DEPARTMENT OF THE NAVY
BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
1455 FRAZEE RD, SUITE 900
SAN DIEGO, CA 92108-4310

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MAY 21 2015

Ms. Alana Lee (2 copies, 2 CDs)
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street, SFD-73
San Francisco, CA 94105

Ms. Elizabeth Wells, P.E. (1 copy, 2 CDs)
California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

Dear Ms. Lee and Ms. Wells:

SUBJECT: DRAFT WORK PLAN, COMBINED ENHANCED ANAEROBIC BIOREMEDIATION/IN SITU CHEMCIAL REDUCTION TREATABILITY STUDY, TRAFFIC ISLAND AREA, INSTALLATION RESTORATION SITE 28, FORMER NAVAL AIR STATION MOFFETT FIELD, MOFFETT FIELD, CALIFORNIA

The Department of the Navy is pleased to transmit the draft Work Plan for Combined Enhanced Anaerobic Bioremediation/in Situ Chemical Reduction Treatability Study at the Traffic Island Area of Installation Restoration (IR) Site 28 at Moffett Field dated May 2015. The Navy is requesting agency comments or concurrence by June 20, 2015.

Thank you for your continued support of this program. Should you have any questions or need additional information, please contact Ms. Valerie Harris, Navy Remedial Project Manager at (619) 532-0981 or me at (619) 532-0938.

Sincerely,

SCOTT D. ANDERSON
BRAC Environmental Coordinator
By direction of the Director

DRAFT
WORK PLAN
Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study
Traffic Island Area, Installation Restoration Site 28
Former Naval Air Station Moffett Field
Moffett Field, California

Environmental Services Contract Number: N62473-10-D-4009
Contract Task Order: 0104

Document Control Number: CBI-4009-0104-2086

April 2015

Submitted to:

Base Realignment and Closure
Program Management Office West Naval Facilities Engineering Command
1455 Frazee Road, Suite 900
San Diego, California 92108

Submitted by:

CB&I Federal Services LLC
4005 Port Chicago Highway, Suite 200
Concord, California 94520-1120

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April 2015

Approved by:_____ Date: _____
Neil Hey, California PG No. 8006
Project Manager

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Acronyms and Abbreviations

µg/kg	microgram per kilogram
µg/L	microgram per liter
APP	*Accident Prevention Plan, Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study, Traffic Island Area, Installation Restoration Site 28, Former Moffett Naval Air Station, Moffett Field, California*
bgs	below ground surface
CB&I	CB&I Federal Services LLC
CE	chlorinated ethene
CQCP	contractor quality control plan
DCE	dichloroethene
DHC	*Dehalococcoides*
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DPT	direct-push technology
DSITMS	direct sample ion-trap mass spectrometer
EAB	enhanced anaerobic bioremediation
EPA	U.S. Environmental Protection Agency
ESD	explanation of significant differences
EVO	emulsified vegetable oil
Final Supplemental Investigation Report	*Final Technical Memorandum, Supplemental Investigation Former Building 88 and Traffic Island Areas, Installation Restoration Site 28, Former Moffett Naval Air Station, Moffett Field, California*
IR	installation restoration
ISCR	in situ chemical reduction
IWCT	injection water conditioning tank
MCL	maximum contaminant level
MEW	Middlefield-Ellis-Whisman
MIP	membrane interface probe
Moffett	Naval Air Station Moffett Field
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
Navy	U.S. Department of the Navy
ORP	oxidation-reduction potential
PCE	tetrachloroethene
PQO	project quality objective
PRC	PRC Environmental Management, Inc.
ROD	*Record of Decision for the Fairchild, Intel, and Raytheon Sites, Middlefield-Ellis-Whisman (MEW) Study Area, Mountain View, California*

ROICC	Resident Officer in Charge of Construction
SAP	sampling and analysis plan
SCVWD	Santa Clara Valley Water District
Shaw	Shaw Environmental, Inc.
SI	supplemental investigation
TCE	trichloroethene
TDR	target distribution radius
TS	treatability study
TtECI	Tetra Tech EC, Inc.
TtFWI	Tetra Tech FW, Inc.
VC	vinyl chloride
VFA	volatile fatty acid
VOC	volatile organic compound
WATS	West-Side Aquifers Treatment System
WP	work plan
ZVI	zero-valent iron

1.0 Introduction

This Work Plan (WP) describes the technical approach and activities to perform a treatability study (TS) of enhanced anaerobic bioremediation (EAB) combined with in situ chemical reduction (ISCR) for remediating chlorinated ethenes (CEs) in the A-Aquifer zone and the B2-Aquifer zone at the Traffic Island Area of Installation Restoration (IR) Site 28, former Naval Air Station Moffett Field (Moffett), California (Figure 1). The site is currently in the remedy optimization phase and a groundwater extraction and treatment system has been operating at IR Site 28 since November 1998. This TS is being performed to evaluate the usefulness of the technology as a source control/treatment measure in the B2-Aquifer where contaminants are not addressed by the current groundwater treatment system. This plan has been prepared by CB&I Federal Services LLC (CB&I) on behalf of the U.S. Department of the Navy (Navy) under Environmental Services Contract No. N62473-10-D-4009, Contract Task Order 0104.

This WP comprises the project plans for the planned activities of the TS. The WP includes the Sampling and Analysis Plan (SAP) (Appendix A of this WP), the Contractor Quality Control Plan (CQCP) (Appendix B of this WP), the Traffic Control Plan (Appendix C of this WP), and references the *Accident Prevention Plan, Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study, Traffic Island Area, Installation Restoration Site 28, Former Moffett Naval Air Station, Moffett Field, California* (APP; CB&I, 2015) (submitted under a separate cover). These documents provide the rationale, methodologies, and procedures for completing the TS.

1.1 Background

IR Site 28 is defined by the aquifers below the area generally bounded by Hangar 1 to the east, McCord Avenue to the west, King Road to the north, and a line approximately 300 feet south of Wescoat Road to the south, as shown on Figure 1. Beneath this area, the A-Aquifer zone is impacted by volatile organic compounds (VOCs), primarily CEs including tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (DCE), and vinyl chloride (VC); and to a lesser extent within the B-Aquifer zone. The contamination at IR Site 28 resulted from on-flow of contamination from upgradient CE sources, primarily TCE, at the Fairchild, Intel, and Raytheon sites (collectively known as the Middlefield-Ellis-Whisman [MEW] Superfund Site) and on-site Navy sources. Historical dry cleaning activities conducted at former Building 88 were determined to be the source of PCE along with the associated sanitary sewer line (Tetra Tech EC, Inc. [TtECI], 2008).

In 1993, the Navy agreed to adopt the *Record of Decision for the Fairchild, Intel, and Raytheon Sites, Middlefield-Ellis-Whisman (MEW) Study Area, Mountain View, California* (ROD;

U.S. Environmental Protection Agency [EPA], 1989) and to remediate contamination attributable to Navy sources (Navy, 1993). To comply with the ROD requirements, the Navy removed Building 88 in 1994, excavated contaminated soil, and installed a groundwater source control measure referred to as the "Building 6 Treatment System." The Building 6 Treatment System was operated until 1997 when it was replaced with a plumewide groundwater control system referred to as the "West-Side Aquifers Treatment System" (WATS). Operation of the WATS has been ongoing since November 1998.

In 2005, the Navy implemented an investigation to evaluate whether the residual PCE in the vadose zone at the former Building 88 location was a continuing source of contamination for groundwater and if so, whether the PCE source area was treatable. In the *Final Former Building 88 Investigation Report, Former Naval Air Station Moffett Field, Moffett Field, California* (TtECI, 2008), it was concluded that residual contamination in the saturated zone in two areas—the Former Building 88 Area and the Traffic Island Area—acts as ongoing PCE sources to groundwater contamination in the upper and lower portion of the A-Aquifer zone (ranging from approximately 0 to 35 feet below ground surface [bgs] and 35 to 65 feet bgs, respectively). These areas of interest are shown on Figure 2. The investigation report recommended further source removal to meet the requirements of the ROD (EPA, 1989) and to expedite the cleanup of contaminated groundwater. Further characterization of the PCE contamination in the saturated zone soil and/or groundwater was also recommended. The vadose zone soil remedy was completed in 1994 and fully meets the cleanup standards set forth in the ROD, so no further action for the vadose zone was recommended (EPA, 2009).

In 2010, additional site work was completed to further characterize the identified potential CE source areas and to investigate possible dense non-aqueous phase liquids (DNAPL) in support of field testing three in situ CE treatment technologies. CE delineation and DNAPL assessments were completed through the use of membrane interface probe (MIP) analysis, visual examination and field/laboratory testing of soil cores, and hydrophobic flexible membrane testing (Shaw Environmental, Inc. [Shaw], 2010). The characterization effort confirmed and further delineated residual CE source materials beneath the Former Building 88 and Traffic Island Areas. DNAPL was not identified during this effort.

Following the characterization effort, a TS was conducted between 2010 and 2011 at the source areas to evaluate the ability of two separate in situ biological treatment technologies (emulsified vegetable oil [EVO] with bioaugmentation and lactate with bioaugmentation) and one in situ combined biotic/abiotic treatment technology (EHC®) to remediate dissolved CEs to concentrations below the site cleanup standard and maximum contaminant levels (MCLs) (EPA, 1989 and 1990). By the end of the study period, concentrations of CEs in the EVO and EHC® test areas continued to decline and reducing conditions persisted, but it was unknown how long the reducing conditions would remain and if concentrations would reach the cleanup standard

and MCLs. Consequently, additional performance monitoring of the EVO and EHC® pilot test areas was recommended (Shaw, 2012) and performed in 2012 (CB&I, 2014). All three technologies tested were found to be very effective at reducing the concentrations of CEs at the site to the extent of their distribution and electron donor capabilities, for example EHC® was difficult to distribute because of its high solids composition and the lactate was least persistent in the treatment area.

Contemporaneously, EPA was in the process of preparing a supplemental sitewide groundwater feasibility study for the MEW superfund study area to evaluate the ability of several remedial alternatives to reduce concentrations of CEs and to remediate the regional plume. All of the alternatives that were to be evaluated in the feasibility study included source treatment. Although prior investigations provided valuable insight into the nature and extent of the Navy's source areas, several key data gaps remained in the conceptual site model for the Former Building 88 and Traffic Island Areas, and other "potential source areas" identified by EPA based on groundwater concentrations that needed to be addressed before completing designs for further remediation.

Consequently, in 2012 and 2013, the Navy implemented a supplemental investigation (SI) to augment the characterization of CE contamination at the Former Building 88 and Traffic Island Areas and to provide information in response to EPA's request to "evaluate and characterize containment of a second smaller, higher-concentration area of contamination in the B2-Aquifer" (EPA, 2012). Utilizing a combination of soil samples, groundwater samples, and MIP/direct sample ion-trap mass spectrometer (DSITMS) data, it was determined that the residual CE source mass is predominately in fine-grained soil at both locations with DNAPL positively identified in the lower A-Aquifer zone at a depth of approximately 65 feet bgs nearby the collapsed sewer line in the Traffic Island Area and concentrations of CEs greater than 1,000 micrograms per liter (µg/L) in the B2-Aquifer beneath where DNAPL was identified in the lower A-Aquifer zone. The *Final Technical Memorandum, Supplemental Investigation Former Building 88 and Traffic Island Areas, Installation Restoration Site 28, Former Moffett Naval Air Station, Moffett Field, California* (Final Supplemental Investigation Report; CB&I, 2014), recommended the following:

1. A TS to evaluate technologies for treating the CEs identified in the B2-Aquifer zone and residual DNAPL identified in the lower portion of the A-Aquifer zone
2. Further investigation of the elevated concentrations of CEs in shallow groundwater at the northeast corner of Building 126
3. Installation of additional wells immediately upgradient of the Former Building 88 and Traffic Island Areas for evaluating on flow of CEs from upgradient sources in the A-Aquifer and B2-Aquifer zone

4. Installation of additional wells immediately downgradient (north-northeast) of the traffic island for further evaluating CEs in the B2-Aquifer zone

The planned work covered by this WP addresses Recommendations 1, 3, and 4. Recommendation 2 will be addressed under a separate effort.

1.2 Objective

The residual DNAPL identified in the lower portion of the A-Aquifer zone and the high concentration of CEs in the B2-Aquifer zone directly beneath the residual DNAPL in the A-Aquifer zone at the southern end of the traffic island are the focus of the TS outlined in this WP. The primary objective of this study is to gather site-specific data to evaluate the effectiveness and viability of the combined biotic/abiotic treatment approach (EAB/ISCR) for reducing the highest concentrations of CEs in the lower portion of the A-Aquifer zone and the B2-Aquifer zone at the Traffic Island Area. Decision criteria for achieving this objective have been developed in the project quality objectives (PQOs) process. The PQOs are presented in Worksheet #11 of the SAP (Appendix A).

The treatment processes proposed for this TS are similar to those implemented in the 2010 to 2011 TS, however this time around they will be tested in higher concentrations of CEs (residual DNAPL), to a much greater depth (120 feet bgs) than previously tested (65 feet bgs), and using improved distribution technology. Plus, the organic substrate being used is different too. Although the treatment processes are the same, the technology and approach are different than the previous TS performed at the Traffic Island Area.

1.3 Technical Approach

The TS will be performed by injecting reagent materials into the aquifer(s) to stimulate biological and chemical reduction of the CEs and is further described in Section 3.0. Groundwater sampling will be completed before and after the substrate injections to generate data necessary to achieve the project objectives.

TS progress and interim results will be provided via bi-monthly meetings with EPA Region 9, California Regional Water Quality Control Board—San Francisco Bay Region, and National Aeronautics and Space Administration (NASA) representatives. Upon completion of the TS, the data will be compiled, evaluated, and published in a final report documenting the results. The final report will include a description and discussion of the activities, results, findings, and recommendations. It is anticipated that sufficient data will be available from the study to fully evaluate the effectiveness of the combined EAB/ISCR approach for treating CEs at IR Site 28.

1.4 Project Schedule

A schedule for implementing the TS at IR Site 28 is presented as Figure 3. The schedule highlights the main project activities, including those previously described in the technical approach for the TS. The monitoring wells are expected to be installed in September 2015 after submittal of the final project plans. Reagent injections are expected to begin in October 2015 and continue through November 2015. Performance monitoring is expected to begin in November 2015 and conclude in September 2016. Following the completion of the performance-monitoring period, a draft technical memorandum will be issued for agency review by April 2017 followed by a final technical memorandum in July 2017. Further discussions of the technical memorandum are presented in Section 7.0.

1.5 Work Plan Organization

This WP is organized as follows:

- **Section 1.0, "Introduction":** Presents the project background, purpose, technical approach, schedule, and plan organization.
- **Section 2.0, "Site Description and Background":** Provides general background information including a site description, a brief summary of site history, a description of the geology and hydrogeology, and a summary of the results from previous investigations and remedial actions.
- **Section 3.0, "Treatability Test Approach":** Provides a brief description of the TS test approach and the technologies proposed.
- **Section 4.0, "General Site Activities and Requirements":** Summarizes general activities to be conducted in support of the field effort.
- **Section 5.0, "Groundwater Monitoring Well Installation and Baseline Sampling":** Presents the monitoring well installation details and protocols for collecting baseline samples at the site.
- **Section 6.0, "Treatability Test Implementation":** Summarizes the plans for implementing the EAB/ISCR pilot test.
- **Section 7.0, "Treatability Study Report":** Presents the plan for evaluating and reporting the study results.
- **Section 8.0, "Health and Safety":** Describes the commitment to health and safety that will be exercised during the course of this work and makes reference to the APP (CB&I, 2015).
- **Section 9.0, "Quality Assurance/Quality Control":** Describes the quality assurance and quality control requirements and makes reference to the CQCP (Appendix B).

- **Section 10.0, "References":** Provides a list of all the cited documents within the text, figures, and tables.

Figures and tables are presented after Section 10.0. The following appendices are included after the figures and tables:

- Appendix A, "Sampling and Analysis Plan"
- Appendix B, "Contractor Quality Control Plan"
- Appendix C, "Traffic Control Plan"
- Appendix D, "Reagent Dosage Calculations"

The project-specific APP (CB&I, 2015) is provided under separate cover.

2.0 Site Description and Background

This section presents a brief description of relevant background information that includes a site description and history, highlights of previous remedial response actions, local geology and hydrogeology, and the nature and extent of contamination. The information presented in this section was compiled primarily from the following documents:

- *Final Former Building 88 Investigation Report, Former Naval Air Station Moffett Field, Moffett Field, California* (TtECI, 2008)
- *Draft, West-Side Aquifers Treatment System, Site 28 Optimization Evaluation Report, Installation Restoration Site 28, Former Naval Air Station Moffett Field, Moffett Field, California* (SES-TECH, 2008)
- *Final 2010 Annual Groundwater Report for Installation Restoration Sites 26 and 28, Former Naval Air Station Moffett Field, Moffett Field, California* (ERS-JV and Brown and Caldwell, 2011)
- Final Supplemental Investigation Report (CB&I, 2014)

Further details about the facility history, previous investigations, remedial actions, and studies at IR Site 28 are also provided in the following documents:

- *Initial Assessment Study of Naval Air Station Moffett Field, Sunnyvale, California Field* (Naval Energy and Environmental Support Activity, 1984)
- *Confirmation Study (Verification Step), Moffett Naval Air Station, California* (Earth Sciences Associates, Inc. and James M. Montgomery, Consulting Engineers, Inc., 1986)
- *Hazardous Materials Underground Storage Tank Study, NAS Moffett Field, California* (ERM-West and Aqua Resources, Inc., 1986)
- *Investigation of Potential Soil and Ground Water Contamination Near Tanks 19 and 20, Tank 66 (sump), and Tanks 67 and 68, Moffett Naval Air Station, California* (ERM-West, 1987)
- *Remedial Investigation Report, Remedial Investigation/Feasibility Study, Middlefield-Ellis-Whisman Area, Mountain View, California* (Harding Lawson Associates, 1988)
- *Characterization Report, Phase I Remedial Investigation, Naval Air Station, Moffett Field, California, Volumes 1 through 5* (IT Corporation, 1991)
- *Draft Tank and Sump Removal Summary Report* (PRC Environmental Management, Inc. [PRC], 1991)

- *Technical Memorandum: Geology and Hydrogeology, Final Draft* (PRC Environmental Management, Inc. and James M. Montgomery, Consulting Engineers, Inc., 1992)
- *Final Westside Groundwater Site Characterization Report, NAS Moffett Field, California* (IT Corporation, 1993)
- *Federal Facilities Agreement Amendment of December 17, 1993, NAS Moffett Field, California* (Navy, 1993)
- *Final Additional Investigation of Inferred Sources Technical Memorandum, Naval Air Station Moffett Field, California* (PRC, 1994)
- *Final Horizontal Conduit Study Technical Memorandum, Moffett Federal Airfield, California* (PRC, 1995a)
- *Final Operable Unit 2-West (Building 88) Project Summary Report* (PRC, 1995b)
- *Draft Wash Rack Area Investigation, Technical Memorandum, Moffett Federal Airfield, California (Formerly Naval Air Station Moffett Field)* (PRC, 1996)
- *Draft Final Interim Remedial Action Report, West-Side Aquifers Treatment System (WATS), Moffett Federal Airfield, California* (Tetra Tech EM, Inc., 2001)
- *Technical Memorandum for Conceptual Model for Groundwater Flow and Chemical Fate and Transport Simulations, Former Naval Air Station Moffett Field, Moffett Field, California* (Tetra Tech FW, Inc. [TtFWI], 2004a)
- *West-Side Aquifers Treatment System Optimization Completion Report, Former Naval Air Station Moffett Field, Moffett Field, California* (TtFWI, 2005a)
- 1999 through 2013 annual groundwater reports for WATS and East-Side Aquifer Treatment System (Foster Wheeler Environmental Corporation, 2002 and 2003; TtFWI, 2004b, 2005b, and 2005c; TtECI, 2006; TN & Associates, 2007 and 2008; SES-TECH, 2009 and 2010; SES-TECH Remediation Services, 2013 and 2014; and ERS-JV and Brown and Caldwell, 2011 and 2012)
- *Draft Site-Wide Focused Feasibility Study and Technical Impracticability Evaluation, Middlefield-Ellis-Whisman Study Area Regional Groundwater Remediation Program Volume 1* (Northgate, 2008)
- *Final Progress Report, In Situ Anaerobic Biotic/Abiotic Treatability Study, IR Site 28, Former Naval Air Station Moffett Field, Moffett Field, California* (Shaw, 2010)
- *Final Technical Memorandum, In Situ Anaerobic Biotic/Abiotic Treatability Study, Installation Restoration Site 28, Former Naval Air Station Moffett Field, Moffett Field, California* (Shaw, 2012)

2.1 Site Description and History

Moffett is located 35 miles south of San Francisco at the northern end of the Santa Clara Valley Basin, approximately 1 mile south of San Francisco Bay (Figure 1). Prior to development in the early 1930s, the surrounding area was used for agriculture, and portions of Moffett consisted of tidal mudflats that had been filled in. Moffett was originally commissioned as Naval Air Station (NAS) Sunnyvale in 1933 to support the West Coast lighter-than-air dirigibles program and was transferred to the U.S. Army Air Corps in 1935 for training purposes. In 1939, a permit was granted to Ames Aeronautical Laboratory to use a portion of the base. NAS Sunnyvale was returned to Navy control in 1942 and was renamed NAS Moffett Field. In 1994, NAS Moffett Field was closed under the U.S. Department of Defense Base Realignment and Closure Program. The operational area of NAS Moffett Field was transferred to the NASA, and the military housing portions were transferred to the U.S. Air Force on July 1, 1994 (SES-TECH, 2009). The housing areas were subsequently transferred to the U.S. Army in 2000. The facility is presently referred to as the NASA Ames Research Center and Moffett Federal Airfield. The facility includes airfield operations, NASA research facilities, and a golf course operated by NASA. Moffett is on the National Priorities List, and site cleanup is conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986. Twenty-nine sites have been identified as IR Program sites at Moffett.

IR Site 28 is comprised of the aquifers below the area generally defined by the outline shown on Figure 1. Current primary uses of this area include airfield operations, administrative offices, and various storage buildings. The A-Aquifer zone at IR Site 28 is impacted by VOCs, primarily CEs, which resulted from on-site Navy sources and on-flow of contamination from upgradient VOC sources originating primarily from the Middlefield-Ellis-Whisman Superfund Site. The requirements for the remediation of impacted groundwater at IR Site 28 are set forth in the ROD (EPA, 1989). The Navy adopted the ROD in 1993, which is documented in the *Federal Facilities Agreement Amendment of December 17, 1993, NAS Moffett Field, California* (Navy, 1993). The selected remedy for groundwater at IR Site 28 is extraction and ex situ treatment to restore groundwater to the cleanup standards specified in the ROD. The EPA's Explanations of Significant Differences (ESD) for the ROD were submitted in September 1990 (*Explanation of Significant Differences for the Fairchild, Intel, and Raytheon Sites, Middlefield-Ellis-Whisman (MEW) Study Area, Mountain View, California* [1990]) and April 1996 (*Explanation of Significant Differences for the Middlefield-Ellis-Whisman Record of Decision* [1996]). The September 1990 ESD clarified that the cleanup goals constituted final cleanup standards and that the remedial activity must meet the final cleanup standard of 5 µg/L for TCE in the upper and lower portions of the A-Aquifer zone (EPA, 1990). TCE was selected as an indicator chemical assuming that by remediating TCE, the other chemicals of concern would be remediated simultaneously. The April 1996 ESD clarified that the groundwater remedy includes the use of

liquid-phase granular activated carbon as a treatment option for extracted groundwater (EPA, 1996).

Previous investigations at Moffett determined that historical dry cleaning activities conducted at former Building 88 were the source of PCE released to the subsurface at IR Site 28 (TtECI, 2008). Building 88 served as a dry cleaning and laundry facility from approximately 1945 until its closure in 1987. It was located south of Wescoat Road between Severyns Avenue and Dugan Avenue (Figure 2). The building occupied approximately 13,500 square feet and was constructed with a concrete floor, which contained numerous floor drains, floor trenches (assumed to be concrete-lined, but construction specifics could not be verified), and subsurface steel piping for wastewater collection, as shown on Figure 2. The floor drains and piping in the main portion of the building drained into Sump 91, a 700-gallon, single-chamber concrete sump used to collect and store wastewater. The floor drains and piping near the equipment room (northeast portion of the building) received and drained wastewater from the dry cleaning machine area into Sump 66, a 100-gallon concrete sump that was reportedly connected to the sanitary sewer. The equipment room had collection floor trenches that may have drained waste dry cleaning fluids into Tank 68, a 2,000-gallon concrete tank. The sumps, tank, and former Building 88 were removed between 1990 and 1994 as described in Section 2.2. Currently, the former Building 88 footprint is a vacant lot.

The branch of the sanitary sewer system that collected wastewater from former Building 88 conveyed the wastewater by gravity: east through the Wescoat Road line, north through the Cummins Avenue line, and eventually to a pump station on the east side of the base (Figure 2). The sanitary lines along Wescoat Road and Cummins Avenue are constructed of vitrified clay pipe with invert elevations ranging from 15 to 9 feet above mean sea level (6 to 8 feet bgs). The section of line along Cummins Avenue immediately downstream of the Wescoat Road line reportedly collapsed and was bypassed with a new line according to the *Final Horizontal Conduit Study Technical Memorandum, Moffett Federal Airfield, California* (PRC, 1995a) as illustrated on Figure 2. Wastewater from the Hangar 1 former aircraft wash rack was also discharged to the sanitary sewer line that collapsed along Cummins Avenue (Figure 2). The wastewater originating at the wash rack was collected in a catchment basin and routed to the Sump 25 oil/water separator, which, in turn, discharged to the Cummins Avenue sanitary sewer line (Figure 2). Wash water from the wash rack could have contributed to the CE contamination in the Traffic Island Area via the sanitary sewer conduit, because chlorinated VOCs were commonly used to clean aircrafts before the Navy switched to citrus-based solvents in the early 1990s. Sump 25 was removed in May 1994 (PRC, 1996), as described in Section 2.2.

2.2 Previous Remedial Response Actions

This subsection highlights remedial actions conducted at IR Site 28 in response to the ROD and ESD requirements (EPA, 1989 and 1990). Initially, remedial actions were completed to address the following:

- Primary and secondary sources of groundwater contamination at the site
- Sump and tank removals
- Building demolition
- Vadose zone soil removal

Subsequent remedial actions involved the installation and operation of groundwater pump-and-treat systems to contain and treat the contaminated groundwater.

2.2.1 Sump and Tank Removals

Two sumps (66 and 91) and one underground storage tank (Tank 68) associated with former Building 88 were removed between 1990 and 1994 (PRC, 1991 and 1995b). In May 1994, Sump 25 oil/water separator, which collected wastewater from the former aircraft wash rack located east of Cody Road, was removed. Sump 25 was a 2,000-gallon concrete, dual-chamber oil/water separator that used an oil skimmer system for oil recovery. The sump discharged to the Cummins Avenue sanitary sewer line. After Sump 25 was removed in 1994, and the aircraft wash rack was no longer used, the drain line from the catchment basin at the former aircraft wash rack was connected to the storm sewer system. Sump 25 and the wash rack area were both investigated in 1995 to see if they were potential sources of VOCs to the regional plume. According to the *Draft Wash Rack Area Investigation, Technical Memorandum, Moffett Federal Airfield, California (Formerly Naval Air Station Moffett Field)* (PRC, 1996), results of the soil and groundwater samples collected from the wash rack area indicated it was a potential source of TCE contamination to the regional groundwater plume. Consequently, a decision was made to install extraction well EA1-2 as a source control measure downgradient of the wash rack area. The results of the groundwater samples collected near Sump 25 indicated that it was not a source of VOCs to groundwater and, therefore, a source control measure was not implemented at this former sump. The chlorinated VOC contamination related to these former features was sufficiently defined, and therefore, no further investigation is planned.

2.2.2 Unsaturated Zone Source Removal

In 1994, Building 88 was demolished, and the vadose zone soil contamination was excavated. At that time, the foundation, floor, floor drains, collection trenches, and subsurface piping were removed by excavation. One hundred nineteen pre-excavation soil samples were collected at locations throughout the building footprint, including under the floor, drains, piping and

trenches, and foundation (PRC, 1995b). Based on the results of these samples, approximately 400 cubic yards of soil were excavated from two areas (northern excavation and southern excavation) where PCE concentrations exceeded the negotiated cleanup level of 500 micrograms per kilogram (µg/kg) for PCE in the unsaturated zone soil (Figure 2). The excavations extended down to the water table at approximately 7 to 8 feet bgs. Seven post-excavation bottom samples were collected from the two areas. PCE was detected at maximum concentrations of 1,100 µg/kg in the bottom samples from the northern excavation and 78 µg/kg in the bottom samples from the southern excavation. No additional excavation was performed, because groundwater was encountered.

2.2.3 Saturated Zone Contaminant Removal

A groundwater source control measure, referred to as the Building 6 Treatment System, was installed in 1994 to provide hydraulic control of potential residual saturated zone contamination from the former Building 88 (Tetra Tech EM, Inc., 2001). The system extracted and treated contaminated groundwater from converted groundwater monitoring well W9-46 (Figure 2). Between 1994 and 1997, the system extracted and treated roughly 800,000 gallons of groundwater and recovered approximately 2.4 pounds of VOCs. The Building 6 system was shut down in 1997 and replaced with the WATS.

The WATS went online in November 1998 and remains in operation currently. The system includes six extraction wells screened in the upper portion of the A-Aquifer zone and three extraction wells screened in the lower portion of the A-Aquifer zone. These extraction wells recover contamination from on-site sources and contamination that migrates from sources upgradient of the WATS area. As of December 31, 2013, the WATS had extracted and treated approximately 476,300,000 gallons of groundwater and storm drain water, and approximately 5,700 pounds of VOCs had been recovered (SES-TECH Remediation Services, 2014). The average WATS influent VOC concentrations have generally declined since system startup in 1998 with the exception of fluctuations in PCE concentrations. Nonetheless, the normalized CE mass removal (the amount of mass being removed by WATS for every gallon of groundwater removed) has been relatively constant.

2.2.4 2010 through 2011 In Situ Anaerobic Biotic/Abiotic Treatability Study

In 2010 through 2011, a TS was performed at IR Site 28 to assess the effectiveness of three potential anaerobic biotic/abiotic technologies for treating CEs in situ. The technologies tested during the TS included a combined biotic/abiotic treatment process and two separate biostimulation with bioaugmentation treatment processes. The combined biotic/abiotic treatment process was conducted in a pilot test using a proprietary blend of organic substrate and zero-valent iron (EHC®). The biostimulation with bioaugmentation treatment process was conducted in two separate pilot tests using different organic substrates, EVO and lactate, and

incorporating bioaugmentation with SDC-9™, a dechlorinating microbial consortium containing *Dehalococcoides* (DHC).

To evaluate the technologies, each pilot test was performed at a separate source area of CEs in the saturated zone. Lactate with SDC-9™ was tested at the Former Building 88 Area; EVO with SDC-9™ was tested at the Traffic Island Area; and EHC® was tested in the area of well W9-18. The lateral and vertical treatment zones varied by location and were defined by previous characterization studies (TtECI, 2008) and pre-study MIP testing. Existing and newly installed observation wells were used to monitor the effectiveness of each pilot test. The activities and results of the TS are summarized in the *Final Technical Memorandum, In Situ Anaerobic Biotic/Abiotic Treatability Study, Installation Restoration Site 28, Former Naval Air Station Moffett Field, Moffett Field, California* (Shaw, 2012).

Based on the test results, each treatment process was determined to be effective in degrading PCE, TCE, and cis-1,2-DCE to below the MCLs, and the ROD and ESD cleanup standard (EPA, 1989 and 1990) within the performance monitoring period for the TS. Although substantial degradation of VC was also observed in each treatment area, VC concentrations remained above the MCL in each test area at the end of the performance monitoring period due to ongoing sequential reductive dechlorination. It was considered likely that degradation would continue in each of the areas where substrate was present (Shaw, 2012).

Although the period of performance for the TS had ended, changes in the geochemistry of the pilot test areas continued. To provide valuable information on the fate of the remaining VC as well as whether high concentrations of the other CEs would be re-established from either on-flow or matrix diffusion, the Navy elected to conduct additional performance monitoring of the EVO pilot test and the EHC® Pilot Test areas in 2012. These areas were selected for additional monitoring because substrate was still available and conditions conducive to continued degradation persisted at the end of the TS. Further monitoring of the Lactate Pilot Test area was not performed because substrate did not remain in this area at the end of the TS.

Additional performance monitoring of the EVO pilot test demonstrated that strongly reducing conditions and continued sequential reductive dechlorination of CEs to nontoxic ethene were sustained in the treatment area up to two years after substrate injection with CE concentrations trending generally downward, except in the two deepest treatment area wells which exhibited increases in DCE and VC concentrations likely due to migration of CEs from untreated upgradient sources (Section 6.2.1). The results of this test demonstrated that CEs in groundwater at IR Site 28 can be effectively remediated by using EVO bioaugmented with the SDC-9™ consortium. PCE and TCE concentrations in the test area decreased greater than 99.4 percent, DCE concentrations decreased greater than 94 percent after initially increasing, and VC concentrations decreased 33 to 99.7 percent after initially increasing, except at one of the wells

where DCE and VC concentrations suddenly increased significantly (roughly 10- and 4-fold, respectively) by the last event likely due to migration of CEs from untreated upgradient sources.

Additional performance monitoring of the EHC® pilot test area demonstrated that the organic carbon concentration in groundwater had been depleted in the vicinity of the treatment area wells and consequently, highly reducing conditions and continued biological degradation of CEs had diminished. However, abiotic degradation of CEs by the zero-valent iron component of EHC® is expected to continue where it is present. The results of this test demonstrated that CEs in groundwater at IR Site 28 can be effectively remediated by using EHC® where distributed, but it is relatively difficult to inject due to the high solids content of the slurry combined with the heterogeneity of the aquifer matrix that limited the amount of slurry the formation could accept and its distribution. Two years after treatment, at the two observation wells where EHC® was more easily distributed, PCE and TCE concentrations decreased greater than 93 percent, DCE concentrations decreased 85 to 99 percent after initially increasing, and VC concentrations decreased by 72 to 99.7 percent after initially increasing but then began to increase again by the last event, likely from on flow of untreated CEs from an upgradient source. PCE, TCE, and DCE concentrations at the other treatment area well, within more fine-grained soil, where EHC® was not as easily distributed, showed little affect from the treatment and had returned to pretreatment concentrations after two years. VC concentrations at this well exhibited a sudden 10-fold increase by the last event, possibly due to on flow from an upgradient source.

2.3 Site Geology and Hydrogeology

This section provides a brief description of the local geology and hydrogeology at IR Site 28. Information was compiled from the *Final Former Building 88 Investigation Report, Former Naval Air Station Moffett Field, Moffett Field, California* (TtECI, 2008); *Draft, West Side Aquifers Treatment System, Site 28 Optimization Evaluation Report, Installation Restoration Site 28, Former Naval Air Station Moffett Field, Moffett Field, California* (SES-TECH, 2008); and the Final Supplemental Investigation Report (CB&I, 2014).

2.3.1 Local Geology

The native subsurface in the IR Site 28 area is characterized by interbedded coarse-grained soil (sand and gravel) and fine-grained soil (silt and clay). Sedimentary deposits that make up the A-Aquifer zone represent the distal end of a Holocene-aged coalescing alluvial fan complex and tidal mud flats (estuarine deposits). Near the bay, fine-grained alluvium is replaced by bay mud (dark-gray silt and clay). The sand and gravel represent anastomosing stream channel deposits between interchannel alluvium and bay mud. Fluvial channel deposits typically display fining-upward sequences that begin with a poorly sorted mixture of gravel and coarse sand at the bottom, overlain by a fining-upward sequence of coarse-to-fine sand, silt, or clay. These channel

deposits have been interpreted to generally trend northwest to southeast, and become more northerly in the vicinity of the WATS (TtFWI, 2005a).

2.3.2 Local Hydrogeology

The focus of this treatability test is the A- and B-Aquifer zones. The A-Aquifer zone extends from grade to approximately 75 feet bgs at IR Site 28. The A-Aquifer zone is divided into two portions: an upper portion above approximately 35 feet bgs (sometimes referred to as the A1 zone) and a lower portion below approximately 35 feet bgs (sometimes referred to as the A2 zone) (TtECI, 2008). Based on the absence of a continuous aquitard separating them, these horizons are considered to be portions of the same A-Aquifer zone rather than independent, discrete aquifers (SES-TECH, 2008).

The A-Aquifer zone is separated from the deeper B-Aquifer zone by clay and clayey silt layers which form the A/B-Aquitard. The A/B-Aquitard varies in thickness and has been encountered at depths ranging from 45 feet bgs to greater than 80 feet bgs.

