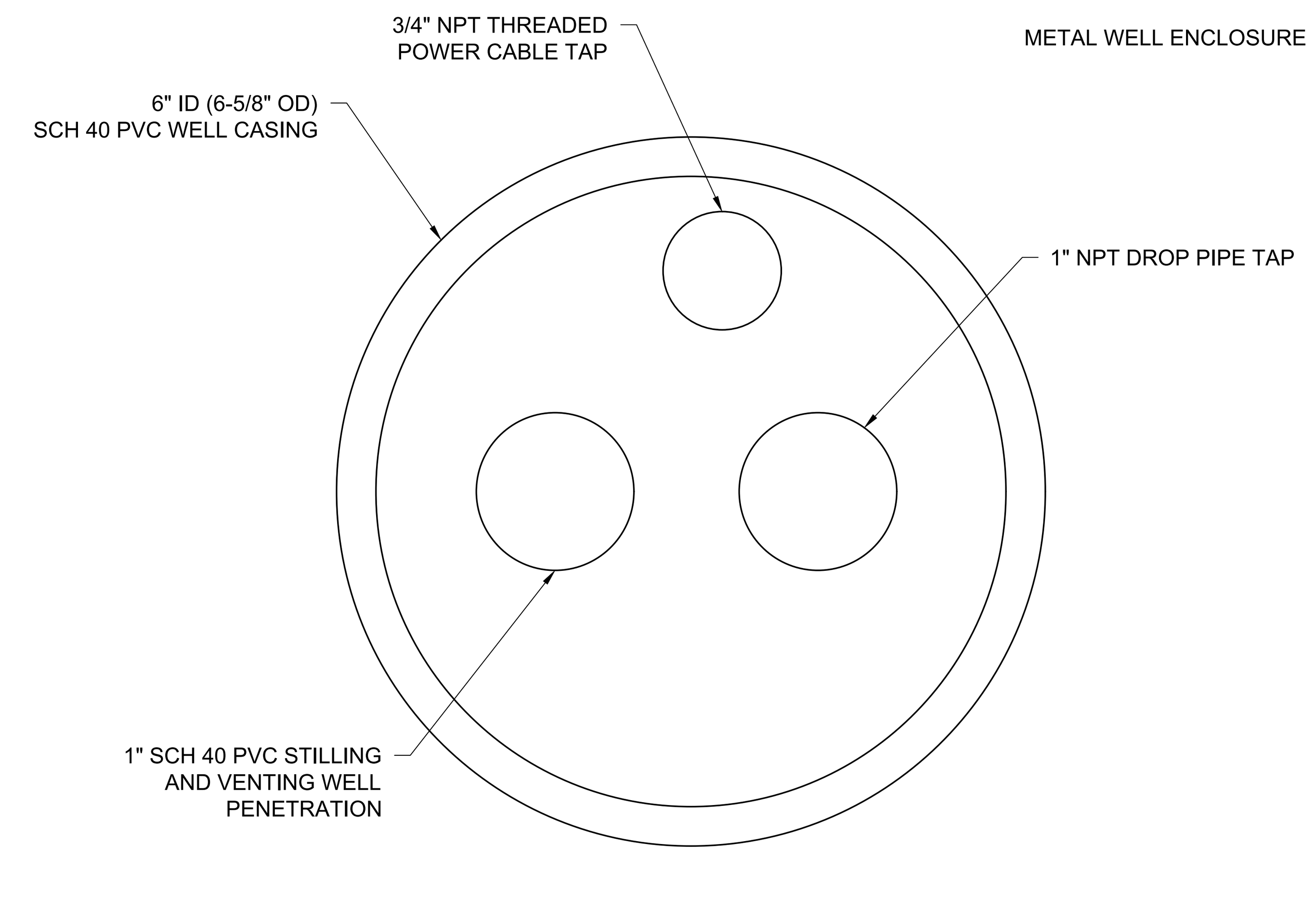
SCALE:

C1

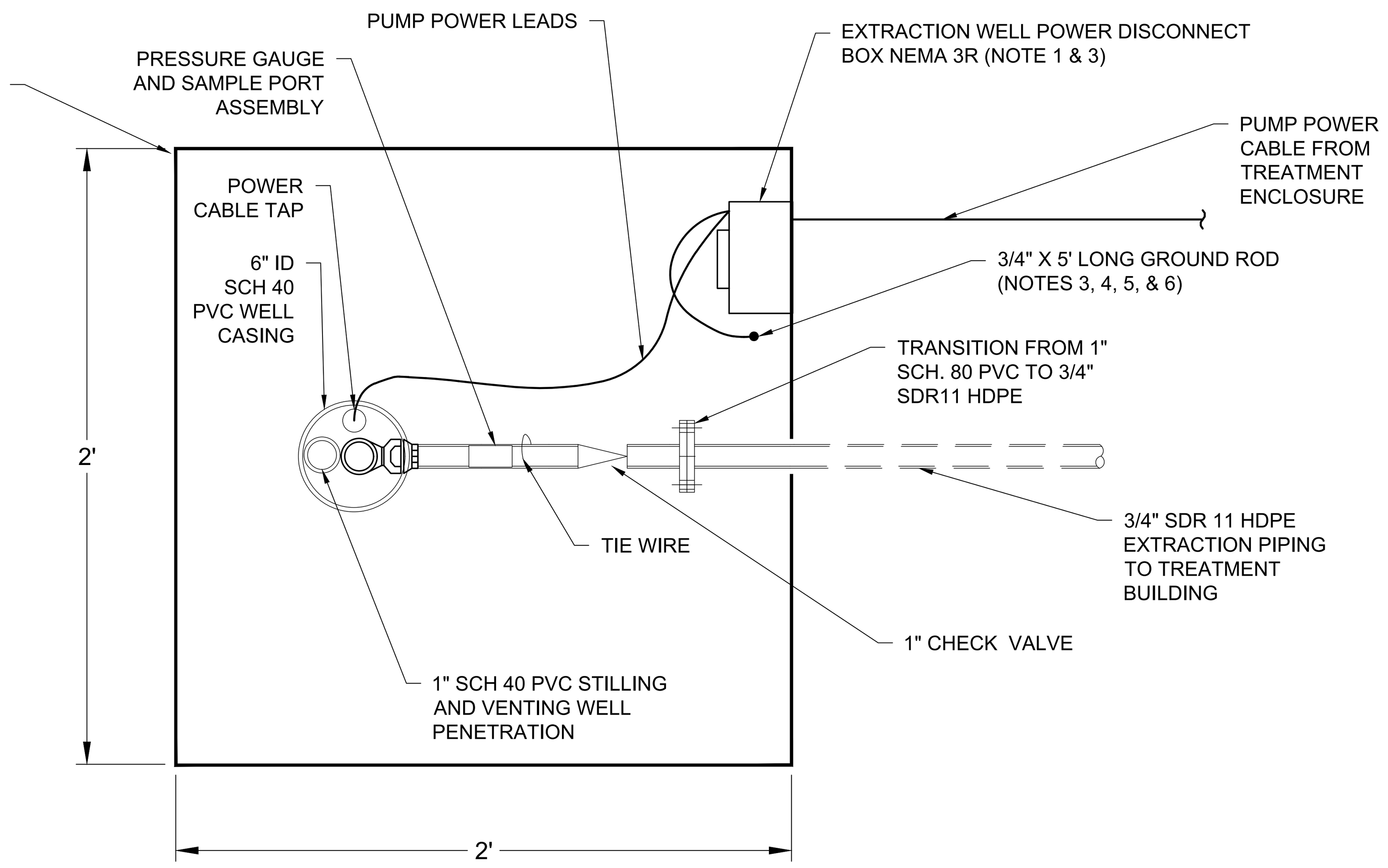
SHEET 1 OF 8



A C1 C2 EXTRACTION WELL
NOT TO SCALE



1 C2 COMPRESSION WELL SEAL
NOT TO SCALE



2 C2 EXTRACTION WELL VAULT PLAN
NOT TO SCALE

WELL CONSTRUCTION SPECIFICATIONS - EXTRACTION WELLS

WELL TYPE	BOREHOLE DIAMETER	WELL DIAMETER	SCREEN MATERIAL	SLOT SIZE	CASING MATERIAL	FILTER PACK	WELL SEAL	SURFACE COMPLETION
EXTRACTION WELL	8-INCH MINIMUM	6-INCH	STAINLESS STEEL WIRE-WRAPPED	0.020-INCH	SCH. 40 PVC	JOHNSON MUNI-PAK	CEMENT GROUT	METAL WELL VAULT

WELL CONSTRUCTION SCHEDULE (DEPTH ARE FEET BELOW GRADE APPROXIMATE)

WELL ID	WELL TYPE	A	B	C	D	E	F	G
EX-1	EXTRACTION WELL	0.54'	2.00'	12.04'	25.00'	29.14'	29.30'	34.14'
EX-2	EXTRACTION WELL	0.62'	2.00'	8.32'	20.00'	25.42'	26.50'	30.42'
EX-3	EXTRACTION WELL	0.51'	2.00'	7.51'	20.00'	24.61'	24.80'	29.61'

NOTES:

1. WELL VAULT WAS INSTALLED FLUSH TO GROUND SURFACE.
2. 3/4" DIAMETER 10-FOOT LONG, STEEL CORE WITH COPPER MOLTEN WELDED OR ELECTRICALLY BONDED TO EXTERIOR, GROUNDING ROD.
3. #2 AWG BARE COPPER GROUND WAS RAN FROM GROUND ROD (EXOTHERMIC WELD) TO GROUND LUG IN THE EXTRACTION WELL POWER JUNCTION BOX.
4. REFER TO RISER DIAGRAM FOR CONDUCTOR SCHEDULE.
5. DETAILS TYPICAL OF THREE EXTRACTION WELLS.
6. ORIENTATION WAS SHOWN TO PROVIDE CLARITY. ACTUAL ORIENTATION WAS DETERMINED IN THE FIELD TO PERMIT ACCESS FOR OPERATION AND MAINTENANCE ACTIVITIES.
7. SAFETY CABLE WAS ATTACHED TO PUMP AND MOUNTED INSIDE THE WELL VAULT.

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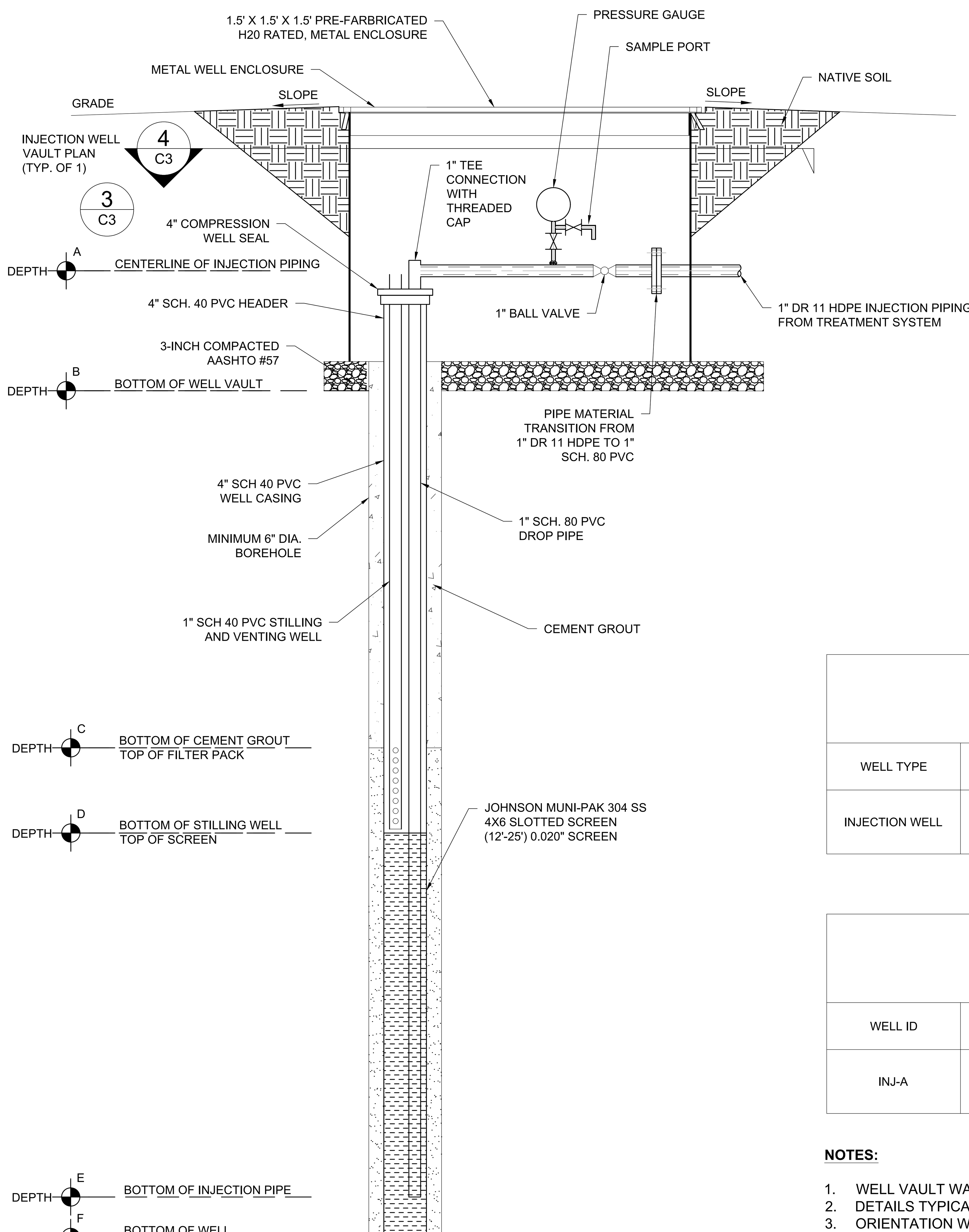
SHEET TITLE
EXTRACTION WELL DETAILS

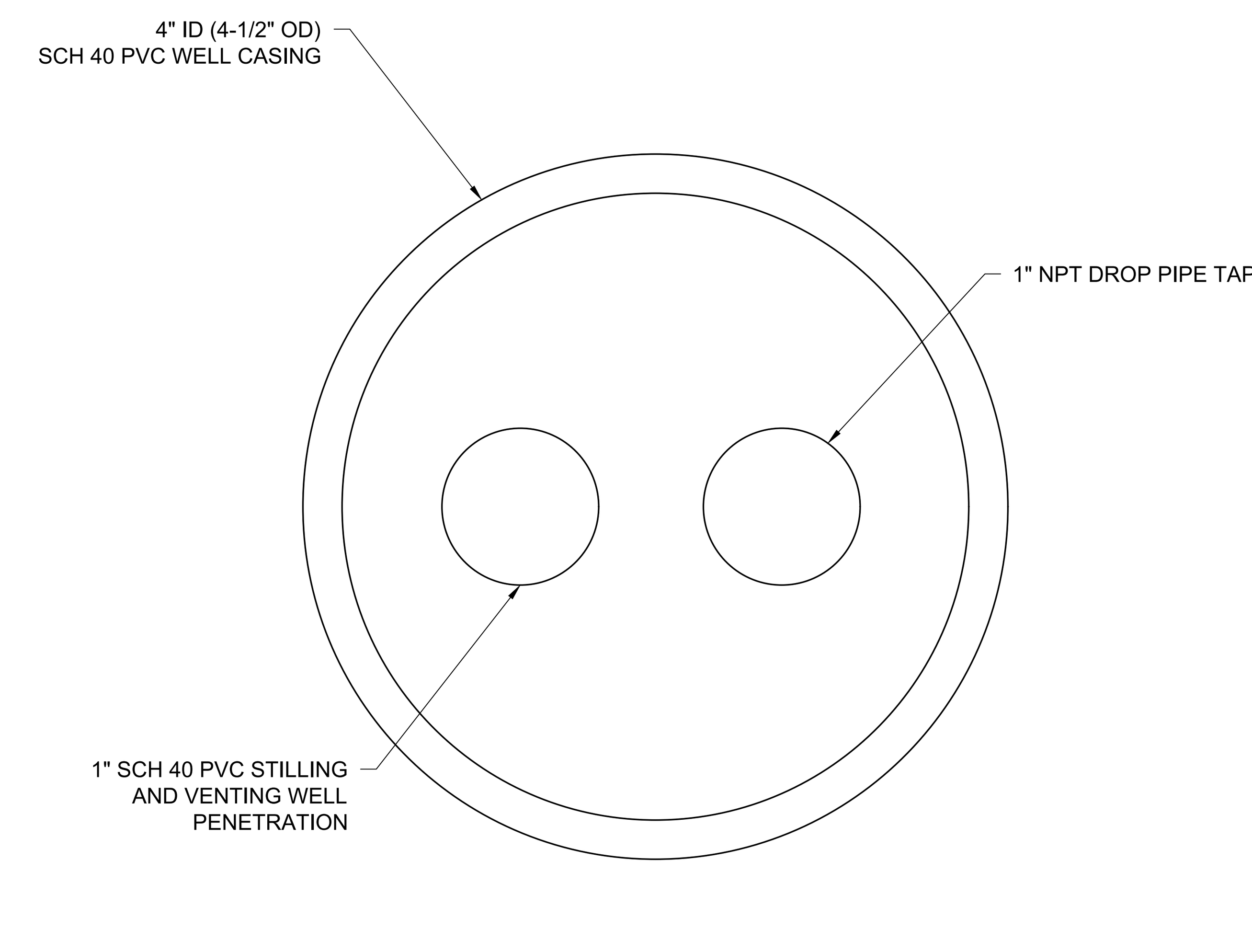
SCALE:

C2

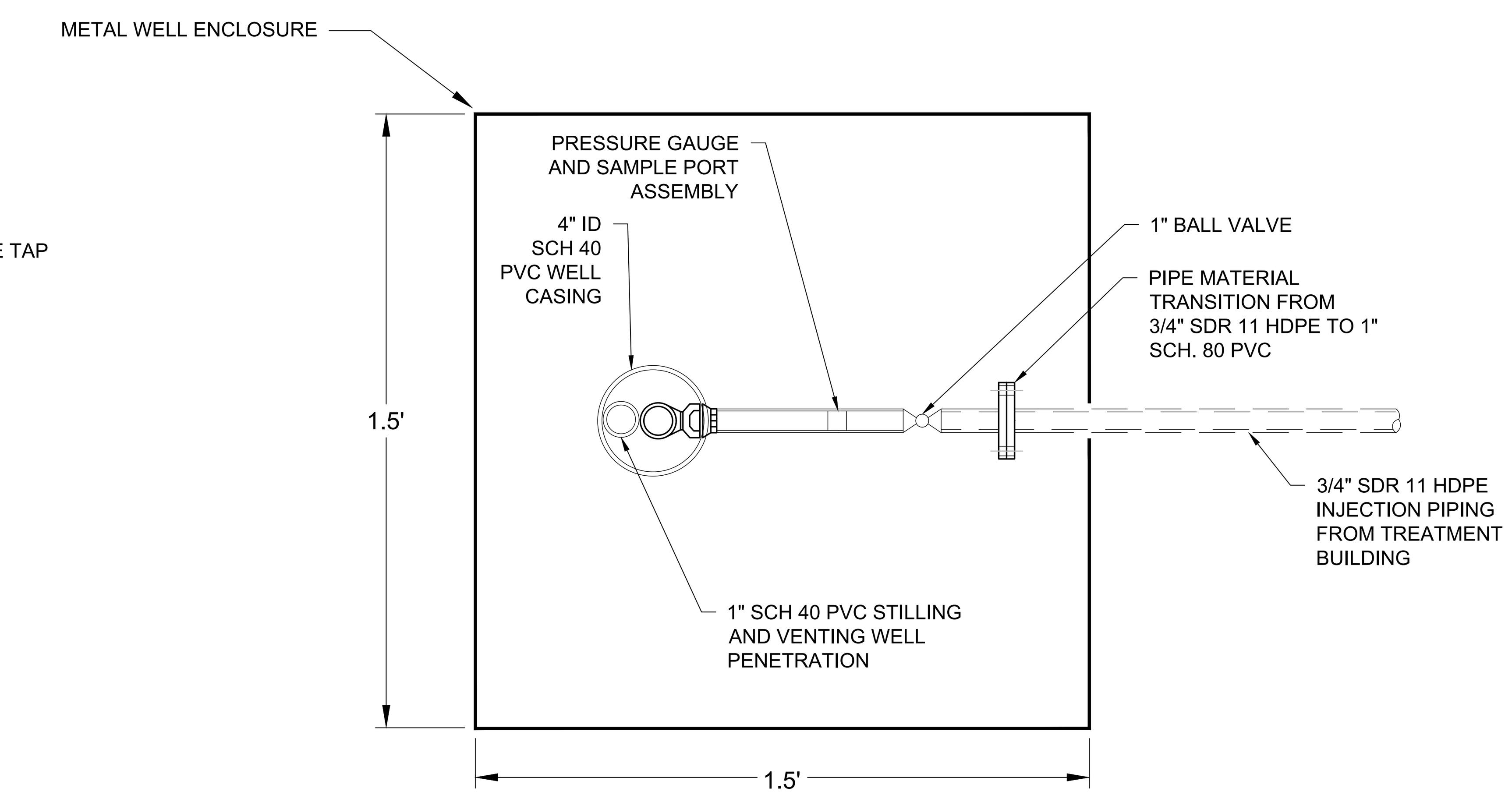
SHEET 2 OF 8



B C1 C3 **INJECTION WELL**
NOT TO SCALE



3 C3 **COMPRESSION WELL SEAL**
NOT TO SCALE



4 C3 **INJECTION WELL VAULT PLAN**
NOT TO SCALE

WELL CONSTRUCTION SPECIFICATIONS - INJECTION WELLS								
WELL TYPE	BOREHOLE DIAMETER	WELL DIAMETER	SCREEN MATERIAL	SLOT SIZE	CASING MATERIAL	FILTER PACK	WELL SEAL	SURFACE COMPLETION
INJECTION WELL	6-INCH MINIMUM	4-INCH	STAINLESS STEEL WIRE-WRAPPED	0.020-INCH	SCH. 40 PVC	JOHNSON MUNI-PAK	CEMENT GROUT	METAL WELL VAULT

WELL CONSTRUCTION SPECIFICATIONS - INJECTION WELLS							
WELL ID	WELL TYPE	A	B	C	D	E	F
INJ-A	INJECTION WELL	1.00'	2.00'	6.65'	18.00'	18.00'	23.75'

NOTES:

1. WELL VAULT WAS INSTALLED FLUSH TO GROUND SURFACE.
2. DETAILS TYPICAL OF ONE INJECTION WELL LOCATED OUTSIDE OF BUILDING.
3. ORIENTATION WAS SHOWN TO PROVIDE CLARITY. ACTUAL ORIENTATION WAS DETERMINED IN THE FIELD TO PERMIT ACCESS FOR OPERATION AND MAINTENANCE ACTIVITIES.

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DRAWN BY: MK
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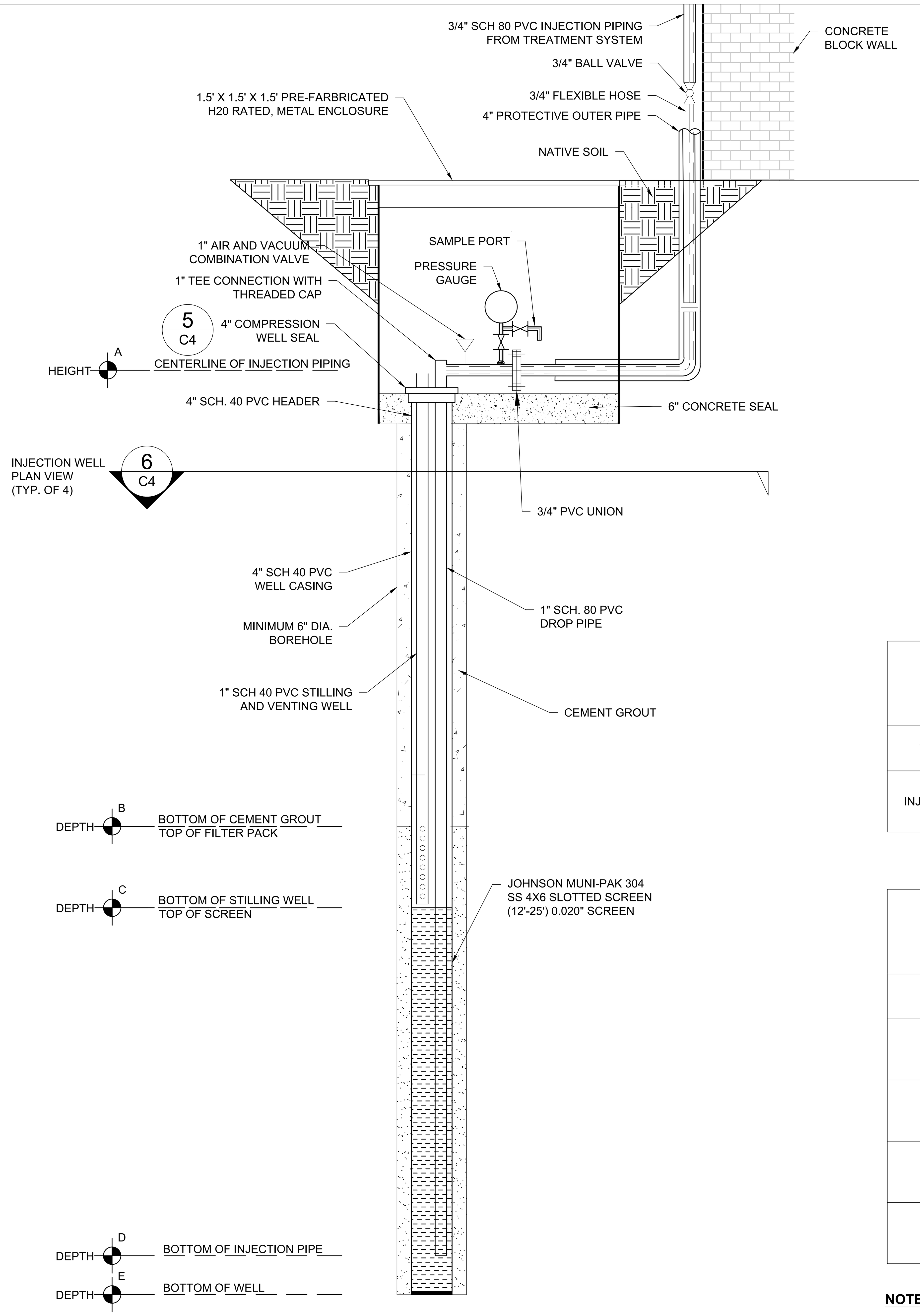
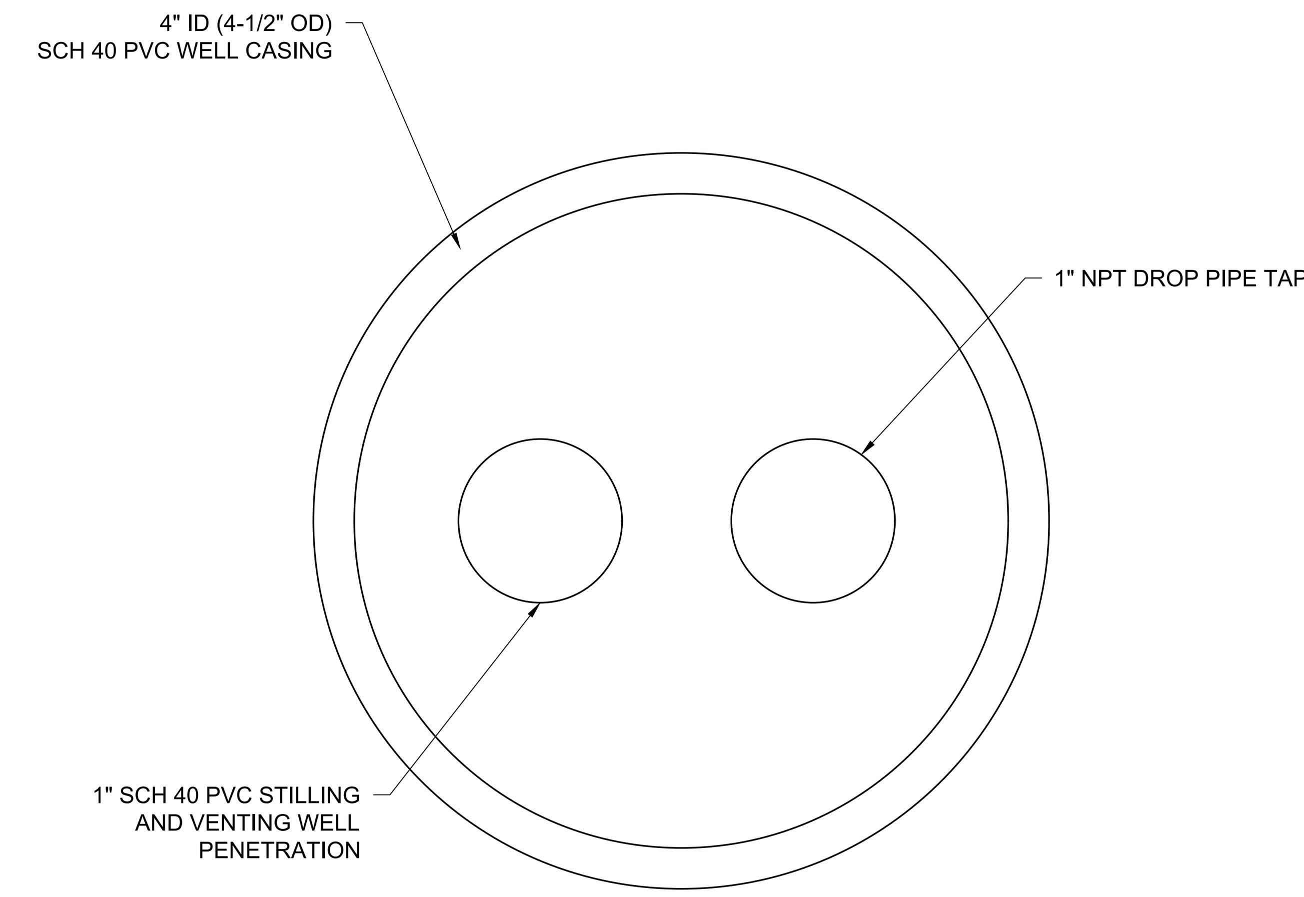
SHEET TITLE
OUTSIDE BUILDING INJECTION WELL DETAILS