The B-Aquifer zone is present below the A/B-Aquitard and extends to depths as great as 160 feet bgs. The B-Aquifer zone is divided into two permeable zones: an upper zone referred to as the B2-Aquifer zone and a lower zone referred to as the B3-Aquifer zone that are separated by a laterally discontinuous and variable thickness aquitard (referred to as the B2/B3-Aquitard) encountered at depths ranging from 95 to 130 feet bgs. The B3-Aquifer zone lies beneath the B2-Aquifer zone and extends to 160 feet bgs. The B-Aquifer zone is underlain by the C and deeper aquifers.

The general groundwater flow direction in the upper and lower portions of the A-Aquifer zone is generally to the north-northeast across Moffett at an average gradient of approximately 0.005 foot per foot between U.S. Highway 101 and Hangar 1. The gradient in the general vicinity of Hangar 1 is affected by the WATS pumping to a north-northwesterly direction; however, the overall flow is north/northeast from Hangar 1 toward the NASA Ames Research Center at a gradient ranging from approximately 0.003 to 0.006 foot per foot (SES-TECH Remediation Services, 2014). Aquifer tests of the upper A-Aquifer zone indicate unconfined to leaky-confined conditions and tests of the lower A-Aquifer zone indicate leaky-confined conditions. There is a predominant upward potential for groundwater flow from the B2-Aquifer zone to the lower portion of the A-Aquifer zone. The general groundwater flow direction in the B2-Aquifer zone appears to be to the north across Moffett as observed on Figure 12, “B2 Zone Groundwater Elevation Contours and Estimated Capture Zones, 31 March 2013” in the *2013 Annual Progress Report, Volume 1: Text, Tables, Figures, Middlefield-Ellis-Whisman Area Regional Groundwater Remediation Program, Mountain View, California* (Geosyntec Consultants, 2014).

2.4 Nature and Extent of Contamination

As previously discussed, the chemicals of concern are VOCs, primarily PCE and related degradation products (TCE, cis-1,2-DCE, and VC) within the upper and lower portions of the A-Aquifer zone, and in the B2-Aquifer zone. Continuing sources of PCE contamination to groundwater have been identified in the Traffic Island Area beneath the sanitary sewer alignment downstream from former Building 88. A brief summary of the PCE, TCE, cis-1,2-DCE, and VC contamination in the Traffic Island Area is provided in the following subsections. The description of CEs in the A-Aquifer within and around the Traffic Island Area is based on the results of:

- 50 soil samples collected from 8 borings during the 2005 site investigation (TtECI, 2008)
- 1 soil sample collected from 1 boring during the 2010 through 2011 TS (Shaw, 2010)
- 16 soil samples collected from 6 borings during the 2012 through 2013 SI (CB&I, 2014)
- 53 discrete-depth groundwater grab samples collected from 8 direct-push locations during the 2005 site investigation (TtECI, 2008)
- 10 discrete-depth groundwater grab samples collected from 6 direct-push locations completed by NASA during a subsurface investigation within Hangar 1 in 2009
- Groundwater samples collected from the 14 TS observation wells between 2010 and 2011 (Shaw, 2012) and in 2012 (CB&I, 2014)
- Groundwater samples collected from 6 wells outside the TS area during the basewide annual groundwater monitoring events between 2010 and 2013 (ERS-JV and Brown and Caldwell, 2011 and 2012; SES-TECH Remediation Services, 2013 and 2014)
- Groundwater samples collected from 9 new groundwater monitoring wells installed during the 2012 through 2013 SI (CB&I, 2014)
- 19 MIP tests completed in March/April 2010 prior to the 2010 through 2011 TS (Shaw, 2010)
- 746 MIP/DSITMS measurements at 28 SCAPS test borings completed during the 2012 through 2013 SI (CB&I, 2014)

The description of CEs in the B2-Aquifer (to the extent investigated) within and around the Traffic Island Area is based on the results of:

- 6 soil samples collected from 4 borings during the 2012 through 2013 SI (CB&I, 2014)

- Groundwater samples collected from 4 new groundwater monitoring wells installed during the 2012 through 2013 SI (CB&I, 2014)
- 219 MIP/DSITMS measurements at 28 SCAPS test borings completed during the 2012 through 2013 SI (CB&I, 2014)

The listed sample locations are shown on Figure 4 of this WP, and the most recent depiction of the distribution of PCE and its daughter products in the A-Aquifer and B2-Aquifer are shown on Figures 19 through 30 in the Final Supplemental Investigation Report (CB&I, 2014). Based on the complex nature and extent of contamination, multiple compounds considered, and the extensive graphics required to adequately illustrate this information, it is recommended that the reader refer to the various graphic illustrations provided in the Final Supplemental Investigation Report (CB&I, 2014), the *Final Former Building 88 Investigation Report, Former Naval Air Station Moffett Field, Moffett Field, California* (TtECI, 2008), and the annual basewide groundwater monitoring reports cited previously in this section.

Based on the 2012 through 2013 MIP/DSITMS survey, it was determined that the majority of the residual CE mass at the traffic island source area is predominantly in fine-grained soil. The locations in the upper portion of the A-Aquifer zone where the greatest amount of MIP/DSITMS responses were recorded over the vertical profile occurred near the southern (upstream) end of the former collapsed sanitary sewer line along Cummins Avenue at the intersection with Wescoat Road (SCAPS-26 and SCAPS-27), downgradient of the sanitary sewer trunk line along the south side of Wescoat Road (SCAPS-48), and adjacent to the northeast corner of Building 126 (SCAPS-22 and SCAPS-43). The responses were predominantly PCE and DCE with lesser amounts of TCE, except for SCAPS-26, which had no DCE. These responses correspond to the elevated concentrations of CEs detected in historical soil and groundwater samples collected in this area.

The locations in the lower portion of the A-Aquifer zone where the greatest amount of MIP/DSITMS responses were recorded over the vertical profile occurred along the former collapsed sanitary sewer line (SCAPS-17, SCAPS-26, SCAPS-27, and SCAPS-28) and downgradient of the sanitary sewer trunk line on the south side of Wescoat Road (SCAPS-48). The responses were predominantly PCE with little TCE and DCE, which corresponds with the elevated concentrations of CEs detected in historical soil and groundwater samples collected from this interval in this area.

Based on the 2012 through 2013 MIP/DSITMS survey, it was determined that the majority of the residual CE mass at the traffic island source area in the B2-Aquifer zone is predominantly in fine-grained soil. In the B2-Aquifer zone, MIP/DSITMS responses were detected at only 6 of the 28 SCAPS test locations, all in the vicinity of the traffic island near the former collapsed sanitary

sewer line (SCAPS-16, SCAPS-26, SCAPS-27, SCAPS-28, SCAPS-51, and SCAPS-52). The responses were predominantly PCE with lesser amounts of TCE and DCE.

2.4.1 Dense Non-aqueous Phase Liquid

The potential presence of DNAPL at the Traffic Island Area has been tested for and evaluated during previous investigations and the recent SI. No positive indications of DNAPL were identified during previous investigations, but positive indications of DNAPL were identified during the recent SI. DNAPL was positively identified in the bottom portion of the lower A-Aquifer zone between 63 and 67 feet bgs at the intersection of Cummins Avenue with Wescoat Road, approximately 20 feet west of the former collapsed sanitary sewer line (near wells 28SI-06 and 28SI-13). The discovery of residual DNAPL substantiates that non-aqueous phase PCE was released from the southern end of the former collapsed sanitary sewer line along Cummins Avenue at the intersection with Wescoat Road, which is corroborated by the vertical distribution of CEs in the subsurface as delineated by the MIP/DSITMS data (CB&I, 2014). The potential presence of DNAPL in the B2-Aquifer zone at the Traffic Island Area was tested for and evaluated during the SI, but no positive indications of DNAPL were identified

2.4.2 Tetrachloroethene

Concentrations of PCE in soil greater than 500 µg/kg (the negotiated cleanup level for PCE in unsaturated zone soil [PRC, 1995b]) have been detected in both the upper and lower portions of the A-Aquifer zone at depths ranging from 6.5 to 67 feet bgs along the former collapsed sanitary sewer alignment, and approximately 180 feet further downstream (north-northwest) at CPT-88-19. The highest concentration of PCE in soil (27,000,000 µg/kg; well boring 28SI-06) was detected in a sample from 63 feet bgs at the intersection of Cummins Avenue with Wescoat Road, approximately 20 feet west of the former collapsed sanitary sewer line, where DNAPL was positively identified. PCE in soil greater than 500 µg/kg was also detected in the upper portion of the A-Aquifer zone between 5 and 13 feet bgs on the northeast side of Building 126 (well boring 28SI-08). In the B2-Aquifer zone, PCE in soil greater than 500 µg/kg was detected in three samples collected at depths ranging from 80 to 109 feet bgs. The samples were collected from well borings 28SI-06 and 28SI-07 located near the former collapsed sanitary sewer line at the southern end of the traffic island.

Within 200 feet upgradient of the Traffic Island Area, PCE was not detected above the MCL (5 µg/L) in any of the A-Aquifer zone well samples collected during the 2013 annual groundwater monitoring event (SES-TECH Remediation Services, 2014). Concentrations of PCE in groundwater greater than 1,000 µg/L were detected along the former collapsed sanitary sewer alignment at depths ranging from 14.5 to 68 feet bgs and beneath the southwest corner of Hangar 1 (grab groundwater sample location PS3-5) at a depth of 40 feet bgs. The highest concentration (28,000 µg/L [December 2013]) was detected between 63 and 68 feet bgs in a

sample from well 28SI-13, located at the intersection of Cummins Avenue with Wescoat Road where residual DNAPL was identified. However, as of 2012, groundwater concentrations of PCE in the EVO pilot test treatment area (southern end of the traffic island) were less than the MCL (5 µg/L) in the upper portion of the A-Aquifer zone (wells 28OW-05 and 28OW-06) and were less than 20 µg/L in the lower portion of the A-Aquifer zone (wells 28OW-07, 28OW-08, and 28OW-12).

Concentrations of PCE in B2-Aquifer zone groundwater greater than 1,000 µg/L were detected in samples collected from the two wells along the sanitary sewer alignment at the southern end of the traffic island (28SI-06 and 28SI-07) where elevated MIP/DSITMS responses and soil concentrations were detected. Well 28SI-06 is screened from 90 to 100 feet bgs and well 28SI-07 is screened from 105 to 115 feet bgs. The maximum concentration of PCE (10,000 µg/L) was detected in a sample from well 28SI-06. The maximum concentration of PCE detected in a sample from the deepest B2-Aquifer zone well, 28SI-07, was 9,500 µg/L. Lower concentrations of PCE, less than 20 µg/L, were detected in samples from the other two B2-Aquifer zone wells, 28SI-09 and 28SI-10, screened from 90 to 100 feet bgs.

2.4.3 Trichloroethene

Concentrations of TCE in soil greater than 500 µg/kg (the cleanup standard for TCE in unsaturated zone soil [EPA, 1989 and 1990]) have been detected in both the upper and lower portions of the A-Aquifer zone at depths ranging from 12 to 63 feet bgs at the intersection of Cummins Avenue with Wescoat Road (well boring 28SI-06). TCE in soil greater than 500 µg/kg was also detected adjacent to the former collapsed sanitary sewer line beneath the traffic island at 8 to 9 feet bgs (soil boring CPT-88-13) and adjacent to the northeast side of Building 126 at 13 feet bgs (well boring 28SI-08). The highest concentration of TCE in soil (110,000 µg/kg; well boring 28SI-06) was detected in a sample from 63 feet bgs at the intersection of Cummins Avenue with Wescoat Road, approximately 20 feet west of the former collapsed sanitary sewer line, where DNAPL was positively identified.

Within 200 feet upgradient of the Traffic Island Area, TCE has been detected in groundwater in the upper portion of the A-Aquifer zone at concentrations ranging from 4.6 µg/L (well 28OW-09 [June 2011]) to 900 µg/L (grab groundwater location CPT-88-16 [April 2005]). Concentrations of TCE greater than the highest upgradient concentration (900 µg/L) were only detected between 14 and 19 feet bgs beneath the traffic island adjacent to the former collapsed sanitary sewer line (grab groundwater location CPT-88-13). However, as of 2012, groundwater concentrations of TCE in the EVO pilot test treatment area (which encompasses CPT-88-13) were less than the ROD cleanup standard (5 µg/L) in the upper portion of the A-Aquifer zone (wells 28OW-05 and 28OW-06).

Within 200 feet upgradient of the Traffic Island Area, TCE has been detected in groundwater in the lower portion of the A-Aquifer zone at concentrations ranging from 6.9 µg/L (CPT-88-17 [April 2005]) to 620 µg/L (CPT-88-16 [April 2005]). Concentrations of TCE greater than the highest upgradient concentration (620 µg/L) have been detected beneath, approximately 140 feet to the west-southwest (CPT-88-20 and CPT-88-21), and approximately 240 feet to the north-northwest (CPT-88-19) of the traffic island at depths ranging from 39 to 65 feet bgs. The highest recent concentration (11,000 µg/L [October 2012]) was detected in a sample from well 28OW-04 (screened 55 to 65 feet bgs), located immediately downgradient of the EVO pilot test area adjacent to the collapsed sanitary sewer line. However, as of 2012, groundwater concentrations of TCE in the EVO pilot test treatment area were less than 40 µg/L in the lower portion of the A-Aquifer zone (28OW-07, 28OW-08, and 28OW-12).

Concentrations of TCE in B2-Aquifer zone groundwater greater than 1,000 µg/L were detected in samples collected from the two wells along the sanitary sewer alignment at the southern end of the traffic island (wells 28SI-06 and 28SI-07) where elevated MIP/DSITMS responses and soil concentrations were detected. Well 28SI-06 is screened from 90 to 100 feet bgs and well 28SI-07 is screened from 105 to 115 feet bgs. The maximum concentration of TCE (10,000 µg/L) was detected in samples from well 28SI-06. Lower concentrations of TCE, less than 20 µg/L, were detected in samples from the other two wells, 28SI-09 and 28SI-10, screened from 90 to 100 feet bgs.

2.4.4 cis-1,2-Dichloroethene

Concentrations of cis-1,2-DCE in soil greater than 500 µg/kg have been detected in both the upper and lower portions of the A-Aquifer zone at depths ranging from 12 to 63 feet bgs at the intersection of Cummins Avenue with Wescoat Road (well boring 28SI-06). Cis-1,2-DCE in soil greater than 500 µg/kg was also detected at depths ranging from 8 to 19 feet bgs adjacent to the former collapsed sanitary sewer line (soil boring CPT-88-13), approximately 50 feet downgradient of the traffic island (soil boring CPT-88-23), and adjacent to the northeast side of Building 126 (well boring 28SI-08). The highest concentration of cis-1,2-DCE in soil (74,000 µg/kg; well boring 28SI-06) was detected in a sample from 63 feet bgs at the intersection of Cummins Avenue with Wescoat Road, approximately 20 feet west of the former collapsed sanitary sewer line, where DNAPL was positively identified. DCE was not detected in any of the six soil samples collected from the B2-Aquifer zone.

Within 200 feet upgradient of the Traffic Island Area, cis-1,2-DCE was most recently detected in groundwater in the upper portion of the A-Aquifer zone at concentrations ranging from 150 µg/L (28OW-10 [June 2011]) to 1,500 µg/L (WNX-2 [October 2013]). Concentrations of cis-1,2-DCE greater than the highest upgradient concentration (1,500 µg/L) were only detected between 12 and 17 feet bgs beneath the traffic island adjacent to the former collapsed sanitary sewer line

(CPT-88-13 and 28OW-05). However, as of 2012, groundwater concentrations of cis-1,2-DCE in the EVO pilot test treatment area (which encompasses CPT-88-13 and 28OW-05) were less than the MCL (5 µg/L) at this depth interval.

Within 200 feet upgradient of the Traffic Island Area, cis-1,2-DCE has been detected in groundwater in the lower portion of the A-Aquifer zone at concentrations ranging from 1.8 µg/L (CPT-88-17 [April 2005]) to an estimated value of 120 µg/L (CPT-88-16 [April 2005]). Concentrations of cis-1,2 DCE greater than the highest upgradient concentration (120 µg/L) were detected beneath, approximately 140 feet to the west-southwest (CPT-88-20 and CPT-88-21), and approximately 200 feet north-northwest (W9-21) of the traffic island at depths ranging from 35 to 68 feet bgs. The highest concentration (84,000 µg/L [December 2013]) was detected between 63 and 68 feet bgs in a sample from well 28SI-13, located at the intersection of Cummins Avenue with Wescoat Road where residual DNAPL was identified.

Cis-1,2-DCE concentrations in B2-Aquifer zone groundwater ranged from an estimated value of 0.4 to 3,800 µg/L. Concentrations of cis-1,2-DCE in groundwater greater than 1,000 µg/L were only detected in a sample collected from well 28SI-06 located immediately southwest of the traffic island where the highest MIP/DSITMS responses and soil concentrations were detected. Concentrations below 1,000 µg/L were detected in the samples from deeper well 28SI-07 and even lower concentrations, below 26 µg/L, were detected in the other two wells, 28SI-09 and 28SI-10.

2.4.5 Vinyl Chloride

VC has been detected in only five soil samples, at concentrations ranging from 2 to 70 µg/kg. The samples were collected from locations upgradient of the traffic island (CPT-88-16), along the collapsed sanitary sewer alignment (CPT-88-13, 28SI-10, and 28SI-11), and approximately 60 feet east of the traffic island (28SI-09) at depths ranging from 8 to 54 feet bgs. VC was not detected in any of the six soil samples collected from the B2-Aquifer zone.

Within 200 feet upgradient of the Traffic Island Area, VC was most recently detected in groundwater in the upper portion of the A-Aquifer zone at concentrations ranging from an estimated value of 0.55 µg/L (28OW-10 [June 2011]) to 130 µg/L (WNX-2 [October 2013]). Concentrations of VC greater than 130 µg/L (the highest upgradient concentration) were detected beneath the traffic island (28OW-02, 28OW-06, W9-29) at depths ranging from 7 to 29 feet bgs. The highest concentration (160 µg/L [September 2012]) was detected in samples from wells 28OW-02 and W9-29, located within the traffic island immediately downgradient and cross-gradient of the EVO pilot test area.

Within 200 feet upgradient of the Traffic Island Area, VC has been detected in groundwater in the lower portion of the A-Aquifer zone only at well 28OW-11 (40 to 50 feet bgs). The VC

concentration in groundwater at this well as of June 2011 was 0.71 µg/L. Concentrations of VC greater than the upgradient concentration (0.71 µg/L) have been detected throughout the Traffic Island Area. Elevated concentrations of VC (1,000 to 12,000 µg/L) have been detected beneath the traffic island due to ongoing reductive dechlorination from the EVO pilot test at depths ranging from 40 to 82 feet bgs. The highest concentration of VC (12,000 µg/L [December 2013]) was detected between 63 and 68 feet bgs in a sample from well 28SI-13, located at the intersection of Cummins Avenue with Wescoat Road where residual DNAPL was identified; upgradient of the EVO pilot test area. Within 50 feet to the north and northwest of the traffic island, VC concentrations drop below 10 µg/L (28SI-11, 28SI-15, PS3-5, and PS3-6). However, approximately 200 feet north-northwest of the traffic island, VC has been detected at well W9-21 at concentrations greater than 10 µg/L (190 µg/L [October 2013]). VC has not been detected in any of the groundwater samples collected from the B2-Aquifer zone wells at the Traffic Island Area during the SI.

3.0 Treatability Test Approach

The following sections summarize the general approach and the technologies proposed for the treatability test.

3.1 Treatment Processes

The proposed treatment approach consists of a combination of biotic and abiotic processes to degrade the CEs to nontoxic end products. The biotic and abiotic processes both degrade CEs by removing the chlorine atoms from the ethene structure, thereby converting them to nonchlorinated and, therefore, nontoxic organic compounds. Because these processes are very similar and occur under similar geochemical conditions, they have a synergistic affect that enhances both processes. Specifically the treatment processes are:

- EAB (biotic process)
- Bioaugmentation (biotic process)
- ISCR (abiotic processes of β-elimination and hydrogenolysis)

These processes are described in the following subsections.

3.1.1 Enhanced Anaerobic Bioremediation—Biotic Process

CEs have been demonstrated to degrade by a biological process called reductive dechlorination (Figure 5). During this process, an electron donor (e.g., organic carbon) is fermented by indigenous organisms that produce molecular hydrogen. The indigenous microbial culture will use the hydrogen in a biologically mediated oxidation-reduction reaction. They will progressively reduce the electron acceptors, including the following:

- Dissolved oxygen (DO)
- Nitrate
- Arsenic (V)
- Manganese (IV)
- Iron (III)
- Sulfate
- Carbon dioxide

This reduction will result in increased concentrations of the following, as reducing conditions progressively intensify:

- Carbon dioxide
- Nitrite
- Arsenic (III)
- Manganese (II)
- Iron (II)
- Sulfide
- Methane

In addition to undergoing changes in aquifer geochemistry, the CEs act as electron acceptors under moderate to strongly reducing conditions. Dechlorinating microorganisms (e.g., DHC) utilize the hydrogen to reduce the CEs in a biologically mediated oxidation-reduction reaction called chlororespiration. In this process, CEs are sequentially degraded under progressively reducing conditions by reductive dechlorination to less oxidized (more reduced) daughter products including DCE and VC, and eventually to nontoxic ethene and ethane, which are ultimately mineralized to carbon dioxide, water, and chloride ions. Because the microorganisms use the CEs to sustain themselves, these organisms prefer to grow in areas where high concentrations of CEs are present.

The enhanced in situ anaerobic bioremediation process is conducted by stimulating (biostimulation) chlororespiration by dechlorinating bacteria. The biostimulation process is applied by distributing an electron donor (e.g., lactate, emulsified oil, or lecithin) through the contaminated zone. Indigenous bacteria utilize the electron donor and generate molecular hydrogen as a waste product. Dechlorinating bacteria use that hydrogen to sequentially replace chlorine atoms on the CE molecular structure with a hydrogen atom in a process called hydrogenolysis. This process sequentially converts PCE and TCE to less chlorinated compounds including DCE and VC. Because the dechlorinating bacteria gain energy from this transfer, this process continues until all chlorines are removed from the CE compounds, reducing them to ethene, which is nontoxic.

3.1.2 Bioaugmentation—Biotic Process

Although many microorganisms participate in the biological degradation process, only DHC has been shown to biologically degrade PCE and TCE to nontoxic ethene. DHC is a naturally occurring organism that is present at many, but not all sites, where CEs have been discharged. DHC has reportedly been detected in the groundwater at all sites evaluated where ethene (the

nontoxic product of CE degradation) has been detected. The presence of DHC is considered essential for successful in situ anaerobic biodegradation, but at many sites the population of DHC is insufficient to successfully compete for hydrogen following the biostimulation process previously described. To optimize biological degradation of the CEs, bioaugmentation is commonly conducted at sites with low concentrations of the indigenous dechlorinating microorganisms. Bioaugmentation is the addition of natural microbial strains or laboratory enriched variants to the subsurface environment to enhance in situ bioremediation of contaminants such as CEs. The bioaugmentation culture to be applied during this treatability test is a naturally occurring microbial culture that was collected from another CE site located in California. This culture has been successfully applied at numerous sites across the United States and has been previously injected at the Former Building 88 and Traffic Island Areas of IR Site 28 at Moffett Field.

3.1.3 Abiotic Degradation Processes

CEs can also be abiotically degraded to nontoxic end products. The abiotic pathway results in the complete conversion of CEs by several mechanisms including hydrogenolysis and by β-elimination (replacement of two chlorine atoms). Each of these processes involves the removal of the chlorine from the ethene structure. The abiotic degradation of CEs by the hydrogenolysis pathway can result in the production of minor amounts of more reduced CEs including DCE isomers, and VC, and then subsequently to nontoxic ethene and ethane. The β-elimination pathway does not generate the daughter products typical of reductive dechlorination or hydrogenolysis pathways. This pathway results in the production of the following:

- Ferrous iron and chloride, which eventually are removed from solution
- Chloroacetylene and acetylene, which are subsequently reduced to nontoxic ethene and ethane and ultimately mineralized to carbon dioxide, chloride ions and water

The abiotic β-elimination and hydrogenolysis pathways are shown on Figure 5.

3.2 Treatment Reagents

To facilitate the biotic and abiotic processes previously described, the following treatment reagents are proposed for injection into the target treatment zone during the treatability test:

- Lactate—a quick hydrogen release substrate used to rapidly stimulate overall biological reduction and provide hydrogen for reductive dechlorination
- Emulsified Lecithin Substrate (ELS™)—a slower hydrogen release substrate to stimulate overall biological reduction and provide hydrogen for longer term reductive dechlorination

- SDC-9™—a laboratory enriched culture of dechlorinating microorganisms for the bioaugmentation step
- Microscale zero-valent iron (ZVI) particles—used to degrade PCE and TCE abiotically via the β-elimination and hydrogenolysis pathways and to rapidly establish and maintain highly reducing conditions for complete reductive dechlorination

The following subsections describe these reagents in more detail.

3.2.1 Lactate

A 60 percent solution of lactate will be used as a rapid hydrogen release substrate to support the growth of indigenous populations of bacteria. As bacteria consume the lactate, volatile fatty acids (VFAs) are produced along with molecular hydrogen. The VFAs are consumed by bacteria and electron acceptors such as DO, nitrate, arsenic (V), manganese (IV), iron (III), and sulfate which are converted to carbon dioxide, nitrite, arsenic (III), manganese (II), iron (II), and sulfide, respectively, in a progressively more reducing environment. This reduced environment favors the dechlorinating bacteria (DHC) as PCE and its subsequent chlororespiration daughter products are consumed as electron acceptors until the nontoxic daughter products ethene and ethane remain. These end products of chlororespiration are eventually mineralized to form carbon dioxide, water, and chloride ions. The rapid biodegradation of the lactate into the VFAs helps to promote dechlorinating conditions quickly. Thus lactate will be used to condition the injection water (lowering the oxidation-reduction potential [ORP]) prior to injections.

3.2.2 ELS™

The organic component of ELS™ (a food-grade based micro-emulsion made from plant tissue, mainly consisting of lecithin) supports growth of bacteria through the slow release of hydrogen and nutrients, providing both organic nitrogen and phosphorus, in an extended release profile of one to three years to the groundwater environment. This makes ELS™ a persistent hydrogen releasing substrate (compared to lactate). ELS™ is an efficient source of hydrogen providing a high yield of hydrogen per gram of substrate with hydrophilic properties and small droplet size (60 percent less than 1 micrometer and 85 percent less than 2 micrometer) creating good distribution properties.

3.2.3 SDC-9™

SDC-9™ is a laboratory enriched culture of DHC bacteria used for bioaugmenting sites where native populations of DHC are presumed to be too low for reductive dechlorination to take place. During the treatability test, SDC-9™ will be added to bioaugment the dechlorination process. DHC is an obligate anaerobe, and thrives poorly in aquifers with DO greater than 1 milligram per liter. Therefore, anaerobic (less than 0.5 milligram per liter DO) must be established in the aquifer for DHC to thrive and degrade CEs. As described previously, organic substrates will be

injected into the aquifer to establish anaerobic and highly reducing conditions conducive to complete reductive dechlorination of CEs by DHC.

3.2.4 Microscale Zero-Valent Iron Particles

Microscale ZVI particles will be combined with a guar gum solution (to allow the ZVI to remain in suspension and be properly mixed) and injected into the aquifer with the ELS™ and lactate. The small ZVI particles (less than 5 to 45 micrometers) provide substantial reactive surface area that stimulates direct chemical dechlorination and an additional drop in the redox potential of the groundwater via chemical oxygen scavenging. The CEs combine with the ZVI and degrade through the β-elimination and hydrogenolysis pathways described in Section 3.1.3.

4.0 General Site Activities and Requirements

This section describes the general activities and requirements associated with implementing the planned treatability test at the site. These include permitting and notification, mobilization, utility clearance, decontamination, surveying, waste management, site security, and traffic control.

4.1 Permits and Notifications

Obtaining federal, state, or local permits is not required for on-site Comprehensive Environmental Response, Compensation, and Liability Act of 1980 activities however, appropriate notifications and permit applications will be completed prior to field implementation of the treatability test. The information requested in the well permit applications will be submitted to the Santa Clara Valley Water District (SCVWD) prior to mobilization. CB&I will notify Underground Service Alert at least 48 hours prior to initiation of drilling and excavation activities, and secure the appropriate authorizations from the Navy Resident Officer in Charge of Construction (ROICC) Office. The soil borings and wells will be installed by a C-57 licensed subcontractor and in accordance with Santa Clara County requirements and California Department of Water Resources regulations (California Department of Water Resources, 1981 and 1991).

Before any construction begins, a permit will be filed with NASA to obtain authorization to perform any subsurface activities, such as drilling and well installation at the site. The permit will be obtained from the Moffett Field Permit Board of NASA Ames Research Center in Moffett Field, California. Applications for the permits will be submitted via the Office of the ROICC. Coordination will be made with the ROICC for activities that will be conducted on site.

It is anticipated that use of CE contaminated groundwater to produce the injection mixtures will not require permitting from either EPA Region 9, California Regional Water Quality Control Board—San Francisco Bay Region, or SCVWD since the treatment test is implemented as part of a remedial action taken under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (EPA, 1985). However, field activities will comply with any substantive requirements imposed by the agencies for reuse of extracted contaminated groundwater.

4.2 Mobilization and Demobilization

Preparation for fieldwork will include procuring all necessary equipment and subcontractor services and conducting preparatory inspections as required by the CQCP (Appendix B). Mobilization will include designating equipment staging and decontamination areas and

installing temporary security fencing around the work area. A temporary decontamination station will be constructed at the site.

At the conclusion of fieldwork, the site and staging areas will be restored to a condition similar to that existing prior to the start of work.

4.3 Utility Clearance

Utility clearance surveys will be conducted to help locate and avoid subsurface hazards (e.g., encounters with live utility lines) during drilling activities. Once Underground Service Alert has coordinated with area utility companies to locate and mark the utility lines, a CB&I subcontracted private underground utility locator will clear the proposed boring locations by searching within a 10-foot radius for underground utilities using geophysical detection equipment. Surface geophysical methods that may be used include, but are not limited to, electromagnetic induction and geomagnetics. Clearance will be performed at every well boring and injection point location.

Prior to utility clearance, existing site utility maps will be obtained from NASA via the ROICC office and reviewed with due diligence. All preliminary boring and subsurface work areas will be marked. Marking will consist of painting or staking the ground surface or pavement at the proposed locations. The stake or ground marking will identify the boring by number. Marking will be done using either a permanent waterproof marker or paint.

The subcontractor will note each cleared sampling location and mark with paint or with a stake immediately upon clearing it. All suspected underground utility conduits and structures will be marked with color-coded marking paint according to standards established by the American Public Works Association. If utilities or other obstructions or hazards are identified at any proposed intrusive location, CB&I's field representative will identify a new location to be surveyed.

In addition to the utility clearance surveys, prior to drilling or driving any tools into the subsurface, each borehole shall be cleared using vacuum excavating/air knife methods to a minimum depth of 5 feet bgs.

4.4 Equipment Decontamination

Drilling, well development, and heavy construction equipment in contact with contaminated soil and/or groundwater will go through decontamination after use. Additionally, drill rigs and equipment will be decontaminated before mobilization to the field, between boreholes, and prior to demobilization from the field. The drill rigs most often will have a decontamination area on the rig or pull trailer in the field with them. These mobile decontamination stations collect all of the rinsate for proper disposal. Clean equipment is kept segregated from contaminated equipment

on the rigs, trailer, or on plastic sheeting prior to reuse. If needed, a decontamination station will be set up in an area exclusively for decontamination of drilling, well development, and heavy equipment. The station will be constructed such that all rinsate, liquid spray, soil, and other wastes are fully contained and collected for disposal. Fluids and sediment generated at the portable decontamination pad will be contained in portable tanks or drums. Nondisposable sampling equipment will also be decontaminated between uses to ensure the quality and integrity of the samples collected.

4.5 Waste Management

All nonexpendable equipment and materials, such as skid units, tanks, hoses, and pipes that come in contact with site contaminants will be decontaminated in the equipment decontamination area. Primary waste streams will be generated during the implementation of the treatability tests, including:

- Personal protective equipment
- Soil cuttings from boring and well installation
- Asphalt concrete and debris generated during boring and well installation
- Well development and sampling purge water
- Water generated during equipment decontamination

These waste materials will be segregated and temporarily stored on site in labeled drums or roll-off bins. After being characterized and profiled, the solid waste materials will be transported off-site by a licensed waste hauler for disposal to the appropriate permitted disposal facility or facilities. Well development, decontamination, and sampling purge water will be accumulated in drums located at the WATS system before being treated through the WATS. Waste sampling and analysis procedures are described in the SAP (Appendix A). In addition to the solid and liquid waste streams, all the empty drums and totes that contained the food-grade reagents will be rinsed out on site and shipped offsite for recycling. Similarly, the wood pallets and Super Sack®-type containers will also be shipped off site for recycling. Storage locations will be designated by the Navy ROICC office in consultation with NASA Ames.

Prior to disposal off site, the CB&I Transportation and Disposal Coordinator will prepare one manifest package for each waste stream. Each manifest package will be signed by a representative of the Navy (ROICC or Caretaker Site Office).

4.6 Land Surveying

The new monitoring wells and injection points will be located using a Global Positioning System receiver to within approximately 1 foot accuracy prior to their installation. Upon completion of

the substrate injections, the new wells and injection points will be surveyed under the supervision or direction of a State of California-certified land surveyor. Vertical elevations of each survey point will be determined to the nearest 0.01 foot and referenced to the North American Vertical Datum of 1988. For wells, the measurement point will be clearly and permanently marked on the rim of the well casing. The horizontal location of each point will be determined to the nearest 0.1 foot, and referenced to the California State Plane Coordinate System, Zone III (NAD83), as published by the National Geodetic Survey. If not already present, a minimum of one permanent control monument will be installed within a distance of 1,000 feet of each point to be surveyed.

4.7 Site Security and Traffic Control

All CB&I employees and its subcontractors involved with the field implementation of the treatability tests will follow the facility regulations governing base access, including work hours, and access route while within the facility limits.

CB&I will also coordinate with the ROICC office and NASA in establishing traffic control during the performance of the treatability test when the work areas encroach on a street. Appendix C describes the "Traffic Control Plan." At a minimum, traffic control signs and cones will be used to demarcate the work area(s), and warning signs will be set up and maintained each day to notify drivers of lane closings and detours. Additional site access and traffic issues will be discussed during the preconstruction conference with the Navy and NASA representatives.

4.8 Demobilization

Demobilization will consist of removing all construction equipment and materials; cleaning the project site; inspecting the project site; and issuing a certification of completion. Demobilization activities will also involve collection and disposal of all contaminated materials, including decontamination water and disposable equipment for which decontamination is inappropriate.

5.0 Groundwater Monitoring Well Installation and Baseline Sampling

This section describes the groundwater monitoring well installations and baseline groundwater sampling that will be performed in support of the treatability test. These activities will occur prior to initiation of the test.

5.1 Monitoring Well Installation

Prior to treatment reagent injection, five new groundwater monitoring wells will be installed to augment the existing monitoring well network. Four of the wells will be used to monitor performance of the treatability test and the fifth well will be used to further characterize CE concentrations in shallow groundwater at the southern end of the former collapsed sanitary sewer line near SCAPS-26 (Figure 6a). The locations, depth, and screen intervals for the proposed wells are presented on Figures 6a through 6d. Figure 6d shows in cross-section view the subsurface stratigraphy, the estimated depths of the plume, target treatment zones, and screen intervals for existing and proposed groundwater monitoring wells along or near section line A-A' on Figures 6a through 6c. The rationale for each new well's placement and screen interval is described in Table 1. Well installation activities will include the following activities:

- Continuous core drilling
- Monitoring well construction
- Monitoring well development

The following subsections provide further details of monitoring well installation activities.

5.1.1 Drilling

The wells will be installed using sonic drilling techniques by a State of California C-57 Licensed Water Well Contractor. While drilling, the ground surface around each well boring will be covered with plastic to prevent soil or fluids from contacting the surrounding ground surface. For wells that will be installed in the A-Aquifer zone, a minimum 6-inch diameter drive casing will be used to create the well borehole. For wells that will be installed in the B2-Aquifer, a combination of minimum 6-inch diameter and 8-inch diameter drive casings will be used in a telescoping approach to isolate A-Aquifer zone contaminants from the B-Aquifer during well construction. The telescoping approach entails advancing the 8-inch diameter drive casing into the A/B-Aquitard, setting a bentonite plug, allowing the plug to adequately hydrate for one hour, and then advancing the 6-inch diameter drive casing through the 8-inch diameter casing and bentonite plug down to the total planned well depth. Each well boring will be continuously cored to total depth with 4-inch diameter core barrels advanced ahead of the outer drive casing. The

soil cores will be logged by a field geologist with oversight by a State of California-licensed Professional Geologist. The logs will include Unified Soil Classification System descriptions, soil color, depth of first encountered groundwater, and any field indications of contamination (odor or staining). A photoionization detector will be used to screen the soil core for VOCs. The core material and any other potential soil waste will be properly containerized, labeled, and stored for waste characterization and future disposal in accordance with Section 4.5.