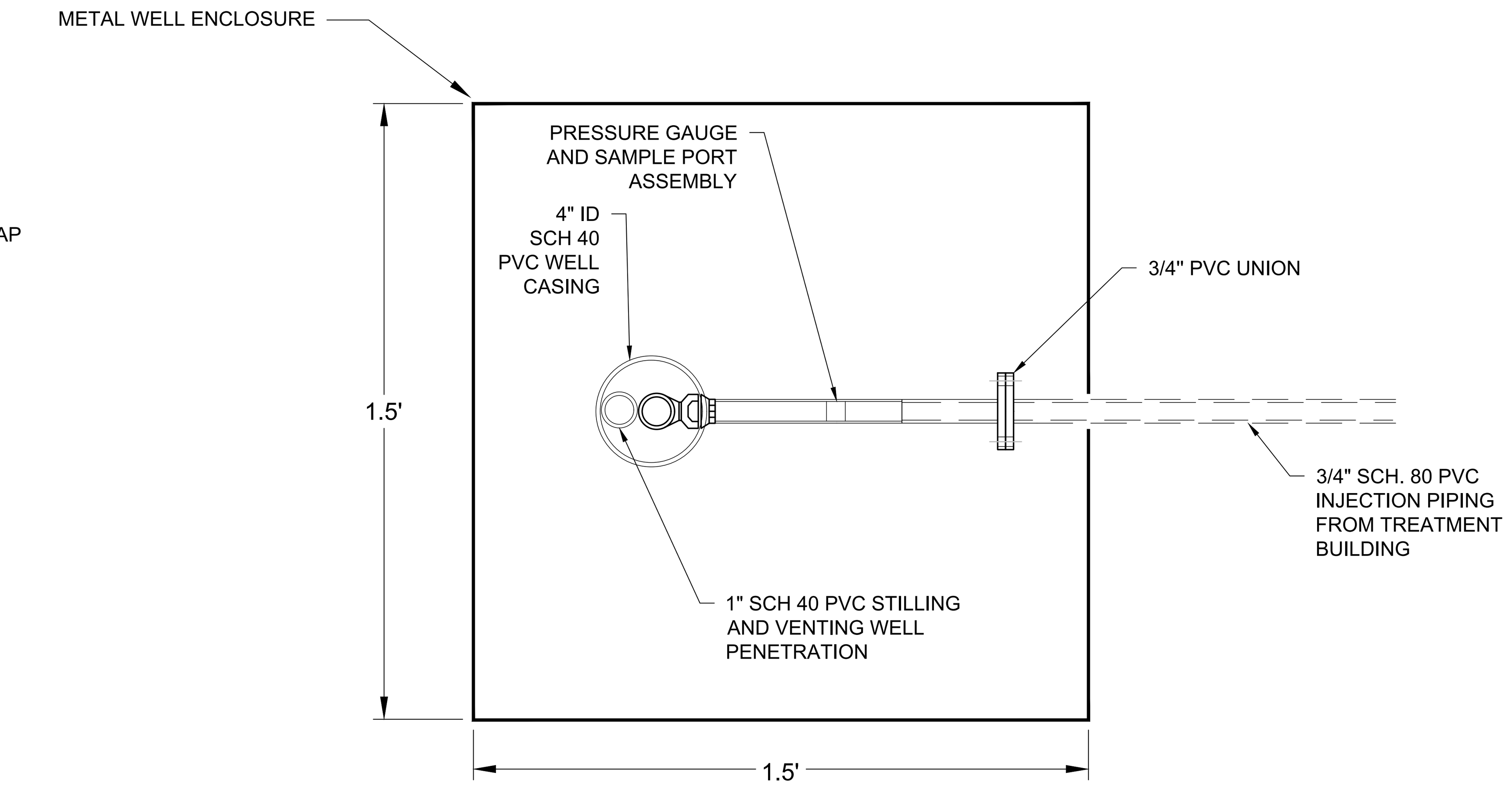
SCALE:
C3



C C1 C4 **INJECTION WELL**
NOT TO SCALE



5 C4 **COMPRESSION WELL SEAL**
NOT TO SCALE



6 C4 **INJECTION WELL PLAN VIEW**
NOT TO SCALE

WELL CONSTRUCTION SPECIFICATIONS - INJECTION WELLS

WELL TYPE	BOREHOLE DIAMETER	WELL DIAMETER	SCREEN MATERIAL	SLOT SIZE	CASING MATERIAL	FILTER PACK	WELL SEAL	SURFACE COMPLETION
INJECTION WELL	6-INCH MINIMUM	4-INCH	STAINLESS STEEL WIRE-WRAPPED	0.020-INCH	SCH. 40 PVC	JOHNSON MUNI-PAK	CEMENT GROUT	METAL WELL VAULT

WELL CONSTRUCTION SPECIFICATIONS - INJECTION WELLS

WELL ID	WELL TYPE	A	B	C	D	E
INJ-B	INJECTION WELL	1.00'	7.94'	20.00'	20.00'	25.02'
INJ-C	INJECTION WELL	1.00'	8.47'	20.00'	20.00'	25.57'
INJ-D	INJECTION WELL	1.00'	8.71'	20.00'	20.00'	25.81'
INJ-E	INJECTION WELL	1.00'	8.67'	20.00'	20.00'	25.77'

NOTES:

1. WELL WAS INSTALLED AS A STICK-UP.
2. DETAILS TYPICAL OF FOUR INJECTION WELLS LOCATED INSIDE BUILDING.
3. ORIENTATION WAS SHOWN TO PROVIDE CLARITY. ACTUAL ORIENTATION WAS DETERMINED IN THE FIELD TO PERMIT ACCESS FOR OPERATION AND MAINTENANCE ACTIVITIES.

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DESIGNED BY: CS
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BIO-ENHANCED DIRECTED GROUNDWATER RECIRCULATION PILOT TEST

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SHEET TITLE

INSIDE BUILDING INJECTION WELL DETAILS

SCALE:

C4

SHEET 4 OF 8

NOTES:

1. ALL EXPOSED PIPE OUTSIDE OF THE TREATMENT COMPOUND WAS LABELED TO REFLECT THE CONTENTS AS NON-POTABLE WATER.
2. 3" WIDE DETECTABLE TAPE 1' BELOW FINISHED GRADE ABOVE THE PROCESS PIPELINES. BLUE TAPE CENTERED ABOVE THE FORCEMAINS AND LABELED "CAUTION BURIED PIPELINE BELOW". RED TAPE CENTERED ABOVE ELECTRICAL CONDUIT AND LABELED "CAUTION BURIED ELECTRICAL BELOW".
3. SEE DRAWING E-02 FOR ELECTRICAL CONDUIT FILL DETAILS

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DATE: FEBRUARY, 2018
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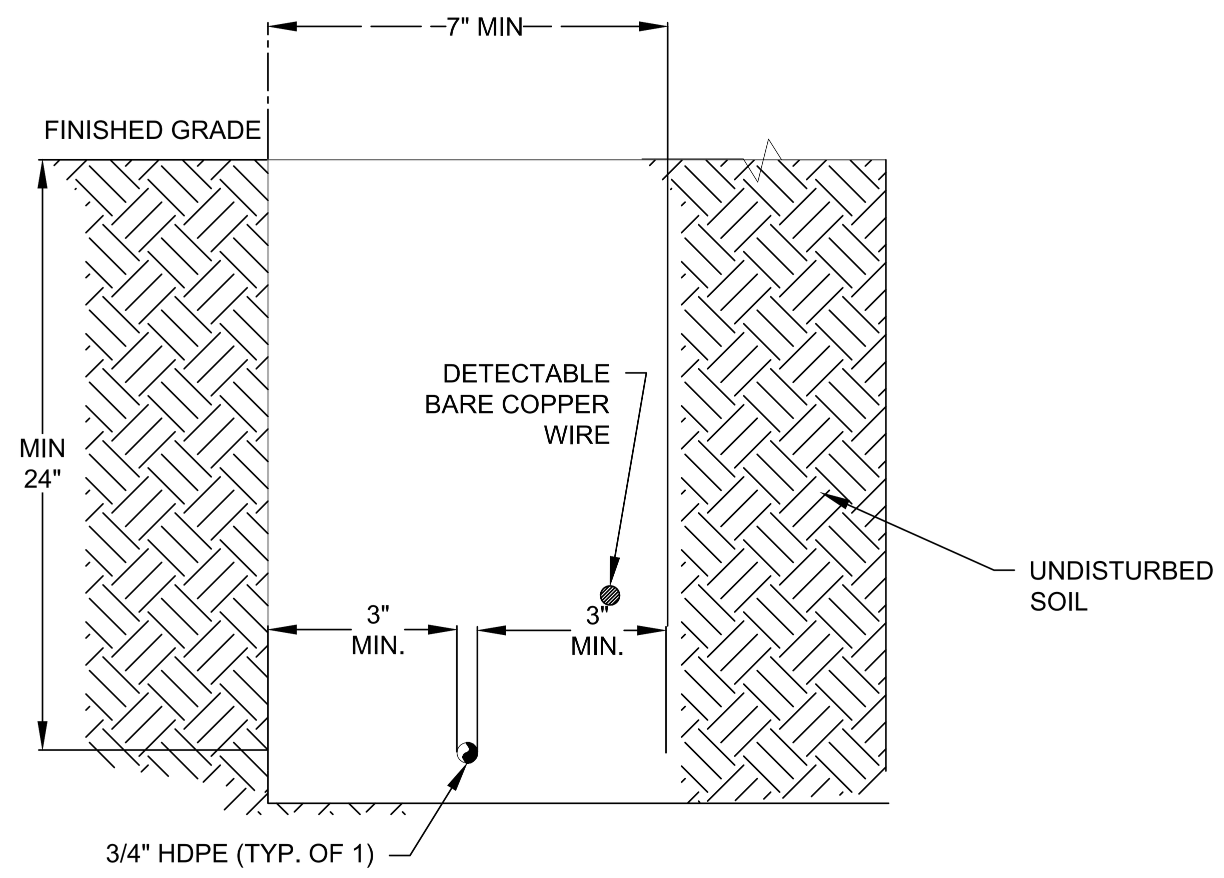
SHEET TITLE
TRENCH SECTIONS

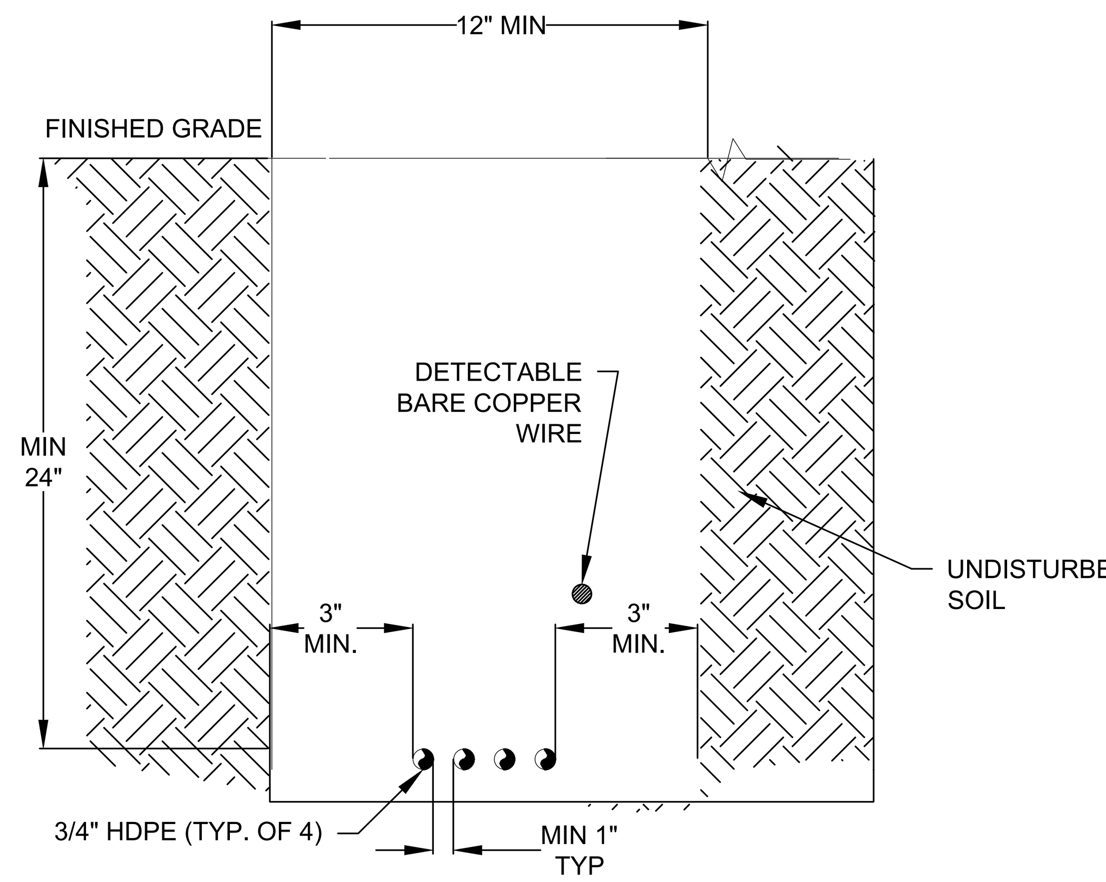
SCALE: VARIES

C5

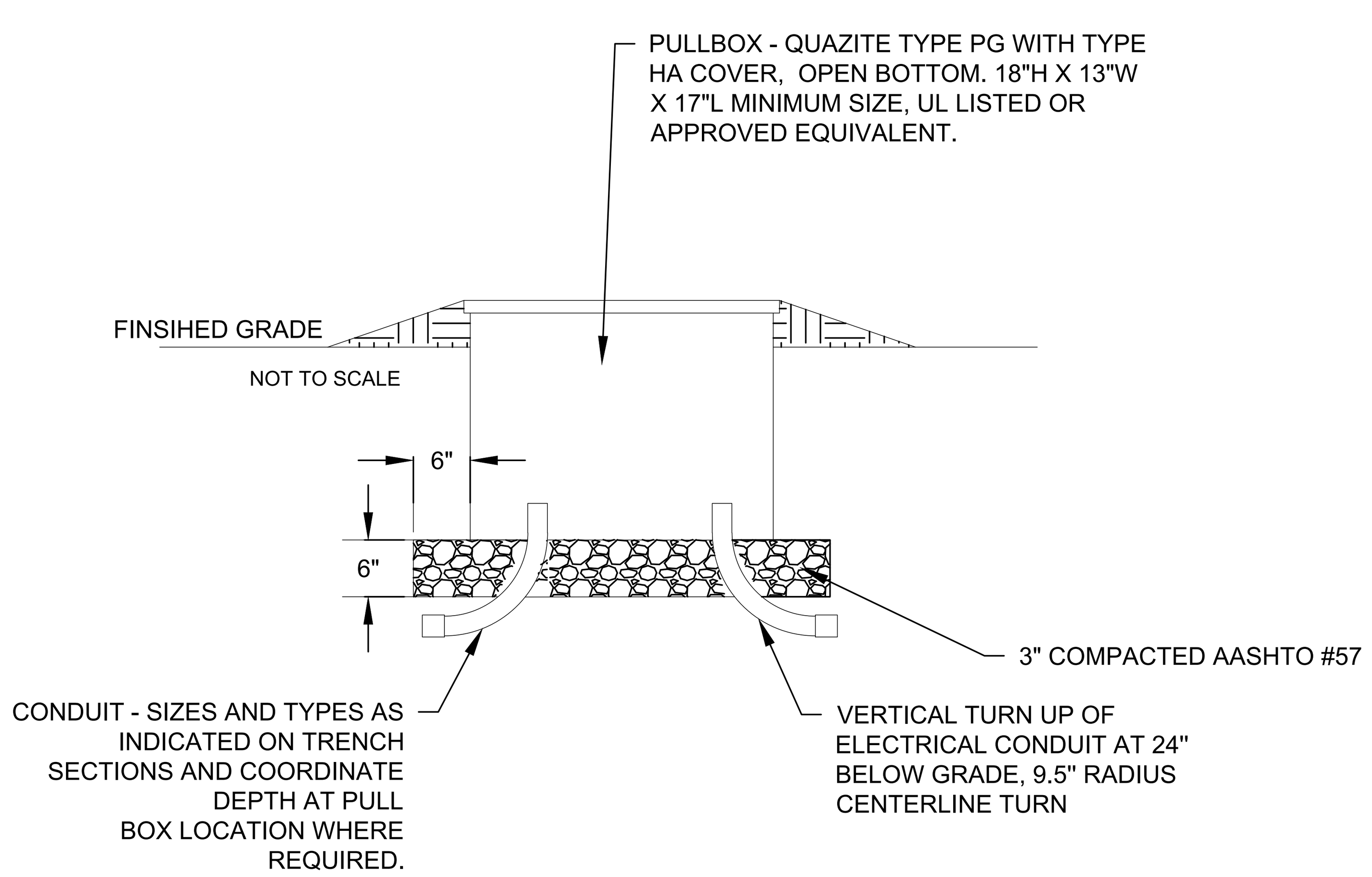
SHEET 5 OF 8



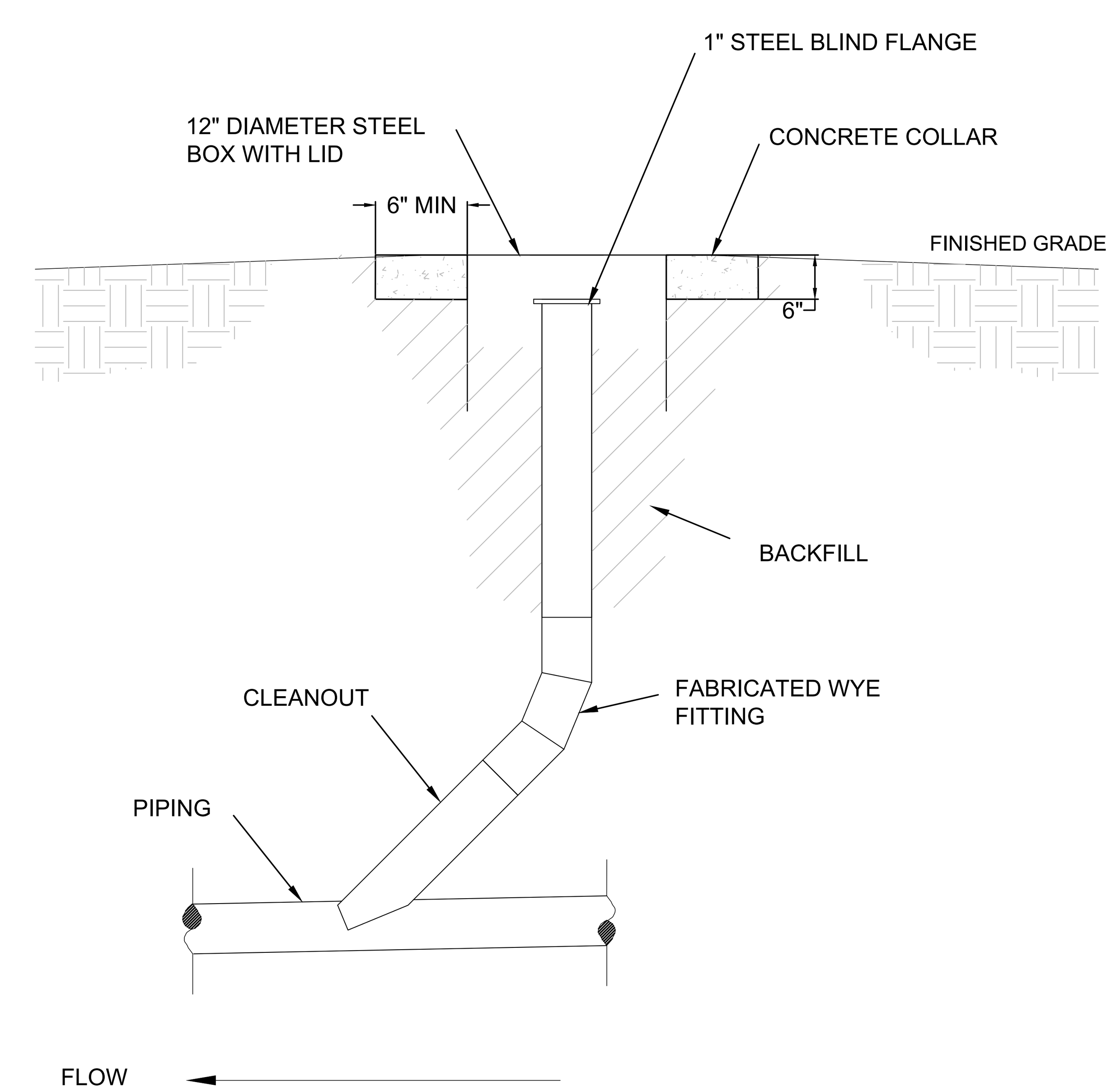
O C1 C6 SECTION
NOT TO SCALE



P C1 C6 SECTION
NOT TO SCALE



J C1 C6 ELECTRICAL HAND HOLE DETAIL



K C1 C6 PIPELINE CLEANOUT SECTION
NOT TO SCALE

NOTES:
1. CLEANOUTS ARE CLEARLY MARKED WITH IDENTIFICATION TAGGING OR LABELING.
2. SUBGRADE AND GRAVEL LOT WAS GRADED TO PROMOTE POSITIVE DRAINAGE AND PREVENT PONDING.

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0	08/16	ISSUE FOR CONSTRUCTION	MK

SEALS

DATE:	FEBRUARY, 2018
PROJECT NO.:	02118201.0001.00300
FILE NAME:	C5 - CIVIL DETAILS
DESIGNED BY:	CS
DRAWN BY:	MK
CHECKED BY:	XX

8000 JEFFERSON DAVIS HWY, RICHMOND, VA 23297
DEFENSE SUPPLY CENTER
BIO-ENHANCED DIRECTED GROUNDWATER RECIRCULATION PILOT TEST
ARCADIS PROJ. NO. 02118201.0001.00300

SHEET TITLE
TRENCH SECTIONS AND MISCELLANEOUS DETAILS

SCALE: VARIES

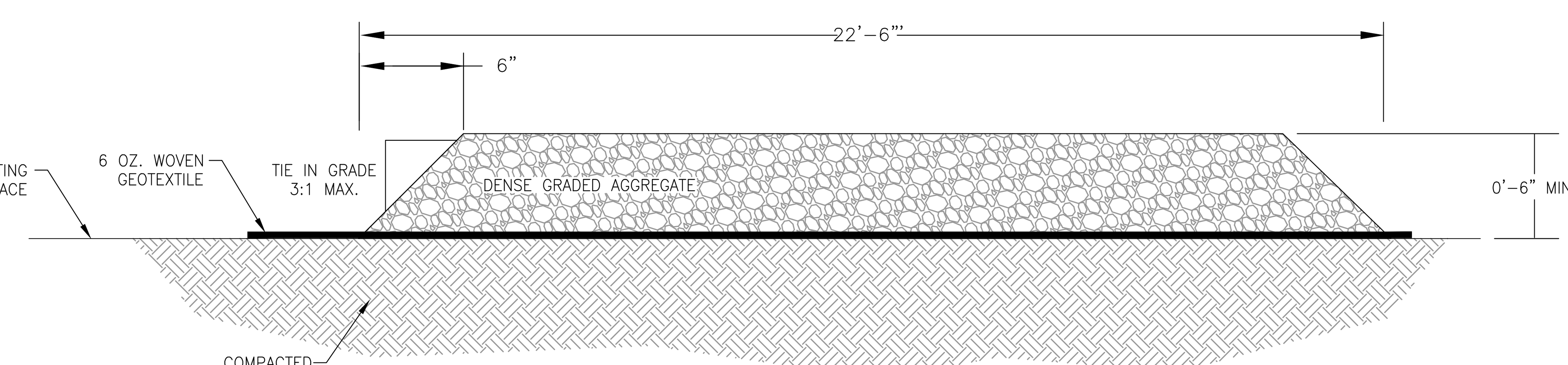
C6

SHEET 5 OF 8

NOTES:

1. 6 OUNCE WOVEN GEOTEXTILE FABRIC WAS PLACED OVER THE COMPACTED SUBGRADE PRIOR TO PLACING AND COMPACTING DENSE GRADED AGGREGATE.
2. SUBGRADE, GRAVEL LOT, ACCESS ROAD, AND SURROUNDING AREAS WAS GRADED TO PROMOTE POSITIVE DRAINAGE AND PREVENT PONDING.

N C1 | C7 **GRAVEL PAD DETAIL**
NOT TO SCALE



M C1 | C7 **GRAVEL PAD DETAIL**
NOT TO SCALE

User:JBOOM Spec:AUS-NCSMOD File:\\ARCADIS-US.COM\OFFICEDATA\MILWAUKEE-WI\EIC_DWG\PROJECTS\DSCR\BDGR\CAD\CIVIL\C5 - CIVIL DETAILS.DWG Scale:1:1 SavedDate:5/2/2018 Time:11:58 Plot Date: Vande Boom, Jill; 5/2/2018; 12:23 : Layout:C7

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ARCADIS PROJ. NO. 02118201.0001.00300