5.1.2 Monitoring Well Construction

Each well will be constructed of 2-inch diameter Schedule 40 polyvinyl chloride with a maximum 10-foot long, 0.010-inch slotted screen. A filter pack consisting of #2/16 (16 × 30 sieve size) clean silica sand will be placed in the borehole annulus from the bottom of the well screen up to 2 feet above the top of the screen interval. A minimum 2-foot layer of 3/8-inch bentonite pellets will then be placed above the filter pack and hydrated. Next, cement bentonite grout will be tremied and pumped in place from the top of the bentonite seal up to 1 foot bgs to leave room to install a well box. Every well will be completed at the surface with a traffic-rated, flush mounted, well box and concrete collar. Figure 7 presents the preliminary design details for the wells to be installed.

5.1.3 Monitoring Well Development

Following installation, each well will be developed no sooner than 48 hours after construction of the grout seal. The wells will be developed by a process of surging, bailing, and purging. A surge block will be lowered into the well and gently moved up and down within the saturated zone to induce movement of residual fine-grained material from the filter pack through the well screen where it can be removed by bailing or pumping. The well will be bailed periodically during the surging process. During development, general water quality parameters, including turbidity, pH, temperature, conductivity, dissolved oxygen, and ORP, will be measured (at a minimum every 15 minutes) and recorded. Development will continue until a minimum of three well volumes have been removed; the well water is free of excessive turbidity (5 nephelometric turbidity units or less); and the indicator water quality parameters (pH, temperature, and conductivity) have stabilized. Additionally, the final measured well depth should be in reasonable agreement with the estimated well completion depth. Monitoring and sampling of new wells shall be performed no sooner than 72 hours following well development activities.

Purge water will be stored in a mobile tank or in U.S. Department of Transportation-approved 55-gallon drums. At the end of each day, the liquid waste will be transported to the temporary waste staging area to allow the solids to settle. Periodically, the accumulated waste water will be transported to the WATS for treatment and disposal, and will be properly labeled should the water be stored before treatment through WATS.

5.2 Baseline Groundwater Sampling

Prior to substrate injection, baseline groundwater monitoring will be performed to define the pretreatment water quality conditions across the treatment area. Baseline groundwater samples will be collected for laboratory analysis from nine existing wells (28OW-03, 28OW-04, 28OW-11, 28SI-06, 28SI-07, 28SI-09, 28SI-10, 28SI-13, and W88-1) and the five new groundwater monitoring wells after installation (Figures 6a through 6c). The samples will be analyzed for the following analytes:

- VOCs by EPA Method 8260C
- Dissolved gases (methane, ethane, ethene, and acetylene) by AM20GAX
- Dissolved metals (manganese, arsenic, and iron) by EPA Method 6010/6020
- Anions (nitrate and sulfate) by EPA Method 300
- Iron II (using an on-site Hach colorimeter)
- Total organic carbon by SM5310
- Alkalinity by SM2320B

Three select samples from treatment area wells will be additionally analyzed for DHC deoxyribonucleic acid by quantitative polymerase chain reaction analysis. In addition, general water quality parameters (pH, temperature, conductivity, turbidity, ORP, and DO) and depth to groundwater will also be measured in the field during sampling.

Measuring metal concentrations will help monitor reducing conditions that develop as a result of substrate injection. Manganese and iron levels will be used to evaluate the extent of reducing conditions established upon injection of the substrates. The solubility of these metals increase as they transform from their relatively oxidized forms to reduced forms as reducing conditions are established. The increased concentrations of these metals and methane as well as decreased concentrations of oxygen, nitrate, and sulfate will be used to geochemically confirm the ORP level that will be established after introducing the reagents.

Groundwater sampling will be performed using low-flow purging and sampling techniques. Further details of the sampling and analytical requirements are provided in the SAP (Appendix A).

6.0 Treatability Test Implementation

Following completion of the baseline sampling event, the treatment component of the TS will be initiated. The treatment test will be conducted in the area of the traffic island where the highest concentrations of CEs were detected during the recently completed supplemental investigation (CB&I, 2014). Specifically, at the south end of the traffic island in the lower portion of the A-Aquifer zone where PCE DNAPL was encountered and directly beneath in the B2-Aquifer zone. Conceptual injection layout for the test as related to the PCE MIP response in the lower A-Aquifer zone and B2-Aquifer zone is presented on Figures 6b and 6c, respectively. Based on the lateral and vertical distribution of the PCE, reagents will be direct injected at 21 locations from 30 to 70 feet bgs and at 23 locations from 80 to 120 feet bgs, as shown on Figures 6b, 6c, and 6d, respectively. Reagents in general will not be injected from 70 to 80 feet bgs to help maintain the integrity of the A/B-Aquitard interval; however, injections will be performed at the three locations surrounding well W88-1 down to 75 feet bgs.

The primary target distribution radius (TDR) for reagent delivery is 15 feet based on previous experience at Moffett and other similar sites; but because of surface and subsurface obstructions, 10-foot TDR injections are planned too. The reagents will be injected on 2.5-foot vertical intervals across the target treatment zone following a top-down approach. At each injection interval the injection process will be initiated by hydraulic fracturing with the ELS™ solution, followed by injection of the ZVI slurry, and chased by injection of more ELS™ solution, as described in Section 6.5. Following injection, groundwater sampling (performance monitoring) will be conducted to track and evaluate treatment performance. The following activities will be performed in support of the treatability test:

- Establishing temporary facilities and work areas
- Groundwater extraction and conditioning for reagent formulation
- Reagent mixing and bioaugmentation
- Hydraulic fracturing and reagent injection
- Performance monitoring

It is currently anticipated that the treatability test will be conducted in the same manner as described herein; however, the reagent injection point locations and concentrations may be revised following confirmation of subsurface obstructions (e.g., utilities) and the viable injection point array layout. The reagent formulas may be modified to provide the required amount of individual reagents to degrade the CEs while limiting both excess reagent, which may result in excessive methane production, and insufficient reagent, which potentially results in incomplete

degradation of the CEs. If it is determined that the spacing of injections or the substrate formula needs to be revised, this information will be communicated with the regulatory agencies, prior to implementation.

6.1 Temporary Facilities and Work Areas

Upon mobilizing to the site for reagent injection, temporary facilities will be established adjacent to the treatment area within a fenced equipment staging and storage area that will include the reagent mixing/injection plant, a 250-kilowatt diesel generator, a bermed area with three 20,000-gallon water conditioning tanks, a bermed decontamination area, a reagent storage area, a waste storage area, and office/storage containers. The dimensions of the area needed to accommodate all these items and to allow safe forklift operations is at least 100 feet by 250 feet.

To enhance worker and public safety as well as meet the requirements of locating the mixing/injection plant and associated support facilities adjacent to the treatment area, the proposed location for the equipment staging and storage area is in the open, flat, smoothly paved area between Hangar 1 and WATS extraction well EA1-2, as outlined on Figure 8.

Several injection points and monitoring wells will be installed either near roadways or in roadways; therefore, parts of Wescoat Road, Cummins Avenue, and Cody Road will be either temporarily reduced to one lane or fully closed. To protect the health and safety of the reagent injection team and the public from work zone hazards, such as a highly pressurized injection hose (up to 2,000 pounds per square inch), the segment of Cody Road north of Wescoat Road, east of the traffic island, will be closed for the duration of the injection effort (up to two months). This segment of Cody Road will be closed-off with water-filled barriers outfitted with reflectors, as shown on Figure 8. Similarly, when reagent injections are being performed in Wescoat Road, Wescoat Road will be fully closed during the work shift (for approximately 9 hours) and then reopened. Under this scenario, CB&I will provide sufficient traffic control to detour traffic around this area using signage and two flag people (Appendix C).

Upon completion of the injection effort, the temporary facilities will be demobilized and the site returned to its original condition.

6.2 Groundwater Extraction

Site groundwater will be used as a component of the treatment reagent solutions. The advantages of using site groundwater for reagent preparation are:

- The groundwater has not been treated with chemicals such as chlorine or chloramines intended to kill microorganisms

The use of site groundwater does not alter the biogeochemical conditions of the aquifer into which it is injected It is anticipated that approximately 190,000 gallons of groundwater will be

needed to prepare the reagents for the treatability test. Groundwater will be obtained from WATS extraction well EA1-2 via a flow valve connected to the wellhead so that groundwater can be diverted to above-ground injection water conditioning tanks (IWCTs) for the TS. Well EA1-2 is estimated as being able to provide groundwater continuously at a rate of approximately 8 gallons per minute for the duration of each field day. However, even at this flow rate, more groundwater may be needed; therefore, influent to WATS will be collected and transported to the water conditioning tanks on a biweekly basis to make up the difference, as necessary.

6.3 Water Conditioning

The extracted groundwater will be pumped into the IWCTs where lactate will be added for quickly establishing anaerobic and strongly reducing conditions necessary for the viability of the bioaugmentation culture. The tanks will be located within the temporary Equipment and Materials Staging Area that will be established adjacent to the treatment area, as described in Section 6.1.

Lactate will be added to the IWCTs at a rate sufficient to maintain a concentration of 0.5 grams of lactate per liter of stored water. Using a product that is 60 percent by weight (sodium) lactate and 40 percent by weight water, approximately 0.0008 gallons of product per 1 gallon of stored water will be used to sustain the target concentration for conditioning. The lactate will be added to the IWCTs daily to keep up with the volume of extracted groundwater being added to the tanks. Gauges on the IWCTs will identify the approximate volume of water in the tanks for calculating proper volumes of lactate required. Small low-flow chemical metering pumps may be used to compliment the hand-fed dosages and centrifugal or submersible pumps may be used to mix the contents of the IWCTs.

ELS™ and dry ZVI/guar gum will NOT be added to the IWCTs. These materials will be added to the reagent mixing tanks (ELS™ solution and ZVI slurry) immediately prior to injection.

6.4 Reagent Mixing and Bioaugmentation

The conditioned water from the IWCTs will be pumped into smaller reagent mixing tanks stationed adjacent to the injection pump within the reagent mixing plant of the Equipment and Materials Staging Area shown on Figure 8. The reagents, namely the ELS™ solution amended with SDC-9™ and the ZVI slurry, will be prepared in separate mixing tanks immediately prior to injection. For the purposes of this WP, the tanks are named:

- ELS™ solution tank
- ZVI slurry tank

The ELS™ solution tank will be used to blend conditioned water with ELS™ and SDC-9™. The ZVI slurry tank will be used to blend conditioned water with ZVI and guar gum. The reagents will be fed directly from these tanks to the injection pump for emplacement. Prescribed dosages for each of the reagent types are discussed in the following section.

6.4.1 Dosages

Determining an appropriate dosage for the various reagents is a function of the expected reagent distribution radius, thickness of the target horizon, soil type, groundwater velocity, effective pore space volume, the electron acceptor demand for the dissolved and sorbed phase CEs, and the competing electron acceptor (e.g., sulfate, nitrate, DO, iron, manganese, arsenic) demand in the dissolved phase. For the purposes of calculating dosages, the target injection volume at any given injection point and TDR is 10 percent of the estimated average effective groundwater volume in the aquifer, using an estimated effective porosity of 20 percent. The VOC and electron acceptor concentrations measured during recent groundwater sampling events conducted at the Traffic Island Area (CB&I, 2014), and past experience, were considered for the dosage calculations. A summary of the dosage calculations are provided in Appendix D.

Lactate

In addition to using lactate for conditioning the reagent mix water (Section 6.2), an additional amount will be added to the conditioned reagent mix water, prior to injection, for quickly establishing anaerobic and strongly reducing conditions in the aquifer which will help the viability and growth of the bioaugmentation culture in situ. Based on the electron acceptor demand and the use of lactate in combination with ELS™ and ZVI, a target concentration of 0.5 grams of lactate per liter of groundwater in the effective pore volume of the aquifer is recommended for this test. To achieve the target concentration in the aquifer, additional lactate will be added to the IWCTs at a dosage of 0.008 gallons of product per 1 gallon of conditioned water.

ELS™—Lecithin

Due to the high CE concentrations and the concurrent use of ZVI, the target concentration of lecithin in the aquifer, as recommended by the ELS™ manufacturer PeroxyChem, is 6.0 grams per liter. This value was used to determine the ELS™ mass required. The ELS™ product will be provided as a pure substance (i.e., 100 percent lecithin). To achieve the target in situ concentration, assuming 59 percent of the conditioned water per interval will be available to prepare the ELS™ solution, an injection dosage of approximately 0.1 gallons of ELS™ (100 percent concentrated) per 1 gallon of conditioned water will be used. The ELS™ will be emulsified with conditioned water and temporarily stored in the ELS™ solution tank pending bioaugmentation and injection.

SDC-9™

SDC-9™ dechlorinating culture will be added to the ELS™ solution tank immediately prior to injection (bioaugmentation step). The prescribed SDC-9™ dosage is based on achieving a target concentration of 5.6×10^6 cells DHC per liter of groundwater in the effective pore volume of the treatment zone (Lu et al., 2006). To achieve the target in situ concentration, assuming there are 1×10^{11} cells of DHC per liter of SDC-9™, an injection dosage of approximately 0.0036 liters of SDC-9™ per 1 gallon of conditioned water will be added to the ELS™ solution tank immediately prior to injection.

The SDC-9™ culture will be produced by the CB&I's Biotechnology Laboratory in Lawrenceville, New Jersey. The culture will be shipped from the laboratory directly to the site. Prior to shipment, the Biotechnology Laboratory will contact the Technical Lead and Project Manager to confirm timing of the shipment.

Zero-Valent Iron and Guar Gum

The design dose of microscale ZVI is based on the vendor's recommended target in situ concentration, and the design dose for guar gum is based on past experience. The ZVI will be blended into a slurry of conditioned water and guar gum to improve hydraulic delivery of the ZVI and to support suspension of the ZVI during injection. To adequately suspend the ZVI, approximately 0.06 pounds of guar gum will be blended with the conditioned water prior to adding the ZVI.

When combined with the proposed amount of ELS™ and lactate, the recommended concentration of ZVI in the target treatment zone is approximately 0.11 percent by soil mass. To achieve the target in situ concentration, assuming an average soil unit weight of 115 pounds per cubic foot and a 25 percent solids slurry, an injection dosage of approximately 2.1 pounds of ZVI per 1 gallon of conditioned water (dosed with lactate) will be used. The ZVI slurry will be prepared in batches immediately prior to being injected into the aquifer.

6.4.2 Material Handling and Storage

The ELS™ and lactate will be delivered to the site in 55-gallon drums and 275-gallon totes, respectively. The ZVI and guar gum will be delivered in 1-ton super sacks and 50-pound bags, respectively. All materials will be stored under ambient temperature in the Equipment and Materials Staging Area (Figure 8).

The lactate will be transferred into the IWCTs via a pump with a hose connected to the bung at the bottom of the tote, or via a high viscosity drum pump. The ELS™ will be transferred into the mixing plant system using a drum pump. ZVI is a dry powder.

Guar gum will be delivered to the site as a dry mix powder in 50-pound sacks. It will be added to the ZVI slurry tank as a dry material or mixed with a small amount of conditioned water and transferred using a high viscosity pump.

The bioaugmentation culture, SDC-9™, will arrive in 5-gallon stainless steel canisters. The culture will be certified free of human pathogens. Although it is nontoxic, the culture has a slightly unpleasant odor. If overnight storage of the culture is required, it will be maintained on ice or within a refrigerator. The culture may be stored for up to two weeks. Immediately prior to injection, SDC-9™ will be added to the substrate solution tank. The shipping containers for the SDC-9™ will be outfitted with quick-connect ports clearly labeled as "in" and "out" and the associated quick-connect fittings for the transfer tubing will accompany the SDC-9™ shipment. An inert gas, either argon or nitrogen, will be used to "push" the SDC-9™ from the shipping containers into the mixing tanks via ¼-inch internal diameter flexible polyethylene tubing. A small cylinder of the pressurized gas outfitted with a pressure regulator will be used to supply the pressure.

There are no significant hazards associated with the previously discussed injected products. Material safety data sheets are provided in the APP (CB&I, 2015).

6.4.3 Hydraulic Fracturing and Reagent Injection

The injection process will rely on hydraulic fracturing and high-pressure/flow rate delivery of the reagents using direct-push techniques. Hydraulic fracturing is anticipated to cause a larger reagent distribution radius, because the aquifer will have a greater, fracture-increased permeability, and the reagents will be "jetted" into the aquifer. High flow delivery is preferred over low-flow delivery, because it requires less mix water and generally reduces the potential for expansion of the plume. Conversely, low-flow injection essentially requires complete replacement of the aquifer pore volume. Under the high flow rate scenario, it is anticipated that the injected materials will replace only 10 percent of the aquifer's effective pore space. To further minimize the potential for plume migration, the injection locations on the exterior portion of the treatment area will be treated first. Simply stated, injections will proceed from the outside of the treatment area towards the center. The reagents will be direct injected using a variable speed positive displacement pump (piston type) capable of generating up to 2,000 pounds per square inch (psi) of pressure at a flow rate of up to 50 gallons per minute.

Hydraulic fracturing and reagent injections will be performed in a top-down approach on 2.5-foot intervals. The reagents will be injected at each interval in three stages, beginning with injecting half of the prescribed ELS™ solution to notch the formation and initiate the fracture, followed by injecting the full ZVI slurry dose and ending with injection of the remaining ELS™ solution to chase the ZVI slurry into the aquifer. The injection borings will be abandoned by tremie grouting a neat cement/bentonite grout in accordance with SCVWD requirements.

6.4.4 Direct-Push Injection Procedures

The treatment reagents will be injected into the aquifer using the following "top-down" injection procedure at each location:

1. Using a direct-push technology (DPT) rig, advance the injection rod to the depth of the first injection interval. Use a pressure activated injection tip with a check valve to allow lateral delivery of the reagent(s) and to prevent backflow.

2. Once the target injection depth has been reached, connect the reagent(s) delivery hose to the DPT rod header using an injection cap and ensure proper hose restraints are in place to prevent hose whip in the case of fitting or hose failure.

3. Once the reagent(s) delivery hose has been securely attached to the DPT rod header, activate the injection pump and begin the hydraulic fracturing process using the ELS™ solution. A pressure gauge will be used to monitor the injection pressure. Increase the pressure to achieve fracture of the aquifer matrix as indicated by a sudden decrease in pressure and increase in flow rate. Injection volume(s) will be determined based on changes in tank volume. Due to the physical characteristics of the reagents that commonly plug flow meters, reagent flow cannot be monitored continuously.

4. Inject the initial volume (prescribed per injection interval and desired TDR) of ELS™ solution to notch and fracture the aquifer.

5. After fracturing and injecting the initial volume of ELS™ solution, immediately switch to injecting the prescribed volume (per injection interval and TDR) of ZVI slurry at a high flow rate.

6. Upon injecting the total prescribed volume of ZVI slurry, immediately switch to injecting the final volume (per injection interval and TDR) of ELS™ solution at a high flow rate.

7. After injecting the final volume of ELS™ solution, isolate the DPT rod from the reagent delivery hose by shutting the appropriate isolation valve on the injection cap, depressurize the DPT rod at the injection cap, confirm the pressure has dissipated prior to removing the injection cap, remove the injection cap from the DPT rod, and then drive the DPT rod to the next injection interval, 2.5 feet below the previous completed injection interval. While depressurizing the DPT rod and proceeding to the next interval, backflow of reagents from the rod may occur and shall be contained. If the amount of reagents is significant, the volume will be recorded to correct the actual amount of reagent(s) injected into that interval.

8. Repeat the hydraulic fracture and injection Steps 2 through 7 until the final injection interval has been completed for the injection point.

9. Upon completing reagent injection at each point, abandon each injection borehole by backfilling with a cement/bentonite grout. The grout will be pumped through a tremie pipe from the bottom injection interval to within 6 inches of the ground surface.

10. Finish the borehole appropriately in accordance with the surrounding surface materials (i.e., concrete or grout) and survey nail set flush-to-grade marking the injection point location for final survey. The boreholes must be finished flush-to-grade to allow vehicular traffic.

11. Upon completion of the reagent injections, clean the injection equipment and injection rods by circulating hot water and detergent through the pump and delivery hose.

12. Repeat the previous steps at each injection point.

6.4.5 Field Records

A CB&I field geologist or engineer will record all injection activities, specifically the following:

- Amount of reagent materials and SDC-9™ culture used per injection interval and point
- Injection volumes per interval and point
- Document any reagent daylighting and estimated quantity
- Injection locations completed each day on a working map
- Personnel on site and times crews enter and leave the site

6.5 Performance Monitoring

Groundwater samples will be collected immediately following completion of all the reagent injections and quarterly thereafter for a total of five sampling events to document and evaluate treatment performance. The events will occur approximately 7 days, 30 days, 120 days, 210 days, and 300 days after reagent injection. The samples will be collected from 13 groundwater monitoring wells in and around the treatment area as listed in Table 2 and shown on Figures 6b and 6c. The samples will be collected using low-flow purging and sampling techniques. The samples will be analyzed for the same analytes and field parameters as the baseline sampling event (Section 5.4):

- VOCs by EPA Method 8260C
- Dissolved gases (methane, ethane, ethene, and acetylene) by AM20GAX
- Dissolved metals (manganese, arsenic, and iron) by EPA Method 6010/6020
- Anions (nitrate and sulfate) by EPA Method 300
- Iron II (using an on-site Hach colorimeter)
- Total organic carbon by SM5310
- Alkalinity by SM2320B

Three select samples from treatment area wells will be additionally analyzed for DHC deoxyribonucleic acid by quantitative polymerase chain reaction analysis during the 30-day and 120-day sampling events. In addition, general water quality parameters (pH, temperature, conductivity, turbidity, ORP, and DO) and depth to groundwater will also be measured in the field during sampling. All sampling and analyses will be conducted in accordance with the approved SAP (Appendix A).

Measuring dissolved metal concentrations will help monitor reducing conditions that develop as a result of substrate injection. Manganese and iron levels will be used to evaluate the extent of reducing conditions established upon injection of the substrates. The solubility of these metals increase as they transform from their relatively oxidized forms to reduced forms as reducing conditions are established. The increased concentrations of these metals and methane as well as decreased concentrations of oxygen, nitrate, and sulfate will be used to geochemically confirm the ORP level that will be established after introducing the reagents.

The results from the performance monitoring will be evaluated and regularly discussed with the regulatory agencies. The technology and its effectiveness at the site will be evaluated for future remedial applications. The Navy will notify the regulatory agencies and discuss any proposed changes that may be required based on the data.

7.0 Treatability Study Report

Following completion of the post-injection performance monitoring events, the resultant data will be used to determine the effectiveness of the treatment and its potential for further application at IR Site 28. Results of the data evaluation and a recommendation for the applicability of the applied technologies will be presented in a TS Technical Memorandum. The Technical Memorandum will summarize the treatment test field activities, results, data evaluation, and conclusions. The report will include at a minimum:

- Boring and well construction logs
- The type, manufacturer, and quantity of the injected substrates
- Maps showing the surveyed locations of the new observation wells and injection points
- Results from the groundwater sampling events
- Laboratory analytical results, field measurements, and field observations
- Appendices with copies of any permits, access agreements, or other documentation needed to perform the injections
- Summary of the test activities and results
- Description of any significant difficulties encountered while performing the field work
- Results of PQOs set forth in the SAP (Appendix A)
- Success of the tests
- Recommended path forward

It is anticipated that sufficient data will be available from the test to fully evaluate the potential for expanding the technology.

8.0 Health and Safety

CB&I maintains a policy of providing a safe and healthful work environment for all employees and subcontractors. Neither phase of operations nor administration is afforded greater importance than injury and illness prevention. Safety shall take precedence over expediency or shortcuts, and all reasonable precautions shall be taken to reduce the possibility of injuries, illnesses, or accidents. The APP and Site Safety and Health Plan (CB&I, 2015) developed for this work, which is provided under separate cover, describes the procedures that CB&I will follow during these site-specific project operations. Job safety analysis sheets will be completed and health and safety tailgate meetings will be held daily during the field operations.

9.0 Quality Assurance/Quality Control

Quality assurance and quality control procedures will be followed to ensure that data collected over the course of the testing activities are of known quality to meet their intended use, and that all components of data acquisition are thoroughly documented, verifiable, and defensible. Quality assurance and quality control requirements for sampling and analysis are provided in the SAP (Appendix A). Quality control requirements for all project activities are provided in the CQCP (Appendix B).

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Figures

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
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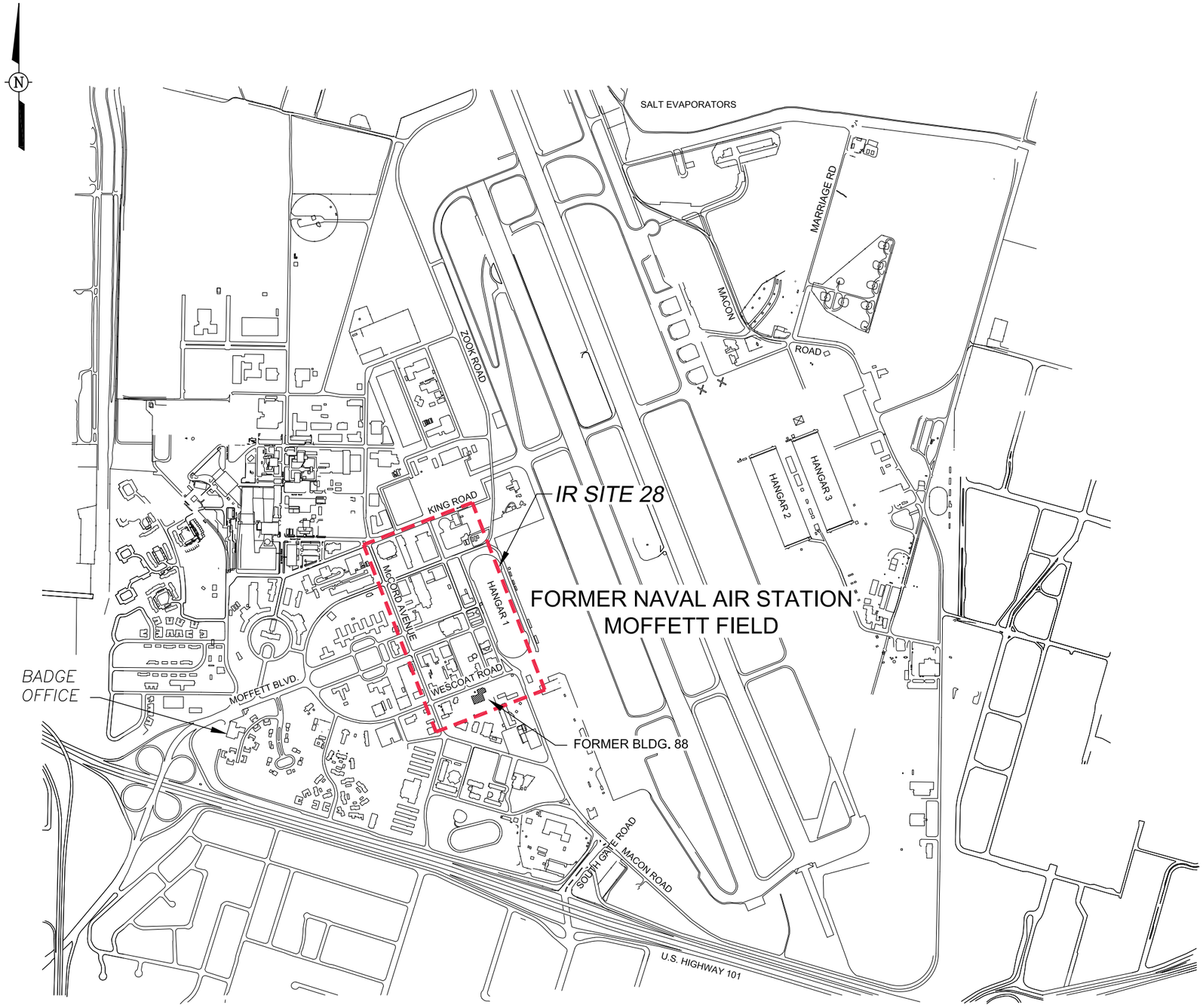
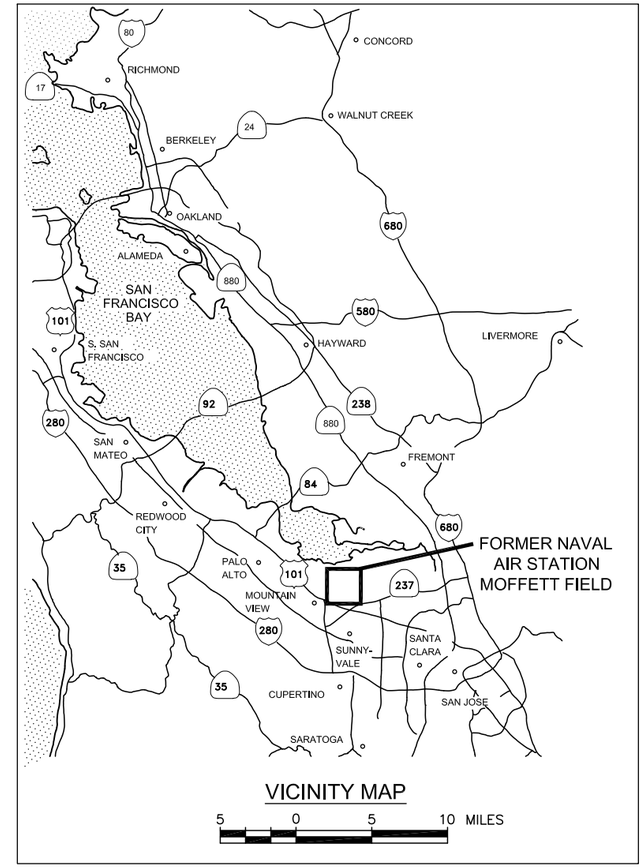
			3-26-14	12-18-14	12-18-14	



SITE LOCATION MAP

600' 0 600' 1200'

Approximate Scale – Feet



VICINITY MAP

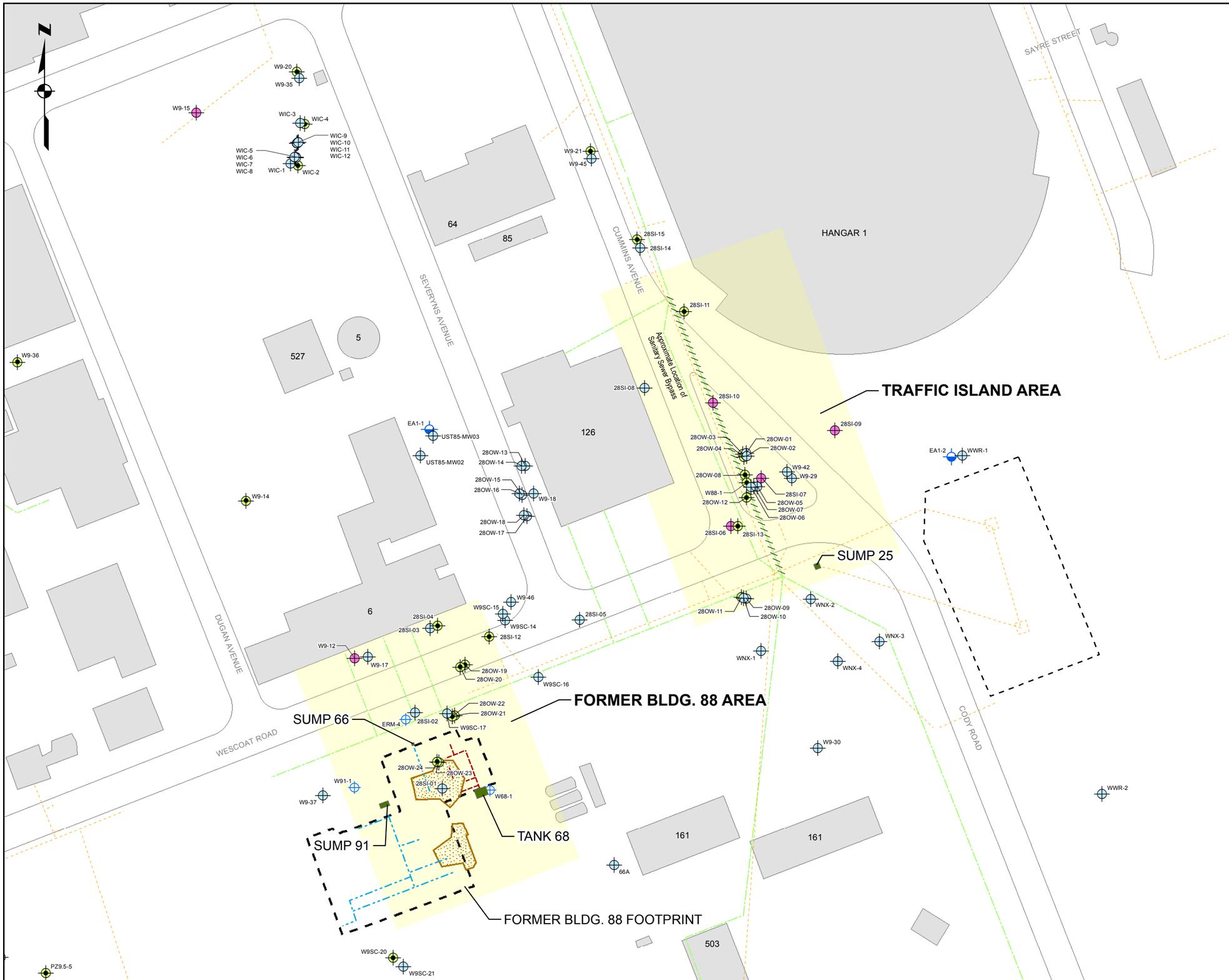
5 0 5 10 MILES

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE 1

SITE LOCATION MAP

IR SITE 28, FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA



Legend

- UPPER A-AQUIFER MONITORING WELL
- LOWER A-AQUIFER MONITORING WELL
- B2-AQUIFER MONITORING WELL
- A-AQUIFER EXTRACTION WELL
- FORMER GROUNDWATER MONITORING WELL LOCATION
- STORM DRAIN LINE
- SANITARY SEWER LINE
- SECTION OF THE SANITARY SEWER LINE THAT REPORTEDLY COLLAPSED (PRC, 1995)
- CONCRETE-LINED WASTEWATER COLLECTION TRENCH (REMOVED)
- FLOOR DRAIN PIPING (REMOVED)
- FORMER AIRCRAFT WASH RACK
- PREVIOUS REMEDIAL EXCAVATION AREA (7 TO 8 FT. BGS)
- AREA OF INTEREST
- SUMP, TANK, OR OIL/WATER SEPARATOR (REMOVED)
- 503 BUILDING AND BUILDING NUMBER

PRC, 1995 - *Final Horizontal Conduit Study Technical Memorandum Text, Tables, and Figures,* August 4

0 80 160

Approximate Scale - Feet

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE 2

SITE FEATURES MAP

IR SITE 28, FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

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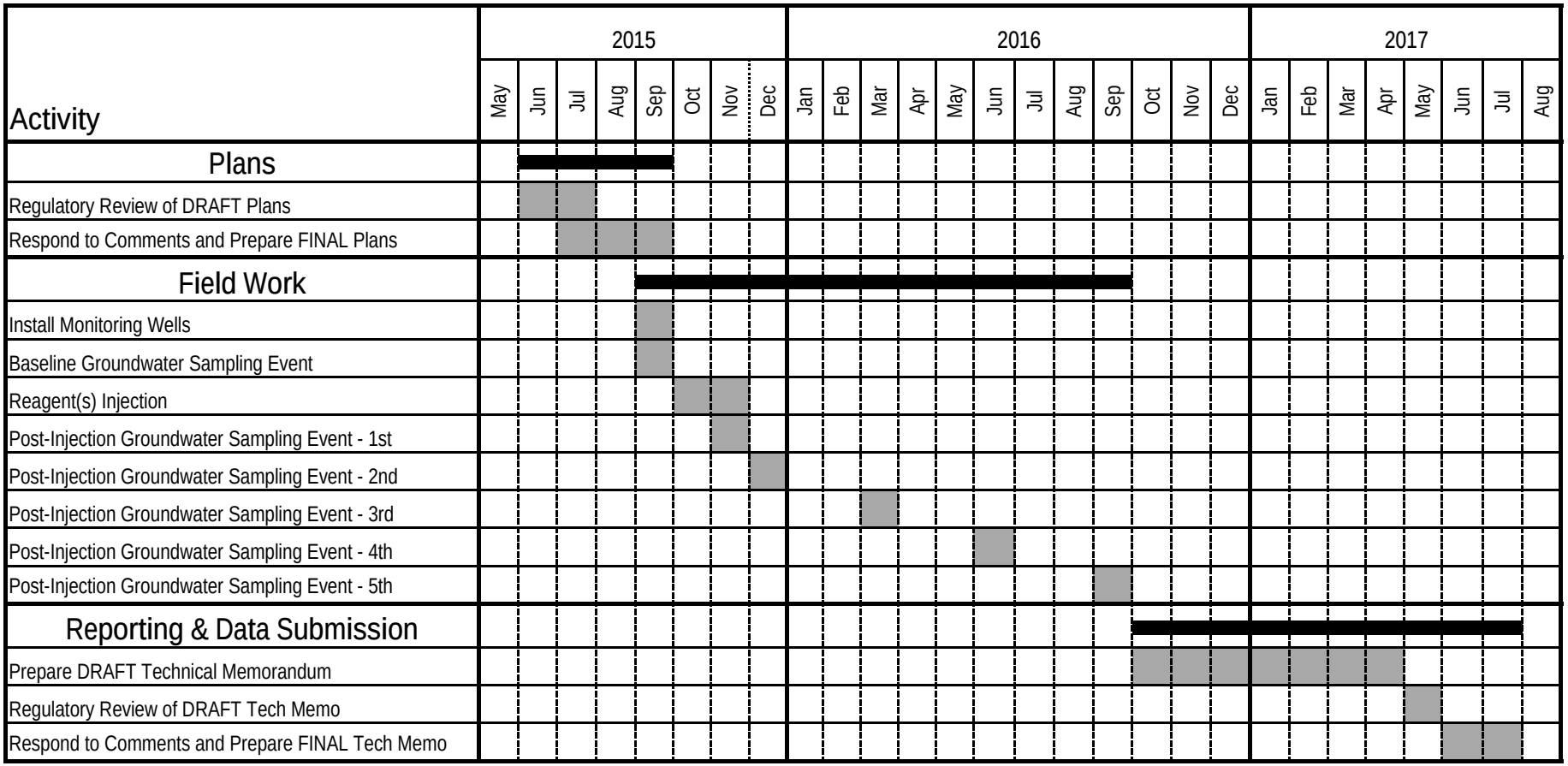
Figure 3
Treatability Study Schedule
IR Site 28, Former NAS Moffett Field, Moffett Field, CA



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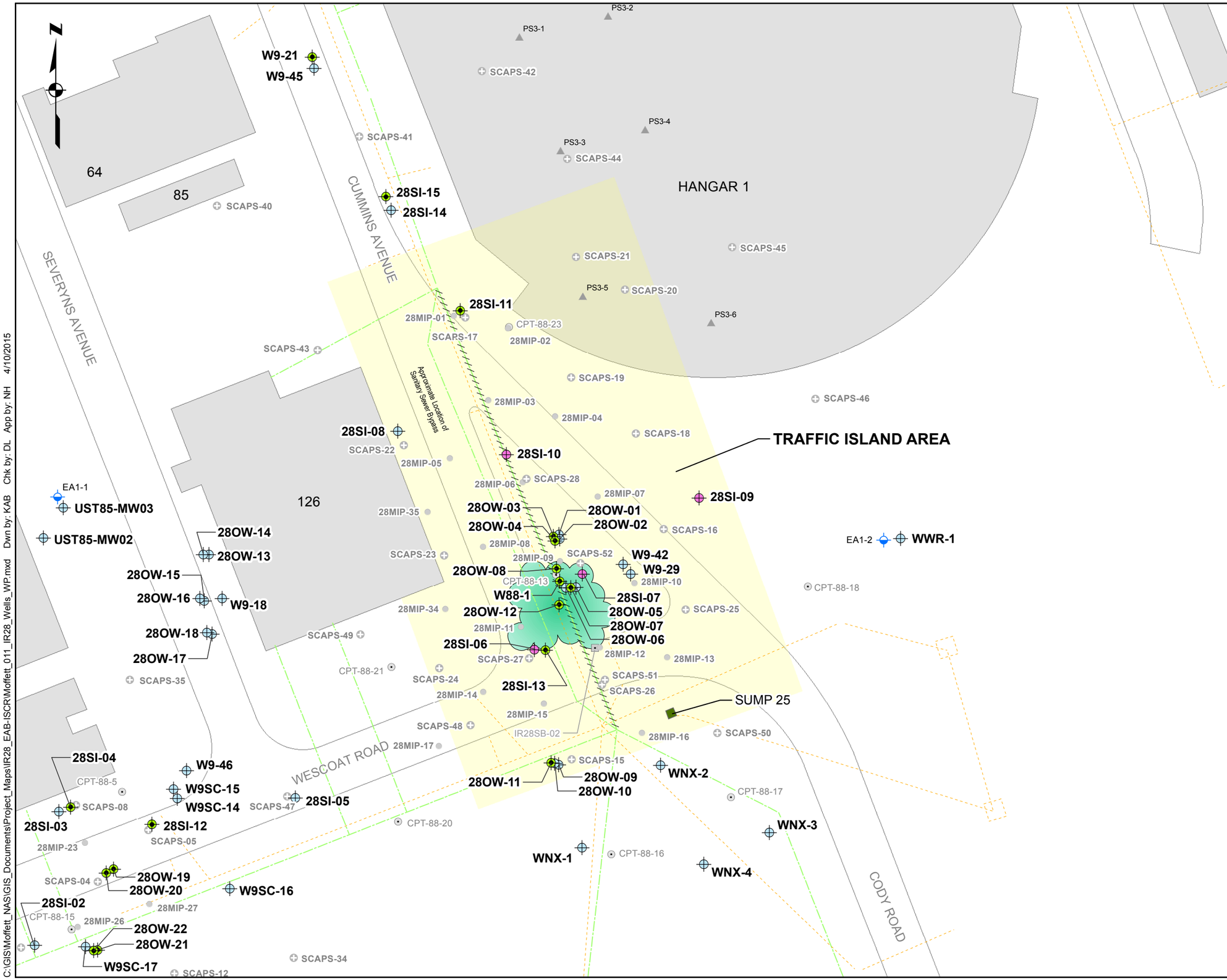

Legend

- UPPER A-AQUIFER MONITORING WELL
- LOWER A-AQUIFER MONITORING WELL
- B2-AQUIFER MONITORING WELL
- A-AQUIFER EXTRACTION WELL
- SCAPS LOCATION
- MIP LOCATION
- CPT LOCATION
- CONTINUOUS CORE LOCATION
- NASA SAMPLE LOCATION [1]
- STORM DRAIN LINE
- SANITARY SEWER LINE
- SECTION OF THE SANITARY SEWER LINE THAT REPORTEDLY COLLAPSED [2]
- IN SITU BIOREMEDIATION TREATMENT TEST AREA (10 to 65 ft bgs) [3]
- AREA OF INTEREST
- SUMP, TANK, OR OIL/WATER SEPARATOR (REMOVED)
- 503 BUILDING AND BUILDING NUMBER

[1] NASA Sensitive but Unclassified Information

[2] PRC, 1995. *Final Horizontal Conduit Study Technical Memorandum Text, Tables, and Figures*, August 4

[3] Shaw, 2010. *Final Progress Report, In Situ Anaerobic Biotic/Abiotic Treatability Study, IR Site 28*

0 50 100

Approximate Scale - Feet

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE 4
SCAPS, MIP, CPT AND
CONTINUOUS CORE LOCATION MAP

IR SITE 28, FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

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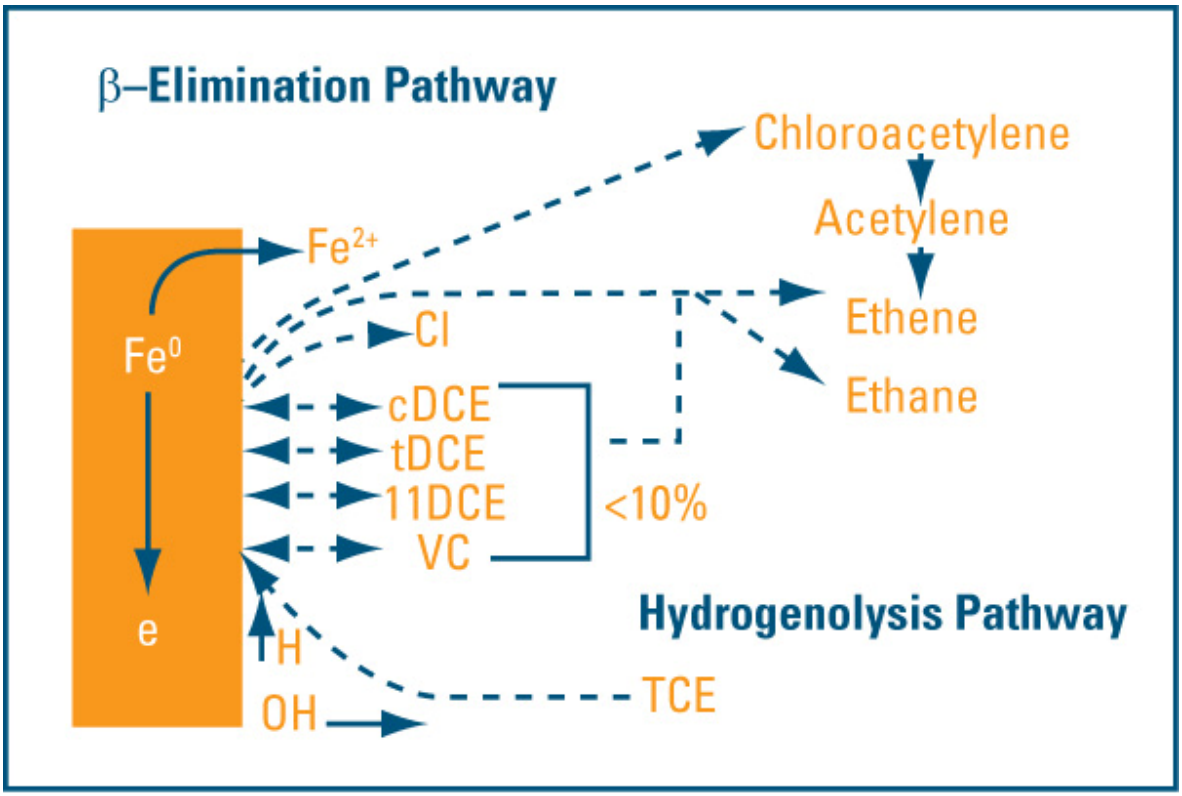
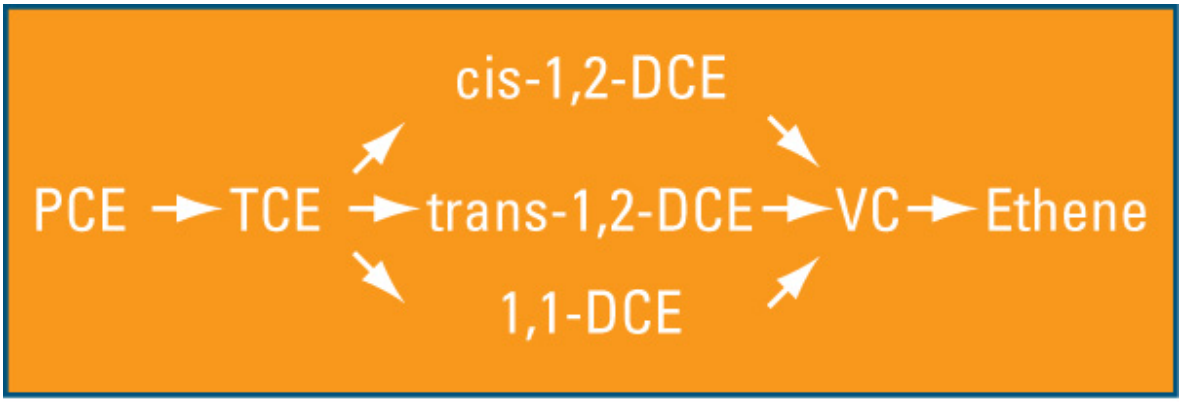
ABIOTIC DEGRADATION PATHWAYS



BIOLOGICAL DEGRADATION PATHWAYS



Source: Adventus Americas Inc.

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE 5
ABIOTIC AND BIOLOGICAL DEGRADATION PATHWAYS OF CHLORINATED ETHENES
FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

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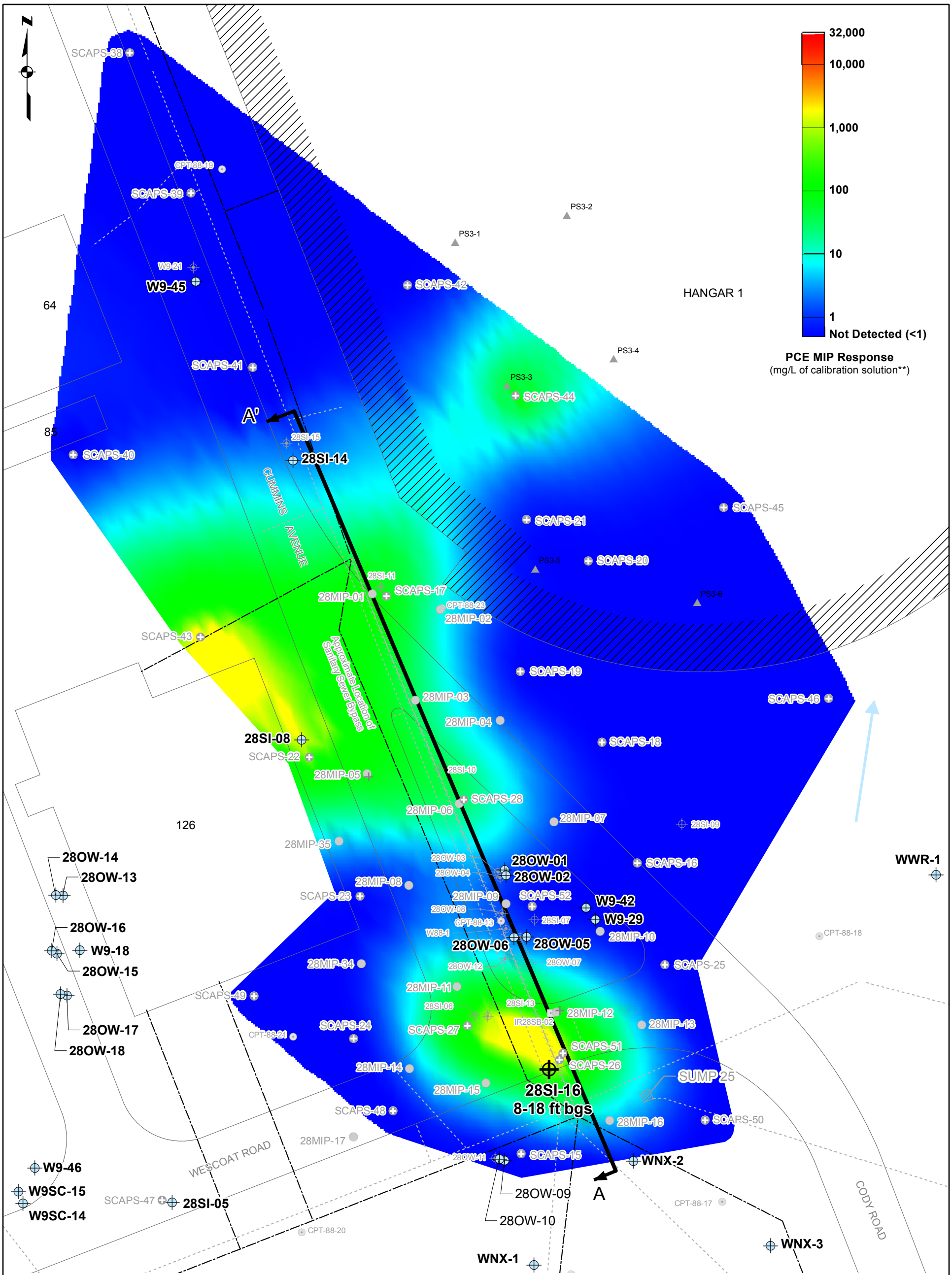

Legend

- Proposed Groundwater Monitoring Well
- SCAPS Location (5)
- MIP Location(1)
- NAPL FLUTe™ Test Location(1)
- Continuous Core Location(1)
- Upper A-Aquifer Monitoring Well
- Lower A-Aquifer Monitoring Well
- B2-Aquifer Monitoring Well
- CPT Location(2)
- NASA Sample Location(3)
- Storm Drain Line
- Sanitary Sewer Line
- Sanitary Sewer Line that Reportedly Collapsed(4)
- Groundwater Flow Direction
- Cross-Section Line
- No Drilling - Surface Obstruction
- 126 Oil/Water Separator (Removed)
- Building and Building Number

Interpolated PCE MIP response surface is horizontal slice through 3-dimensional solid model generated using C Tech's EVS software.

**Membrane interface probe (MIP) results are in milligrams per liter (mg/L) of calibration solution and are subject to matrix effects. The actual soil and groundwater concentrations may be different.

[1] *Final Progress Report, In Situ Anaerobic Biotic/Abiotic Treatability Study, IR Site 28 (Shaw, 2010).*
[2] *Final Former Building 88 Investigation Report (Tetra Tech, 2008).*
[3] *NASA Sensitive but Unclassified Information*
[4] *Final Horizontal Conduit Study Technical Memorandum Text, Tables, and Figures (PRC, 1995).*
[5] *Final Technical Memorandum, Supplemental Investigation, Former Building 88 and Traffic Island Areas (CB&I, 2014)*

0 40 80
Approximate Scale - Feet

CB&I

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE 6a
PROPOSED NEW WELL LOCATION
UPPER A-AQUIFER ZONE

IR SITE 28, FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

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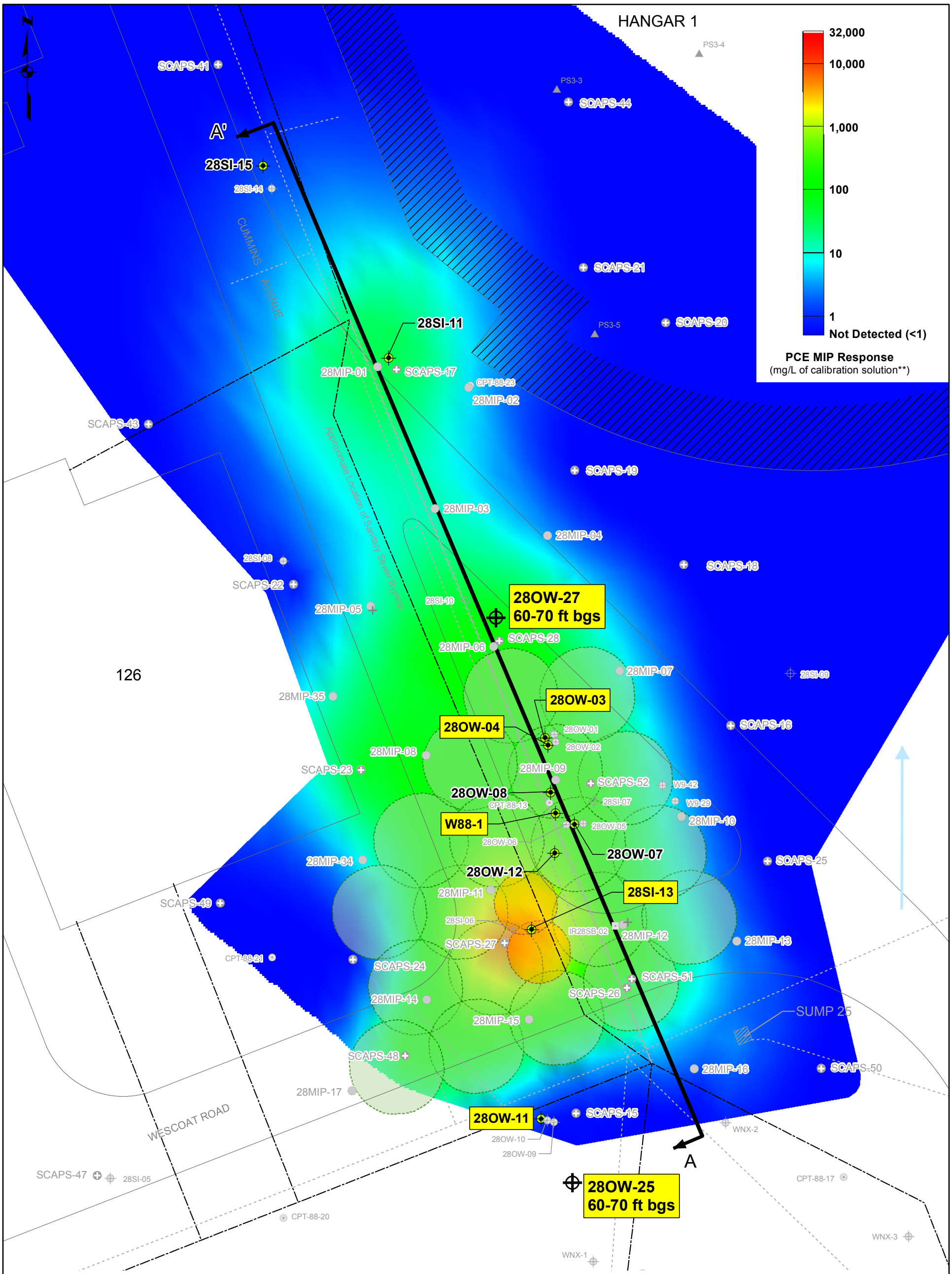

Proposed Groundwater Monitoring Well
Performance Monitoring Well
SCAPS Location
MIP Location(1)
NAPL FLUTe™ Test Location(1)
Continuous Core Location(1)
Upper A-Aquifer Monitoring Well
Lower A-Aquifer Monitoring Well
B2-Aquifer Monitoring Well
CPT Location(2)
NASA Sample Location(3)

Storm Drain Line
Sanitary Sewer Line
Sanitary Sewer Line that Reportedly Collapsed(4)
Groundwater Flow Direction
No Drilling - Surface Obstruction
Oil/Water Separator (Removed)
126 Building and Building Number
Cross-Section Line
Proposed Injection Locations
10-ft Target Distribution Radius
15-ft Target Distribution Radius

Interpolated PCE MIP response surface is horizontal slice through 3-dimensional solid model generated using C Tech's EVS software.

The limited extent of the interpolated PCE MIP response surface depicted on this figure is to the extent of the available MIP data points.

**Membrane interface probe (MIP) results are in milligrams per liter (mg/L) of calibration solution and are subject to matrix effects. The actual soil and groundwater concentrations may be different.

[1] *Final Progress Report, In Situ Anaerobic Biotic/Abiotic Treatability Study, IR Site 28 (Shaw, 2010).*
[2] *Final Former Building 88 Investigation Report (Tetra Tech, 2008).*
[3] *NASA Sensitive but Unclassified Information*
[4] *Final Horizontal Conduit Study Technical Memorandum Text, Tables, and Figures (PRC, 1995).*
[5] *Final Technical Memorandum, Supplemental Investigation, Former Building 88 and Traffic Island Areas (CB&I, 2014)*

0 30 60
Approximate Scale - Feet

CB&I

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE 6b
CONCEPTUAL INJECTION ARRAY LAYOUT
LOWER A-AQUIFER ZONE - 30 to 70 ft bgs

IR SITE 28, FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

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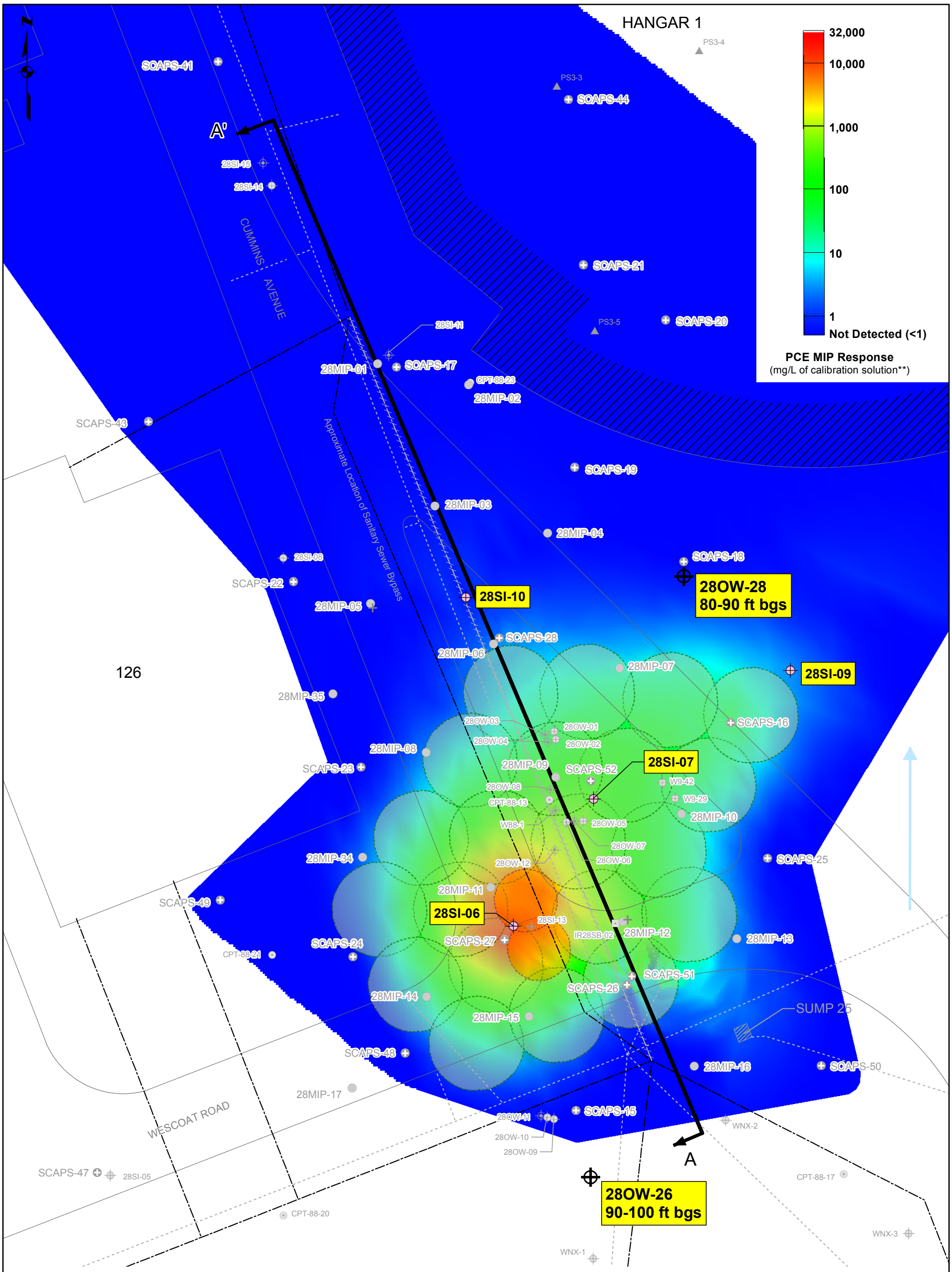


Proposed Groundwater Monitoring Well
Performance Monitoring Well
SCAPS Location
MIP Location(1)
NAPL FLUTe™ Test Location(1)
Continuous Core Location(1)
Upper A-Aquifer Monitoring Well
Lower A-Aquifer Monitoring Well
B2-Aquifer Monitoring Well
CPT Location(2)
NASA Sample Location(3)

Storm Drain Line
Sanitary Sewer Line
Sanitary Sewer Line that Reportedly Collapsed(4)
Groundwater Flow Direction
No Drilling - Surface Obstruction
Oil/Water Separator (Removed)
126 Building and Building Number
Cross-Section Line

Proposed Injection Locations
10-ft Target Distribution Radius
15-ft Target Distribution Radius

Interpolated PCE MIP response surface is horizontal slice through 3-dimensional solid model generated using C Tech's EVS software.

The limited extent of the interpolated PCE MIP response surface depicted on this figure is to the extent of the available MIP data points.

**Membrane interface probe (MIP) results are in milligrams per liter (mg/L) of calibration solution and are subject to matrix effects. The actual soil and groundwater concentrations may be different.

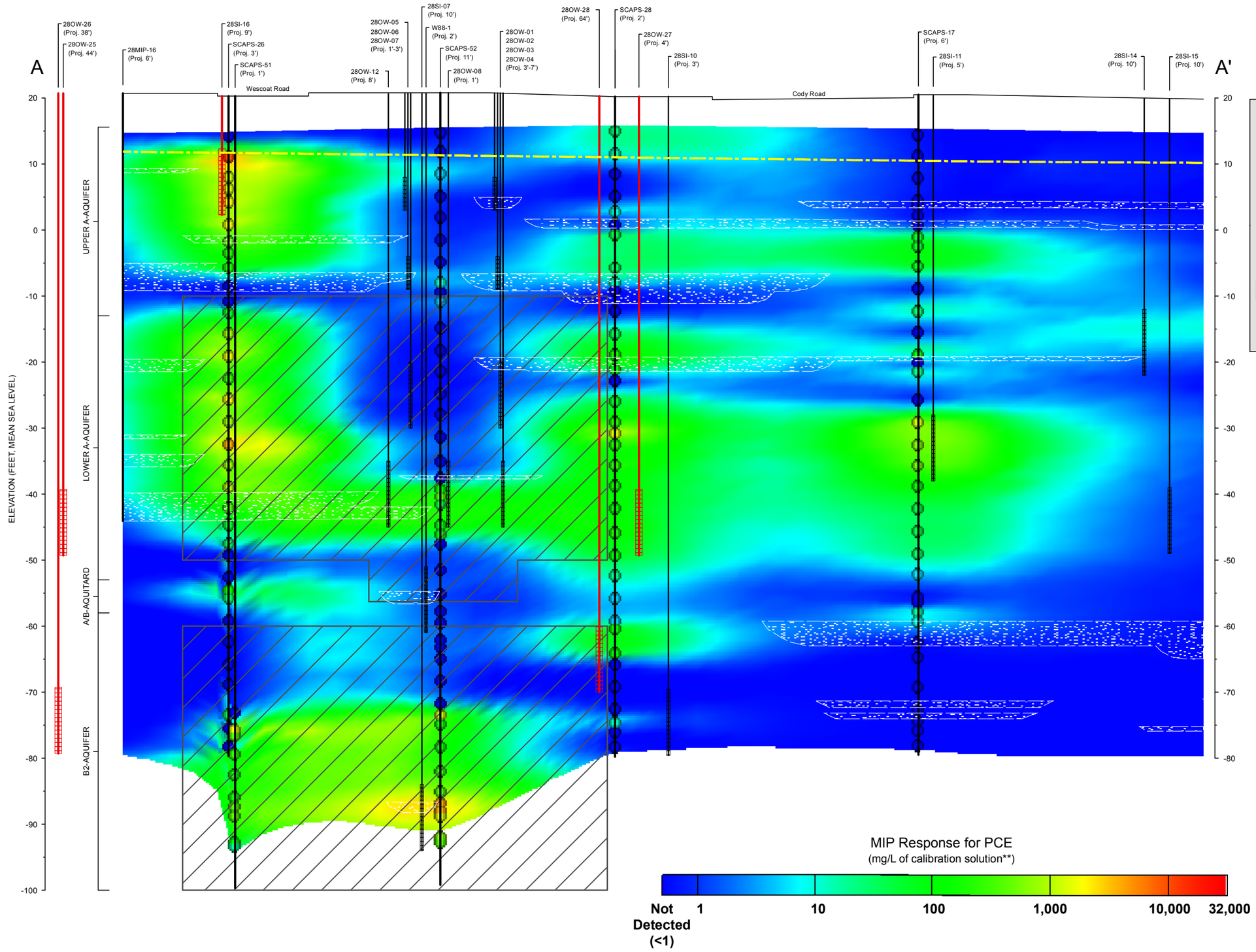
[1] *Final Progress Report, In Situ Anaerobic Biotic/Abiotic Treatability Study, IR Site 28 (Shaw, 2010).*
[2] *Final Former Building 88 Investigation Report (Tetra Tech, 2008).*
[3] *NASA Sensitive but Unclassified Information*
[4] *Final Horizontal Conduit Study Technical Memorandum Text, Tables, and Figures (PRC, 1995).*
[5] *Final Technical Memorandum, Supplemental Investigation, Former Building 88 and Traffic Island Areas (CB&I, 2014)*

0 30 60
Approximate Scale - Feet

BASE REALIGNMENT AND CLOSURE PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE 6c
CONCEPTUAL INJECTION ARRAY LAYOUT
B2-AQUIFER ZONE - 80 to 120 ft bgs

IR SITE 28, FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA



Legend

- COARSE-GRAINED SEDIMENTS (GRAVEL TO SILTY SAND)
- SANITARY SEWER LINE
- WELL SCREEN INTERVAL
- MIP SAMPLE POINT
- PROPOSED TREATMENT ZONE
- PROPOSED GROUNDWATER MONITORING WELL

** Membrane interface probe (MIP) results are in milligrams per liter (mg/L) of calibration solution and are subject to matrix effects. The actual soil and groundwater concentrations may be different.

The limited extent of the interpolated PCE MIP response surface depicted on this figure is to the extent of the available MIP data points.

The information in parentheses below well IDs (e.g. Proj. 10') indicates the distance in feet the well is projected onto the section.

Please note that although well 28OW-28 appears to be within the treatment zone it actually is located downgradient of the treatment zone, as shown on Figure 6c. This illusion is because well 28OW-28 has been projected 64 feet onto the section.