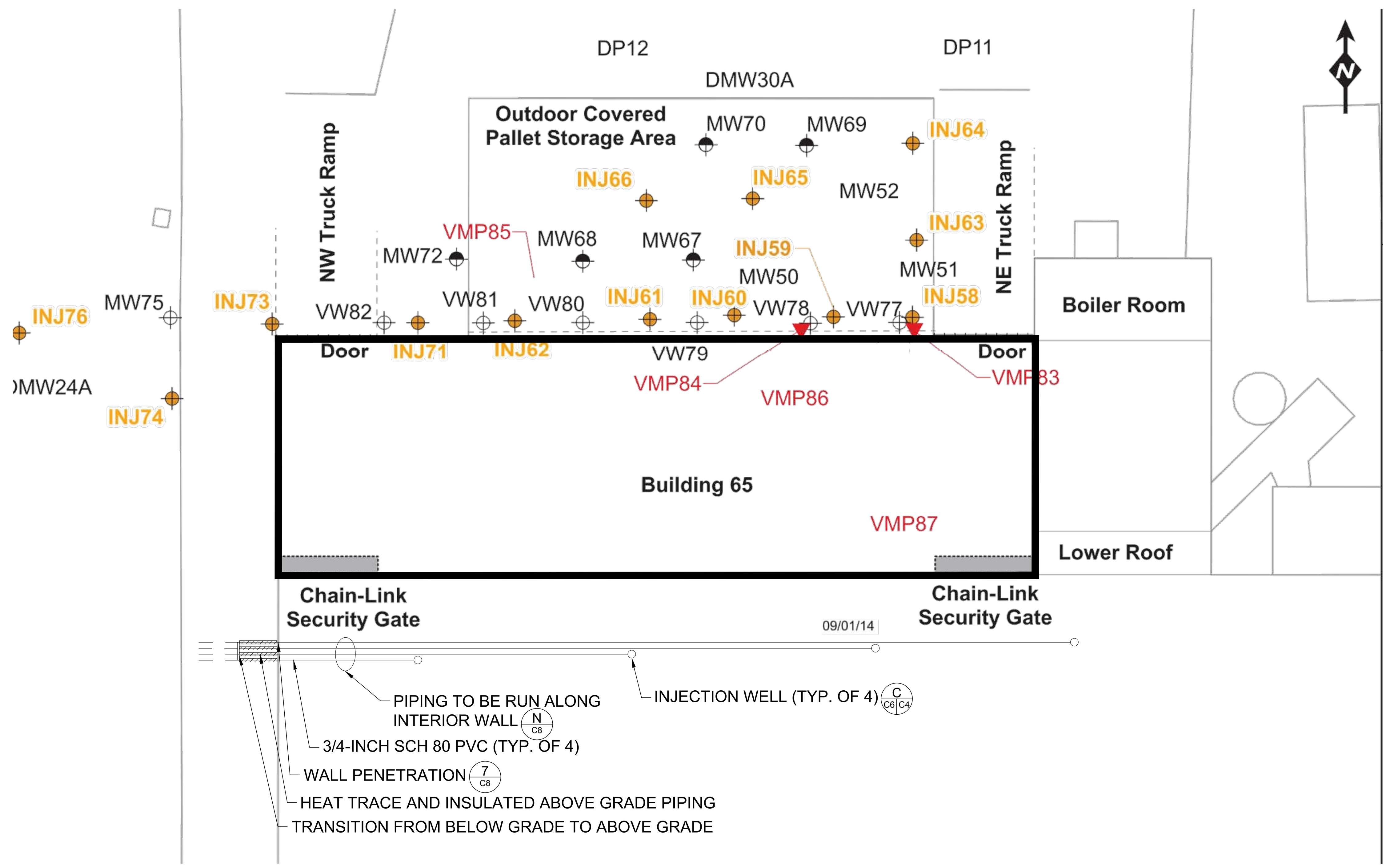
SHEET TITLE

MISCELLANEOUS DETAILS

SCALE: VARIES

C7

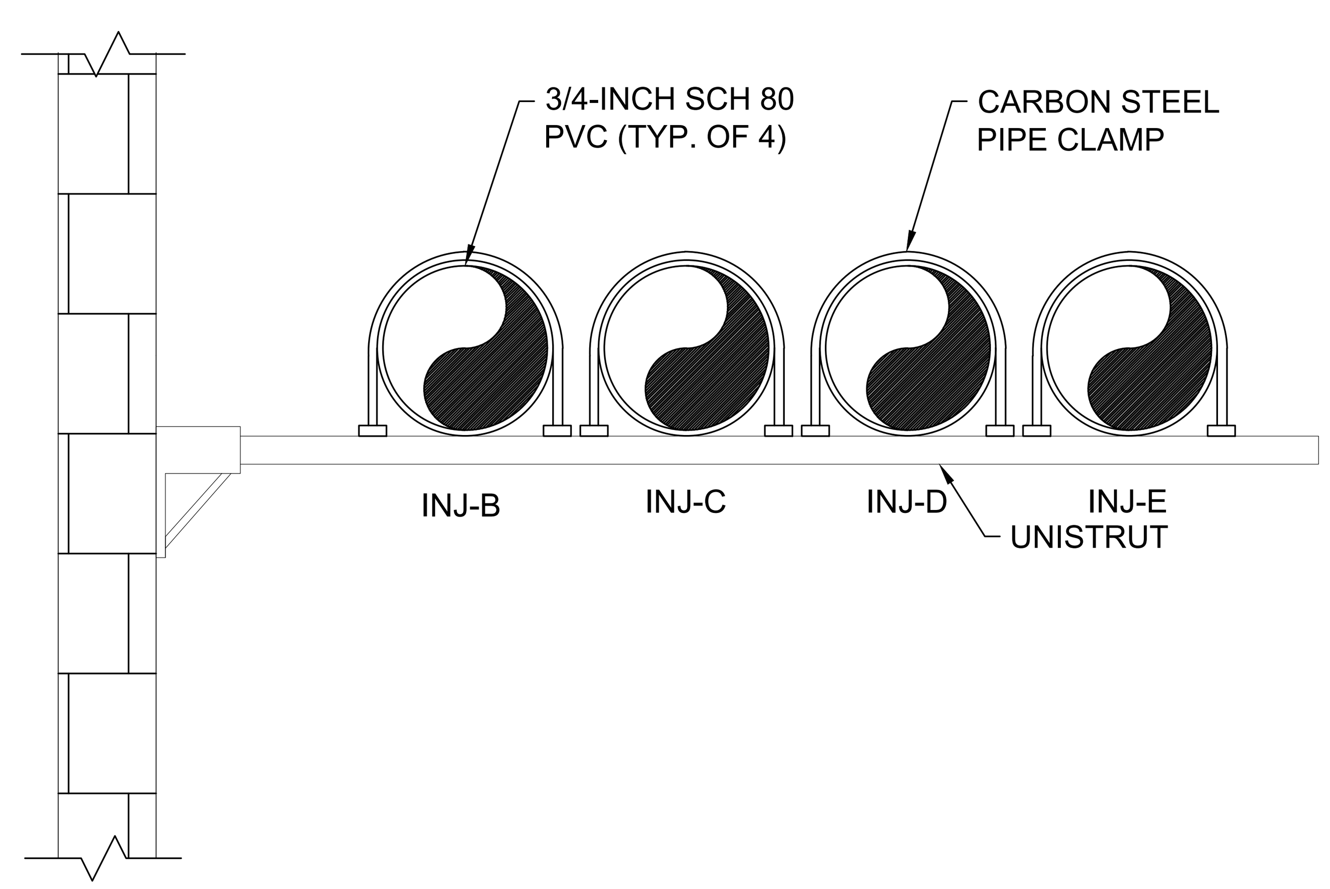
SHEET 5 OF 8



BUILDING LAYOUT

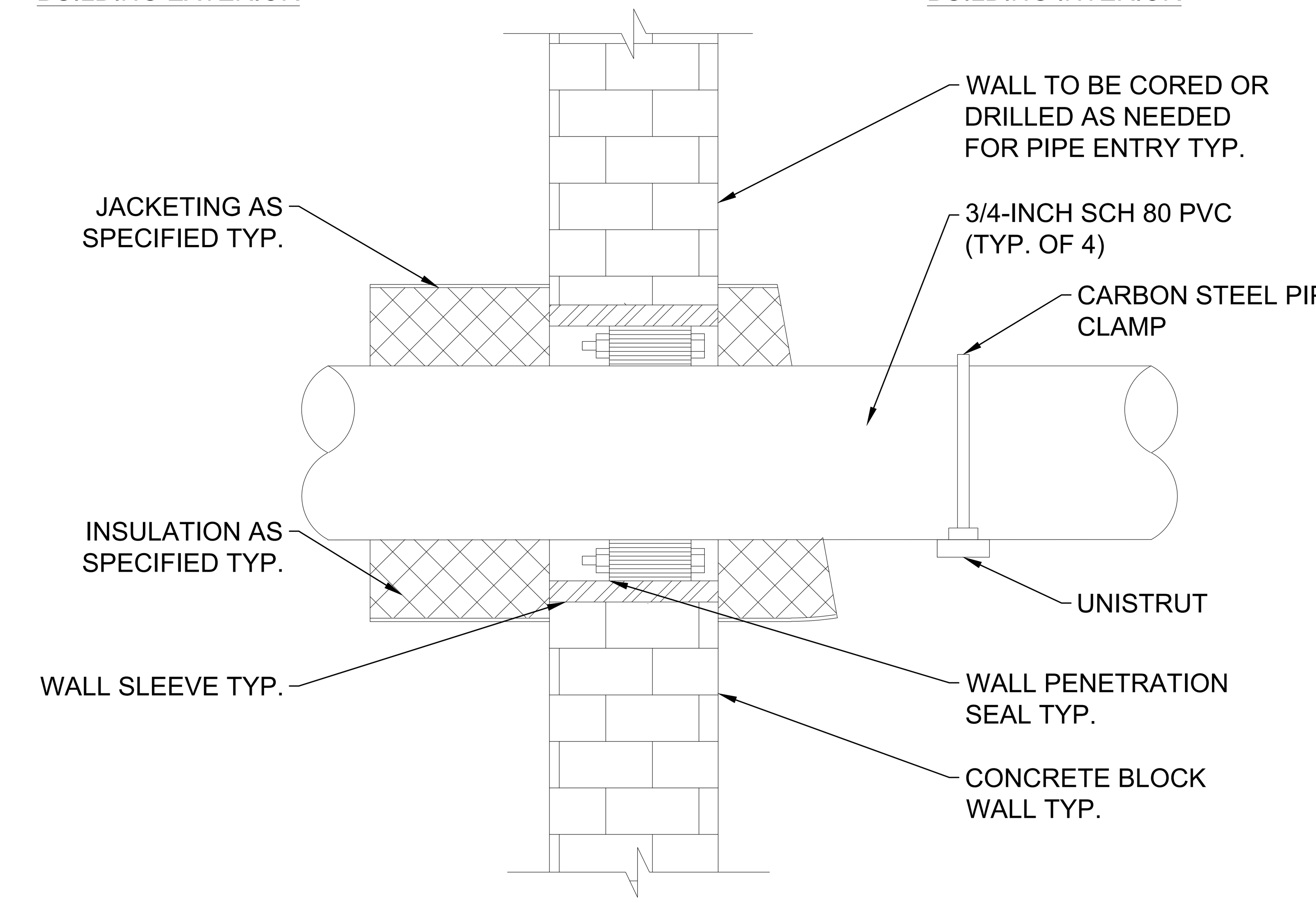
NOTES:

1. ALL ABOVE GRADE PIPING WAS HEAT TRACED AND INSULATED.
2. HEAT TRACE SYSTEM COMPONENTS ARE INDICATED ON DRAWING E-03.
3. 3/4-INCH SDR 11 HPDE WAS TRANSITIONED TO 3/4" SCH 80 PVC WHEN CONVEYANCE PIPE WAS ABOVE GRADE.



N C8 TYPICAL WALL SUPPORT/MOUNT DETAIL

NOT TO SCALE



7 C8 INSULATED PIPE WALL PENETRATION DETAIL (TYP.)

NOT TO SCALE

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SEALS

DATE:	FEBRUARY, 2018
PROJECT NO.:	02118201.0001.00300
FILE NAME:	C8 - INJ PIPING LAYOUT
DESIGNED BY:	CS
DRAWN BY:	MK
CHECKED BY:	XX

8000 JEFFERSON DAVIS HWY, RICHMOND, VA 23297

DEFENSE SUPPLY CENTER

BIO-ENHANCED DIRECTED GROUNDWATER RECIRCULATION PILOT TEST

ARCADIS PROJ. NO. 02118201.0001.00300

SHEET TITLE

INSIDE BUILDING INJECTION PIPING LAYOUT

SCALE:

C8

SHEET 8 OF 8

User:NTHOMAS Spec:AUS-NCSMOD File:G:\EIC_DWG\PROJECTS\DSCR\BDGR\CAD\CIVIL\C8 - INJ PIPING LAYOUT.DWG Scale:1:1 SavedDate:5/2/2018 Time:12:26 Plot Date: Thomas, Nick; 5/11/2018; 11:27 ; Layout:C8

ELECTRICAL SPECIFICATIONS:

GENERAL

1. ALL ELECTRICAL EQUIPMENT SHALL BE U.L. LISTED AND LABELED.

2. THE CONTRACTOR SHALL FAMILIARIZE HIMSELF WITH THE EXISTING CONDITIONS AND HIS PROPOSAL SHALL INCLUDE ALL CONTINGENCIES NECESSARY FOR THE COMPLETION OF HIS WORK REGARDING SUCH EXISTING CONDITIONS.

3. ALL ELECTRICAL WORK SHALL BE COMPLETED IN ACCORDANCE WITH ALL LOCAL, STATE AND FEDERAL REGULATIONS INCLUDING THE MOST RECENT EDITION OF THE NATIONAL ELECTRIC CODE (NEC) AND OSHA REQUIREMENTS, ALL AS INTERPRETED BY THOSE HAVING JURISDICTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY COORDINATION REQUIRED WITH THE LOCAL FIRE DEPARTMENT. ANY DRAWINGS REQUIRED FOR PERMITS OTHER THAN THOSE PRESENTED HEREIN WILL BE THE RESPONSIBILITY OF THE CONTRACTOR AND SHALL BE REVIEWED BY THE ENGINEER PRIOR TO USE.

4. THERE SHALL BE NO SUBSTITUTIONS UNLESS THE CONTRACTOR HAS OBTAINED WRITTEN APPROVAL FROM THE OWNER AFTER HAVING SUBMITTED AN ALTERNATIVE PROPOSAL COMPLETE WITH A DESCRIPTION OF DEVIATION FROM THE SPECIFICATIONS AND A STATEMENT OF BENEFITS TO BE DERIVED SHOULD SUCH A PROPOSED SUBSTITUTE BE ACCEPTED.

5. THE ELECTRICAL DRAWINGS ARE DIAGRAMMATIC AND ARE INTENDED TO SHOW THE APPROXIMATE LOCATIONS OF OUTLETS, CONDUIT, JUNCTION BOXES, EQUIPMENT, ETC. DIMENSIONS PRESENTED ON THE DRAWINGS SHALL TAKE PRECEDENCE OVER SCALED DIMENSIONS AND ALL DIMENSIONS, WHETHER SHOWN ON THE DRAWINGS OR SCALED, SHALL BE VERIFIED IN THE FIELD.

6. ELECTRICAL PANEL BUILDER(S) SHALL PROVIDE DETAILED SHOP DRAWINGS OF PANEL FOR ENGINEER APPROVAL PRIOR TO CONSTRUCTION.

7. UNLESS OTHERWISE NOTED, CONDUIT USE SHALL BE AS FOLLOWS:

   7.1. CONDUIT ABOVE GRADE AND EXPOSED TO THE ELEMENTS SHALL BE RIGID METAL CONDUIT.
   7.2. EXPOSED CONDUIT ABOVE GRADE AND PROTECTED FROM THE ELEMENTS SHALL BE EMT.
   7.3. FINAL CONNECTION TO MOVING EQUIPMENT (i.e. MOTORS, TRANSFORMERS, FREE STANDING EQUIPMENT, ECT.) SHALL BE BY LIQUID TIGHT FLEXIBLE METALLIC CONDUIT.
   7.4. INTERIOR LIGHTING CIRCUITS ABOVE 8'-0" AFF SHALL BE MC CABLE WITH A DEDICATED GROUNDING CONDUCTOR.
   7.5. DIRECT BURIED CONDUIT BELOW GRADE SHALL BE SCHEDULE 40 PVC. FACTORY MADE RGS SWEEPS AND APPROPRIATE FITTINGS SHALL BE USED TO TRANSITION BELOW GRADE PVC TO ABOVE GRADE RGS CONDUIT SYSTEMS.

8. INSTALL PULL BOXES, JUNCTION BOXES, SPLICE BOXES AND FITTINGS WHERE SHOWN AND AT OTHER LOCATIONS AS NECESSARY. PULL AND JUNCTION BOX MATERIAL SHALL MATCH THE CONDUIT SYSTEM ATTACHED.

9. ALL 125 VOLT, SINGLE PHASE 20 AMPERE RECEPTACLE OUTLETS USED BY THE WORKMEN SHALL BE GROUND FAULT CIRCUIT INTERRUPTER (GFCI) TYPE. ALL RECEPTACLES INSTALLED OUTDOORS SHALL BE WEATHER RESISTANT, GFCI TYPE RECEPTACLES, PER NEC 406.9.

RIGID METAL CONDUIT (RGS)

1. GALVANIZED STEEL, HOT-DIPPED ZINC, ANSI STANDARD C80.1 AND C80.4.

2. MANUFACTURER SHALL BE ALLIED TUBE & CONDUIT CORPORATION, TRIANGLE WIRE AND CABLE INC., OR EQUAL.

NONMETALLIC CONDUIT (PVC)

1. NONMETALLIC RIGID CONDUIT AND FITTINGS SHALL BE CORROSION RESISTANT. CONDUIT SHALL BE SCHEDULE 40 BELOW GRADE AND SCHEDULE 80 ABOVE.

2. CONDUIT AND FITTINGS SHALL BE IN ACCORDANCE WITH NEMA STANDARD TC-2 AND TC-3, LATEST REVISION.

3. MANUFACTURER SHALL BE CARLON ELECTRIC CONDUIT CO., TRIANGLE PWC CO., OR EQUAL.

LIQUID TIGHT FLEXIBLE METALLIC CONDUIT (LFMC)

1. FLEXIBLE CONDUIT SHALL BE AN INTERLINKED GALVANIZED STEEL CORE WITH A SMOOTH LIQUID TIGHT PVC COVER.

2. NEMA RATING OF FITTINGS SHALL MATCH THAT OF THE ENCLOSURE WHERE CONDUIT TERMINATES.

3. MANUFACTURER'S SHALL BE ANACONDA, LIQUATITE OR EQUAL.

JUNCTION BOXES

JUNCTION BOXES SHALL BE A MINIMUM OF 4" X 4" WITH COVER. PROVIDE GASKETED COVER IN WET LOCATION.

WIRES AND CABLES

1. GENERAL

   A. ALL CONDUCTORS, UNLESS OTHERWISE NOTED, SHALL BE STRANDED COPPER, CONSTRUCTED OF SOFT DRAWN OR ANNEALED COPPER.

   B. CONDUCTORS INSULATION SHALL BE COLOR CODED. COLOR OF INSULATION SHALL BE ONE COLOR THROUGHOUT THE ENTIRE RUN.

   C. 480Y/277 VAC, THREE PHASE, 4 WIRE
      PHASE A - BROWN
      PHASE B - ORANGE
      PHASE C - YELLOW
      NEUTRAL - GRAY
      GROUND - GREEN

   D. 120/240 VAC, SINGLE PHASE, 3 WIRE
      PHASE A - RED
      PHASE B - BLACK
      NEUTRAL - WHITE
      GROUND - GREEN

2. LOW VOLTAGE CONDUCTORS

   A. ALL CONDUCTORS FOR POWER, LIGHTING AND 120 VAC CONTROL SHALL BE RATED FOR A MINIMUM OF 600 VAC.

   B. CONDUCTORS SHALL BE CONSTRUCTED OF UNCOATED CLASS C COPPER CONCENTRIC-LAY-STRANDED WIRES.

   C. DRY AND DAMP LOCATIONS: SHALL BE TWWN-2, 90DEG C. WET AND BELOW GRADE LOCATION: SHALL BE TYPE XHHW WITH PVC JACKET.

3. INSTRUMENTATION CABLES

   TWISTED PAIR, WITH QUANTITY OF PAIRS AS SHOWN ON DRAWINGS, OF NO. 18 AWG TINNED COATED CLASS C COPPER CONCENTRIC LAY STRANDED WIRES WITH AN ALUMINUM POLYESTER SHIELD AND COPPER DRAIN. RATED FOR 600V AND COLOR CODED WITH PVC OUTER JACKET.

4. VARIABLE FREQUENCY DRIVE (VFD) CABLES

   SHALL HAVE A MINIMUM OF 45 MILS OF CROSS LINKED POLYETHYLENE INSULATION.

5. CONNECTORS

   A. PIGTAIL SPLICING #10 AND SMALLER, USE TAPERED SPRING WIRE NUTS. MANUFACTURER SHALL BE IDEAL WING NUT, BUCHANAN B-CAP, T&B PIGGIES, OR EQUAL.

   B. FOR TERMINATION OF #14 CONTROL WIRES TO TERMINALS, USE INSULATED COMPRESSION SPADE TYPE CONNECTORS. MANUFACTURER SHALL BE BURNDY HYDENT, T&B STA-KON, OR EQUAL.

   C. SPLICES AND TERMINALS FOR #8 AND LARGER SHALL BE COPPER COMPRESSION TYPE. MANUFACTURER SHALL BE BURNDY HYDENT OR HYLUG, T&B, STA-CON, OR EQUAL.

   D. FIXTURE CONNECTIONS MANUFACTURER SHALL BE T&B STA-KON SERIES PT-66M, IDEAL CRIMP SLEEVE NO. 410 WITH LONG BARREL, OR EQUAL.

   E. PROVIDE HEATSHRINK INSULATION OVER ALL UNINSULATED SPLICES TO MATCH VOLTAGE AND INSULATION LEVEL OF CONDUCTORS.

GROUNDING

1. GROUNDING OF ELECTRICAL SYSTEMS AND EQUIPMENT SHALL, AT A MINIMUM, MEET THE REQUIREMENTS OF NEC ARTICLE 250 OR SHALL EXCEED ARTICLE 250 AS HEREIN SPECIFIED.