0 30 60 Feet

APPROXIMATE HORIZONTAL SCALE

0 10 20 Feet

APPROXIMATE VERTICAL SCALE

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE 6d
CONCEPTUAL TREATMENT ZONE
CROSS SECTION

IR SITE 28, FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

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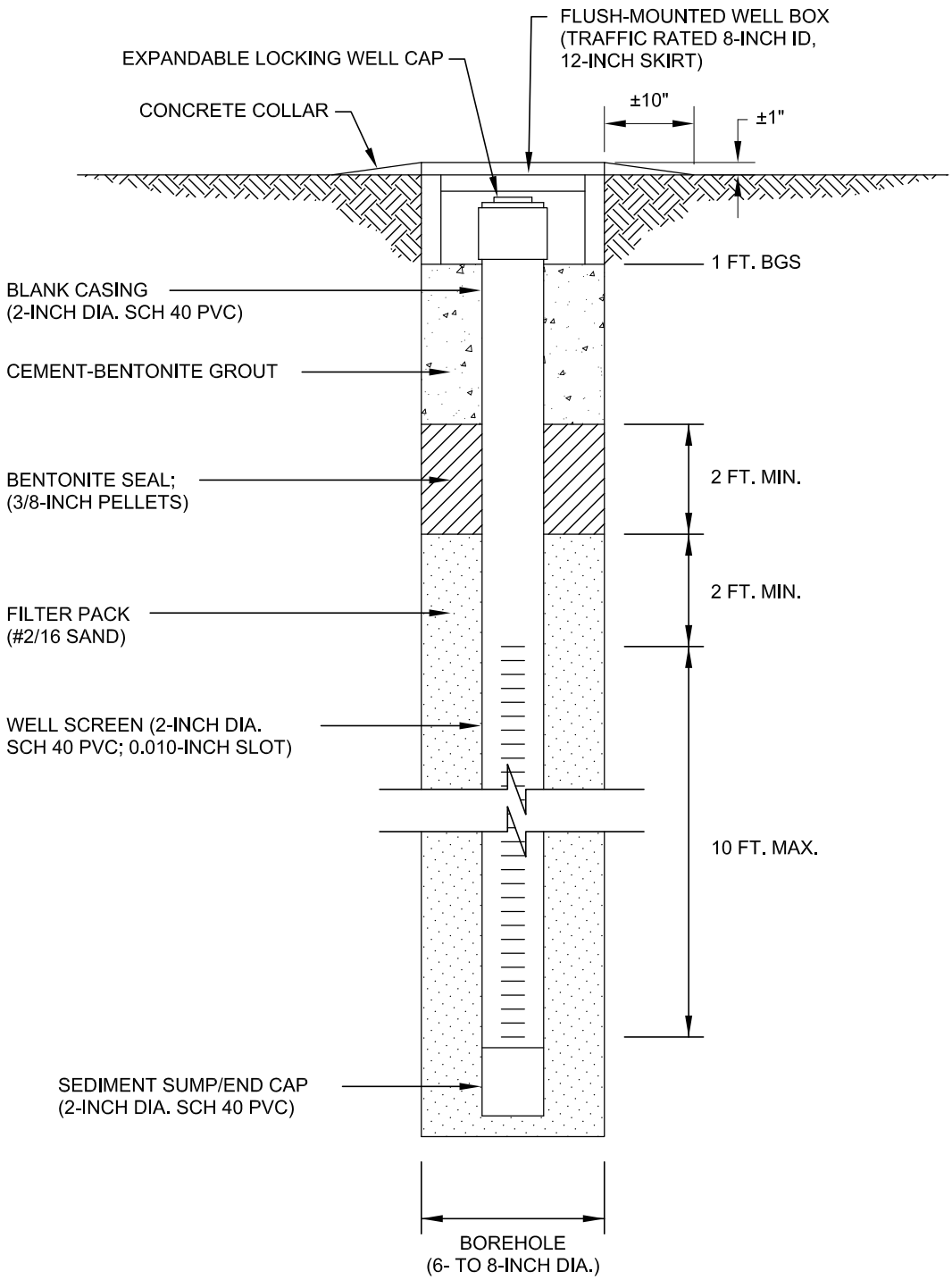


NOT TO SCALE

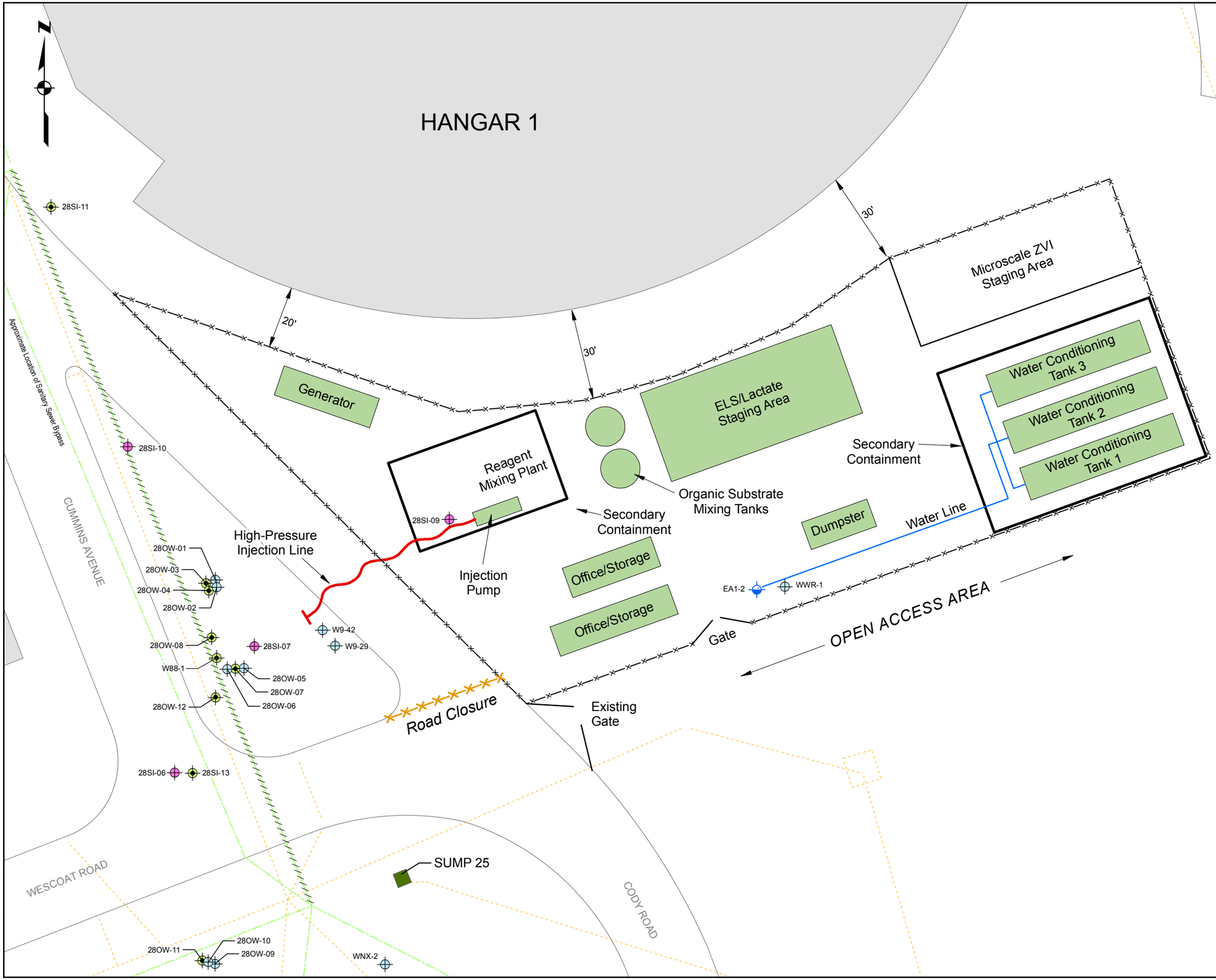
BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE 7

TYPICAL MONITORING WELL
CONSTRUCTION DIAGRAM

FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

DRAWING NUMBER	APPROVED BY		CHECKED BY		DRAWN BY		OFFICE	X-REF	IMAGE
500238-A1	NH	1/26/15	AM	1/26/15	KAB	1/26/15	Concord	---	---



Legend

- TEMPORARY FENCE
- WATER-FILLED BARRIER
- UPPER A-AQUIFER MONITORING WELL
- LOWER A-AQUIFER MONITORING WELL
- B2-AQUIFER MONITORING WELL
- A-AQUIFER EXTRACTION WELL
- STORM DRAIN LINE
- SANITARY SEWER LINE
- SECTION OF THE SANITARY SEWER LINE THAT REPORTEDLY COLLAPSED (PRC, 1995)
- OIL/WATER SEPARATOR (REMOVED)
- 503 BUILDING AND BUILDING NUMBER

PRC, 1995 - *Final Horizontal Conduit Study Technical Memorandum Text, Tables, and Figures*, August 4

0 30 60

Approximate Scale - Feet

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE 8
CONCEPTUAL EQUIPMENT AND MATERIALS STAGING AREA

IR SITE 28, FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

C:\GIS\Moffett_NAS\GIS_Documents\Project_Maps\IR28_EAB-ISCR\Moffett_002_IR28_equipment.mxd 4/10/2015

Tables

Table 1
Well Placement and Screen Interval Rationale

Proposed Well ID	Rationale
28SI-16	Locate the well near SCAPS-26 and screen the well from 8 to 18 feet bgs to determine the concentration of dissolved CEs in the upper portion of the A-Aquifer zone near the southern (upstream) end of the former collapsed sanitary sewer line from which contaminants were released to the subsurface.
28OW-25	Locate the well upgradient of the traffic island and screen the well from 60 to 70 feet bgs to determine and monitor the concentrations of dissolved CEs in the lower portion of the A-Aquifer zone upgradient of the treatment area in the interval where the presence of DNAPL was positively identified while installing wells 28SI-06 and 28SI-13.
28OW-26	Locate the well upgradient of the traffic island and screen the well from 90 to 100 feet bgs to determine and monitor the concentrations of dissolved CEs in the B2-aquifer upgradient of the treatment area.
28OW-27	Locate the well downgradient of the treatment area near SCAPS-28 and screen the well from 60 to 70 feet bgs to determine and monitor the concentrations of dissolved CEs in the lower portion of the A-Aquifer zone downgradient of the treatment area in the interval where the presence of DNAPL was positively identified while installing wells 28SI-06 and 28SI-13.
28OW-28	Locate the well downgradient of the treatment area near SCAPS-18 and screen the well from 80 to 90 feet bgs to determine and monitor the concentrations of dissolved CEs within coarse-grained, sedimentary deposits in the B2-Aquifer downgradient of the treatment area.

Notes:

CB&I	*CB&I Federal Services LLC*
CE	*chlorinated ethene*
DNAPL	*dense non-aqueous phase liquid*
ft bgs	*feet below ground surface*
ID	*identification*
SCAPS	*Site Characterization and Analysis Penetrometer System*

Table 2
Performance Monitoring Wells Summary

Well Identification	Monitoring Location	Screen Interval (feet below ground surface)
Lower A-Aquifer Zone		
28OW-11	Upgradient of treatment area	40 to 50
28OW-25	Upgradient of treatment area	60 to 70
28SI-13	Treatment area	63 to 68
W88-1	Treatment area	72 to 82
28OW-03	Treatment area	40 to 50
28OW-04	Treatment area	55 to 65
28OW-27	Downgradient of treatment area	60 to 70
B2-Aquifer Zone		
28OW-26	Upgradient of treatment area	90 to 100
28SI-06	Treatment area	90 to 100
28SI-07	Treatment area	105 to 115
28SI-09	Downgradient of treatment area	90 to 100
28SI-10	Downgradient of treatment area	90 to 100
28OW-28	Downgradient of treatment area	80 to 90

Appendices A through D
provided on electronic copy only

Appendix A
Sampling and Analysis Plan
(Dated May 2015)

SAP Worksheet #1: Title and Approval Page

Draft

Sampling and Analysis Plan
(Field Sampling Plan and Quality Assurance Project Plan)

May 2015

Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study
Traffic Island Area, Installation Restoration Site 28
Former Naval Air Station Moffett Field, Moffett Field, California

Prepared for:
Base Realignment and Closure
Program Management Office West Naval Facilities Engineering Command
1455 Frazee Road, Suite 900
San Diego, California 92108

Prepared by:
CB&I Federal Services LLC
4005 Port Chicago Highway, Suite 200
Concord, California 94520-1120
925.288.9898

Prepared under:
Contract Number N62473-10-D-4009
Contract Task Order 0104
Document Control Number: CB&I-4009-0104-2086

Review Signatures: Stephen D. Massey — May 11, 2015
Stephen Massey/Program QA Manager — Date

Approval Signatures: Joseph Michalowski — May 14, 2015
Joseph Michalowski/NAVFAC SW QA Officer — Date

Approval Signatures: SOLOMON.JUDITH.A.1461885000 — Digitally signed by SOLOMON.JUDITH.A.1461885000 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USN, cn=SOLOMON.JUDITH.A.1461885000 Date: 2015.05.14 14:31:51 -04'00'
Judy Solomon/NAVFAC LANT Chemist — Date

EXECUTIVE SUMMARY

This sampling and analysis plan has been prepared to describe sampling and analysis activities associated with the activities to perform a treatability study of combined enhanced anaerobic bioremediation and in situ chemical reduction for remediating chlorinated ethenes in the A-Aquifer and the B2-Aquifer zones at Installation Restoration Site 28, former Naval Air Station Moffett Field, California (Figure A-1).

The primary objective of the treatability study is to gather site-specific data to evaluate the effectiveness and viability of the combined biotic/abiotic treatment approach (enhanced anaerobic bioremediation/in situ chemical reduction) for reducing the highest concentrations of chlorinated ethenes in the lower portion of the A-Aquifer zone and the B2-Aquifer zone at the Traffic Island Area.

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List of Attachments

Attachment 1 Field Forms
Attachment 2 Laboratory Certifications and Standard Operating Procedures

List of Acronyms

%	percent
<	less than
>	greater than
±	plus or minus
≤	less than or equal to
≥	greater than or equal to
°C	degree Celsius
µg/kg	microgram per kilogram
µg/L	microgram per liter
bgs	below ground surface
CB&I	CB&I Federal Services LLC
CCV	continuing calibration verification
CE	chlorinated ethene
COC	chemical of concern
DCE	dichloroethene
DHC	dehalococcoides
DNA	deoxyribonucleic acid
DNAPL	dense non-aqueous phase liquids
DO	dissolved oxygen
DoD	U.S. Department of Defense
DQA	data quality assessment
DQI	data quality indicator
DSITMS	direct sample ion-trap mass spectrometer
EAB	enhanced anaerobic bioremediation
EDD	electronic data deliverable
EMAX	EMAX Laboratories, Inc.
EPA	U.S. Environmental Protection Agency
ESD	explanation of significant differences
EVO	emulsified vegetable oil
GC	gas chromatography or gas chromatograph
GC/MS	gas chromatography/mass spectrometry
H&S	health and safety
HSO	Health and Safety Officer
IC	ion chromatography
ICAL	initial calibration
ICP	inductively coupled plasma
ICS	interference check standard
ICV	initial calibration verification
IDL	instrument detection limit
IR	Installation Restoration
ISCR	in situ chemical reduction

List of Acronyms (continued)

LCD	laboratory control duplicate
LCS	laboratory control sample
LOD	limit of detection
LOQ	limit of quantitation
MB	method blank
MCL	maximum contaminant level
MEW	Middlefield-Ellis-Whisman
mg/L	milligram per liter
MIP	membrane interface probe
mL	milliliter
MS	matrix spike
MSD	matrix spike duplicate
NASA	National Aeronautics and Space Administrations
NAVFAC SW	Naval Facilities Engineering Command Southwest
Navy	U.S. Department of the Navy
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
PCE	tetrachloroethene
PDB	passive diffusion bags
PID	photoionization detector
PM	project manager
POC	point of contact
QA	quality assurance
QAO	Quality Assurance Officer
QC	quality control
qPCR	quantitative polymerized chain reaction
QSM	*Quality Systems Manual for Environmental Laboratories*
RL	reporting limit
ROD	*Record of Decision for the Fairchild, Intel, and Raytheon sites, Middlefield-Ellis-Whisman (MEW) Study Area, Mountain View, California*
ROICC	Resident Officer in Charge of Construction
RPD	relative percent difference
RPM	Remedial Project Manager
RSD	relative standard deviation
RWQCB	California Regional Water Quality Control Board—San Francisco Bay Region
SAP	sampling and analysis plan
SCAPS	Site Characterization and Analysis Penetrometer System
Shaw	Shaw Environmental, Inc.
SI	supplemental investigation
SOP	standard operating procedure
SSHO	site safety and health officer

List of Acronyms (continued)

SVOC	semivolatile organic compound
TCE	trichloroethene
TOC	total organic carbon
TS	treatability study
TtECI	Tetra Tech EC, Inc.
VC	vinyl chloride
VOC	volatile organic compound
WATS	West-Side Aquifers Treatment System
WS	worksheet
ZVI	zero-valent iron

SAP Worksheet #2: SAP Identifying Information

Site Name/Number:	**Installation Restoration (IR) Site 28**
Contractor Name:	**CB&I Federal Services LLC (CB&I)**
Contract Number:	**N62473-10-D-4009**
Contract Title:	**Environmental Services**
Work Assignment Number (optional):	**Contract Task Order 0104**

1. This sampling and analysis plan (SAP) was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (U.S. Environmental Protection Agency [EPA], 2005) and *Guidance for Quality Assurance Project Plans* (EPA, 2001). With additional guidance from the following:

    - *Quality Systems Manual for Environmental Laboratories* (QSM, U.S. Department of Defense [DoD], 2013)
    - *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006)
    - *Environmental Work Instruction 3EN2.1—Chemical Data Validation* (Naval Facilities Engineering Command Southwest [NAVFAC SW], 2001)
    - *Environmental Work Instruction EV3.2—Review, Approval, Revision, and Amendment of Sampling and Analysis Plans (SAPs)* (NAVFAC SW, 2011)
    - *Environmental Work Instruction EVR.4—Implementing and Maintaining the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Administrative Record and Compendium at NAVFAC Southwest* (NAVFAC SW, 2007)
    - *Environmental Work Instruction EVR.6—Environmental Data Management and Required Electronic Delivery Standards* (NAVFAC SW, 2005)

2. Identify regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

3. This is a project-specific SAP.

4. List dates of scoping sessions that were held:

    Project kickoff meeting, September 15, 2014 and regulatory agency scoping meeting, October 21, 2014.

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

Title	Date
None	

6. List organizational partners (stakeholders) and connection with lead organization:

Oversight by the EPA, Region 9
Oversight by the California Regional Water Quality Control Board—San Francisco Bay Region (RWQCB)
Active property occupant—National Aeronautics and Space Administration (NASA)

7. Lead organization:

U.S. Department of the Navy (Navy)

8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

Worksheet (WS) #8—No special training required

UFP-QAPP WS #	Required Information	Crosswalk to Related Information
A. Project Management		
Documentation		
1	Title and Approval Page	
2	Table of Contents; SAP Identifying Information	
3	Distribution List	
4	Project Personnel Sign-Off Sheet	
Project Organization		
5	Project Organizational Chart	
6	Communication Pathways	
7	Personnel Responsibilities and Qualifications Table	
8	Special Personnel Training Requirements Table	No special training required
Project Planning/Problem Definition		
9	Project Planning Session Documentation (Including Data Needs Tables), Project Scoping Session Participants Sheet	
10	Problem Definition, Site History, and Background Site Maps (Historical and Present)	
11	Site-Specific Project Quality Objectives	
12	Measurement Performance Criteria Table	
13	Sources of Secondary Data and Information Secondary Data Criteria and Limitations Table	
14	Summary of Project Tasks	
15	Reference Limits and Evaluation Table	
16	Project Schedule/Timeline Table	
B. Measurement Data Acquisition		
Sampling Tasks		
17	Sampling Design and Rationale	
18	Sampling Locations and Methods/Standard Operating Procedure (SOP) Requirements Table Sample Location Map(s)	
19	Analytical Methods/SOP Requirements Table	
20	Field Quality Control (QC) Sample Summary Table	
21	Project Sampling SOP References Table Sampling SOPs	
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	

UFP-QAPP WS #	Required Information	Crosswalk to Related Information
Analytical Tasks		
23	Analytical SOPs Analytical SOP References Table	
24	Analytical Instrument Calibration Table	
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	
Sample Collection		
26	Sample Handling System, Documentation Collection, Tracking, Archiving, and Disposal Sample Handling Flow Diagram	
27	Sample Custody Requirements, Procedures/SOPs Sample Container Identification Example Chain of Custody Form	
QC Samples		
28	QC Samples Table; Screening/Confirmatory Analysis Decision Tree	
Data Management Tasks		
29	Project Documents and Records Table	
30	Analytical Services Table Analytical and Data Management SOPs	
C. Assessment Oversight		
31	Planned Project Assessments Table Audit Checklists	
32	Assessment Findings and Corrective Action Responses Table	
33	Quality Assurance (QA) Management Reports Table	
D. Data Review		
34	Verification (Step I) Process Table	
35	Validation (Steps IIa and IIb) Process Table	
36	Validation (Steps IIa and IIb) Summary Table	
37	Usability Assessment	

SAP Worksheet #3: Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	Email Address or Mailing Address
Valerie Harris	Remedial Project Manager (RPM)	Base Realignment and Closure Program Management Office West	619.532.0981	valerie.j.harris@navy.mil Base Realignment and Closure Program Management Office West 1455 Frazee Rd, Suite 900 San Diego, California 92108
Gary Munekawa	Resident Officer in Charge of Construction (ROICC)	NAVFAC SW	650.603.9834	gary.munekawa@navy.mil NAVFAC SW PO Box 68, Building 107 Moffett Field, California 94035
Joseph Michalowski	NAVFAC SW Quality Assurance Officer (QAO)	NAVFAC SW	619.532.4125	joseph.michalowski@navy.mil NAVFAC SW 1220 Pacific Hwy, Building 127 San Diego, California 92132-5190
Alana Lee	RPM	EPA Region 9	415.972.3141	lee.alana@epa.gov EPA Region 9 Mail Code SFD-7-3 75 Hawthorne St San Francisco, California 94105
Elizabeth Wells	RPM	RWQCB	510.622.2440	ewells@waterboards.ca.gov RWQCB San Francisco Bay Region 1515 Clay St, Suite 1400 Oakland, California 94612
Neil Hey	Project Manager (PM)	CB&I	925.288.2141	neil.hey@cbifederalservices.com CB&I Federal Services 4005 Port Chicago Hwy, Suite 200 Concord, California 94520
Rose Condit	Program Chemist	CB&I	925.288.2151	rose.condit@CBIfederalservices.com CB&I Federal Services 4005 Port Chicago Hwy, Suite 200 Concord, California 94520

SAP Worksheet #3: Distribution List (continued)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	Email Address or Mailing Address
Junn Masongsong	Project Chemist	CB&I	925.288.2314	junn.masongsong@CBIfederalservices.com CB&I Federal Services 4005 Port Chicago Hwy, Suite 200 Concord, California 94520
Kevin O'Leary	Project QC Manager/ Site Safety and Health Officer (SSHO)	CB&I	925.288.2254	kevin.oleary@CBIfederalservices.com CB&I Federal Services 4005 Port Chicago Hwy, Suite 200 Concord, California 94520
Ye Myint	PM	EMAX Laboratories, Inc. (EMAX)	310.618.8889	EMAX 1835 W. 205th St Torrance, California 90501
Robin Robyl	PM	Pace Laboratory	412.826.5245	rrobl@microseeps.com 220 William Pitt Way Pittsburgh, Pittsburg 15238
Sandra Obleas	Data Validation	The Data Validation Group	949.709.7442	thedvgroup@cox.net

SAP Worksheet #4: Project Personnel Sign-Off Sheet

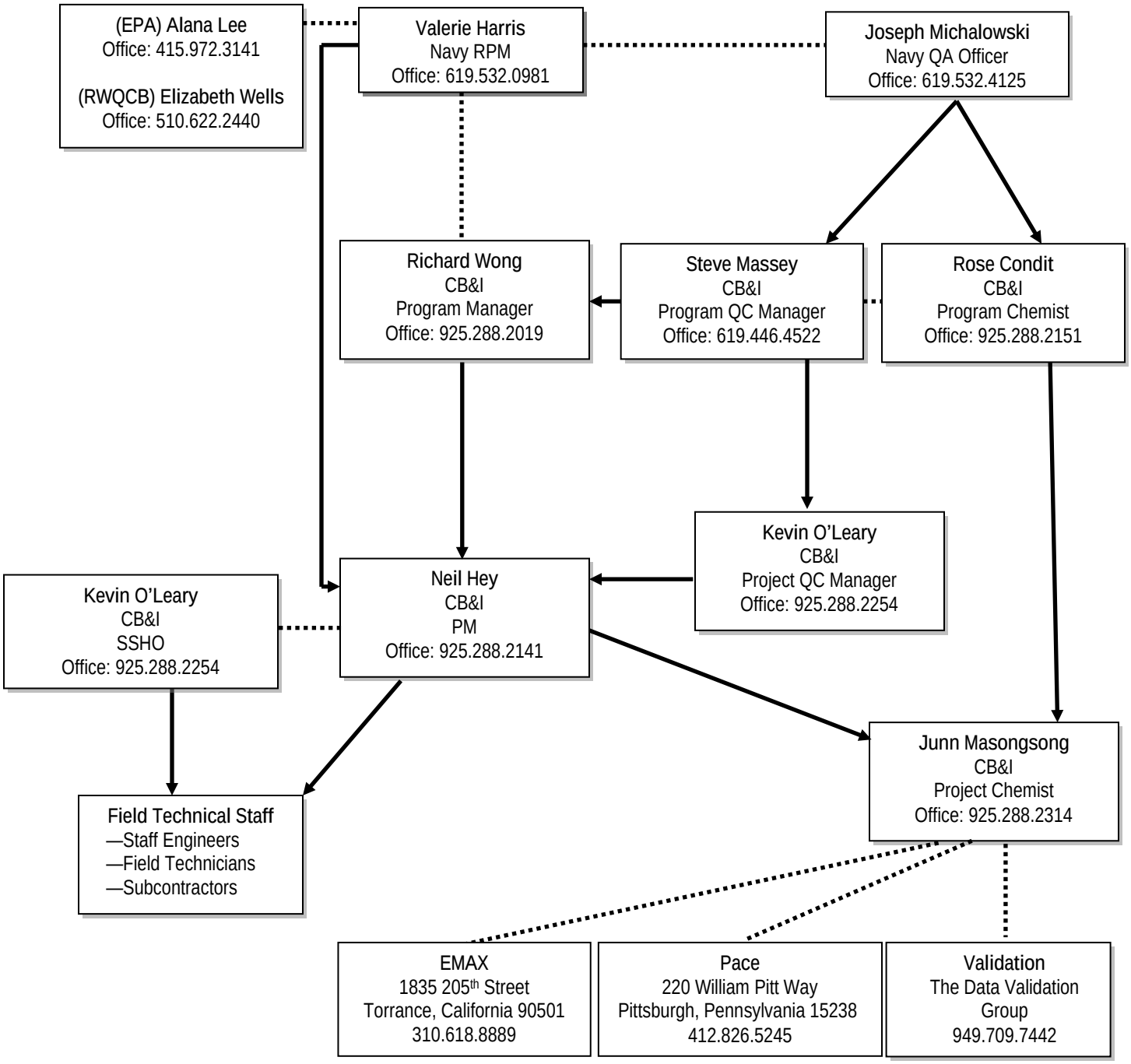
Name	Organization/Title/Role	Signature/Email Receipt	SAP Section Reviewed	Date SAP Read
Neil Hey	CB&I, PM			
Junn Masongsong	CB&I, Project Chemist			
Kevin O'Leary	CB&I, Project QC Manager			
Ye Myint	EMAX, PM			
Sandra Obleas	The Data Validation Group			

Note:

The signed SAP WS #4 will be stored in the on-site project files, and then will be transferred to the CB&I home office file storage at completion of fieldwork.

SAP Worksheet #5: Project Organization Chart

All lines of responsibility (solid lines) and lines of communication (dotted lines) are provided.



SAP Worksheet #6: Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Telephone Number	Procedure
Communication with regulators	Navy RPM	Valerie Harris	619.532.0981	The Navy RPM will be the primary point of contact for communication with regulators for project information. The Navy RPM will communicate any project field changes, construction or quality issues to the regulators.
Point of Contact (POC) with Navy RPM	CB&I PM	Neil Hey	925.288.2141	All materials and information about the project will be forwarded to RPM by the PM.
SAP Changes in the Field	Project or Program Chemist	Junn Masongsong or Rose Condit	925.288.2314 925.288.2151	The Project Chemist is responsible for documenting field changes related to sampling and for informing or seeking approval from the Program Chemist or Navy QAO. The Project Chemist or Program Chemist is also responsible for generating SAP amendments as necessary for approval by the Navy QAO. The Project Chemist oversees the documentation, notification, and corrective actions associated with project management issues in writing. Due to the potential impact field changes and SAP amendments may have on the project, the Project Chemist is to be notified of such issues within 24 hours or one business day.
Stop Work Issues (Quality)	Navy QAO	Joseph Michalowski	619.532.4125	The Navy QAO is authorized to suspend project execution if QA requirements are not adequately followed. The Navy QAO will notify the Navy RPM and CB&I Program QC Manager if QC issues requiring Stop Work are identified. The CB&I Program QC Manager or Program Chemist, in consultation with the PM and Navy RPM, will work with the Navy QAO to resolve QA issues and resume work. Upon resolution, the Project QC Manager oversees the documentation, notification, and corrective actions associated with site issues in writing within five business days.
Sampling Quality Issues	Project or Program QC Manager	Kevin O'Leary or Steve Massey	925.288.2383 619.446.4522	In general, the Project Chemist is the POC for sampling and chemistry issues and the Project QC Manager is the POC for other quality issues. If quality issues are not resolved at the project level (in consultation with the Task Order Manager, Site Supervisor, Technical Manager, etc.), then the issue will be elevated to the Program Chemist or Program QC Manager.
	Project or Program Chemist	Junn Masongsong or Rose Condit	925.288.2314 925.288.2151	The Program Chemist or designee will seek additional guidance or approval from the Navy QAO, if necessary. Upon resolution, the Project QC Manager or Project Chemist oversees the documentation, notification, and corrective actions associated with the QC issue in writing.

SAP Worksheet #6: Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Telephone Number	Procedure
Health and Safety (H&S) Issues	SSHO	Kevin O'Leary	925.288.2383	The SSHO is the POC for H&S issues. If H&S issues are not resolved at the project level (in consultation with the PM, Site Supervisor, Technical Manager, etc.), then the issue will be elevated to the Program Health and Safety Officer (HSO). The Program HSO or designee will seek additional guidance or approval from the Navy HSO, if necessary. Upon resolution, the SSHO oversees the documentation, notification, and corrective actions associated with the issue in writing. Due to the potential seriousness of H&S issues, the SSHO is to be notified of H&S issues immediately.
Sample Collection Issues	Project or Program Chemist	Junn Masongsong or Rose Condit	925.288.2055 925.288.2151	The Project Chemist is the POC for sampling and chemistry issues. If sampling issues are not resolved at the project level (in consultation with the PM, Site Supervisor, Technical Manager, Geologist, etc.), then the issue will be elevated to the Program Chemist or Program QC Manager. The Program Chemist or Program QC Manager will seek additional guidance or approval from the Navy QAO, if necessary. Upon resolution, the Project Chemist oversees the documentation, notification, and corrective actions associated with the QA issue in writing. Due to the potential impact sampling issues may have on the project; the Project Chemist is to be notified of sampling issues within 24 hours or one business day.
Amendments to Approved SAP	Project or Program Chemist	Junn Masongsong or Rose Condit	925.288.2055 925.288.2151	If field activities change to such a degree the original existing SAP does not adequately cover the work being performed, then a SAP Addendum will be written. SAP Addendum will follow the requirements of *Environmental Work Instruction EV3.2—Review, Approval, Revision, and Amendment of Sampling and Analysis Plans (SAPs)* (NAVFAC SW, 2011). SAP Addendums may be written by the Project Chemist or the Program Chemist. SAP Addendums will be reviewed and approved by the Navy QAO prior to regulatory review or field implementation.

SAP Worksheet #6: Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Telephone Number	Procedure
Stop Work Issues (H&S)	SSHO CB&I Employees	Kevin O'Leary	925.288.2383	All employees have the right and duty to Stop Work when conditions are unsafe, or when established safety procedures are being disregarded. Whenever an employee determines that workplace conditions present an immediate uncontrolled risk of injury or illness, immediate resolution with the appropriate supervisor shall be sought. Should the supervisor be unable or unwilling to correct the unsafe conditions, the employee is authorized and required to issue a Stop Work Order in accordance with CB&I procedures The specific activity or operation in question shall be discontinued until the issue is resolved.
Laboratory Reporting or Data Quality Issues	Project or Program Chemist	Junn Masongsong or Rose Condit	925.288.2314 925.288.2151	The Project Chemist is the POC for laboratory issues. The project data manager is the POC for electronic data deliverables (EDDs). If laboratory issues are not resolved with the Project Chemist or data manager, then laboratory the issue will be elevated to the Program Chemist. Upon resolution, the Project Chemist oversees the documentation, notification, and corrective actions associated with the laboratory issue in writing.
Notification of Non-usable Analytical Data	Program Chemist	Rose Condit	925.288.2151	If significant problems are identified by the laboratory or the project team that impact the usability of the data (i.e., the data is rejected or the data quality objective are not met), the Program Chemist will notify the CB&I PM and the Navy RPM within 24 hours or the next business day. CB&I will also notify the Navy QAO if directed by the Navy PRM.

SAP Worksheet #7: Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibility
Valerie Harris	RPM	Navy	Manages governmental oversight of the project Manages project funding and scope Coordinates project documents review Primary contact and liaison with regulatory agencies Responsible for technical oversight of the project
Joseph Michalowski	QAO	Navy	Provides governmental oversight of the CB&I QA Program Provides quality-related directives through Contracting Officer's Technical Representative Reviews and approves the SAP prior to regulatory review and field implementation Provides technical and administrative oversight of CB&I surveillance audit activities Acts as POC on all matters concerning QA and the client's Laboratory QA Program Authorized to suspend project execution if QA requirements are not adequately followed
Neil Hey	PM	CB&I	Manages oversight of the project for CB&I POC for communication with the Navy RPM and Navy Contracts Ensures that all requirements of project contract are attained in a manner consistent with Project Plans Oversees planning, execution, and conclusion of all project activities Manages project budgets and schedules
Rose Condit	Program Chemist	CB&I	Reviews and approves the SAP Guides the selection of subcontract analytical laboratories Conducts field and laboratory audits Serves as a POC for the Navy QAO Develops corrective action as required Serves as a technical advisor to the project
Neil Hey	Technical Manager	CB&I	Develops Work Plans to address project scope of work Serves as a technical manager to the project Reports to PM

SAP Worksheet #7: Personnel Responsibilities and Qualifications Table (continued)

Name	Title/Role	Organizational Affiliation	Responsibility
Junn Masongsong	Project Chemist	CB&I	Develops the project data quality objectives and prepares the SAP Selects qualified subcontract laboratories Implements chemical data QC procedures and audits field performance Reviews laboratory data prior to use Performs validation of laboratory data Prepares the appropriate sections of the report summarizing the project sampling activities
Kevin O'Leary	Project QC Manager	CB&I	Develops the project QC objectives and prepares the QC Plan Administers the QC Plan Manages QC documentation and QC deliverables Lists definable features of work Conducts inspections (preparatory, initial, follow-up, completions)
Kevin O'Leary	SSHO	CB&I	Develops and administers the accident prevention plan/site safety and health plan Manages personnel and environmental monitoring Coordinates preparation of Job Safety Analyses Selects appropriate personal protective equipment Reviews essential H&S requirements with on-site personnel Facilitates daily safety meetings
Junn Masongsong or other CB&I Field Sampling Technician	Field Technician (sampling)	CB&I	Performs all sampling in accordance with approved SAP Ensures that field QC samples are collected as specified in the SAP Completes field documentation Coordinates laboratory and field sampling activities Implements field corrective actions as required Must have Occupational Safety and Health Administration (OSHA) 40-hour Certification and 8-hour OSHA Refresher Certification
Ye Myint	Laboratory PM	EMAX	Oversees proper analysis and reporting of project samples according to Approved SAP Manages communication between laboratory and CB&I Project Chemist Ensure proper QA/QC procedures are followed during laboratory analysis

SAP Worksheet #7: Personnel Responsibilities and Qualifications Table (continued)

Name	Title/Role	Organizational Affiliation	Responsibility
Robbin Robyl	Laboratory PM	Pace	Oversees proper analysis and reporting of project samples according to Approved SAP Manages communication between laboratory and CB&I Project Chemist Ensure proper QA/QC procedures are followed during laboratory analysis
Sandra Obleas	Data Validation PM	The Data Validation Group	Performing data validation according to applicable methods and approved SAP Reviewing laboratory reports for compliance with applicable methods and approved SAP Applying validation qualifiers to analytical data Preparing data validation report

SAP Worksheet #8: Special Personnel Training Requirements Table

All field personnel will be required to have completed the OSHA 40-hour Hazardous Waste Operations and Emergency Response Standard Protection training, continued 8-hour Hazardous Waste Operations and Emergency Response and submit to annual medical surveillance, as required by OSHA. The CB&I SSHO will be responsible for ensuring that training and/or certification is met and that qualified personnel are performing the work.

Specialized training is not required for this project.

SAP Worksheet #9: Project Scoping Session Participants Sheet

Project Name: Task Order 0104—Treatability Study, Soil & Groundwater at the Traffic Island Area IR Site 28, Former Naval Air Station Moffett Field	Site Name: Installation Restoration Site 28
Projected Date(s) of Sampling: Project Period of Performance August 2014 through August 2017	Site Location: Moffett Field, California
Project Manager: Neil Hey	

Date of Session: September 15, 2014

Scoping Session Purpose: Project Kickoff Meeting

Name	Title	Affiliation	Phone #	Email Address	Project Role
Roderick Soule	Contracting Officer Representative	NAVFAC SW	619.532.3178	roderick.soule@navy.mil	Contracting Officer Representative
Lara Urizar	Contracting Officer Representative	NAVFAC SW	619.532.4945	lara.urizar@navy.mil	Contracting Officer Representative
Jim Whitcomb	Lead RPM	NAVFAC SW	619.532.0936	james.h.whitcomb@navy.mil	Lead RPM
Valerie Harris	RPM	NAVFAC SW	619.532.0981	valerie.j.harris@navy.mil	Technical RPM
Gary Munekawa	ROICC	NAVFAC SW	650.603.9834	gary.munekawa@navy.mil	ROICC
Richard Wong	Program Manager	CB&I	619.778.6122	richard.wong@cbifederalservices.com	Contract Program Manager
Neil Hey	PM	CB&I	925.288.2141	neil.hey@cbifederalservices.com	Contract Task Order Manager
Kevin O'Leary	Project QC Manager/SSHO	CB&I	925.288.2254	kevin.oleary@cbifederalservices.com	QC Manager and SSHO

Comments/Decisions:

Project description, project objectives, organization and staffing, and schedule

Action Items:

NASA security information, update schedule, formally notify NASA of required site logistics for implementing treatability study (TS)

Consensus Decisions:

SAP Worksheet #9: Project Scoping Session Participants Sheet (continued)

Project Name: Task Order 0104—Treatability Study, Soil & Groundwater at the Traffic Island Area IR Site 28, Former Naval Air Station Moffett Field	Site Name: Installation Restoration Site 28
Projected Date(s) of Sampling: Project Period of Performance August 2014 through August 2017	Site Location: Moffett Field, California
Project Manager: Neil Hey	

Date of Session: October 21, 2014

Scoping Session Purpose: Regulatory Agency Scoping Meeting

Name	Title	Affiliation	Phone #	Email Address	Project Role
Alana Lee	RPM	EPA Region 9	415.972.3141	lee.alana@epa.gov	EPA RPM
Grace Ma	RPM	EPA Region 9	415.947.4212	ma.grace@epa.gov	Former EPA RPM
Elizabeth Wells	RPM	RWQCB	510.622.2440	Elizabeth.Wells@waterboards.ca.gov	RWQCB RPM
Valerie Harris	RPM	NAVFAC SW	619.532.0981	valerie.j.harris@navy.mil	Navy Technical RPM
Neil Hey	PM	CB&I	925.288.2141	neil.hey@cbifederalservices.com	Contract Task Order Manager
Allen Martin	Project Geologist	Former CB&I Employee	n/a	n/a	n/a

Comments/Decisions:

Site history, project objectives, conceptual technical approach, and schedule

Action Items:

Provide EPA and RWQCB layout of the preferred equipment/materials staging area

Consensus Decisions:

SAP Worksheet #10: Problem Definition

The planning team consists of the representatives of the Navy and CB&I with oversight and input by EPA Region 9, RWQCB, and NASA. The Navy is the lead federal agency for the direction of the site activities and the prime decision maker.

The primary objective of this study is to gather site-specific data to evaluate the effectiveness and viability of the combined biotic/abiotic treatment approach (enhanced anaerobic bioremediation [EAB]/in situ chemical reduction [ISCR]) for reducing the highest concentrations of chlorinated ethenes (CEs) in the lower portion of the A-Aquifer zone and the B2-Aquifer zone at the Traffic Island Area.

The TS will be performed by injecting reagents into a targeted test area of the aquifer to stimulate biological and chemical reduction of CEs. Groundwater sampling will be completed before and after the substrate injections to generate data necessary to achieve the project objectives. TS progress and interim results will be provided via bi-monthly meetings with the EPA, RWQCB, and NASA. Upon completion of the TS, the data will be compiled, evaluated, and published in a final report documenting the results. The final report will include a description and discussion of the activities, results, findings, and recommendations. It is anticipated that sufficient data will be available from the study to fully evaluate the effectiveness of the combined biotic/abiotic technology to reduce the concentration of source area CEs.

10.1 CONCEPTUAL SITE MODEL

The following section presents summaries of site history and background, previous investigations, and information used to develop the TS.

10.1.1 Site Description

IR Site 28 is defined by the aquifers below the area generally bounded by Hangar 1 to the east, McCord Avenue to the west, King Road to the north, and a line approximately 300 feet south of Wescoat Road to the south, as shown on Figure A-1. Beneath this area, the A-Aquifer zone is impacted by volatile organic compounds (VOCs), primarily CEs including tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (DCE), and vinyl chloride (VC); and to a lesser extent within the B-Aquifer zone. The contamination at IR Site 28 resulted from on-flow of contamination from up-gradient CE sources, primarily TCE, at the Fairchild, Intel, and Raytheon sites (collectively known as the Middlefield-Ellis-Whisman [MEW] Superfund Site) and on-site Navy sources. Historical dry cleaning activities conducted at former Building 88 were determined to be the source of PCE along with the associated sanitary sewer line (Tetra Tech EC, Inc. [TtECI], 2008).

In 1993, the Navy agreed to adopt the *Record of Decision for the Fairchild, Intel, and Raytheon sites, Middlefield-Ellis-Whisman (MEW) Study Area, Mountain View, California* (ROD; EPA,

1989) and to remediate contamination attributable to Navy sources (Navy, 1993). To comply with the ROD requirements, the Navy removed Building 88 in 1994, excavated contaminated soil, and installed a groundwater source control measure referred to as the "Building 6 Treatment System." The Building 6 Treatment System was operated until 1997 when it was replaced with a plumewide groundwater control system referred to as the "West-Side Aquifers Treatment System" (WATS). Operation of the WATS has been ongoing since November 1998.

In 2005, the Navy implemented an investigation to evaluate whether the residual PCE in the vadose zone at the former Building 88 location was a continuing source of contamination for groundwater and if so, whether the PCE source area was treatable. In the *Final Former Building 88 Investigation Report, Former Naval Air Station Moffett Field, Moffett Field, California* (TtECI, 2008), it was concluded that residual contamination in the saturated zone in two areas—the Former Building 88 Area and the Traffic Island Area—act as ongoing PCE sources to groundwater contamination in the upper and lower portion of the A-Aquifer zone (ranging from approximately 0 to 35 feet below ground surface [bgs] and 35 to 65 feet bgs, respectively). These areas of interest are shown on Figure A-2. The investigation report recommended further source removal to meet the requirements of the ROD (EPA, 1989) and to expedite the cleanup of contaminated groundwater. Further characterization of the PCE contamination in the saturated zone soil and/or groundwater was also recommended. The vadose zone soil remedy was completed in 1994 and fully meets the cleanup standards set forth in the ROD, so no further action for the vadose zone was recommended (EPA, 2009).

In 2010, additional site work was completed to further characterize the identified potential CE source areas and to investigate possible dense non-aqueous phase liquids (DNAPL) in support of field testing three in situ CE treatment technologies. CE delineation and DNAPL assessments were completed through the use of membrane interface probe (MIP) analysis, visual examination and field/laboratory testing of soil cores, and hydrophobic flexible membrane testing (Shaw Environmental, Inc. [Shaw], 2010). The characterization effort confirmed and further delineated residual CE source materials beneath the Former Building 88 and Traffic Island Areas. DNAPL was not identified during this effort.

Following the characterization effort, a TS was conducted between 2010 and 2011 at the source areas to evaluate the ability of two separate in situ biological treatment technologies (emulsified vegetable oil [EVO] with bioaugmentation and lactate with bioaugmentation) and one in situ combined biotic/abiotic treatment technology (EHC®) to remediate dissolved CEs to concentrations below the site cleanup standard and maximum contaminant levels (MCLs) (EPA, 1989 and 1990). By the end of the study period, concentrations of CEs in the EVO and EHC® test areas continued to decline and reducing conditions persisted, but it was unknown how long the reducing conditions would remain and if concentrations would reach the cleanup standard

and MCLs. Consequently, additional performance monitoring of the EVO and EHC® pilot test areas was recommended (Shaw, 2012) and performed in 2012 (CB&I, 2014). All three technologies tested were very effective at reducing the concentrations of CEs at the site to the extent of their distribution and electron donor capabilities, for example EHC® was difficult to distribute because of its high solids composition and the lactate was least persistent in the treatment area.

Contemporaneously, EPA was in the process of preparing a supplemental sitewide groundwater feasibility study for the MEW superfund study area to evaluate the ability of several remedial alternatives to reduce concentrations of CEs and to remediate the regional plume. All of the alternatives that were to be evaluated in the feasibility study included source treatment. Although prior investigations provided valuable insight into the nature and extent of the Navy's source areas, several key data gaps remained in the conceptual site model for the Former Building 88 and Traffic Island Areas, and other "potential source areas" identified by EPA based on groundwater concentrations that needed to be addressed before completing designs for further remediation.

Consequently, in 2012 and 2013, the Navy implemented a Supplemental Investigation (SI) to augment the characterization of CE contamination at the Former Building 88 and Traffic Island Areas and to provide information in response to EPA's request to "evaluate and characterize containment of a second smaller, higher-concentration area of contamination in the B2-Aquifer" (EPA, 2012). Utilizing a combination of soil samples, groundwater samples, and MIP/direct sample ion-trap mass spectrometer (DSITMS) data, it was determined that the residual CE source mass is predominately in fine-grained soil at both locations with DNAPL positively identified in the lower A-Aquifer zone at a depth of approximately 65 feet bgs nearby the collapsed sewer line in the Traffic Island Area and concentrations of CEs greater than 1,000 micrograms per liter (µg/L) in the B2-Aquifer beneath where DNAPL was identified in the lower A-Aquifer zone. The *Final Technical Memorandum, Supplemental Investigation Former Building 88 and Traffic Island Areas, Installation Restoration Site 28, Former Moffett Naval Air Station, Moffett Field, California* (CB&I, 2014) recommended:

1. A TS to evaluate technologies for treating the CEs identified in the B2-Aquifer zone and residual DNAPL identified in the lower portion of the A-Aquifer zone
2. Further investigation of the elevated concentrations of CEs in shallow groundwater at the northeast corner of Building 126
3. Installation of additional wells immediately up-gradient of the Former Building 88 and Traffic Island Areas for evaluating on-flow of CEs from up-gradient sources in the A-Aquifer and B2-Aquifer zone

4. Installation of additional wells immediately downgradient (north-northeast) of the traffic island for further evaluating CEs in the B2-Aquifer zone

The planned work covered by the parent Work Plan to this SAP addresses recommendations 1, 3, and 4. Recommendation 2 will be addressed under a separate effort.

10.2 SITE GEOLOGY AND HYDROGEOLOGY

The following subsection provides a brief description of the local geology and hydrogeology at IR Site 28. Information was compiled from the *Final Former Building 88 Investigation Report, Former Naval Air Station Moffett Field, Moffett Field, California* (TtECI, 2008); *Draft, West-Side Aquifers Treatment System, Site 28 Optimization Evaluation Report, Installation Restoration Site 28, Former Naval Air Station Moffett Field, Moffett Field, California* (SES-TECH, 2008); and the *Final Technical Memorandum, Supplemental Investigation Former Building 88 and Traffic Island Areas, Installation Restoration Site 28, Former Moffett Naval Air Station, Moffett Field, California* (CB&I, 2014).

10.2.1 Local Geology

The native subsurface in the IR Site 28 area is characterized by interbedded coarse-grained soil (sand and gravel) and fine-grained soil (silt and clay). Sedimentary deposits that make up the A-Aquifer zone represent the distal end of a Holocene-aged coalescing alluvial fan complex and tidal mud flats (estuarine deposits). Near the bay, fine-grained alluvium is replaced by bay mud (dark-gray silt and clay). The sand and gravel represent anastomosing stream channel deposits between interchannel alluvium and bay mud. Fluvial channel deposits typically display fining-upward sequences that begin with a poorly sorted mixture of gravel and coarse sand at the bottom, overlain by a fining-upward sequence of coarse-to-fine sand, silt, or clay. These channel deposits have been interpreted to generally trend northwest to southeast, and become more northerly in the vicinity of the WATS (Tetra Tech FW, Inc., 2005).

10.2.2 Local Hydrogeology

The focus of this TS is the A- and B-Aquifer zones. The A-Aquifer zone extends from grade to approximately 75 feet bgs at IR Site 28. The A-Aquifer zone is divided into two portions: an upper portion above approximately 35 feet bgs (sometimes referred to as the A1 zone) and a lower portion below approximately 35 feet bgs (sometimes referred to as the A2 zone) (TtECI, 2008). Based on the absence of a continuous aquitard separating them, these horizons are considered to be portions of the same A-Aquifer zone rather than independent, discrete aquifers (SES-TECH, 2008).

The A-Aquifer zone is separated from the deeper B-Aquifer zone by clay and clayey silt layers which form the A/B-Aquitard. The A/B-Aquitard varies in thickness and has been encountered at depths ranging from 45 feet bgs to greater than 80 feet bgs.

The B-Aquifer zone is present below the A/B-Aquitard and extends to depths as great as 160 feet bgs. The B-Aquifer zone is divided into two permeable zones: an upper zone referred to as the B2-Aquifer zone and a lower zone referred to as the B3-Aquifer zone that are separated by a laterally discontinuous and variable thickness aquitard (referred to as the B2/B3-Aquitard) encountered at depths ranging from 95 to 130 feet bgs. The B3-Aquifer lies beneath the B2-Aquifer and extends to 160 feet bgs. The B-Aquifer zone is underlain by the C and deeper aquifers.

The general groundwater flow direction in the upper and lower portions of the A-Aquifer zone is generally to the north-northeast across Moffett at an average gradient of approximately 0.005 foot per foot between U.S. Highway 101 and Hangar 1. The gradient in the general vicinity of Hangar 1 is affected by the WATS pumping to a north-northwesterly direction; however, the overall flow is north/northeast from Hangar 1 toward the NASA Ames Research Center at a gradient ranging from approximately 0.003 to 0.006 foot per foot (SES-TECH Remediation Services, 2014). Aquifer tests of the upper A-Aquifer zone indicate unconfined to leaky-confined conditions and tests of the lower A-Aquifer zone indicate leaky-confined conditions. There is a predominant upward potential for groundwater flow from the B2-Aquifer zone to the lower portion of the A-Aquifer zone. The general groundwater flow direction in the B2-Aquifer zone appears to be to the north across Moffett as observed on Figure 12 in the *2013 Annual Progress Report, Volume 1: Text, Tables, Figures, Middlefield-Ellis-Whisman Area Regional Groundwater Remediation Program, Mountain View, California* (Geosyntec Consultants, 2014).

10.3 NATURE AND EXTENT OF CONTAMINATION

As previously discussed, the chemicals of concern (COCs) are VOCs, primarily PCE and related degradation products (TCE, cis-1,2-DCE, and VC) within the upper and lower portions of the A-Aquifer zone, and in the B2-Aquifer zone. Continuing sources of PCE contamination to groundwater have been identified in the Traffic Island Area beneath the sanitary sewer alignment downstream from former Building 88. A brief summary of the PCE, TCE, cis-1,2-DCE, and VC contamination in the Traffic Island Area is provided in the following subsections. The description of CEs in the A-Aquifer within and around the Traffic Island Area is based on the results of:

- 50 soil samples collected from eight borings during the 2005 site investigation (TtECI, 2008)
- 1 soil sample collected from one boring during the 2010 through 2011 TS (Shaw, 2010)
- 16 soil samples collected from six borings during the 2012 through 2013 SI (CB&I, 2014)

- 53 discrete-depth groundwater grab samples collected from eight direct-push locations during the 2005 site investigation (TtECI, 2008)
- 10 discrete-depth groundwater grab samples collected from six direct-push locations completed by NASA during a subsurface investigation within Hangar 1 in 2009
- Groundwater samples collected from the 14 TS observation wells between 2010 and 2011 (Shaw, 2012) and in 2012 (CB&I, 2014)
- Groundwater samples collected from six wells outside the TS area during the basewide annual groundwater monitoring events between 2010 and 2013 (ERS Joint Venture and Brown and Caldwell, 2011 and 2012; SES-TECH, 2013 and 2014)
- Groundwater samples collected from nine new groundwater monitoring wells installed during the 2012-2013 SI (CB&I, 2014)
- 19 MIP tests completed in March/April 2010 prior to the 2010 through 2011 TS (Shaw, 2010)
- 746 MIP/DSITMS measurements at 28 Site Characterization and Analysis Penetrometer System (SCAPS) test borings completed during the 2012 through 2013 SI (CB&I, 2014)

The description of CEs in the B2-Aquifer (to the extent investigated) within and around the Traffic Island Area is based on the results of:

- 6 soil samples collected from four borings during the 2012 through 2013 SI (CB&I, 2014)
- Groundwater samples collected from four new groundwater monitoring wells installed during the 2012 through 2013 SI (CB&I, 2014)
- 219 MIP/DSITMS measurements at 28 SCAPS test borings completed during the 2012 through 2013 SI (CB&I, 2014)

The listed sample locations are shown on Figure A-3 of this SAP, and the most recent depiction of the distribution of PCE and its daughter products in the A-Aquifer and B2-Aquifer are shown on Figures 19 through 30 in the *Final Technical Memorandum, Supplemental Investigation Former Building 88 and Traffic Island Areas, Installation Restoration Site 28, Former Moffett Naval Air Station, Moffett Field, California* (CB&I, 2014). Based on the complex nature and extent of contamination, multiple compounds considered, and the extensive graphics required to adequately illustrate this information, it is recommended that the reader refer to the various graphic illustrations provided in the *Final Technical Memorandum, Supplemental Investigation Former Building 88 and Traffic Island Areas, Installation Restoration Site 28, Former Moffett Naval Air Station, Moffett Field, California* (CB&I, 2014), the *Final Former Building 88*

Investigation Report, Former Naval Air Station Moffett Field, Moffett Field, California (TtECI, 2008), and the annual basewide groundwater monitoring reports cited previously in this section.

Based on the 2012 through 2013 MIP/DSITMS survey it was determined that the majority of the residual CE mass at the traffic island source area is predominantly in fine-grained soil. The locations in the upper portion of the A-Aquifer zone where the greatest amount of MIP/DSITMS responses were recorded over the vertical profile occurred near the southern (upstream) end of the former collapsed sanitary sewer line along Cummins Avenue at the intersection with Wescoat Road (SCAPS-26 and SCAPS-27), downgradient of the sanitary sewer trunk line along the south side of Wescoat Road (SCAPS-48), and adjacent to the northeast corner of Building 126 (SCAPS-22 and SCAPS-43). The responses were predominantly PCE and DCE with lesser amounts of TCE, except for SCAPS-26, which had no DCE. These responses correspond to the elevated concentrations of CEs detected in historical soil and groundwater samples collected in this area.

The locations in the lower portion of the A-Aquifer zone where the greatest amount of MIP/DSITMS responses were recorded over the vertical profile occurred along the former collapsed sanitary sewer line (SCAPS-17, SCAPS-26, SCAPS-27, and SCAPS-28) and downgradient of the sanitary sewer trunk line on the south side of Wescoat Road (SCAPS-48). The responses were predominantly PCE with little TCE and DCE, which corresponds with the elevated concentrations of CEs detected in historical soil and groundwater samples collected from this interval in this area.

Based on the 2012 through 2013 MIP/DSITMS survey it was determined that the majority of the residual CE mass at the traffic island source area in the B2-Aquifer zone is predominantly in fine-grained soil. In the B2-Aquifer zone, MIP/DSITMS responses were detected at only six of the 28 SCAPS test locations, all in the vicinity of the traffic island near the former collapsed sanitary sewer line (SCAPS-16, SCAPS-26, SCAPS-27, SCAPS-28, SCAPS-51, and SCAPS-52). The responses were predominantly PCE with lesser amounts of TCE and DCE.

DNAPL

The potential presence of DNAPL at the Traffic Island Area has been tested for and evaluated during previous investigations and the recent SI. No positive indications of DNAPL were identified during previous investigations, but positive indications of DNAPL were identified during the recent SI. DNAPL was positively identified in the bottom portion of the lower A-Aquifer zone between 63 and 67 feet bgs at the intersection of Cummins Avenue with Wescoat Road, approximately 20 feet west of the former collapsed sanitary sewer line (near wells 28SI-06 and 28SI-13). The discovery of residual DNAPL substantiates that non-aqueous phase PCE was released from the southern end of the former collapsed sanitary sewer line along Cummins Avenue at the intersection with Wescoat Road, which is corroborated by the vertical distribution

of CEs in the subsurface as delineated by the MIP/DSITMS data (CB&I, 2014). The potential presence of DNAPL in the B2-Aquifer zone at the Traffic Island Area was tested for and evaluated during the SI, but no positive indications of DNAPL were identified

PCE

Concentrations of PCE in soil greater than 500 micrograms per kilogram (µg/kg) (the negotiated cleanup level for PCE in unsaturated zone soil (PRC Environmental Management, Inc., 1995) have been detected in both the upper and lower portions of the A-Aquifer zone at depths ranging from 6.5 to 67 feet bgs along the former collapsed sanitary sewer alignment, and approximately 180 feet further downstream (north-northwest) at CPT-88-19. The highest concentration of PCE in soil (27,000,000 µg/kg; well boring 28SI-06) was detected in a sample from 63 feet bgs at the intersection of Cummins Avenue with Wescoat Road, approximately 20 feet west of the former collapsed sanitary sewer line, where DNAPL was positively identified. PCE in soil greater than 500 µg/kg was also detected in the upper portion of the A-Aquifer zone between 5 and 13 feet bgs on the northeast side of Building 126 (well boring 28SI-08). In the B2-Aquifer zone, PCE in soil greater than 500 µg/kg was detected in three samples collected at depths ranging from 80 to 109 feet bgs. The samples were collected from well borings 28SI-06 and 28SI-07 located near the former collapsed sanitary sewer line at the southern end of the traffic island.

Within 200 feet up-gradient of the Traffic Island Area, PCE was not detected above the maximum contaminant level (5 µg/L) in any of the A-Aquifer zone well samples collected during the 2013 annual groundwater monitoring event (SES-TECH, 2014). Concentrations of PCE in groundwater greater than 1,000 µg/L were detected along the former collapsed sanitary sewer alignment at depths ranging from 14.5 to 68 feet bgs and beneath the southwest corner of Hangar 1 (grab groundwater sample location PS3-5) at a depth of 40 feet bgs. The highest concentration (28,000 µg/L [December 2013]) was detected between 63 and 68 feet bgs in a sample from well 28SI-13, located at the intersection of Cummins Avenue with Wescoat Road where residual DNAPL was identified. However, as of 2012, groundwater concentrations of PCE in the EVO pilot test treatment area (southern end of the traffic island) were less than the MCL (5 µg/L) in the upper portion of the A-Aquifer zone (wells 28OW-05 and 28OW-06) and were less than 20 µg/L in the lower portion of the A-Aquifer zone (wells 28OW-07, 28OW-08, and 28OW-12).

Concentrations of PCE in B2-Aquifer zone groundwater greater than 1,000 µg/L were detected in samples collected from the two wells along the sanitary sewer alignment at the southern end of the traffic island (28SI-06 and 28SI-07) where elevated MIP/DSITMS responses and soil concentrations were detected. Well 28SI-06 is screened from 90 to 100 feet bgs and well 28SI-07 is screened from 105 to 115 feet bgs. The maximum concentration of PCE (10,000 µg/L) was detected in a sample from well 28SI-06. The maximum concentration of PCE detected in a sample from the deepest B2-Aquifer zone well, 28SI-07, was 9,500 µg/L. Lower concentrations

of PCE, less than 20 µg/L, were detected in samples from the other two B2-Aquifer zone wells, 28SI-09 and 28SI-10, screened from 90 to 100 feet bgs.

TCE

Concentrations of TCE in soil greater than 500 µg/kg (the cleanup standard for TCE in unsaturated zone soil [EPA, 1989 and 1990]) have been detected in both the upper and lower portions of the A-Aquifer zone at depths ranging from 12 to 63 feet bgs at the intersection of Cummins Avenue with Wescoat Road (well boring 28SI-06). TCE in soil greater than 500 µg/kg was also detected adjacent to the former collapsed sanitary sewer line beneath the traffic island at 8 to 9 feet bgs (soil boring CPT-88-13) and adjacent to the northeast side of Building 126 at 13 feet bgs (well boring 28SI-08). The highest concentration of TCE in soil (110,000 µg/kg; well boring 28SI-06) was detected in a sample from 63 feet bgs at the intersection of Cummins Avenue with Wescoat Road, approximately 20 feet west of the former collapsed sanitary sewer line, where DNAPL was positively identified.

Within 200 feet up-gradient of the Traffic Island Area, TCE has been detected in groundwater in the upper portion of the A-Aquifer zone at concentrations ranging from 4.6 µg/L (well 28OW-09 [June 2011]) to 900 µg/L (grab groundwater location CPT-88-16 [April 2005]). Concentrations of TCE greater than the highest up-gradient concentration (900 µg/L) were only detected between 14 and 19 feet bgs beneath the traffic island adjacent to the former collapsed sanitary sewer line (grab groundwater location CPT-88-13). However, as of 2012, groundwater concentrations of TCE in the EVO pilot test treatment area (which encompasses CPT-88-13) were less than the ROD (EPA, 1989) cleanup standard (5 µg/L) in the upper portion of the A-Aquifer zone (wells 28OW-05 and 28OW-06).

Within 200 feet up-gradient of the Traffic Island Area, TCE has been detected in groundwater in the lower portion of the A-Aquifer zone at concentrations ranging from 6.9 µg/L (CPT-88-17 [April 2005]) to 620 µg/L (CPT-88-16 [April 2005]). Concentrations of TCE greater than the highest up-gradient concentration (620 µg/L) have been detected beneath, approximately 140 feet to the west-southwest (CPT-88-20 and CPT-88-21), and approximately 240 feet to the north-northwest (CPT-88-19) of the traffic island at depths ranging from 39 to 65 feet bgs. The highest recent concentration (11,000 µg/L [October 2012]) was detected in a sample from well 28OW-04 (screened 55 to 65 feet bgs), located immediately downgradient of the EVO pilot test area adjacent to the collapsed sanitary sewer line. However, as of 2012, groundwater concentrations of TCE in the EVO pilot test treatment area were less than 40 µg/L in the lower portion of the A-Aquifer zone (28OW-07, 28OW-08, and 28OW-12).

Concentrations of TCE in B2-Aquifer zone groundwater greater than 1,000 µg/L were detected in samples collected from the two wells along the sanitary sewer alignment at the southern end of the traffic island (wells 28SI-06 and 28SI-07) where elevated MIP/DSITMS responses and soil

concentrations were detected. Well 28SI-06 is screened from 90 to 100 feet bgs and well 28SI-07 is screened from 105 to 115 feet bgs. The maximum concentrations of TCE (10,000 µg/L) was detected in samples from well 28SI-06. Lower concentrations of TCE, less than 20 µg/L, were detected in samples from the other two wells, 28SI-09 and 28SI-10, screened from 90 to 100 feet bgs.

cis-1,2-DCE

Concentrations of cis-1,2-DCE in soil greater than 500 µg/kg have been detected in both the upper and lower portions of the A-Aquifer zone at depths ranging from 12 to 63 feet bgs at the intersection of Cummins Avenue with Wescoat Road (well boring 28SI-06). Cis-1,2-DCE in soil greater than 500 µg/kg was also detected at depths ranging from 8 to 19 feet bgs adjacent to the former collapsed sanitary sewer line (soil boring CPT-88-13), approximately 50 feet downgradient of the traffic island (soil boring CPT-88-23), and adjacent to the northeast side of Building 126 (well boring 28SI-08). The highest concentration of cis-1,2-DCE in soil (74,000 µg/kg; well boring 28SI-06) was detected in a sample from 63 feet bgs at the intersection of Cummins Avenue with Wescoat Road, approximately 20 feet west of the former collapsed sanitary sewer line, where DNAPL was positively identified. DCE was not detected in any of the six soil samples collected from the B2-Aquifer zone.

Within 200 feet up-gradient of the Traffic Island Area, cis-1,2-DCE was most recently detected in groundwater in the upper portion of the A-Aquifer zone at concentrations ranging from 150 µg/L (28OW-10 [June 2011]) to 1,500 µg/L (WNX-2 [October 2013]). Concentrations of cis-1,2-DCE greater than the highest up-gradient concentration (1,500 µg/L) were only detected between 12 and 17 feet bgs beneath the traffic island adjacent to the former collapsed sanitary sewer line (CPT-88-13 and 28OW-05). However, as of 2012, groundwater concentrations of cis-1,2-DCE in the EVO pilot test treatment area (which encompasses CPT-88-13 and 28OW-05) were less than the MCL (5 µg/L) at this depth interval.

Within 200 feet up-gradient of the Traffic Island Area, cis-1,2-DCE has been detected in groundwater in the lower portion of the A-Aquifer zone at concentrations ranging from 1.8 µg/L (CPT-88-17 [April 2005]) to an estimated value of 120 µg/L (CPT-88-16 [April 2005]). Concentrations of cis-1,2 DCE greater than the highest up-gradient concentration (120 µg/L) were detected beneath, approximately 140 feet to the west-southwest (CPT-88-20 and CPT-88-21), and approximately 200 feet north-northwest (W9-21) of the traffic island at depths ranging from 35 to 68 feet bgs. The highest concentration (84,000 µg/L [December 2013]) was detected between 63 and 68 feet bgs in a sample from well 28SI-13, located at the intersection of Cummins Avenue with Wescoat Road where residual DNAPL was identified.

Cis-1,2-DCE concentrations in B2-Aquifer zone groundwater ranged from an estimated value of 0.4 to 3,800 µg/L. Concentrations of cis-1,2-DCE in groundwater greater than 1,000 µg/L was

only detected in a sample collected from well 28SI-06 located immediately southwest of the traffic island where the highest MIP/DSITMS responses and soil concentrations were detected. Concentrations below 1,000 µg/L were detected in the samples from deeper well 28SI-07 and even lower concentrations, below 26 µg/L, were detected in the other two wells, 28SI-09 and 28SI-10.

VC

VC has been detected in only five soil samples, at concentrations ranging from 2 to 70 µg/kg. The samples were collected from locations up-gradient of the traffic island (CPT-88-16), along the collapsed sanitary sewer alignment (CPT-88-13, 28SI-10, and 28SI-11), and approximately 60 feet east of the traffic island (28SI-09) at depths ranging from 8 to 54 feet bgs. VC was not detected in any of the six soil samples collected from the B2-Aquifer zone.

Within 200 feet up-gradient of the Traffic Island Area, VC was most recently detected in groundwater in the upper portion of the A-Aquifer zone at concentrations ranging from an estimated value of 0.55 µg/L (28OW-10 [June 2011]) to 130 µg/L (WNX-2 [October 2013]). Concentrations of VC greater than 130 µg/L (the highest up-gradient concentration) were detected beneath the traffic island (28OW-02, 28OW-06, W9-29) at depths ranging from 7 to 29 feet bgs. The highest concentration (160 µg/L [September 2012]) was detected in samples from wells 28OW-02 and W9-29, located within the traffic island immediately downgradient and cross-gradient of the EVO pilot test area.

Within 200 feet up-gradient of the Traffic Island Area, VC has been detected in groundwater in the lower portion of the A-Aquifer zone only at well 28OW-11 (40 to 50 feet bgs). The VC concentration in groundwater at this well as of June 2011 was 0.71 µg/L. Concentrations of VC greater than the up-gradient concentration (0.71 µg/L), have been detected throughout the Traffic Island Area. Elevated concentrations of VC (1,000 to 12,000 µg/L) have been detected beneath the traffic island due to ongoing reductive dechlorination from the EVO pilot test at depths ranging from 40 to 82 feet bgs. The highest concentration of VC (12,000 µg/L [December 2013]) was detected between 63 and 68 feet bgs in a sample from well 28SI-13, located at the intersection of Cummins Avenue with Wescoat Road where residual DNAPL was identified; up-gradient of the EVO pilot test area. Within 50 feet to the north and northwest of the traffic island, VC concentrations drop below 10 µg/L (28SI-11, 28SI-15, PS3-5, and PS3-6). However, approximately 200 feet north-northwest of the traffic island, VC has been detected at well W9-21 at concentrations greater than 10 µg/L (190 µg/L [October 2013]). VC has not been detected in any of the groundwater samples collected from the B2-Aquifer zone wells at the Traffic Island Area during the SI.

SAP Worksheet #11: Project Quality Objectives/Systematic Planning Process Statements

Step	Project Quality Objectives
1	Define the problem that necessitates the study

The A-Aquifer at IR Site 28 is impacted by VOCs, primarily CEs, which resulted from on-site Navy sources and on-flow of contamination from up-gradient VOC sources at the MEW Superfund Site. Sampling conducted in the Traffic Island Area of IR Site 28 since 2005 has suggested that the B2-Aquifer, which underlies the A-Aquifer, is also impacted with CEs (TtECI, 2008). The SI completed in 2013 confirmed concentrations of CE greater than 1,000 µg/L in the B2-Aquifer in the area of the Traffic Island. Additionally, the SI identified an isolated location where field tests (Sudan Dye test) had positive results for DNAPL in material collected from a depth of approximately 65 feet bgs. Previous investigations at Moffett Field between 2005 and 2013 determined that historical dry cleaning activities conducted at former Building 88 along with the associated sanitary sewer line that reportedly collapsed in the Traffic Island Area were the sources of PCE in this area of IR Site 28.

For this project, the Navy has contracted CB&I to conduct a TS for focused treatment of the highest concentration intervals in the lower A-Aquifer and B2-Aquifer zones at the Traffic Island Area by using a combined in situ biotic/abiotic treatment approach of EAB and ISCR. Collection of groundwater samples from the study area, throughout the TS, are necessary for evaluating the effectiveness of the combined EAB/ISCR treatment approach.

2	Identifying the goal of the study

The goal of the study is to generate site-specific data to evaluate the effectiveness of combined EAB/ISCR treatment through direct reagent application for reducing the highest CE concentrations in the lower A-Aquifer and B2-Aquifer zones at the Traffic Island Area, identified during the 2013 SI.

The goals of the sampling activities are:

- Establish baseline concentrations of VOCs in groundwater within the treatment area
- Determine the effectiveness of the treatment approach to reduce the high CE concentrations in groundwater.
- Identify changes in groundwater chemistry resulting from the injection of the substrates.

The following study questions are:

- After injection of treatment reagents, to what extent have the CE concentrations in groundwater at the study area decreased?
- Are reducing conditions sufficient for complete anaerobic biotic and abiotic degradation of the target CEs based on the detection of select metals (arsenic, iron, and manganese), anions (nitrate and sulfate), dissolved gases (oxygen, ethane, ethane, methane, and acetylene), and VOCs in the treatment area?
- Does the application of the selected reagent mixture maintain strongly reducing conditions in the study area throughout the period of performance to achieve degradation of the CEs?

SAP Worksheet #11: Project Quality Objectives/Systematic Planning Process Statements (continued)

Step	Project Quality Objectives
3	Identifying information inputs

Groundwater samples will be collected from up to 14 monitoring wells over multiple sampling events during the TS. The samples will be analyzed for the COCs and a variety of parameters used to evaluate chemical processes and conditions associated with the combined biotic/abiotic treatment. The sampling frequency and analyses for each well is presented in WS#18.

The analyses for groundwater include:

- VOCs—EPA Method 8260
- Total organic carbon (TOC)—SM5310
- Anions (sulfate, nitrate)—EPA Method 300.0
- Alkalinity—SM2320
- Dissolved metals (arsenic, iron, manganese)—EPA Method 6010B/6020
- Dissolved gases (ethene, ethane, methane, acetylene)—Pace Method AM20GAX
- Dehalococcoides (DHC) deoxyribonucleic acid (DNA)—quantitative polymerized chain reaction (qPCR)

Dissolved metals are analyzed to assess only the soluble metals in the groundwater with no bias from sediment or soil suspended in the groundwater.

Groundwater will also be analyzed using field instruments during sampling collection for the following parameters:

- Ferrous iron by Hach Method 8146
- Dissolved oxygen
- pH
- Oxidation-reduction potential
- Specific conductance
- Temperature

4	Define the boundaries of the study

IR Site 28 encompasses approximately 63 acres, and the area targeted for the TS encompasses approximately 12,000 square feet. Figures 6b and 6c in the parent Work Plan show the proposed treatment area. The period of performance for this TS extends to August 2017. The field portion of the study will be performed within a two year period.

Depth to groundwater is approximately 7 to 8 feet below ground surface. The depth of reagent injection is expected to range from approximately 30 to 120 feet below ground surface targeting the highest concentrations of CEs at the south end of the traffic island as identified during the SI (CB&I, 2014).

SAP Worksheet #11: Project Quality Objectives/Systematic Planning Process Statements (continued)

Step	Project Quality Objectives
5	Develop the analytic approach

The treatment will be considered an effective remedial technology for treatment of high concentration CEs at IR Site 28 if the total concentration of dissolved CEs in the treatment area is reduced by 90 percent. If this criterion is not achieved by the end of the period of performance the potential cause(s) for the nonattainment of this goal will be evaluated by the decision process described below.

The following decisions will be made based on the data collected after the end of the test period:

- 1a. If the combined concentration of CEs in groundwater at the test area is reduced by 90 percent, then the applicability of EAB/ISCR treatment will be considered for hot spots or other areas of IR Site 28.
- 1b. If the concentrations of CEs in groundwater at the test area are not reduced by 90 percent, then evaluation of geochemical indicators (e.g., pH, dissolved oxygen [DO], oxidation-reduction potential [ORP], nitrate, manganese, arsenic, ferrous iron, sulfate, and methane) will be conducted to determine the reason for the lack of degradation and further evaluation of applying this technology should be performed before its additional use.
- 2a. If the concentration of oxygen in groundwater decreases relative to baseline concentrations, then oxygen reducing and anaerobic conditions (DO less than 0.5 milligram per liter [mg/L]) will be considered to have been established in the treatment area.
- 2b. If oxygen concentrations in groundwater in the treatment area do not decrease below baseline concentrations, then oxygen reducing and anaerobic (DO less than 0.5 mg/L) conditions will not be considered to have been established in the treatment area.
- 2c. If the concentrations of nitrate in groundwater decrease below the baseline concentrations, then nitrate reducing conditions will be considered to have been established.
- 2d. If the concentrations of nitrate in groundwater do not decrease below the baseline concentrations, then nitrate reducing conditions will not be considered to have been established, in which case other potential causes for the persistence of the nitrate will be evaluated.
- 2e. If the concentrations of arsenic, manganese, and iron in groundwater increase over the baseline concentrations, then moderately reducing conditions will be considered to have been established and the acceptability of selected substrate application at IR Site 28 may be further evaluated through additional monitoring of the persistence of these metals in the aquifer (depending on the results of item 1a and 1b, above).
- 2f. If the concentrations of arsenic, manganese, and iron in groundwater do not increase over the baseline concentrations, then moderately reducing conditions will not be considered to have been established.
- 2g. If the concentrations of sulfate in groundwater decrease below the baseline concentrations then sulfate reducing conditions will be considered to have been established.
- 2h. If the concentrations of sulfate in groundwater do not decrease below the baseline concentrations, then sulfate reducing conditions will not be considered to have been established, in which case other potential causes for the persistence of the sulfate will be evaluated.
- 2i. If the concentrations of ethene, ethane, methane, and/or acetylene in groundwater increase over the baseline concentrations, then reducing conditions for complete degradation of the VOCs will be considered to have been established.
- 2j. If the concentrations of ethene, ethane, methane, and acetylene in groundwater do not increase over the baseline concentrations, then reducing conditions for complete degradation of the VOCs may not be considered to have been established, in which case other potential causes for the lack of these dissolved gases will be evaluated.