2. ALL CONDUITS SHALL HAVE AN INTERNAL GROUNDING CONDUCTOR. THIS GROUNDING CONDUCTOR SHALL BE PROVIDED ALTHOUGH IT MAY NOT BE SHOWN OR SCHEDULED ON THE PLANS.

3. UNLESS NOTED OTHERWISE, GROUNDING ELECTRODE CONDUCTORS SHALL BE A MINIMUM OF NO. #2/0 AWG BARE STRANDED COPPER.

4. GROUND RODS SHALL BE 3/4" DIAMETER, 10 FEET LONG, STEEL CORE WITH COPPER MOLTEN WELDED OR ELECTROLYTICALLY BONDED TO EXTERIOR. GROUND ROD SHALL BE DRIVEN SUCH THAT THE TOP IS 24" BELOW GRADE.

5. ALL CONNECTIONS SHALL BE MADE WITH PERMANENT COMPRESSION OR CADWELD CONNECTORS.

6. GROUND RING SHALL BE #2/0 AWG BARE COPPER. GROUND RING SHALL BE BURIED 30" BELOW GROUND SURFACE.

7. FOR CONDUIT RUNS THAT ARE NOT CONTINUOUS STEEL CONDUIT (I.E. UNDERGROUND FEEDERS), PROVIDE BONDING BUSHINGS WHERE TERMINATING RGS CONDUIT AT AN ENCLOSURE.

ENCLOSURES

1. ENCLOSURES SHALL BE NEMA RATED FOR LOCATION UNLESS OTHERWISE NOTED.

2. WET LOCATIONS OR OUTDOORS, ENCLOSURES SHALL BE NEMA TYPE 3R.

3. ENCLOSURES SHALL HAVE A NAMEPLATE ON THE EXTERIOR IDENTIFYING THE APPLICATION OR FUNCTION OF THE EQUIPMENT ENCLOSED. COORDINATE NAMING IN THE FIELD.

WIRING DEVICES

1. RECEPTACLES MARKED AS GFCI SHALL BE OF THE GROUND FAULT CIRCUIT INTERRUPTER TYPE. MANUFACTURER SHALL BE GE TYPE TGTR 20, OR EQUAL.

2. RECEPTACLES USED IN CLASS 1, DIVISION 2 AREAS SHALL BE CROUSE-HINDS CAT. NO. ENR 21201 WITH EDS BACKBOX AND ENP5201 PLUG.

3. GFCI RECEPTACLES INSTALLED OUTDOORS SHALL BE WEATHER RESISTANT 'WR' TYPE.

4. SWITCHES

   A. LIGHTING SWITCHES SHALL BE RATED 20 AMPERES AT 277 VAC, TOGGLE OPERATED, PLASTIC ENCLOSED, SINGLE POLE, THREE-WAY OR FOUR-WAY AS SHOWN OR REQUIRED. MANUFACTURER SHALL BE P&S SERIES 20AC1 SPECIFICATION GRADE, OR EQUAL.

   B. SWITCHES SHALL HAVE SILVER ALLOY CONTACTS AND PROVISIONS FOR SIDE AND BACK WIRING.

   C. EACH SWITCH SHALL BE SUITED FOR FULL-RATED CAPACITY ON TUNGSTEN FILAMENT AND FLUORESCENT LAMP LOADS.

5. FACEPLATE AND COVERS

   A. FINISHED AREAS SHALL BE STAINLESS STEEL TYPE 302 ALLOY COVERS.

   B. WET AND CORROSIVE AREAS SHALL BE WEATHERPROOF COVERS WITH GASKETS.

ELECTRICAL HANDHOLES

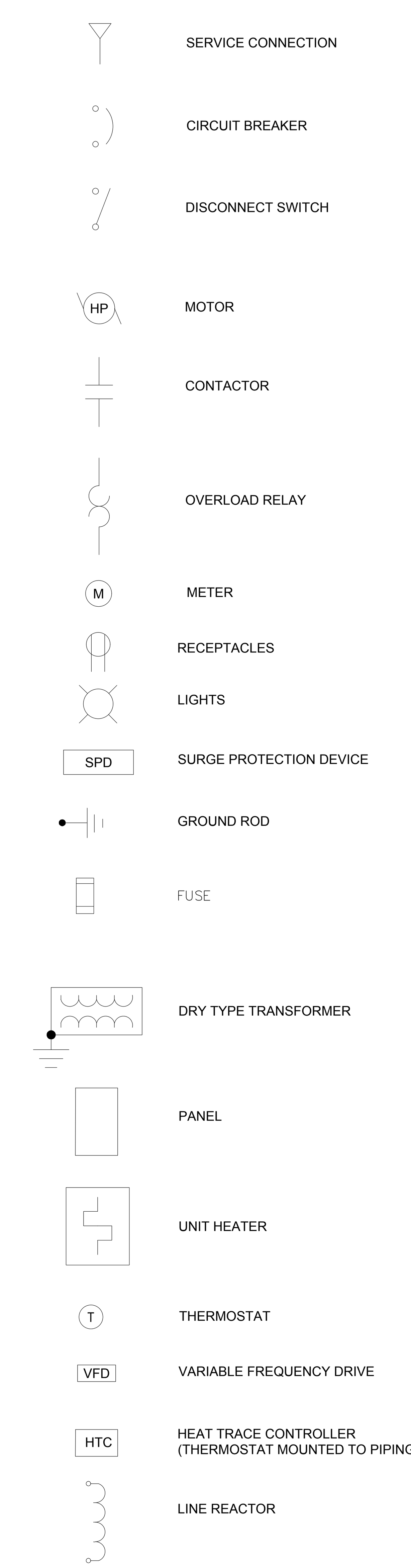
1. ELECTRICAL HANDHOLES TO BE FIELD LOCATED BY EC TO FACILITATE PULLS AND TO HAVE NO MORE THAN 270 DEGREES OF BENDS IN A SINGLE CONDUIT RUN.

2. HANDHOLES SHALL BE INSTALLED AS PER MANUFACTURER'S INSTALLATION INSTRUCTION TO INCLUDE A 6" LAYER OF COMPACTED #8 GRAVEL BELOW EACH HANDHOLE.

3. DO NOT LOCATE HANDHOLES IN DRIVEWAYS OR OTHER VEHICLE ACCESS PATHS.

4. HANDHOLES SHALL BE 11"x18"x18" DEEP, ANSI TIER 8, POLYMER REINFORCED CONCRETE WITH A BOLT ON COVER TO MATCH ENCLOSURE TIER RATING. COVER SHALL BE STAMPED "ELECTRIC" FROM THE FACTORY. QUAZITE #B10111818A WITH COVER #C1011182A017, OR EQUAL.

ELECTRICAL SYMBOL LEGEND



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0	08/16	ISSUE FOR CONSTRUCTION	NT

SEALS

DATE: FEBRUARY, 2018
PROJECT NO.: 02118201.0001.00300
FILE NAME: E-01_SINGLE_LINE_RECOVER
DESIGNED BY: J. KIM
DRAWN BY: N. THOMAS
CHECKED BY: D. GERDEMAN

8000 JEFFERSON DAVIS HWY, RICHMOND, VA 23297
DEFENSE SUPPLY CENTER
BIO-ENHANCED DIRECTED GROUNDWATER RECIRCULATION PILOT TEST

ARCADIS PROJ. NO. 02118201.0001.00300

SHEET TITLE
SINGLE LINE DIAGRAM

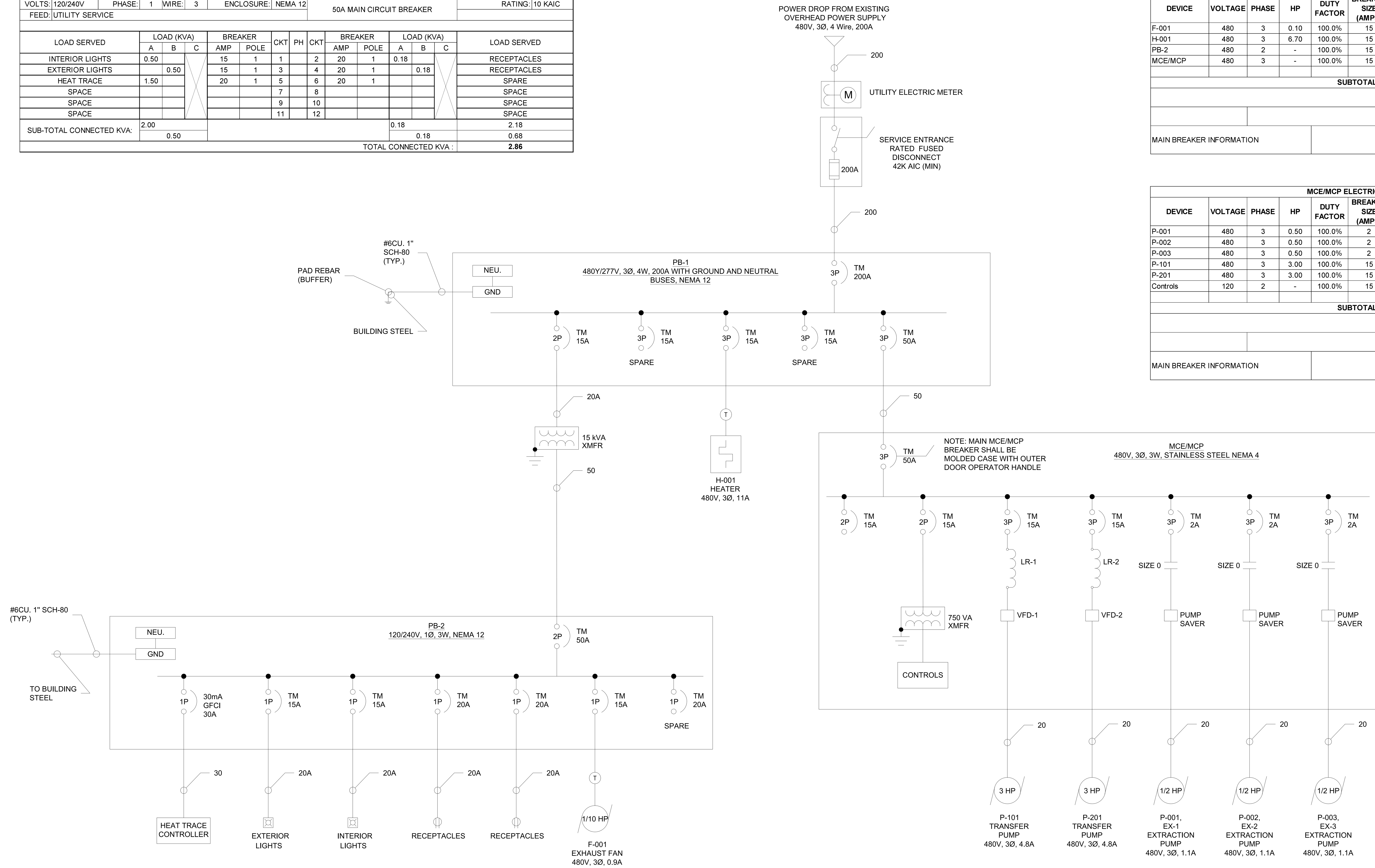
SCALE: NTS

E-01

SHEET 15 OF 8

	PB-2	LOCATION:	REMEDIATION SYSTEM ENCLOSURE				NOTES	CABINET MOUNTING:	SURFACE
VOLTS:	120/240V	PHASE:	1	WIRE:	3	ENCLOSURE: NEMA 12	50A MAIN CIRCUIT BREAKER	RATING:	10 KAIC
FEED:	UTILITY SERVICE								

LOAD SERVED	LOAD (KVA) A	LOAD (KVA) B	LOAD (KVA) C	BREAKER AMP	BREAKER POLE	CKT	PH	CKT	BREAKER AMP	BREAKER POLE	LOAD (KVA) A	LOAD (KVA) B	LOAD (KVA) C	LOAD SERVED
INTERIOR LIGHTS	0.50			15	1	1		2	20	1	0.18			RECEPTACLES
EXTERIOR LIGHTS		0.50		15	1	3		4	20	1		0.18		RECEPTACLES
HEAT TRACE	1.50			20	1	5		6	20	1				SPARE
SPACE						7		8						SPACE
SPACE						9		10						SPACE
SPACE						11		12						SPACE
SUB-TOTAL CONNECTED KVA:	2.00										0.18			2.18
		0.50										0.18		0.68
													TOTAL CONNECTED KVA :	**2.86**



PANEL PB-1 ELECTRICAL LOAD CALCULATION									
DEVICE	VOLTAGE	PHASE	HP	DUTY FACTOR	BREAKER SIZE (AMPS)	CONNECT LOAD - 480V, 3-PHASE (AMPS)	DEMAND LOAD - 480V, 3-PHASE (AMPS)	kVA	
F-001	480	3	0.10	100.0%	15	0.12	0.12	0.10	
H-001	480	3	6.70	100.0%	15	11.00	11.00	9.15	
PB-2	480	2	-	100.0%	15	5.01	5.01	4.16	
MCE/MCP	480	3	-	100.0%	15	14.15	14.15	11.76	
					SUBTOTALS :	30	30	25.17	TOTAL KVA
						TOTAL ELECTRICAL LOAD:		30.28	CONNECTED AMPS, 3-PHASE
								30.28	DEMAND AMPS, 3-PHASE
MAIN BREAKER INFORMATION								38	MINIMUM BREAKER SIZE
								50	MAIN BREAKER

MCE/MCP ELECTRICAL LOAD CALCULATION									
DEVICE	VOLTAGE	PHASE	HP	DUTY FACTOR	BREAKER SIZE (AMPS)	CONNECT LOAD - 480V, 3-PHASE (AMPS)	DEMAND LOAD - 480V, 3-PHASE (AMPS)	kVA	
P-001	480	3	0.50	100.0%	2	1.10	1.10	0.91	
P-002	480	3	0.50	100.0%	2	1.10	1.10	0.91	
P-003	480	3	0.50	100.0%	2	1.10	1.10	0.91	
P-101	480	3	3.00	100.0%	15	4.80	4.80	3.99	
P-201	480	3	3.00	100.0%	15	4.80	4.80	3.99	
Controls	120	2	-	100.0%	15	5.00	5.00	1.04	
					SUBTOTALS :	18	18	11.76	TOTAL KVA
						TOTAL ELECTRICAL LOAD:		14.15	CONNECTED AMPS, 3-PHASE
								14.15	DEMAND AMPS, 3-PHASE
MAIN BREAKER INFORMATION								18	MINIMUM BREAKER SIZE
								50	MAIN BREAKER

CONDUIT AND CONDUCTOR SCHEDULE				
TAG	WIRE TYPE	CONDUCTORS	GROUND	CONDUIT
20	XHHW	(3) #12	(1) #12	2"
20A	XHHW	(2) #12	(1) #12	3/4"
30	XHHW	(2) #10	(1) #10	2"
50	XHHW	(3) #6	(1) #8	1"
200	XHHW	(3) #3/0	(1) #4	1-1/2"

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SEALS

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FILE NAME: E-01_SINGLE_LINE_RECOVER
DESIGNED BY: J. KIM
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8000 JEFFERSON DAVIS HWY, RICHMOND, VA 23297