SAP Worksheet #11: Project Quality Objectives/Systematic Planning Process Statements (continued)

Step	Project Quality Objectives
5 (cont.)	Develop the analytic approach

- 2k. If the concentrations of the target CEs in groundwater decrease below the baseline concentrations, then reducing conditions to degrade each target CE will be considered to have been established.
- 2l. If the concentrations of the target CEs in groundwater do not decrease below the baseline concentrations, then reducing conditions to degrade each target CE may not have been established, in which case other potential causes for the persistence of the target CEs will be evaluated.
- 3a. If dissolved methane is detected above method reporting limits (RLs) (WS #15) in groundwater at the test area at the end of the performance period, then reducing conditions for complete conversion of VC to ethene by reductive processes will be considered established.
- 3b. If dissolved methane is not detected above method RLs (WS #15) in groundwater at the test area prior to the end of the performance period, then reducing conditions for complete degradation of CEs by reductive processes may not be considered established and an evaluation of other geochemical parameters (i.e., ORP, electron acceptors) will be completed to determine if reducing conditions have been attained.
- 3c. If the ORP of the groundwater at the test area is lower than -100 millivolts by the end of the period of performance, then the application of substrate has maintained strongly reducing conditions throughout the period of performance.
- 3d. If the ORP of the groundwater at the test area is higher than -100 millivolts by the end of the period of performance, then the application of substrate may not have maintained strongly reducing conditions throughout the period of performance and the level of reducing conditions will be evaluated relative to other geochemical parameters (i.e. electron acceptor data), VOCs, and dissolved gases.

6	Specifying performance or acceptance criteria

To limit uncertainty in the obtained environmental data, criteria for the precision, accuracy, representativeness, completeness, and comparability parameters and limit of detection (LOD) for the COC have been developed. Measurement errors will be controlled by using appropriate sampling and analytical methods. Laboratory errors will controlled by adhering to the DoD QSM (2013), following established SOPs, and having the CB&I chemist review, as well as third party data validation, to verify laboratory processes. The field crews will review the SAP before sample collection to apply consistent sampling methods and limit sample collection errors. The subcontract analytical laboratory will have a copy of the SAP and will adhere to DoD QSM guidance to limit measurement errors.

7	Plan the design for obtaining data

Groundwater samples will be collected from up to 14 monitoring wells located within, downgradient, and up-gradient of the TS area. Groundwater samples will be collected six times during the period of performance to monitor the remediation process: prior to substrate injection (baseline), immediately following injection, and quarterly thereafter for one year. The samples will be analyzed for the various parameters listed in Step 3 and WS #18.

The sampling design is described in WS #17.

SAP Worksheet #12: Measurement Performance Criteria Table—Field Quality Control Samples (Water)

QC Sample	Analytical Group	Frequency	Data Quality Indicator (DQI)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Field Duplicates	VOCs	One per 20 field samples collected (5 percent [%])	Precision	30% Relative percent difference (RPD)	S&A
Rinse Blanks	VOCs	None—if dedicated sampling equipment is used, one per day if using non-dedicated sampling equipment (dedicated sampling pumps will be used for sampling purposes, therefore rinse blanks are not anticipated)	Representativeness Bias Contamination	Analytes not detected above limit of quantitation (LOQ)	S
Matrix spikes (MSs) and Matrix spike duplicates (MSDs)	VOCs	5% One per 20 field samples collected	Precision and Accuracy	DoD QSM (2013) control limits	A
Trip Blanks	VOCs	One per each day of sampling per cooler shipped with VOC samples	Representativeness Bias Contamination	Analytes not detected above LOQs	S
Temperature Blanks	VOCs Sulfate Nitrate Alkalinity TOC Dissolved gases	Every cooler shipped to the laboratory	Representativeness	0–6 degrees Celsius (°C)	S

SAP Worksheet #13: Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation/collection dates)	How Data Will Be Used	Limitations on Data Use
Soil and groundwater data	*Final Technical Memorandum Supplemental Investigation, Former Building 88 and Traffic Island Areas, Installation Restoration Site 28, Former Naval Air Station Moffett Field, Moffett Field, California* December 2014	CB&I, 2014	Identification of current concentrations of COCs in the planned TS area.	None

SAP Worksheet #14: Summary of Project Tasks

14.1 SCOPE OF WORK

The scope of work for this project includes:

- Utility clearance (see Work Plan Section 4.3)
- Installation of new groundwater monitoring wells (see Work Plan Section 5.0; Figure A-2)
- Conduct in situ fracturing and high pressure injection of organic substrates, microscale zero-valent iron (ZVI), and dechlorination microbes to apply combined biological and abiotic processes to treat CEs in the saturated zone (see Work Plan Section 6.0)
- Collect and analyze groundwater samples from wells up-gradient, within, and downgradient of the treatment area to determine biogeochemical processes and monitor contaminant degradation in the saturated zone (SAP WSs #14, #17, and #18)
- Analytical requirements
- QC samples
- Waste characterization
- Data review, validation, and reporting

14.2 SAMPLE COLLECTION METHODS AND PROCEDURES

The following sections describe the sampling methods and procedures that will be used to collect samples for this project.

14.2.1 Groundwater Sampling

Groundwater monitoring wells will be sampled in accordance with the procedures described in this section. The wells will be purged and sampled, by a low flow purging technique, using dedicated bladder pumps (or equivalent) for each well. Portable bladder pumps may be used as backup sampling systems, if necessary.

The following standard procedures will be followed when sampling a monitoring well:

1. Don appropriate personal protective equipment.
2. Confirm the well identification at each monitoring/observation well.
3. Calibrate field instruments in accordance with the manufacturer’s directions. Record all calibration documentation in the field logbook.

4. Measure the depth to water at each well using an electronic water level indicator probe. Record the water level measurement to the nearest 0.01 of a foot in the field logbook. Decontaminate the water level indicator before each measurement.

5. Each well will have dedicated bladder pumps and tubing for sampling. The intake to the pump at the middle of the screen interval. The initial pump speed will be set at approximately 100 milliliters (mL) per minute until the well recovery rate can be established so that the water column in the well does not drop more than 0.3 foot below the initial water level reading. Using a low flow purge technique, the flow rates should range between 100 and 500 mL per minute. Slower purge rates may be necessary to maintain drawdown requirements. Some low producing wells may exceed the 0.3 foot drawdown requirement. If this occurs, the pump speed will be lowered until the water level reading is stabilized and is no longer continually dropping during purging. If the 0.3 foot drawdown requirement cannot be maintained even at a low purge rate, then the well will be sampled using conventional purging techniques described in Section 14.2.2.

6. Monitor water quality parameters (e.g., DO, conductivity, pH, ORP, and temperature) every three to five minutes during purging. Use in-line monitoring equipment to increase the reading stability. Record the water quality parameters on the groundwater sampling log form (Attachment 2). If the water quality parameters are stable for three consecutive readings, collect samples for chemical analysis. Stabilization is achieved if successive readings are within plus or minus (±) 0.1 pH units, ±1°C for temperature, 3 percent conductivity, ±10 millivolt ORP, and 10 percent DO readings. If DO readings are less than 3 mg/L, then stability criteria will be ±0.3 mg/L. Turbidity readings will be collected but will not be used as a stabilization parameter. If the water quality parameters have not stabilized, continue purging until stabilization occurs or three calculated well volumes have been purged.

7. Do not stop the pump after stabilization and prior to sample collection.

8. Collect samples from the discharge of the pump; fill the appropriate sample containers, shown in WS #19. Collect field QC samples (e.g., field duplicates) as required. Dissolved metals samples will be collected by field filtering groundwater using an in-line disposable 0.45 micrometer filter.

9. Label, package, and prepare the samples for shipment to the laboratory. Transfer the samples to cold storage after collection.

14.2.2 Groundwater Sampling Conventional Purging

Groundwater monitoring wells with low water production rates and cannot be purged using the low-flow sampling technique described above will be purged with the procedures described in this section. The wells will be purged and sampled using portable or dedicated submersible pumps (bladder, peristaltic or equivalent). The following standard procedures will be followed when sampling a monitoring well:

1. Don appropriate personal protective equipment.

2. Confirm the well identification at each monitoring/observation well.

3. Calibrate field instruments in accordance with the manufacturer's directions. Record all calibration documentation in the field logbook.

4. Measure the depth to water at each well using an electronic water level indicator probe. Record the water level measurement to the nearest 0.01 of a foot in the field logbook. Decontaminate the water level indicator before each measurement.

5. Calculate well casing volume. Set the intake to the pump near the bottom of the screen interval. Purge the well of three casing volumes monitor water quality parameters (i.e., conductivity, pH, ORP, turbidity and temperature) after every volume. Record the water quality parameters on the groundwater sampling log form (Attachment 2). If the well fully dewaters, allow the water level to recover to 85 percent of initial reading and then collect samples for chemical analysis.

6. Collect samples from the discharge of the pump set at 100 mL per minute or less; fill the appropriate sample containers, as listed in WS #19. Collect field QC samples (e.g., field duplicates) as required. VOA vials for VOC analysis will be filled leaving no headspace (bubbles) in the vial. Dissolved metals samples will be collected by field filtering groundwater using an in-line disposable 0.45 micrometer filter.

7. Label, package, and prepare the samples for shipment to the laboratory. Transfer the samples to cold storage after collection

14.2.3 Groundwater Sampling Procedures Using Passive Diffusion Bags

Groundwater monitoring wells to be sampled for VOCs only will be sampled using passive diffusion bags (PDBs) in accordance with the procedures described in this section.

1. Don appropriate personal protective equipment.

2. Confirm the well identification at each monitoring/observation well.

3. Obtain sealed PDB and hardware kit. Measure the depth to water in the well using an electronic water level indicator probe and record the water level measurement to the nearest 0.01 of a foot in the field logbook. Decontaminate the water level indicator before each measurement.

4. Determine desired depth of sample collection. The center of the bag should be positioned at the desired depth interval.

5. Attach the end of the hardware line to the well head hanging device.

6. Attach a stainless steel weight to the end of the line. Sufficient weight should be added to counterbalance the buoyancy of the PDB samplers. The weight should rest on the bottom of the well, with the line taut above the weight. Calculate the distance from the bottom of the well, or top of the sediment in the well, up to the point where the PDB sampler is to be placed.

7. Once the necessary PDB samplers have been installed, carefully lower the hardware kit until the stainless steel weight touches the well bottom.
8. Record date, time and bag position in the well.
9. QC bags (duplicate samples) should be paired with field sample bags (share loops).
10. Leave PDB in the well for a minimum of two weeks allowing time for VOC equilibrium between the bag water and the groundwater. Bag may be left longer than two weeks for equilibration.
11. After equilibration period, retrieve the bag from the well, cut open and the transfer the water into volatile organic acid vials (WS #19). Volatile organic acid vials for VOC analysis will be filled leaving no headspace (bubbles) in the vial.
12. Label, package, and prepare the samples for shipment to the laboratory. Transfer the samples to cold storage after collection.

14.2.4 Investigation-Derived Waste Disposal

All waste generated will be characterized for proper disposal. CB&I will coordinate with the Navy on the management of all nonhazardous, California Hazardous, and hazardous waste to ensure that the waste soil and wastewater from this project are disposed of in accordance with all federal and state regulations, and Navy policies.

14.2.4.1 Soil Waste Sampling Procedures

Waste soil stored in 55-gallon drums or roll-off bins, will be sampled following the general steps described as follows:

1. Put on new, clean, chemical-resistant gloves.
2. For semivolatile organic compound (SVOC) and metals analyses, prepare a composite from four locations within the soil pile. Fill a pre-cleaned, eight-ounce, wide-mouth jar with soil using a disposable scoop.
3. For VOC analysis, collect samples using En Core® device (or equivalent) as described in Section 14.2.3.3.
4. Label, package, and prepare the samples for shipment to the laboratory. Transfer the samples to cold storage after collection.

14.2.4.2 Wastewater Sampling Procedures

If wastewater stored in 55-gallon drums needs to be sampled, the following steps will be conducted:

1. Put on new, clean, chemical-resistant gloves.
2. Obtain an unused disposable bailer for each sampling event.

3. Tie the bailer to a nylon cord.
4. Lower the bailer into the containment area. Allow sufficient time for the bailer to fill with water.
5. Retrieve the bailer and fill appropriate bottles for the analyses being requested.
6. Cap the bottles and wipe any moisture from the outside of the bottles.
7. Label, package, and prepare the samples for shipment to the laboratory. Transfer the samples to cold storage after collection.

14.2.4.3 En Core® Soil Sampling for VOCs

VOCs in soil will be collected for waste soil samples only.

1. Obtain En Core® device and T-Handle (or equivalent).
2. Put on a new, clean, and chemical-resistant pair of disposable gloves prior to taking the sample. The Sample Technician will test the plunger free movement by pushing the plunger rod down until it rests against the tabs.
3. The locking lever on the En Core® T-Handle must be depressed as the cartridge is inserted. Line up the slots on the cartridge with the locking pins in the T-Handle. Plunger end first, insert cartridge into T-Handle with locking tabs aligned and twist cartridge clockwise locking the cartridge in place.
4. Apply En Core® to freshly exposed surface soil or from one end of a sleeve core as soon as it is brought to the surface. Holding the device with the T-Handle up and the cartridge down, insert the sampling device into the soil. The coring body must be full; check to make sure the plunger end is seen in the viewing hole. Withdraw sampling device from soil and wipe of excess dirt from cartridge body.
5. The cartridge core is capped while it is still on the T-Handle. Push or twist cap on until the grooves are seated over the ridge of the coring body.
6. Remove the capped sampler by pushing down locking lever on T-Handle and twisting and pulling sampler from T-Handle. The plunger is locked by rotating plunger rod until the wings rest against the tabs. Attach the label and seal the cartridge in the En Core® sampler bag.
7. The En Core® sampler holding time is 48 hours. Soil samples are shipped to the laboratory for preservation or freezing within the 48 hour holding time. After preservation, the soil sample can be held up to 14 days for analysis.
8. Store the En Core® sampler bag in a cooler with ice until it can be delivered to the laboratory.

14.2.5 Photoionization Detector Operation

A portable photoionization detector (PID) will be used to monitor breathing zone during well installation for VOCs in air. The PID measures the presence of total volatile ionizable contaminants in vapor. The PID will be operated and calibrated daily according to the manufacturer's directions. The procedure for PID operation is summarized as follows:

1. Turn on instrument according to the manufacturer's directions and allow the lamp to stabilize.
2. Establish "zero" for the PID calibration using atmospheric air.
3. Verify the instrument is in calibration by reading a known concentration, usually 50 to 100 parts per million by volume of iso-butylene in air. If the instrument reading is more than 20 percent off from the true value, recalibrate the PID following manufacturer's directions.
4. Attach inlet of the meter to the location requiring monitoring.
5. Collect the reading from the instrument, and record it in the field logbook.

14.2.6 Soil Core Headspace Screening

A PID will be used to screen soil core headspace samples for VOCs. The PID measures the presence of total volatile ionizable contaminants in vapor. The PID will be operated and calibrated daily according to the manufacturer's directions and operated per Section 14.2.5. The procedure for soil core headspace sampling is summarized as follows:

1. Obtain a soil sample from the soil core immediately after removal from the ground. In order to reduce loss of the volatiles, take care to minimize handling of the sample and exposure to the air during transfer to the baggie.
2. Half-fill a clean zip lock type baggie with the sample to be analyzed and quickly close the zip lock seal. One quart (approximately 950 mL) size freezer type baggies are preferred.
3. Allow sealed baggie to sit for at least 10 minutes. Vigorously shake baggie for 15 seconds at the beginning of the headspace development period.
4. After 10 minutes, carefully insert the PID probe tip through the zip lock seal into the headspace of the baggie (while maintaining a minimal opening as possible). Keep the PID probe tip sufficiently above the soil surface to avoid uptake of soil particulates into the PID probe.
5. Following PID probe insertion into the baggie headspace, the maximum instrument response should occur between two and five seconds. Record the highest meter response as the headspace concentration in the field log book or boring log.

14.3 EQUIPMENT DECONTAMINATION

Dedicated sampling pumps and other equipment will be primarily used for this project, so decontamination of sampling equipment is not anticipated. However if decontamination becomes necessary it will be performed to prevent the introduction of extraneous material into samples, and to prevent cross-contamination between samples. Sampling equipment will be decontaminated by washing with a nonphosphate detergent such as Liquinox™ or equivalent. Decontamination water will be collected in 55-gallon U.S. Department of Transportation-approved drums or a poly-tank.

The following procedures will be used for decontamination of nondisposable sampling equipment:

1. If mud or soil is adhering to the sampling equipment, first rinse with potable water. This step will decrease the gross contamination and reduce the frequency at which the nonphosphate detergent and water solution need to be changed.

2. Wash with the nonphosphate detergent and water solution. This step will remove remaining contamination from the equipment. Dilute the nonphosphate detergent as directed by the manufacturer.

3. Rinse with potable water. Change the water frequently.

4. Rinse with deionized water. This step will rinse any detergent solution and potable water residues. Rinsing will be done by applying the deionized water from a clean squeeze bottle (or equivalent) while holding equipment over a bucket.

5. The decontaminated equipment will be air dried or dried with paper towels prior to re-use.

14.4 ANALYTICAL REQUIREMENTS

Samples from the TS area will be analyzed for the following parameters:

- VOCs by EPA Method 8260
- TOC by EPA Method SM5310
- Anions (sulfate and nitrate) by EPA Method 300.0
- Alkalinity by SM 2320B
- Dissolved metals by EPA Method 6010B/6020

The above analytical methods will be performed according to the applicable EPA and DoD QSM (2013) QC requirements as shown in WS #24 and WS #28.

The following analyses will be performed following manufacturer directions or proprietary laboratory-specific SOPs:

- Ferrous iron by Hach Method 8146
- Dissolved gases by Pace Method AMG20GAX
- DHC DNA by qPCR

14.5 DATA RECORDING AND TRANSFER

This section details the requirements for data reporting and data package formats that will be provided by the laboratory.

14.5.1 Hard Copy Deliverables

All relevant raw data and documentation, including (but not limited to) logbooks, data sheets, electronic files, and final reports, will be maintained by the laboratory for at least 10 years. The laboratory will notify CB&I 30 days before disposal of any relevant laboratory records.

The hard copy data deliverable requirements for this project will be:

- Groundwater samples—90 percent Level III and 10 percent Level IV
- Waste samples—100 percent Level II

14.5.2 Electronic Deliverables

The EDD will be in EnviroData (or equivalent) format. The analytical laboratory will follow the requirements stated in the Laboratory Interface Document for the Analytical Laboratory EDD. After the data validation/data review are complete, CB&I will submit analytical data to the Naval Installation Restoration Information Solutions database in the Naval EDD format. All data collected for this project (except waste data) will be uploaded to Naval Installation Restoration Information Solutions.

The laboratory will certify that the EDD and the hard copy reports are identical. Both the EDD and the hard copy report will present results to two or three significant figures. Field information (e.g., date and time collected, sample identification, etc.) will be entered directly into the main database from the chain-of-custody or uploaded from electronic files generated in the field by the Project Chemist or Database Manager.

14.6 DATA MANAGEMENT

This section describes the data management procedures for data review, verification, reporting, and validation.

14.6.1 Data Reduction, Verification, and Reporting

All analytical data generated by the laboratory projects will be reviewed prior to reporting to assure the validity of reported data. This internal laboratory data review process will consist of data reduction, three levels of documented review, and reporting. Review processes will be documented using appropriate checklist forms, or logbooks, that will be signed and dated by the reviewer.

14.6.2 Data Reduction

Data reduction involves the mathematical or statistical calculations used by the laboratory to convert raw data to the reported data. The laboratory will perform reduction of analytical data as specified in each of the appropriate analytical methods and laboratory SOPs. For each method, all raw data results will be recorded using method-specific forms or a standardized output from each of the various instruments.

All data calculations will be verified and initialed by personnel both generating and approving them. All raw and electronic data, notebook references, supporting documentation, and correspondence will be assembled, packaged, and stored for a minimum of 10 years for future use. All reports will be held client confidential. If the laboratory is unable to store project-related data for 10 years, then it is the responsibility of the laboratory to contact CB&I to make alternative arrangements.

14.6.3 Laboratory Data Verification and Review

The laboratory analyst who generates the analytical data will have the primary responsibility for the correctness and completeness of data. Each step of this verification and review process will involve the evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the review. This application of technical knowledge and experience to the evaluation of data is essential in ensuring that data of known quality are generated consistently. All data generated and reduced will follow well-documented in-house protocols.

Level 1—Technical (Peer) Data Review

Analysts will review the quality of their work based on an established set of guidelines, including the QC criteria established in each method, in this SAP, and as stated within the laboratory QA manual. This review will, at a minimum, ensure that the following conditions have been met:

- Sample preparation information is correct and complete
- Analysis information is correct and complete
- Appropriate SOPs have been followed
- Calculations are verified
- There are no data transposition errors

- Analytical results are correct and complete
- QC samples are within established control limits
- Blanks and laboratory control sample (LCS) are within appropriate QC limits
- Special sample preparation and analytical requirements have been met

Documentation is complete, for example, when all anomalies (e.g. sample preservation, shipping, analytical method QC or holding time violations) have been documented and appropriate forms have been completed.

Level 2—Technical Data Review

A supervisor or data review specialist whose function is to provide an independent review of data packages will perform this review. This review will also be conducted according to an established set of guidelines and will be structured to verify the following finding of Level 1 data review:

- All appropriate laboratory SOPs have been followed
- Calibration data are scientifically sound, appropriate to the method, and completely documented
- QC samples are within established guidelines
- Qualitative identification of contaminants is correct
- Manual integrations are justified and properly documented
- Quantitative results and calculations are correct
- Data are qualified correctly
- Documentation is complete, for example, any anomalies and holding times have been documented and appropriate forms have been completed
- Data are ready for incorporation into the final report
- The data package is complete and complies with contract requirements

The Level 2 review will be structured so that all calibration data and QC sample results are reviewed and all of the analytical results from at least 10 percent of the samples are checked back to the sample preparation and analytical bench sheets. If no problems are found with the data package, the review will be considered complete.

If any problems are found with the data package, an additional 10 percent of the sample results will be checked back to the sample preparatory and analytical bench sheets. This cycle will then

be repeated either until no errors are found in the checked data set or until all data has been checked. All errors and corrections noted will be documented.

Level 3—Administrative Quality Assurance Data Review

The Laboratory QA Manager will review 10 percent of all data packages. This review should be similar to the review as provided in Level II, except that it will provide a total overview of the data package to ensure its consistency and compliance with project requirements. All errors noted will be corrected and documented.

14.7 DATA VALIDATION AND REVIEW

The data collected for VOC analysis (site COCs, definitive data) will be validated by an independent third party data validation company. All other general chemistry results used to monitor the bioremediation process will be reviewed by a CB&I Project Chemist to ensure QC criteria have been met and to establish data usability. The laboratory will provide EPA Level III and Level IV data packages as requested by the CB&I Project Chemist for all samples, with the exception of waste characterization samples, which will be delivered at EPA Level II.

The data validation and review will be in compliance with the method criteria specified in the DoD QSM (2013) and the QC criteria specified in this SAP. If necessary, further validation guidance will be obtained from *National Functional Guidelines for Inorganic Superfund Data Review, EPA-540-R-013-001* (EPA, 2014a) and *National Functional Guidelines for Superfund Organic Methods Data Review, EPA 540-R-014-002* (EPA, 2014b). Data will be flagged with the following data qualifiers:

- ***J qualifier*** denotes the analyte was positively identified, but the associated numerical value is estimated.
- ***R qualifier*** denotes the data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.
- ***U qualifier*** denotes the analyte was analyzed for, but not detected, at or below the LOQ.
- ***UJ qualifier*** denotes the analyte was analyzed for, but not detected. There is uncertainty associated with the LOQ.

14.7.1 Level II and Level III Data Review

Data review and validation requirements will follow the guidelines established in *Environmental Work Instruction 3EN2.1—Chemical Data Validation* (NAVFAC SW, 2001). The following paragraphs briefly describe what is reviewed for each validation level.

For a Level III data validation effort, the data values for routine and QC samples are generally assumed to be correctly reported by the laboratory. Data quality is assessed by comparing the

parameters listed below to the appropriate criteria (or limits) as specified in the project SAP, DoD QSM (2013) or by EPA method-specific requirements. If calculations for quantitation are verified, it is done on a limited basis and may require raw data in addition to the standard data forms normally present in a data package.

Level III data review may include the following QC elements (depending on the analysis being reviewed):

- Sample receipt and preservation
- Sample holding times
- Laboratory method blanks (MBs)
- Surrogate recoveries
- LCS/laboratory control duplicate (LCD) recoveries
- MS/MSD recoveries
- RPD
- Initial calibrations (ICAL)
- Continuing calibration verification (CCV)
- Interference check standards (Metals)
- Serial dilutions and post digestion spikes (Metals)
- Field blanks
- Field duplicate

Level II data review includes the following QC elements:

- Sample receipt and preservation
- Sample holding times
- Laboratory MBs
- Surrogate recoveries
- LCS/LCD
- MS/MSD
- RPD

SAP Worksheet #15.1: Reference Limits and Evaluation Table—Volatile Organic Compounds (Water Matrix)

Analyte	CAS Number	Project Action Limit (µg/L)[1]	Project Action Limit Reference	Project Quantitation Limit Goal (µg/L)	Laboratory-Specific (µg/L)	
					LOQ	LOD
Site-Specific VOCs						
Tetrachloroethene	127-18-4	5	MCL	1	1.0	0.2
Trichloroethene	79-01-6	5	ROD and Explanation of Significant Differences (ESD) cleanup standard (EPA 1989 and 1990)	1	1.0	0.2
1,1-Dichloroethene	75-35-4	6	MCL	1	1.0	0.2
cis-1,2-Dichloroethene	156-59-2	6	MCL	1	1.0	0.2
trans-1,2-Dichloroethene	156-60-5	6	MCL	1	1.0	0.2
VC	75-01-4	0.5	MCL	0.5	1.0	0.2
1,1-Dichloroethane	75-34-3	5	MCL	1	1.0	0.2
Other VOCs						
Acetone	67-64-1	None	Not applicable	10	10	5
Benzene	74-43-2	None	Not applicable	1	1.0	0.2
Bromodichloromethane	75-27-4	None	Not applicable	1	1.0	0.2
Bromoform	75-25-2	None	Not applicable	1	1.0	0.3
Bromomethane	74-83-9	None	Not applicable	1	1.0	0.3
2-Butanone	78-93-3	None	Not applicable	10	10	4
Carbon Disulfide	75-15-0	None	Not applicable	1	1.0	0.5
Carbon Tetrachloride	56-23-5	None	Not applicable	0.5	1.0	0.2
Chlorobenzene	108-90-7	None	Not applicable	1	1.0	0.2
Dibromochloromethane	124-48-1	None	Not applicable	1	1.0	0.2
Chloroethane	75-00-3	None	Not applicable	1	1.0	0.3

SAP Worksheet #15.1: Reference Limits and Evaluation Table—Volatile Organic Compounds (Water Matrix) (continued)

Analyte	CAS Number	Project Action Limit (µg/L)[1]	Project Action Limit Reference	Project Quantitation Limit Goal (µg/L)	Laboratory-Specific (µg/L)	
					LOQ	LOD
Chloromethane	74-87-3	None	Not applicable	1	1.0	0.2
1,2-Dichloroethane	107-06-2	None	Not applicable	0.5	1.0	0.2
1,2-Dibromoethane (EDB)	106-93-4	None	Not applicable	1	1.0	0.2
1,2-Dichlorobenzene	95-50-1	None	Not applicable	1	1.0	0.2
1,2-Dichloropropane	78-87-5	None	Not applicable	1	1.0	0.2
Ethyl benzene	100-41-4	None	Not applicable	1	1.0	0.2
Methylene Chloride	75-09-2	None	Not applicable	2	2.0	0.5
Methyl isobutyl ketone	108-10-1	None	Not applicable	10	10	4
Methyl tertiary butyl ether	1634-04-4	None	Not applicable	1	1.0	0.2
Styrene	100-42-5	None	Not applicable	1	1.0	0.5
1,1,2,2-Tetrachloroethane	79-34-5	None	Not applicable	1	1.0	0.2
Toluene	108-88-3	None	Not applicable	1	1.0	0.2
2-Hexanone	591-78-6	None	Not applicable	10	10	4
cis-1,3-dichloropropene	10061-01-5	None	Not applicable	1	1.0	0.2
trans-1,3-dichloropropene	10061-02-6	None	Not applicable	1	1.0	0.2
1,1,1-Trichloroethane	71-55-6	None	Not applicable	1	1.0	0.2
1,1,2-Trichloroethane	79-00-5	None	Not applicable	1	1.0	0.2
1,1,2-trichloro-1,2,2-Trifluoroethane	76-13-1	None	Not applicable	1	1.0	0.2
Vinyl Acetate	108-05-4	None	Not applicable	1	1.0	0.2
Xylene (Total)	1330-20-7	None	Not applicable	2	2.0	0.4

[1]The September 1990 ESD to the ROD (EPA, 1989) selected TCE as an indicator chemical for remediation purposes and set the final cleanup standard at 5 µg/L, no other cleanup standards were specified. The ROD also states that the federal and State of California drinking water standards are chemical-specific applicable and relevant and appropriate requirements that are relevant and appropriate at the site (i.e., MCLs) for the other COC.

SAP Worksheet #15.2: Reference Limits and Evaluation Table—Miscellaneous Remediation Parameters (Water)

Analyte	CAS Number	Units	Project Action Limit[1]	Project Action Limit Reference	Project Quantitation Limit Goal	Laboratory-Specific		
						LOQ	LOD	DL
Metals								
Arsenic	7440-38-2	µg/L	None	Not applicable	10	10	5	3
Iron	7439-89-6	µg/L	None	Not applicable	1000	200	40	20
Manganese	7439-96-5	µg/L	None	Not applicable	10	10	3	1.5
Dissolved Gases								
Methane	74-82-8	µg/L	None	Not applicable	0.1	0.1	NA	0.018
Ethane	74-84-0	µg/L	None	Not applicable	0.025	0.025	NA	0.007
Ethene	74-85-1	µg/L	None	Not applicable	0.025	0.025	NA	0.005
Acetylene	74-86-2	µg/L	None	Not applicable	0.50	0.50	NA	0.017
Anions and TOC								
TOC	Not applicable	mg/L	None	Not applicable	1	1	0.5	0.25
Sulfate	14808-79-8	mg/L	None	Not applicable	1	0.5	0.25	0.13
Nitrate	Not applicable	mg/L	None	Not applicable	0.5	0.1	0.05	0.025
Alkalinity	Not applicable	mg/L	None	Not applicable	5	5	5	5
Microbial Deoxyribonucleic Acid								
Dehalococcoides	--	cells/mL	None[2]	Not Applicable	10	10	10	NA

Notes:

[1]The September 1990 ESD to the ROD (EPA, 1989) selected TCE as an indicator chemical for remediation purposes and set the final cleanup standard at 5 µg/L, no other cleanup standards were specified. The ROD also states that the federal and State of California drinking water standards are chemical-specific applicable and relevant and appropriate requirements that are relevant and appropriate at the site (i.e., MCLs) for the other COC.

[2]No action limit for this parameter. Data collected to monitor abiotic/biotic breakdown of chlorinated ethenes.

cells/mL — *cells per milliliter*
DL — *detection limit*
NA — *not applicable*

SAP Worksheet #16: Project Schedule/Timeline Table

Activity	2015								2016												2017							
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Plans																												
Regulatory Review of DRAFT Plans																												
Respond to Comments and Prepare FINAL Plans																												
Field Work																												
Install Monitoring Wells																												
Baseline Groundwater Sampling Event																												
Reagent(s) Injection																												
Post-Injection Groundwater Sampling Event - 1st																												
Post-Injection Groundwater Sampling Event - 2nd																												
Post-Injection Groundwater Sampling Event - 3rd																												
Post-Injection Groundwater Sampling Event - 4th																												
Post-Injection Groundwater Sampling Event - 5th																												
Reporting & Data Submission																												
Prepare DRAFT Technical Memorandum																												
Regulatory Review of DRAFT Tech Memo																												
Respond to Comments and Prepare FINAL Tech Memo																												

SAP Worksheet #17: Sampling Design and Rationale

17.1 Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Test

The requirements for the remediation of impacted groundwater at IR Site 28 are set forth in the ROD for the Fairchild, Intel, and Raytheon National Priorities List sites in the MEW Superfund Site study area (EPA, 1989), which was adopted by the Navy in an amendment to the Federal Facilities Agreement. The selected remedy for groundwater at IR Site 28 is extraction and ex situ treatment to restore groundwater to the cleanup standards specified in the ROD. There have been two ESDs for the ROD (September 1990 and April 1996). The September 1990 ESD (EPA 1990) clarified that the cleanup goals constituted final cleanup standards that the remedial activity must meet. The September 1990 ESD stated that the final cleanup standard for TCE in the upper and lower portions of the A-Aquifer is 5 µg/L. TCE was selected as an indicator chemical because it was assumed that by remediating TCE, the other COCs would be remediated simultaneously. The April 1996 ESD (EPA, 1996) clarified that the groundwater remedy includes the use of liquid-phase granular activated carbon as a treatment option for extracted groundwater.

Reductive dechlorination for the treatment of CEs in groundwater and soil has been implemented on a field scale at numerous sites, including Site 28, and has involved both abiotic and biotic agents and processes. The former typically involves the introduction of a reducing agent (reagent) into the subsurface, such as ZVI, and does not involve microorganisms (abiotic), whereas the latter process is biotic and uses the injection of an organic carbon source, such as lactate or vegetable oil, to stimulate native bacteria.

For this TS, a combination of biotic and abiotic processes for degrading CEs to nontoxic products will be tested. These processes are similar in that they both degrade CEs by removing the chlorine atoms from the ethene structure thereby converting them to nonchlorinated and therefore nontoxic organic compounds. Because these processes are very similar and occur under similar geochemical conditions they have a synergistic affect that enhances both processes. Specifically the processes are:

- EAB (biotic process)
- Bioaugmentation (biotic process)
- ISCR (abiotic processes, β-elimination and hydrogenolysis through ZVI addition)

CEs can be degraded to nontoxic end products both biotically and abiotically. The abiotic degradation process will occur as CEs react in contact with zero- and divalent-iron added to the groundwater. The abiotic pathway results in the complete conversion of CEs via several mechanisms to first produce minor amounts of reduced CEs including DCE isomers (cis- and trans-1,2-DCE and 1,1-DCE) and VC. Then, in the final steps of the mechanism, these isomers

are subsequently degraded to nontoxic ethene and ethane and ultimately mineralized to carbon dioxide and water. The alternative (β-elimination) pathway does not generate the daughter products typical of reductive dechlorination or hydrogenolysis pathways. The β-elimination pathway converts TCE to chloroacetylene. Chloroacetylene is further dechlorinated to acetylene by hydrogenolysis. Acetylene degrades to ethene and ethane via hydrogenation. Both β-elimination and hydrogenolysis pathways instigated by reaction with ZVI result in the production of iron (II) and chloride ions. Iron (II) typically precipitates from solution in aquifers as ferrous sulfide, which also acts to abiotically degrade CEs by β-elimination and hydrogenolysis pathways.

The inorganic reagent proposed for use in the TS is microscale ZVI. Following placement of ZVI in the groundwater, several physical, chemical and microbiological processes create strong reducing conditions that stimulate complete dechlorination of CEs.

In addition to the abiotic degradation processes described above, the EAB/ISCR process also stimulates the biological degradation of the CEs. ELS™, a lecithin based organic substrate, supports growth of bacteria in the groundwater environment. As the bacteria grows on the organic material, they ferment organic carbon and release volatile fatty acids (acetic, propionic, butyric) and molecular hydrogen, which diffuse from the site of fermentation into the groundwater plume and serve as electron donors for other bacteria. Indigenous heterotrophic bacteria utilize the organic acids and hydrogen and consume DO, nitrate, arsenic (V), manganese (IV), iron (III), sulfate, and carbon dioxide and other electron acceptors, in a biologically-mediated oxidation-reduction reaction called respiration. This reduction results in increased concentrations of carbon dioxide, nitrite, arsenic (III), manganese (II), iron (II), sulfide, and methane as reducing conditions progressively intensify. The sequential consumption of these electron acceptors progressively lowers the ORP of the groundwater.

These physical, chemical, and biological processes combine to create an extremely reduced environment that stimulates chemical and microbiological dechlorination of otherwise persistent compounds. At very low reduction potential (Eh) levels, many organic constituents of interest are thermodynamically unstable and will readily degrade via physical pathways with minimum production and no accumulation of typically-recognized biodegradation intermediates such as DCE for TCE.