DEFENSE SUPPLY CENTER

BIO-ENHANCED DIRECTED GROUNDWATER RECIRCULATION PILOT TEST

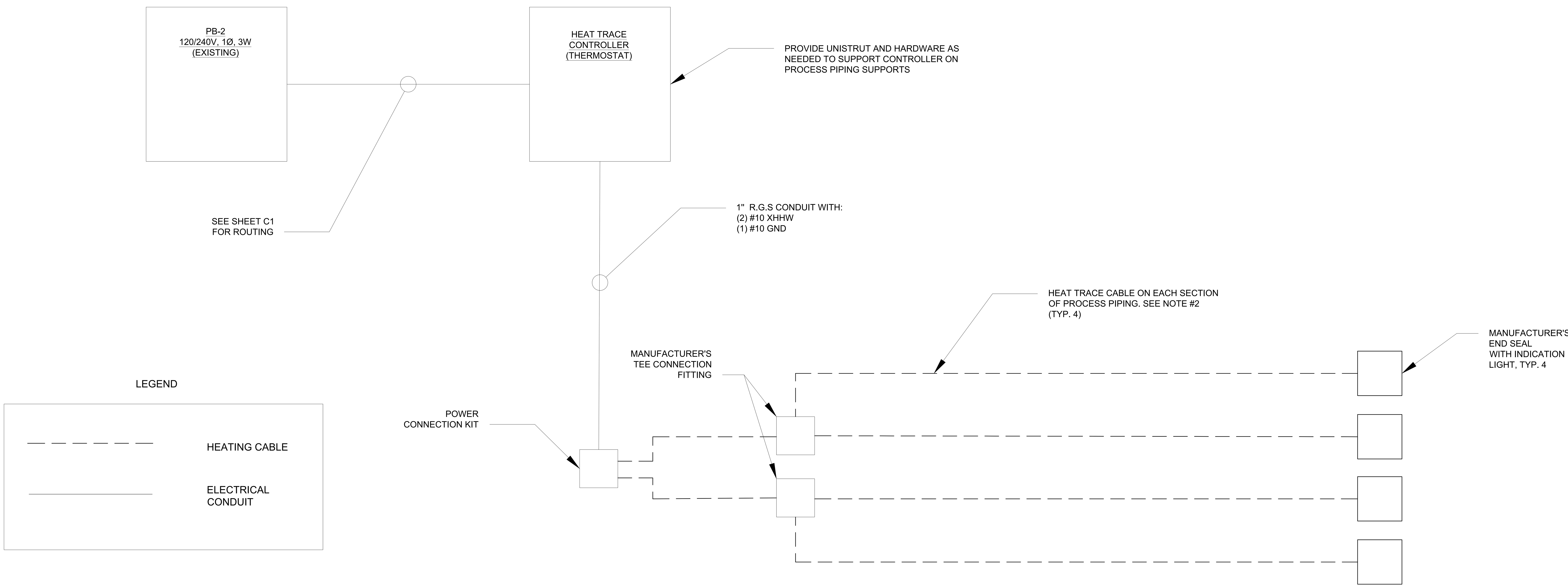
ARCADIS PROJ. NO. 02118201.0001.00300

SHEET TITLE

SINGLE LINE DIAGRAM

SCALE: NTS

E-02



HEAT TRACE INSTALLATION NOTES:

1. HEAT TRACE INSTALLATION WAS STRAIGHT RUN ON EACH ABOVE GROUND INJECTION WELL PROCESS PIPE (APPROXIMATELY 25 FT. EACH). PROCESS PIPE RUN IS VERTICAL FROM GRADE UP BUILDING WALL.
2. HEAT TRACE CONTROLLER (THERMOSTAT) INSTALLED OUTDOORS NEAR PROCESS PIPING. THERMOSTAT BULB SECURED IN FREE AIR.
3. POWER CONNECTION KIT WAS INSTALLED AT THE BEGINNING OF THE PROCESS PIPING RUNS, CENTRALLY LOCATED.
4. HEAT TRACED PROCESS PIPE WAS INSULATED WITH 2" FIBERGLASS INSULATION AND JACKETING.
5. CONTINUOUS "ELECTRIC TRACED" LABEL INSTALLED ON WRAPPED PROCESS PIPING.

HEAT TRACE COMPONENTS BILL OF MATERIALS

QTY	MANUFACTURER	PART NUMBER	DESCRIPTION
4	RAYCHEM	5BTV1-CT	120V SELF REGULATING HEATING CABLE, 5W/FT
1	RAYCHEM	AMC-F5	40F THERMOSTAT, HEAT TRACE CONTROLLER
1	RAYCHEM	JBM-100-A	POWER CONNECTION KIT
2	RAYCHEM	T-100	TEE CONNECTION
4	RAYCHEM	E-100-L-A	LIGHTED END SEAL
6	RAYCHEM	PS-01	PIPE STRAP
1	RAYCHEM	AT-180	ALUMINUM TAPE
~100FT	MANVILLE	MICRO-LOK	2" FIBERGLASS INSULATION PLUS JACKET

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DATE: FEBRUARY, 2018
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FILE NAME: E-3-HEAT_TRACE_RECORD
DESIGNED BY: J. KIM
DRAWN BY: N. THOMAS
CHECKED BY: D. GERDEMAN

8000 JEFFERSON DAVIS HWY, RICHMOND, VA 23297
DEFENSE SUPPLY CENTER
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ARCADIS PROJ. NO. 02118201.0001.00300

SHEET TITLE
ABOVE GROUND INJECTION WELL PROCESS PIPING HEAT TRACE WIRING DIAGRAM

SCALE: NTS

E-03

SHEET 15 OF 8

LEGEND:

- PROCESS PIPING
- INSTRUMENT SIGNAL
- BUILDING LIMITS
- DIAPHRAGM VALVE
- TRUE UNION BALL VALVE
- BUTTERFLY VALVE
- SWING CHECK VALVE
- AIR/VACUUM RELIEF VALVE
- PRESSURE RELIEF VALVE
- FM FLOW METER
- M MOTOR
- FLANGED CONNECTION
- UNION
- REDUCER
- INJECTION QUILL
- CENTRIFUGAL PUMP
- METERING PUMP
- STATIC MIXER

PIPELINE DESIGNATION:

6"-S04P

- LINE TYPE
- MATERIAL
- SIZE

TYPE:

D = DUCT
H = HOSE
C = DOUBLE WALL CONTAINMENT PIPE
P = PIPE
T = TUBE

MATERIAL:

BRZ	- BRASS/BRONZE
CIR	- CAST IRON
CST	- CARBON STEEL
CPR	- COPPER
CVC	- CHLORINATED POLYVINYL CHLORIDE
DIR	- DUCTILE IRON
FRP	- FIBERGLASS
GCS	- GALVANIZED CARBON STEEL
HDPE	- HIGH DENSITY POLYETHYLENE
LCS	- LINED CARBON STEEL
PET	- POLYETHYLENE
POP	- POLYPROPYLENE
PVC	- POLYVINYL CHLORIDE
RUB	- RUBBER
S04	- 304 STAINLESS STEEL
S4L	- 304L STAINLESS STEEL
S16	- 316 STAINLESS STEEL
S6L	- 316L STAINLESS STEEL
TEF	- TEFLON
VIT	- VITON
TYG	- TYGON

INTERLOCKS:

1. A STATUS ALARM (YA-001, YA-002, YA-003) FROM AN EXTRACTION PUMP (P-001, P-002, P-003) SHALL DISABLE THE PUMP. STATUS ALARMS ARE GENERATED BY THE MOTOR OVERLOAD SWITCH AND/OR THE PUMP SAVER NOTICING A LOW WELL LEVEL. ALARM NOTIFICATION.
2. A LOW LEVEL ALARM (LAL-101, LAL-103) IN THE EQUALIZATION TANK (T-101) SHALL DISABLE ALL EXTRACTION PUMPS AND TRANSFER PUMP (P-101). ALARM NOTIFICATION.
3. A HIGH LEVEL ALARM (LAH-102, LAH-103) IN T-101 SHALL DISABLE ALL EXTRACTION PUMPS. ALARM NOTIFICATION.
4. A VFD FAULT (YA-101) FOR P-101 SHALL DISABLE THE PUMP AND ALL EXTRACTION PUMPS. ALARM NOTIFICATION.
5. A HIGH PRESSURE ALARM (PAH-101, PAH-102, PAH-103) AROUND THE BAG FILTERS (F-101A, F-101B) OR GAC VESSELS (GAC-102A, GAC-102B) SHALL DISABLE P-101, P-001, P-002, P-003. ALARM NOTIFICATION.
6. A HIGH DIFFERENTIAL PRESSURE ALARM (DPAH-101, DPAH-102) AROUND THE BAG FILTERS (F-101A, F-101B) OR GAC VESSELS (GAC-102A, GAC-102B) SHALL NOTIFY OPERATORS.
7. A HIGH HIGH DIFFERENTIAL PRESSURE ALARM (DPAHH-101, DPAHH-102) AROUND THE BAG FILTERS (F-101A, F-101B) OR GAC VESSELS (GAC-102A, GAC-102B) SHALL DISABLE P-101, P-001, P-002, P-003. ALARM NOTIFICATION.
8. A HIGH OR LOW pH ALARM (AAH-201, AAL-201) IN THE INJECTION MONITORING TANK (T-201) SHALL DISABLE ALL PUMPS (P-001, P-002, P-003, P-101, P-110, P-201, P-210, P-211). ALARM NOTIFICATION.
9. A LOW LEVEL ALARM (LAL-201, LAL-203) IN T-201 SHALL DISABLE ALL PUMPS. ALARM NOTIFICATION.
10. A HIGH LEVEL ALARM (LAH-202, LAH-203) IN T-201 SHALL DISABLE P-001, P-002, P-003, P-101, AND CAUSTIC METERING PUMP (P-110). ALARM NOTIFICATION.
11. A VFD FAULT (YA-201) FOR INJECTION PUMP (P-201) SHALL DISABLE ALL PUMPS. ALARM NOTIFICATION.
12. A HIGH OR LOW PRESSURE ALARM (PAH-201, PAH-202, PAL-202) ON THE INJECTION LINE SHALL DISABLE ALL PUMPS. ALARM NOTIFICATION.
13. A HIGH DIFFERENTIAL PRESSURE ALARM (DPAH-201) AROUND BAG FILTERS (F-201A, F-201B) SHALL NOTIFY OPERATORS.
14. A HIGH HIGH DIFFERENTIAL PRESSURE ALARM (DPAHH-201) AROUND BAG FILTERS (F-201A, F-201B) SHALL DISABLE ALL PUMPS. ALARM NOTIFICATION.
15. A HIGH LEVEL ALARM IN THE BUILDING SUMP SHALL DISABLE ALL PUMPS. ALARM NOTIFICATION.

ABBREVIATIONS:

%	PERCENT
AC	AIR COMPRESSOR
AD	AIR DRYER
AR	AIR RECEIVER TANK
CFM	CUBIC FEET PER MINUTE
E	ELECTRIC ACTUATOR
F	MULTIMEDIA FILTER
FAH	FLOW ALARM HIGH
FAL	FLOW ALARM LOW
FC	FLOW CONTROL
FE	FLOW ELEMENT
FI	FLOW INDICATOR
FIC	FLOW INDICATING CONTROL
FIR	FLOW INDICATE RECORDER
FIT	FLOW INDICATING TRANSMITTER
FITQS	FLOW INDICATING TRANSMITTER QUANTITY SWITCH
FM	FLOW METER
FQ	FLOW TOTALIZER
FQI	FLOW QUANTITY INDICATOR
FQIR	FLOW QUANTITY INDICATOR RECORDER
FQR	FLOW QUANTITY RECORDER
FQS	FLOW QUANTITY SWITCH
FT	FLOW TRANSMITTER
FV	FLOW VALVE
GAL	GALLON(S)
GPD	GALLONS PER DAY
GPM	GALLONS PER MINUTE
HAZ	HAZARDOUS
HDPE	HIGH DENSITY POLYETHYLENE
HIM	HUMAN INTERFACE MACHINE
HOA	HAND/OFF/AUTO
HR	HOUR
HS	HAND SWITCH
INCH H2O	INCHES WATER COLUMN
LAH	LEVEL ALARM HIGH
LAHH	LEVEL ALARM HIGH HIGH
LAL	LEVEL ALARM LOW
LALL	LEVEL ALARM LOW LOW
LB	POUND(S)
LC	LEVEL CONTROLLER
LE	LEVEL ELEMENT
LG	LEVEL GAUGE
LI	LEVEL INDICATOR
LIC	LEVEL INDICATING CONTROL
LIR	LEVEL INDICATE RECORDER
LIT	LEVEL INDICATING TRANSMITTER
LPGAC	LIQUID PHASE GRANULAR ACTIVATED CARBON
LS	LEVEL SWITCH
LSH	LEVEL SWITCH HIGH
LSHH	LEVEL SWITCH HIGH HIGH
LSL	LEVEL SWITCH LOW
LSLL	LEVEL SWITCH LOW LOW
LT	LEVEL TRANSMITTER
M	MOTOR
NA	NOT APPLICABLE
NC	NORMALLY CLOSED
NPT	NATIONAL PIPE THREAD
PAH	PRESSURE ALARM HIGH
PAHH	PRESSURE ALARM HIGH HIGH
PAL	PRESSURE ALARM LOW
PDAH	PRESSURE DIFFERENTIAL ALARM HIGH
PDAHH	PRESSURE DIFFERENTIAL ALARM HIGH HIGH
PDI	PRESSURE DIFFERENTIAL INDICATOR
PDIR	PRESSURE DIFFERENTIAL INDICATE RECORDER
PDIT	PRESSURE DIFFERENTIAL INDICATING TRANSMITTER
PDITSH	PRESSURE DIFFERENTIAL INDICATING TRANSMITTER SWITCH HIGH
PDSH	PRESSURE DIFFERENTIAL SWITCH HIGH
PE	PRESSURE ELEMENT
PI	PRESSURE INDICATOR
PIR	PRESSURE INDICATE RECORDER
PISH	PRESSURE INDICATING SWITCH HIGH
PISHT	PRESSURE INDICATING SWITCH HIGH
PISL	PRESSURE INDICATING SWITCH LOW
PIT	PRESSURE INDICATING TRANSMITTER
PRV	PRESSURE RELIEF VALVE
PSIG	PRESSURE PER SQUARE INCH GAUGE
PSL	PRESSURE SWITCH LOW
PSV	PRESSURE SAFETY VALVE
PT	PRESSURE TRANSMITTER
SC	SPEED CONTROL
SI	SPEED INDICATOR
SIC	SPEED INDICATING CONTROL
ST	SPEED TRANSMITTER
T	TANK
TAH	TEMPERATURE ALARM HIGH
TAHH	TEMPERATURE ALARM HIGH HIGH
TAL	TEMPERATURE ALARM LOW
TC	TEMPERATURE CONTROL
TET	TEMPERATURE ELEMENT TRANSMITTER
TI	TEMPERATURE INDICATOR
TIR	TEMPERATURE INDICATE RECORDER
TISH	TEMPERATURE INDICATE SWITCH HIGH
TOC	TOP OF CASING
TSH	TEMPERATURE SWITCH HIGH
TW	THERMAL WELL
TYP	TYPICAL
V	VALVE
VFD	VARIABLE FREQUENCY DRIVE
VPGAC	VAPOR PHASE GRANULAR ACTIVATED CARBON
YA	STATUS ALARM
YI	STATUS INDICATOR
ZA	POSITION INDICATING ALARM
ZAC	POSITION ALARM VALVE FAILED TO CLOSE
ZAO	POSITION ALARM VALVE FAILED TO OPEN
ZSC	POSITION SWITCH CLOSED
ZSO	POSITION SWITCH OPENED

INSTRUMENT IDENTIFICATION LETTERS

FIRST LETTER		SUCCEEDING LETTERS		
MEASURE OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A = ANALYSIS		ALARM		
B = BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C = USER'S CHOICE			CONTROL, CLOSED	
D =	DIFFERENTIAL			
E = VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F = FLOW RATE	RATIO (FRACTION)			
G = USER'S CHOICE		GLASS, VIEWING DEVICE		
H = HAND				HIGH
I = CURRENT (ELECTRICAL)		INDICATE		
J = POWER	SCAN			
K = TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L = LEVEL		LIGHT		LOW
M = USER'S CHOICE	MOMENTARY			MIDDLE, INTERMEDIATE
N = USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O = PULSE		ORIFICE, RESTRICTION	OPEN	
P = PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q = QUANTITY	INTEGRATE, TOTALIZE			
R = RADIATION		RECORD	RUN	
S = SPEED, FREQUENCY	SAFETY	SWITCH	STOP	
T = TEMPERATURE			TRANSMIT	
U = MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V = VACUUM, MECH. ANALYSIS			VALVE, DAMPER, LOUVER	
W = WEIGHT, FORCE		WELL		
X = UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y = EVENT, STATUS OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z = POSITION, DIMENSION	Z AXIS	UNCLASSIFIED	DRIVE, ACTUATOR, FINAL CONTROL ELEMENT	

INSTRUMENT SYMBOLS

	PRIMARY CONTROL PANEL NORMALLY ACCESSIBLE TO OPERATOR	FIELD MOUNTED	AUXILIARY PANEL OR RACK NORMALLY ACCESSIBLE TO OPERATOR
DISCRETE INSTRUMENTS			
SHARED DISPLAY, SHARED CONTROL			
COMPUTER FUNCTION INCLUDING DISTRIB. CNTL. SYS.			
PROGRAMMABLE LOGIC CONTROLLER FUNCTION			

LEGENDS NOTES:

1. ANY FIRST LETTER COMBINED WITH MODIFIER REPRESENTS A NEW AND SEPARATE MEASURED VARIABLE. EXAMPLES: PD = DIFFERENTIAL PRESSURE FQ = TOTALIZED OR INTEGRATED FLOW. EXCEPTION IS THE MODIFIER "J" FOR MULTIPOINT SCANNING.
2. FOR ANALYSIS NOT IDENTIFIED BY A SPECIFIC LETTER IN THE TABLE, USE FIRST LETTER "A" NEAR THE INSTRUMENT SYMBOL, SPECIFY THE NATURE OF THE ANALYSIS. EXAMPLE: PH
3. MEANING OF A "USER'S CHOICE" LETTER SHALL BE CONSISTENT THROUGHOUT A PROJECT, AND SHALL BE SPECIFIED IN THE DRAWING LEGEND.
4. UNCLASSIFIED LETTER MAY HAVE A FEW DIFFERENT MEANINGS ON A PROJECT, THE MEANING SHALL BE SPECIFIED NEAR EACH INSTRUMENT SYMBOL USING THE UNCLASSIFIED LETTER.
5. THE MODIFIER "SCAN" APPLIES TO MULTIPOINT PRINTING INSTRUMENTS, SUCH AS CJRS (MULTIPOINT CONDUCTIVITY RECORDER WITH ALARM SWITCHES).

GENERAL NOTES:

1. ALL ANALOG SETPOINTS SHALL BE FIELD ADJUSTED BY OPERATOR AT HMI INTERFACE SCREEN.
2. ALARMS THAT SHUT DOWN EXTRACTION WELLS AND TREATMENT EQUIPMENT MUST BE CLEARED BY OPERATOR BEFORE BEING RESTARTED.
3. THIS DRAWING IS PROVIDED FOR INFORMATIONAL PURPOSES ONLY.
4. WHERE APPLICABLE, TEES AND REDUCERS SHALL BE INSTALL IN LIEU OF PIPE TAPPING.

ARCADIS

LEGAL ENTITY:
ARCADIS U.S., Inc.
ARCHITECTURAL AND
ENGINEERING SERVICES, INC.

CONSULTANTS

NO.	DATE	ISSUED FOR	BY
1	02/18	RECORD DRAWINGS	
0	08/16	ISSUE FOR CONSTRUCTION	

SEALS

DATE: FEBRUARY, 2018
PROJECT NO.: 02118201.0001.00300
FILE NAME: RICHMOND AFB PIDS_DRAFT
DESIGNED BY: CS
DRAWN BY: MK
CHECKED BY: XX

8000 JEFFERSON DAVIS HWY, RICHMOND, VA 23297
DEFENSE SUPPLY CENTER
BIO-ENHANCED DIRECTED GROUNDWATER RECIRCULATION PILOT TEST
ARCADIS PROJ. NO. 02118201.0001.00300

SHEET TITLE
PIPING AND INSTRUMENTATION DIAGRAM

SCALE:

PID-0

SHEET OF 8

User:NTHOMAS Spec:AUS-NCSMOD File:G:\EIC_DWG\PROJECTS\DSCR\BDGR\CAD\PIDS AND PFD\RICHMOND AFB PIDS_DRAFT.DWG Scale:1:1/2 SavedDate:10/21/2016 Time:16:13 Plot Date: Thomas, Nick: 2/5/2018; 12:04 : Layout:PID-1

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DEFENSE SUPPLY CENTER

BIO-ENHANCED DIRECTED GROUNDWATER RECIRCULATION PILOT TEST

ARCADIS PROJ. NO. 02118201.0001.00300

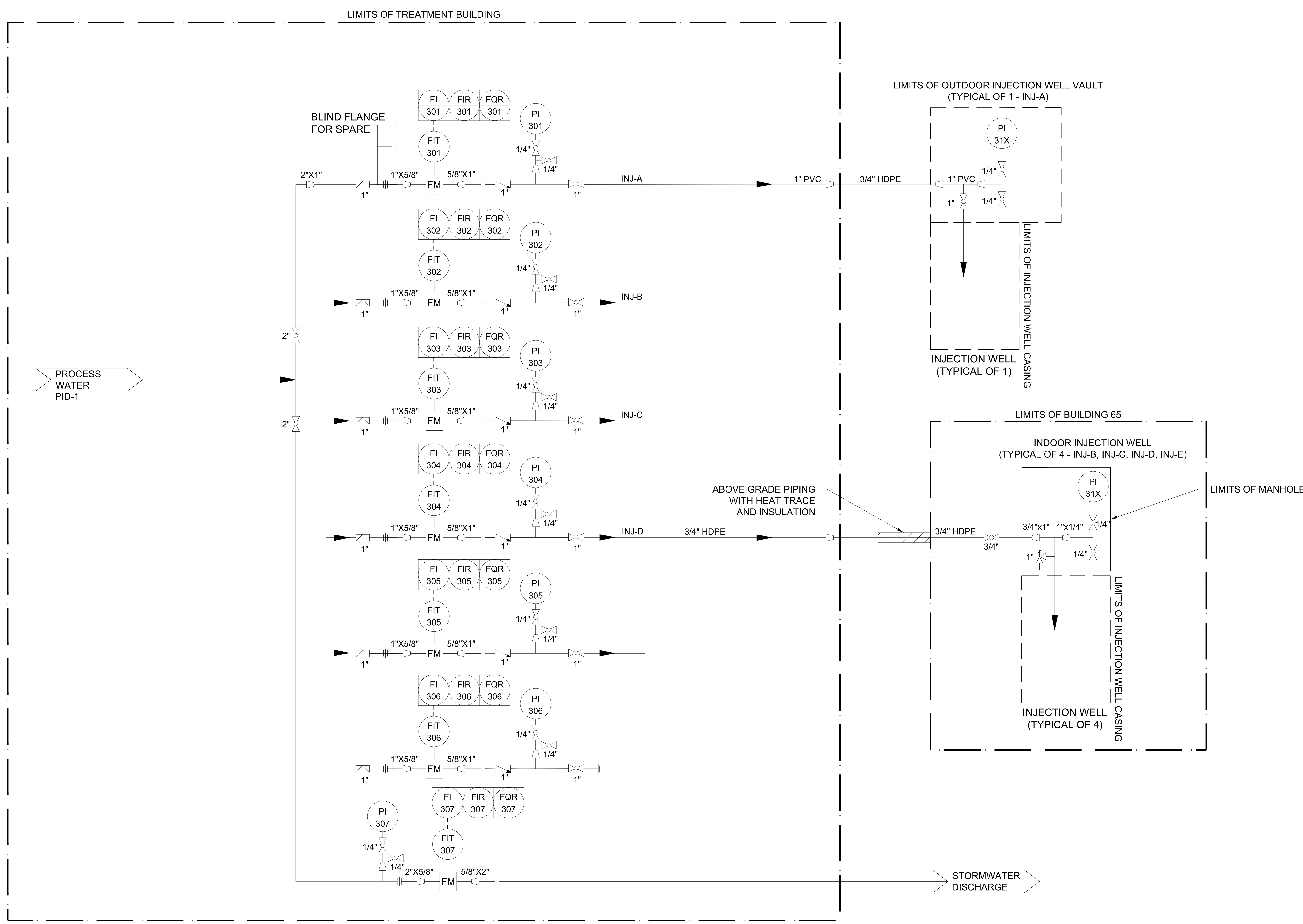
SHEET TITLE

PIPING AND INSTRUMENTATION DIAGRAM

SCALE:

PID-1

SHEET ___ OF 8



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ARCADIS PROJ. NO. 02118201.0001.00300

SHEET TITLE

PIPING AND INSTRUMENTATION DIAGRAM

SCALE:

PID-2

SHEET ___ OF 8

Appendix B Cost Estimates

Appendix B
Building 65 Engineering Evaluation/Cost Assessment
Alternative 2 - In SItu Treatment of Soil

Remedial Alternative	Task	Sub-Task	Description	Takeoff Quantity	Labor Hours	Grand Total Amount	% Total
002			Alternative 2 - In Situ Treatment of Soil				
	1105		Mobilization / Demobilization				
		101	Mobilization	1.00 LS	72	9,858	1.40%
		102	Demobilization	1.00 LS	72	9,858	1.40%
			1105 Mobilization / Demobilization	1.00 LS	144	19,716	2.79%
	1107		F-Bay Waste Infrastructure Closure In Place				
		421	F-Bay Waste Infrastructure Closure In Place	1.00 LS	36	47,951	6.79%
			1107 F-Bay Waste Infrastructure Closure In Place	1.00 LS	36	47,951	6.79%
	1215		SVE Well & Piping Installation				
		1011	SVE Well Installation	1.00 LS		10,436	1.48%
		1013	VMP Installation	1.00 LS		10,994	1.56%
		1016	SVE Well & System Installation Oversight	1.00 LS	92	9,974	1.41%
		1017	VMP Installation Oversight	1.00 LS	60	6,477	0.92%
		1100	SVE Well Vault Piping & Tie-In To SSDS Piping	1.00 LS	120	47,226	6.69%
			1215 SVE Well & Piping Installation	1.00 LS	272	85,107	12.06%
	1300		SVE System O&M				
		2005	SVE System O&M	1.00 LS	108	229,102	32.46%
		2006	Monthly O&M Reporting	1.00 LS	1,418	143,647	20.35%
			1300 SVE System O&M *	1.00 LS	1,526	372,749	52.82%
	1301		Post SVE Shutdown VMP Monitoring				
		2007	Monthly Post Shutdown VMP Sampling	1.00 LS	18	36,480	5.17%
		2008	Annual Post Remedial VMP Monitoring Report	1.00 LS	473	51,007	7.23%
			1301 Post SVE Shutdown VMP Monitoring	1.00 LS	491	87,487	12.40%
	1350		Post SVE Effectiveness Soil Sampling and Reporting				
		2025	DPT Soil Sampling	1.00 LS		15,809	2.24%
		2049	Data Validation - Soil Samples	1.00 LS	15	1,840	0.26%
		2050	SVE Effectiveness Soil Sampling Report	1.00 LS	114	12,642	1.79%
			1350 Post SVE Effectiveness Soil Sampling and Reporting	1.00 LS	129	30,291	4.29%
	3390		SVE / SSDS System Removal				
		910	Well Abandonment Oversight	1.00 LS	280	30,304	4.29%
		920	DPW Well and Vault Decommissioning	1.00 LS	180	21,427	3.04%
		33901	SVE / SSDS Equipment Removal	1.00 LS	90	10,713	1.52%
			3390 SVE / SSDS System Removal	1.00 LS	550	62,444	8.85%
			002 Alternative 2 - In Situ Treatment of Soil	1.00 LS	3,737	705,745	

Notes: *For Task 1300 SVE Operation, Maintenance, and Monitoring is total duration of 3 years subdivided by 6 months in 2026, 12 months in 2027, 12 months in 2028, and 6 months in 2029.

Appendix B
Building 65 Engineering Evaluation/Cost Assessment
Cost Estimate for Alternative 3 - Non-Time Critical Removal Action

Remedial Alternative	Task	Sub-Task	Phase	Item	Description	Takeoff Quantity	Labor Hours	Grand Total Amount	% Total
003a					Alternative 3 - Full Removal of F-Bay Soils				
	1010				Pre-Construction				
		100			Geotechnical & Structural Evaluation	1.0 LS	548	71,192	2.98%
					1010 Pre-Construction	1.0 LS	548	71,192	2.98%
	1105				Mobilization / Demobilization				
		110			NTCRA Work Plan	1.0 LS	205	26,697	1.12%
		115			Mobilization	1.0 LS	72	10,196	0.43%
		120			Demobilization	1.0 LS	72	10,196	0.43%
					1105 Mobilization / Demobilization	1.0 LS	349	47,089	1.97%
	1110				F Bay Full Removal Action & Decommissioning				
		405			F Bay Super Structure Demolition	5,800.0 SF	24	3,632	0.15%
		407			Covered Area Structure Demolition	2,370.0 SF	24	3,632	0.15%
		410			F-Bay Floor Slab / Foundaiton Demolition	5,800.0 SF	24	3,632	0.15%
		413			Building Ramp Demolition	1,160.0 SF	24	3,632	0.15%
		421			F-Bay Waste Infrastructure Demolition & Removal	1.0 LS	36	6,385	0.27%
		430			Concrete Debris Disposal (As C&D)	1,120.0 Ton		162,999	6.82%
		500			Contaminated Soil Removal	2,182.0 CY	508	142,482	5.96%
		503			Excavation Backfill (Removal + 1' Fill Across F-Bay Bldg Area to Account for Slab)	2,396.0 CY	737	345,174	14.45%
		505			Geotechnical Oversight	1.0 LS	48	13,092	0.55%
		510			Contaminated Soil Transport & Disposal	3,491.0 Ton		1,142,712	47.82%
		520			Removal Action FIeld Oversight + GC PM	6.0 WK	382	42,963	1.80%
		530			NTCRA REport	1.0 LS	274	35,833	1.50%
					1110 F Bay Full Removal Action & Decommissioning	1.0 LS	2,080	1,906,170	79.77%
	3310				Decomission Subslab De-Pressurization System				
		910			Well Abandonment Oversight	1.0 LS	140	15,133	0.63%
		33101			SVE/SSDS Well Removal	1.0 LS	140	15,133	0.63%
		33901			SVE / SSDS Equipment Removal	1.0 LS	90	11,082	0.46%
					3310 Decomission Subslab De-Pressurization System	1.0 LS	370	41,348	1.73%
					003a Alternative 3 - Full Removal of F-Bay Soils	1.0 LS	3,347	2,065,799	86.45%
0003b					Site Restoration				
	4010				Restoration Design				
		590			Pavement Design	1.0 LS	150	24,514	1.03%
		595			E-Bay Restoration Design	1.0 LS	100	16,343	0.68%
					4010 Restoration Design	1.0 LS	250	40,856	1.71%
	4100				E-Bay Restoration				
		600			E-Bay Exterior Restoration	1.0 LS	45	17,671	0.74%
		605			West Dock Gate	1.0 LS	5	10,073	0.42%
					4100 E-Bay Restoration	1.0 LS	50	27,744	1.16%
	4200				Pavement Restoration				
		800			Site Preparation	1,100.0 SY	65	54,139	2.27%
		805			Concrete Pavement Placement	1,100.0 SY	1,410	184,999	7.74%
					4200 Pavement Restoration	1,100.0 SY	1,475	239,138	10.01%
	4300				Replacement Well Installation	1.0 LS		16,016	0.67%
					003b Site Restoration	1.0 LS	1,775	323,754	13.55%
					Alternative 3 - Total			2,389,553	