Following injection of the treatment reagents into the subsurface, several physical, chemical and microbiological processes combine to create very strong reducing conditions that stimulate rapid and complete dechlorination of CEs. The reagents will be injected into the soil and groundwater at the treatment area using direct-push technology and the concentrations of CEs will be monitored through groundwater sampling over a period of approximately 12 months prior to and following the treatment reagent(s) injection.

Related activities include monitoring well installation, groundwater monitoring and sampling, laboratory analysis, and data reduction and evaluation, which will assess the progress of the remediation and the feasibility of the treatment technology for further application. In order to achieve project objectives groundwater samples will be collected from monitoring wells at the treatment area. Up to 14 monitoring wells (five new wells and nine existing wells), located up-gradient, within and downgradient of the treatment area will be sampled.

17.1.1 Groundwater Sampling—Performance Monitoring

Six groundwater sampling events will be conducted to monitor performance of the treatability test. The first event will be conducted prior to treatment (reagent injection) to establish baseline conditions and the other five events will be conducted after reagent injection (one week, one month, four months, seven months, and ten months) to track and evaluate treatment performance. Thirteen wells (listed in WS #18 and shown on Figure A-2) will be sampled during each event. The samples will be collected using low flow purge and sampling techniques and will be analyzed at an off-site fixed base lab for the following:

- VOCs by EPA Method 8260C
- Dissolved gases (methane, ethane, ethene, and acetylene) by Pace Method AMGAX20
- Dissolved metals (manganese, arsenic, and iron) by EPA Method 6010B/6020
- Anions (nitrate and sulfate) by EPA Method 300.0
- TOC by SM 5310
- Alkalinity by SM 2320B
- Ferrous iron (using an on-site Hach colorimeter)

In addition to the laboratory analyzed parameters, general water quality parameters (pH, temperature, conductivity, turbidity, ORP, and DO) and groundwater elevation data will be measured in the field during sampling. Select samples will also be analyzed for DHC DNA by qPCR analysis. Specifically, samples from six wells (28OW-03, 28OW-04, 28SI-06, 28SI-07, 28SI-13, and W88-1) will be analyzed for DHC DNA during the baseline, 4-month, and 10-month events. The sample for DHC will be collected after low-flow purging and sampling is complete. The sediment in the bottom of the well will be stirred up using a disposable bailer. The best sample for DHC DNA analysis contains a mixture of well sediment and groundwater.

17.1.2 Additional Groundwater Monitoring

In addition to the performance monitoring wells, one new shallow well (28SI-16) adjacent to SCAPS -26 in the upper A-Aquifer zone will be installed and monitored during the treatability

test. This well will be sampled during the baseline event, four-month event, and ten-month event and lab analyze the samples for VOCs only, using passive diffusion bag sampling described in WS #14.

17.2 WASTE SOIL AND WASTEWATER SAMPLING

Waste soil generated from the well installation activities will be consolidated into one waste stream and will be characterized for off-site disposal. Waste soil samples will be analyzed for the following parameters:

- VOCs by EPA Method 5035/8260
- SVOCs by EPA Method 8270
- California Code of Regulation, Title 22 Metals by EPA Method 6010B/7471

Wastewater generated from well development and sampling activities will be stored in U.S. Department of Transportation-approved 55-gallon drums (or storage tank). Wastewater may be reused during injection activities or treated through WATS. If not reused or not treated through WATS, wastewater will be sampled to characterize for off-site disposal. Wastewater samples will be analyzed for the following parameters:

- VOCs by EPA Method 8260
- SVOCs by EPA Method 8270
- California Code of Regulation Title 22 Metals by EPA Method 6010B/7471

SAP Worksheet #18: Sampling Locations and Methods/Standard Operating Procedures Requirements Table

Sampling Location	Sample ID Number	Purpose	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
New and Existing Monitoring Wells	28OW-11 28OW-25 (new well) 28OW-26 (new well) 28OW-27 (new well) 28OW-28 (new well) 28SI-09 28SI-10	Baseline sampling	Groundwater	40–50 60–70 90–100 60–70 80–90 90–100 90–100	VOCs TOC Sulfate and nitrate Alkalinity Dissolved metals Dissolved gases	7 1-field duplicate	SAP WS #14
	28OW-03 28OW-04 28SI-06 28SI-07 28SI-13 W88-1		Groundwater	40–50 55–65 90–100 105–115 63–68 72–82	VOCs TOC Sulfate and nitrate Alkalinity Dissolved metals Dissolved gases DHC DNA	6 1-field duplicate	SAP WS #14
	28SI-16 (new shallow well)		Groundwater	8–18	VOCs	1	SAP WS #14
Monitoring Wells	28OW-11 28OW-25 28OW-26 28OW-27 28OW-28 28SI-09 28SI-10 28OW-03 28OW-04 28SI-06 28SI-07 28SI-13 W88-1	Performance Monitoring (1 Week, 1-Month, and 7-months after injection) 3-events	Groundwater	40–50 60–70 90–100 60–70 80–90 90–100 90–100 40–50 55–65 90–100 105–115 63–68 72–82	VOCs TOC Sulfate and nitrate Alkalinity Dissolved metals Dissolved gases	39 4-field duplicates	SAP WS #14

SAP Worksheet #18: Sampling Locations and Methods/Standard Operating Procedures Requirements Table (continued)

Sampling Location	Sample ID Number	Purpose	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
Monitoring Well	28SI-16	Monitoring 4 and 10 months after injection	Groundwater	8–18	VOCs	1	SAP WS #14
Monitoring Wells	28OW-11 28OW-25 28OW-26 28OW-27 28OW-28 28SI-09 28SI-10	Performance Monitoring 4 and 10-months after injection	Groundwater	40–50 60–70 90–100 60–70 80–90 90–100 90–100	VOCs TOC Sulfate and nitrate alkalinity Dissolved metals Dissolved gases	14 2-field duplicate	SAP WS #14
	28OW-03 28OW-04 28SI-06 28SI-07 28SI-13 W88-1		Groundwater	40–50 55–65 90–100 105–115 63–68 72–82	VOCs TOC Sulfate and nitrate alkalinity Dissolved metals Dissolved gases DHC DNA	12 1-field duplicate	SAP WS #14
Wastewater	WW-XXX	Waste Characterization	Water	Not applicable	VOCs Metals SVOCs	As needed	SAP WS #14
Waste Soil	WS-XXX	Waste Characterization	Soil	Not applicable	VOCs Metals SVOCs	As needed	SAP WS #14

SAP Worksheet #19: Analytical Standard Operating Procedures Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Sample Volume	Container	Preservation Requirements	Maximum Holding Time
Water	VOCs	Preparation: EPA Method 5030B Analysis: EPA Method 8260 SOP# EMAX-8260	40 mL	Three 40-mL vials, Teflon™-lined septum	Hydrochloric acid to pH less than (<) 2, Cool at 0 to 6°C	14 days
Water	Anions	Preparation and Analysis: EPA Method 300.0 /SOP# EMAX-300.0	100 mL	One 250-mL high-density polyethylene	Cool at 0 to 6°C	28 days
Water	Alkalinity	Preparation and Analysis: EPA Method 310.1 SOP# EMAX-310.1	100 mL	One 250-mL high-density polyethylene	Cool at 0 to 6°C	14 days
Water	TOC	Preparation and Analysis: SM 5310 SOP# EMAX-415.1	40 mL	One 40-mL amber vial, Teflon™-lined septum	Sulfuric Acid (H2SO4) to pH<2, Cool at 0 to 6°C	28 days
Water	Metals	Preparation: 3010A Analysis: EPA Method 6010B/6020 SOP# EMAX-6010	50 mL	One 250-mL high-density polyethylene	Nitric Acid (HNO3)	6 months
Water	Dissolved gases	Preparation and Analysis: Pace AM20GAX / SOP# AM20GAX	40 mL	Two 40-mL vials with Butyl rubber septa	trisodium phosphate (Na3PO4), Cool at 0-6°C	14 days
Water	DHC DNA	Preparation and Analysis: qPCR SOP# CB&I qPCR DNA Method	1 L	One (1) 1-L amber glass bottle	None	28 days
Soil (waste)	VOCs	Preparation: EPA Method 5035 Analysis: EPA Method 8260B SOP# EMAX-8260	5 grams	Three En Core® devices	Cool at 0 to 6°C	48 hours until preservation at the lab 14 days after preservation
Soil (waste)	Metals	Preparation: 3050B Analysis: EPA Method 6010B/6020 SOP EMAX-6010	2 grams	4- or 8-ounce glass jar with Teflon™-lined lid	Cool at 0 to 6°C	180 days
Soil (waste)	Mercury	Preparation & Analysis: EPA Method 7471A / SOP EMAX 7471	2 grams	4- or 8-ounce glass jar with Teflon™-lined lid	Cool at 0 to 6°C	28 days
Soil (waste)	SVOCs	Preparation: 3550B/3540C Analysis: EPA Method 8270 SOP EMAX-8270	30 grams	4- or 8-ounce glass jar with Teflon™-lined lid	Cool at 0 to 6°C	14 days to extraction 40 days after extraction

SAP Worksheet #20: Field Quality Control Sample Summary Table

Matrix	Analytical Group	# of Primary Sampling Locations	# of Field Duplicates	# of MS/MSDs	# of Field Blanks	# of Equipment Rinse Blanks	# of Trip Blanks	Total # of Samples to Laboratory
Groundwater (baseline)	VOCs TOC Anions Alkalinity Dissolved metals Dissolved gases DHC DNA (select wells)	14	2 (VOCs only)	1	None	1 per day if not using dedicated pumps	4—estimated (one per shipment of VOC sample)	44 -estimated
Groundwater (performance Monitoring)	VOCs TOC Anions Alkalinity Dissolved metals Dissolved gases DHC DNA (select wells)	14 locations 5 sampling events 70 samples	7 (VOCs only)	4	None	1 per day if not using dedicated pumps	10—estimated (one per shipment of VOC sample)	91—estimated
Waste Soil	VOCs SVOCs Metals	as needed	None	None	None	None	None	as needed
Waste Water	VOCs SVOCs Metals	If needed	None	None	None	None	None	as needed

SAP Worksheet #21: Project Sampling Standard Operating Procedures References Table

Reference Number	Title	Date, Revision and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SAP WS # 14	Groundwater Sampling—Low Flow	Not Applicable	CB&I	Bladder Pump	N	
SAP WS # 14	En Core® Sampler	Not Applicable	CB&I	En Core®	N	
SAP WS # 14	Groundwater Sampling—PDBs	Not Applicable	CB&I	PDBs	N	
SAP WS # 14	Waste Sampling	Not Applicable	CB&I	Disposable scoops/trowels	N	

SAP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Verification Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	Standard Operating Procedure Reference
PID	Isobutylene Standard (100 parts per million in air)	Start of working day	±20% of the standard value	Recalibrate	Field Sample Technician or SSHO	Manufacturer Operation Manual
Water Quality Meter	ORP	Start of working day	±20% of the standard value	Recalibrate	Field Sample Technician or Project Chemist	Manufacturer Operation Manual
	DO (ambient air)	Start of working day	±20% of 100% Saturation	Recalibrate	Field Sample Technician or Project Chemist	Manufacturer Operation Manual
	DO (zero standard)	Start of working day (alternative check standard to ambient air)	0 to 0.5 mg/L	Recalibrate	Field Sample Technician or Project Chemist	Manufacturer Operation Manual
	pH (7.0 or 4.0) standard	Start of working day	±0.2 pH unit of the standard value	Recalibrate	Field Sample Technician or Project Chemist	Manufacturer Operation Manual
	Specific Conductance Standard	Start of working day	±20% of the standard value	Recalibrate	Field Sample Technician or Project Chemist	Manufacturer Operation Manual

SAP Worksheet #23: Analytical Standard Operating Procedures References Table

Lab SOP Number[1]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Variance to the DoD QSM? (Y/N)
EMAX-8260	Volatile Organics by Gas Chromatography/Mass Spectrometry (GC/MS), Rev. 10; 6/5/14	Definitive	Soil and Water—VOCs	GC/MS	EMAX	N
EMAX-300.0	Ion Chromatography (IC) Analysis, Rev. 10; 9/24/14	Definitive	Water—Anions	IC/Conductivity	EMAX	N
EMAX-310.1	Alkalinity, Rev. 5; 1/9/14	Definitive	Water—Alkalinity	Titration	EMAX	N
EMAX-415.1	TOC, Rev. 4; 5/30/14	Definitive	Water—TOC	Combustion Infrared	EMAX	Not Applicable
EMAX-6010	Inductively Coupled Plasma (ICP) Emission Spectrometric Method for Trace Metals Rev. 7 5/21/14	Definitive	Water—Metals	ICP	EMAX	N
EMAX-6020	Trace Metals by ICP-MS, Rev 8; 7/8/14	Definitive	Water—Metals	ICP/Mass Spectrometry	EMAX	N
AM20GAX	Gas Chromatography (GC) dissolved gases chromatography	Definitive	Water—Dissolved gases	GC Flame Ionization Detector Thermal Conductivity Detector	Pace	Not Applicable
SOP-TAG-BIO-027	Detection of Dehalococcoides using real-time PCR, 2005	Screening	Water - DNA	Polymerize Chain Reaction (qPCR)	CB&I	N

Notes:

[1] Electronic (.pdf) copies of analytical SOPs are provided in Attachment 2.

SAP Worksheet #24.1: Analytical Instrument Calibration Table (Gas Chromatography/Mass Spectrometry Volatile Organic Compounds)

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions	SOP Reference
GC/MS VOCs (8260)	Check of mass spectral ion intensities (tuning procedure) using bromofluorobenzene	Prior to ICAL and calibration verification	Must meet the EPA method requirements before samples are analyzed m/z Required Intensity (relative abundance) mass 50 -15 to 40% of m/z 95 mass 75 -30 to 60% of m/z 95 mass 95 Base peak, 100% relative abundance mass 96 -5 to 9% of m/z 95 mass 173 <2% of m/z 174 mass 174 greater than (>) 50% of m/z 95 mass 175 -5 to 9% of m/z 174 mass 176>95% but <101% of m/z 174 mass 177-5 to 9% of m/z 176	If necessary, perform maintenance such as clean/change injection port, clip column, clean detector, etc. and Retune instrument and verify the tune acceptability	EMAX Chemist	EMAX-8260
	Five-point ICAL for target analytes, lowest standard at or near the LOQ	ICAL prior to sample analysis	The minimum average system performance check compound response factor is 0.1 for chloromethane, 1,1-dichloroethane, and bromoform and 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane	If necessary, perform maintenance and Retune instrument and verify the tune acceptability, then repeat ICAL	EMAX Chemist	
	Second source calibration verification	Once per five-point ICAL	<20% difference for all target analytes and calibration check compounds	First—reanalyze second source standard. If necessary, perform preventative maintenance. Then repeat ICAL	EMAX Chemist	

SAP Worksheet #24.1: Analytical Instrument Calibration Table (Gas Chromatography/Mass Spectrometry Volatile Organic Compounds) (continued)

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions	SOP Reference
GC/MS VOCs (8260) (continued)	Daily calibration verification	Before sample analysis and every 12 hours of analysis time	Average response factors for system performance check compounds greater than or equal to (≥) 0.30 for Chlorobenzene and 1,1,2,2-trichloroethane; ≥0.1 for chloromethane, bromoform and 1,1-DCA Less than or equal to (≤) 20% difference for all target analytes and calibration check compounds	If necessary, perform maintenance such as clean/change injection port, clip column, clean detector, etc. Then repeat ICAL Reanalyze samples with noncompliant bracketing CCVs	EMAX Chemist	EMAX-8260 (continued)
	Internal standards	During acquisition of calibration standard	Areas within -50% to +100% of ICAL midpoint standard h	Inspect mass spectrometer and GC for malfunctions; determine if internal standards failure was due to sample matrix or instrument malfunction. If necessary re-extract and reanalyze samples with noncompliant Internal standards	EMAX Chemist	

Notes:

m/z *mass to charge ratio*

SAP Worksheet #24.2: Analytical Instrument Calibration Table (Inductively Coupled Plasma)

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions	SOP Reference
ICP	ICAL	Daily	Acceptable ICV	Prepare fresh standard and reanalyze ICV to rule out standard degradation or inaccurate injection. If problem persist perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	EMAX Chemist	EMAX-6010
	ICV	After ICAL	All analytes within ±10% of expected value Relative standard deviation (RSD) of Replicate integrations: <5%	If RSDs <5%, prepare fresh standard and reanalyze CCV to rule out standard degradation or inaccurate injection. If RSD >5%, perform instrument maintenance to correct the problem and repeat ICAL.	EMAX Chemist	
	CCV	Daily before sample analysis, every 10 samples and at the end of the analysis sequence	All analytes within +10% of expected value RSD of replicate integrations: <5%	If RSDs <5%, prepare fresh standard and reanalyze CCV to rule out standard degradation or inaccurate injection. If RSD >5%, perform instrument maintenance to correct the problem. Recalibrate and reanalyze all samples since last successful CCV.	EMAX Chemist	

SAP Worksheet #24.3: Analytical Instrument Calibration Table—Inductively Coupled Plasma/Mass Spectrometry

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions	SOP Reference
ICP/Mass Spectrometry	Check of mass spectral ion intensities (tuning procedure)	Prior to initial calibration	Accepted if tuning passes in accordance with DoD QSM (2013) requirements	Perform maintenance if necessary, retune instrument then reanalyze tuning solution	EMAX Chemist	EMAX-6020
	ICAL with a minimum of one high standard	Initial calibration prior to sample analysis	Correlation coefficient (r^2) >0.995	Perform maintenance if necessary; correct problem, then repeat initial calibration	EMAX Chemist	
	Low standard at or near the RL	Daily after one-point initial calibration	<20% difference from ICAL for all target analytes	Perform maintenance if necessary, then rerun low standard	EMAX Chemist	
	Second source calibration standard, prepared at the calibration midpoint	Once per initial calibration, prior to sample analysis	<10% difference from expect value for all target analytes in accordance with DoD QSM (2013) requirements	Perform maintenance if necessary; prepare fresh standard; then rerun second source calibration	EMAX Chemist	
	CCV	Following ICAL, after every 10 samples and the end of the sequence	<10% difference from ICAL for all target analytes	Correct problem, then repeat CCV	EMAX Chemist	

SAP Worksheet #24.4: Analytical Instrument Calibration Table (Total Organic Compound)

Instrument	Calibration Procedure	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	SOP Reference
TOC Combustion/ Infrared Analyzer	ICAL	Daily	Correlation Coefficient (r^2) $\geq$0.995	Locate the source of the problem. If outliers exist, prepare fresh calibration standards and repeat ICAL. If problem persist, perform Photometric Linearity Check. If maximum absorbance is noncompliant, replace the spectrometer lamp and repeat the ICAL.	EMAX Chemist	EMAX-415.1
	ICV	After ICAL	All analytes within $\pm$10% of expected value	Prepare fresh standard and reanalyze ICV to rule out standard degradation or inaccurate injection. If problem persist perform instrument maintenance to correct the problem and repeat ICAL.	EMAX Chemist	
	CCV	Daily before sample analysis, at the end of the analysis sequence	All analytes within $\pm$10% of expected value	Repeat calibration and reanalyze all samples since last successful calibration.	EMAX Chemist	

SAP Worksheet #24.5: Analytical Instrument Calibration Table (Anions/Alkalinity)

Instrument	Calibration Procedure	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	SOP Reference
IC	ICAL	Initially; as needed	1) RSD for all analytes ≤20% 2) linear—least squares regression r >0.995 3) nonlinear—COD >0.990 (six points shall be used for second order, seven points shall be used for third order)	Locate the source of the problem. If expected RSD is not met, check for standard degradation or perform instrument adjustment and/or maintenance to correct the problem then repeat ICAL.	EMAX Chemist	EMAX.300.0
	ICV	Every after ICAL	All analytes within ±15% of expected value	Prepare fresh standard and reanalyze ICV to rule out standard degradation or inaccurate injection. If problem persist perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	EMAX Chemist	
	Daily calibration check	Every 12 hours	All analytes within ±15% of expected value	Prepare fresh standard and reanalyze daily calibration check to rule out standard degradation or inaccurate injection. If problem persist perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	EMAX Chemist	
Titration	Standard Check	Daily before sample analysis	All analytes within +10% of expected value	Discard the standard and use a new standard lot.	EMAX Chemist	EMAX-310.1

SAP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS ICP IC	Parameter Setup	Physical check	Check that the auto sampler is functioning as expected Check that temperature program is set at the most recently determined optimum condition	Initially; prior to each use	Auto sampler must move to the expected position when activated. Refer to instrument optimize temperature program setup	Reset auto sampler, if problems persist perform auto sampler troubleshooting prior to instrument use. Reset to optimized temperature setup (e.g., if temperature program is optimized at the following conditions: • Initial Temp=40°C, hold for 1 minute • Ramp= 6°C • Final Temp=200°C • Injection port=160°C • Interface=250°C Then the instrument setting must be on that condition when checked.)	EMAX Chemist	EMAX-8260 EMAX-300.0
GC/MS	Tune Check	Instrument Performance	Conformance to instrument tuning	Initially; prior to daily calibration check	Compliance to ion abundance criteria as specified by the method (WS #24)	Repeat tune check to rule out standard degradation or inaccurate injection. If problems persist perform retune the instrument and repeat tune check.	EMAX Chemist	EMAX-8260

SAP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
ICP	Interference check standard (ICS)/ICS A	Instrument Performance	Conformance to interference check	Prior to sample analysis	Within ±20% of expected value	Terminate analysis, reanalyze ICS to rule out standard degradation or inaccurate injection. If problems persist, perform instrument maintenance, repeat calibrations and reanalyze all associated samples.	EMAX Chemist	EMAX-6010 EMAX-6020
ICP	Initial calibration blank/continuing calibration blank	Instrument Performance	Instrument contamination check	After every calibration verification	No analytes detected > three times instrument detection limit (IDL)	Determine possible source of contamination and apply appropriate measure to correct the problem. Reanalyze calibration blank and all associated samples.	EMAX Chemist	EMAX-6010 EMAX-6020
Combustion Infrared	Initial calibration blank/continuing calibration blank	Instrument Performance	Instrument contamination check	After every calibration verification	No analytes detected > three times IDL	Determine possible source of contamination and apply appropriate measure to correct the problem. Reanalyze calibration blank and all associated samples.	EMAX Chemist	EMAX-415.1

SAP Worksheet #26: Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): CB&I, Field Technician, or CB&I Project Chemist
Sample Packaging (Personnel/Organization): CB&I; Field Technician, or CB&I Project Chemist
Coordination of Shipment (Personnel/Organization): CB&I, Field Technician, or CB&I Project Chemist
Type of Shipment/Carrier: United Parcel Service
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): EMAX and Pace
Sample Custody and Storage (Personnel/Organization): EMAX and Pace
Sample Preparation (Personnel/Organization): EMAX and Pace
Sample Determinative Analysis (Personnel/Organization): Various chemists and technicians, EMAX and Pace
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): Shipped to laboratory the same day as collection if possible, if not possible to ship the same day; storage ice-packed cooler in locked building
Lab Sample Storage (No. of days from sample collection): at least 30 days after completion of analyses
Sample Extract/Digestate Storage (No. of days from extraction/digestion): at least 30 days after completion of analyses
Biological Sample Storage (No. of days from sample collection): Not applicable to this project
SAMPLE DISPOSAL
Personnel/Organization: EMAX and Pace
Number of Days from Analysis: 60 days

SAP Worksheet #27: Sample Custody Requirements Table

27.1 SAMPLE CUSTODY AND DOCUMENTATION

Sampling information will be recorded on a chain-of-custody (Attachment 1) form and in a permanently bound field logbook. All entries will be legible and recorded in indelible ink.

27.2 SAMPLE NUMBERING

All project samples will be uniquely numbered using a system that identifies the location, type and sequential number (or date). Sample identifications will be recorded in sample collection logs and Chain of Custody Forms.

Groundwater Samples will use the following naming convention:

Well ID-Date-MM/DD/YY
Example: 28SI06-10/31/14

Waste Samples will use the following naming convention:

Waste Soil (WS) # or Bin #-consecutive number
Example: WS-001

Wastewater (WW)-consecutive number
Example: WW-001

27.3 SAMPLE LABELING

Sample labels will be filled out with indelible ink and affixed to each sample container. Non-waterproof sample labels will be covered with clear tape. Sample containers will be placed in resealable plastic bags to protect the sample from moisture during transportation to the laboratory. Each sample container will be labeled with the following, at minimum:

- Sample identification number
- Sample collection date (month/day/year)
- Time of collection (24-hour clock)
- Project number
- Sampler’s initials
- Analyses to be performed
- Preservation (if any)
- Location (i.e., site name)

27.4 CHAIN-OF-CUSTODY

An example chain-of-custody is shown in Attachment 1. In addition to providing a custody exchange record for the samples, the chain-of-custody serves as a formal request for sample analyses. The chain-of-custody will be completed, signed, and distributed as follows:

- One copy retained by the sample coordinator for inclusion in the project files
- The original sent to the analytical laboratory with the sample shipment

After the laboratory receives the samples, the Sample Custodian will inventory each shipment before signing for it, and note on the original Chain of Custody Form any discrepancy in the number of samples, temperature of the cooler or broken samples. The Project Chemist will be notified immediately of any problems identified with shipped samples. The Project Chemist will in turn notify the Project QC Manager, and together they will determine the appropriate course of action. The Project Chemist will also notify the PM if the project budget and schedule may be impacted.

The laboratory will initiate an internal chain-of-custody that will track the sample within the various areas of the laboratory. The relinquishing signature of the Sample Custodian and the custody acceptance signature of the laboratory personnel transfer custody of the sample. This procedure is followed each time a sample changes hands. The laboratory will archive the samples and maintain their custody as required by the contract or until further notification from the Project Chemist, at which time the samples will either be returned to the project for disposal, or disposed by the laboratory.

27.5 SAMPLE PACKING AND SHIPMENT

After sample collection, sample labels will be affixed to each sample container. Each sample will be placed in a resealable plastic bag to keep the sample container and the label dry. All glass sample containers will be protected with bubble wrap (or other cushioning material) to prevent breakage. A temperature blank will be placed in every cooler with samples.

Samples to be shipped by commercial carrier will be packed in a sample cooler lined with a plastic bag. Ice, double bagged in resealable bags, will be added to the cooler in sufficient quantity to keep the samples cooled to 4±2°C for the duration of the shipment to the laboratory. Sample cooler drain spouts will be taped from the inside and outside of the cooler to prevent any leakage. Saturday deliveries will be coordinated with the laboratory.

The Chain of Custody Form will then be taped to the inside of the sample cooler lid. The cooler will be taped shut with strapping tape, and two custody seals will be taped across the cooler lid. Clear tape will be applied to the custody seals to prevent accidental breakage during shipping.

The samples will then be shipped to the analytical laboratory. A copy of the courier airbill will be retained for documentation.

The shipping of samples to the analytical laboratory by land delivery services will be performed according to the U.S. Department of Transportation-regulations. The International Air Transportation Association regulations will be adhered to when shipping samples by air courier services. Transportation methods will be selected to assure that the samples arrive at the laboratory in time to permit testing according to established holding times and project schedules. No samples will be accepted by the receiving laboratory without a properly prepared chain-of-custody record and properly labeled and sealed shipping container(s).

27.6 FIELD LOGBOOKS

A permanently bound field logbook with consecutively numbered pages will be assigned to this project. All entries will be recorded in indelible ink. Corrections will be made following the procedure described below in Section 27.6. The responsible sampler will sign the logbook pages, as the corrections are completed and any unused portions of a logbook page will be crossed out, signed, and dated.

At a minimum, the logbook will contain the following information:

- Project name and location (on the front page of the log book)
- Date and time of collection for each sample (in the upper right corner of each page)
- Sample number
- Sample location (i.e., monitoring well ID or sampling point)
- Sample type (i.e., soil and water)
- Composite or grab
- Composite type (the number of grab samples)
- Depth of sample
- Weather information (e.g., rain, sunny, approximate temperature)
- Containers used and requested analyses

In the graph paper portion of the field logbook, the sampler will fill in the following information:

- A map with sample locations (drawn or paste copy). Each sample location must be clearly identified on the map. Several sample locations may be presented on one map; however, the page with the map must be referred on each of the individual sample pages

- Field analyses performed, including results, instrument checks, problems, and calibration records for field instruments
- Descriptions of deviations from this SAP
- Problems encountered and corrective action taken
- Identification of field QC samples
- List of QC activities
- Verbal or written instructions from the Navy and CB&I Project QC Manager

The sampler will cross out the unused portion and sign each page.

27.7 DOCUMENT CORRECTIONS

Changes or corrections on any project documentation will be made by crossing out the item with a single line, initialing by the person performing the correction, and dating the correction. The original item, although erroneous, will remain legible beneath the cross out. The new information will be written above the crossed out item. Corrections will be written clearly and legibly with indelible ink.

SAP Worksheet #28.1: Laboratory Quality Control Samples Table (EPA Method 8260)

Matrix: Water

Analytical Group: VOCs

Analytical Method/SOP Reference: EPA Method 8260/EMAX-8260

QC Check	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicator (DQI)	Measurement Performance Criteria
Check of mass spectral ion intensities using bromofluorobenzene	Prior to ICAL and ICV	Must meet the method requirements before samples are analyzed (see WS # 24)	Retune instrument and verify the tune acceptability	EMAX Chemist	Representativeness	Meets all EPA Method requirements (WS #24)
Internal standards	During acquisition of calibration standard, samples, and QC check samples	Retention time within ± 10 seconds of ICAL midpoint standard Areas within .50% to +100% of ICAL midpoint standard	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning	EMAX Chemist	Representativeness	Areas within .50% to +100% of ICAL midpoint standard
MB	One per analytical batch (20 samples or less)	No target analytes ≥½ LOQ. For common laboratory contaminants, no analytes detected >LOQ	Determine the source of blank contamination, If necessary, re-extract and reanalyze MB and all samples processed with the contaminated blank	EMAX Chemist	Representativeness Bias Contamination	No target analytes ≥½ LOQ. For common laboratory contaminants, no analytes detected >LOQ

SAP Worksheet #28.1: Laboratory Quality Control Samples Table (EPA Method 8260) (continued)

Matrix: Water

Analytical Group: VOCs

Analytical Method/SOP Reference: EPA Method 8260/EMAX-8260

QC Check	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicator (DQI)	Measurement Performance Criteria
MS/MSD for all analytes	One MS/MSD per analytical/preparation batch (20 samples or less)	DoD QSM (2013) control Limits (Attachment 2)	Identify problem; if not related to matrix interference, re-extract and reanalyze MS/MSD and all associated batch samples	EMAX Chemist	Precision and Accuracy	DoD QSM (2013) control Limits (Attachment 2)
LCS/LCD pair if there is not enough sample for MS/MSD	One LCS or LCS/LCD per analytical/preparation batch (20 samples or less)	DoD QSM (2013) control limits	Identify the problem, then re-extract and reanalyze the LCS (LCS/LCD) and all associated batch samples	EMAX Chemist	Precision and Accuracy	DoD QSM (2013) control limits
Surrogate standards	Every sample, spiked sample, standard, and MB	DoD QSM (2013) control limits	Identify problem; if not related to matrix interference, reanalyze the extract or re-extract and reanalyze all affected samples	EMAX Chemist	Accuracy	DoD QSM (2013) control limits

SAP Worksheet #28.2: Laboratory Quality Control Samples Table (EPA Method 6010B)

Matrix: Water

Analytical Group: ICP Metals

Analytical Method/SOP Reference: EPA Method 6010B/EMAX-6010

QC Check	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicator (DQI)	Measurement Performance Criteria
Calibration blank	After ICAL, before daily CCV, after every 10 samples, and at the end of the sequence	No target analytes ≥LOD	Correct the problem; Re-prepare and reanalyze the blank	EMAX Chemist	Representativeness	No target analytes ≥LOD
IDL study	Initial instrument setup and after significant change	IDLs will be below the LOD	Determine the source of the problem, then repeat the IDL study	EMAX Chemist	Sensitivity	IDLs will be below the LOD
MDL study	Once per 12.month period	MDLs will be below the LOD	Repeat the MDL study	EMAX Chemist	Sensitivity	MDLs will be below the LODs
MB	One per digestion batch	No target analytes ≥½ LOQ	Identify the source of blank contamination, then re-prepare and reanalyze the MB and all samples processed with the contaminated blank	EMAX Chemist	Representativeness	No target analytes ≥½ LOQ
ICS	At the beginning of an analytical run	Within ±20% of expected value for spiked analytes, absolute value for non-spiked analytes <LOD	Terminate analysis, perform maintenance to correct the problem if necessary, recalibrate if necessary then reanalyze ICS and all affected samples	EMAX Chemist	Accuracy	Within ±20% of expected value

SAP Worksheet #28.2: Laboratory Quality Control Samples Table (EPA Method 6010B) (continued)

Matrix: Water

Analytical Group: ICP Metals

Analytical Method/SOP Reference: EPA Method 6010B/EMAX-6010

QC Check	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicator (DQI)	Measurement Performance Criteria
MS/MSD for all analytes	One MS/MSD pair per preparation batch (20 samples or less)	DoD QSM (2013) control limits (Attachment 2) RPD ≤20%	evaluate LCS recovery; Identify problem; if not related to matrix interference then re-prepare and reanalyze the MS/MSD pair and all samples in the associated batch	EMAX Chemist	Precision and Accuracy	DoD QSM (2013) control limits (Attachment 2) RPD ≤20%
LCS or LCS/LCD pair if there is not enough sample for MS/MSD	One LCS or LCS/LCD pair per each preparation batch (20 samples or less)	DoD QSM (2013) Control Limits: RPD ≤20%	Terminate analysis, identify and correct the problem, then re-prepare and reanalyze all affected samples	EMAX Chemist	Precision and Accuracy	DoD QSM (2013) Control Limits: RPD ≤20%
Dilution test	One dilution test per preparation batch (20 samples or less)	1:5 dilution must agree within ±10% of the original determination	Perform post digestion spike Evaluate for matrix interference	EMAX Chemist	Accuracy	10% Difference
Post digestion spike addition	When MS fails or dilution test fails	Recovery within 80% to 120% of expected results	Narrate matrix interference,	EMAX Chemist	Accuracy	Recovery within 80% to 120% of expected results

Notes:

MDL *method detection limit*

SAP Worksheet #28.3: Laboratory Quality Control Samples Table (Anions)

Matrix: Water

Analytical Group: Anions

Analytical Method/SOP Reference:
EPA 300.0/9056
EMAX-300.0

QC Check	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicator (DQI)	Measurement Performance Criteria
MB	One per preparation batch (20 samples or less)	All analytes <1/2 LOQ	Reprep and reanalyze MB and all samples processed with the nonconforming MB.	EMAX Chemist	Accuracy/Bias Contamination	All analytes <1/2 LOQ
LCS or LCS/LCD pair if there is not enough sample for MS/MSD	One in the absence of MS/MSD per preparation batch (20 samples or less)	DoD QSM (2013) control limits	Reprep and reanalyze LCS and all samples processed with the nonconforming LCS.	EMAX Chemist	Accuracy/Bias	% Recovery. Nitrate: 88% to 111% Sulfate: 87% to 112% RPD: 15%
MS/MSD	Project designated sample matrix QC. One per preparation batch (20 samples or less)	DoD QSM (2013) control limits	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract/reanalyze the sample.	EMAX Chemist	Interferences Accuracy/Bias	% Recovery. Nitrate: 88% to 111% Sulfate: 87% to 112% RPD: 15%

SAP Worksheet #28.4: Laboratory QC Samples Table (Dissolved Gases)

Matrix: Water

Analytical Group: Dissolved Gases

Analytical Method/SOP Reference:AM20GAX

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blank	One per analytical batch (20 samples or less)	No target analytes ≥ ½ RL	Determine the source of contamination, reanalyze blank, then reanalyze method blank and all samples processed with the contaminated blank	Lab Manager/ Analyst	Representativeness	No target analytes ≥ ½ RL
MS/MSD	MS/MSD pair only analyzed if specifically requested by client—not included in batch QC	Laboratory control limits	Identify problem; if not related to matrix interference, evaluate LCS results; Narrate	Lab Manager/ Analyst	Precisions and Accuracy	Laboratory control limits Methane—70%–130% Ethane—70%–130% Ethene—70%–130% Acetylene—70%–130% RPD—≤20%
LCS/LCD pair	One LCS or LCS/LCD pair per analytical/preparation batch (20 samples or less)	Laboratory control limits	Identify the problem; reanalyze the LCS or re-extract and reanalyze the LCS and all associated batch samples	Lab Manager/ Analyst	Precisions and Accuracy	Laboratory control limits Methane—80%–120% Ethane—80%–120% Ethene—80%–120% Acetylene—80%–120% RPD—≤20%

SAP Worksheet #29: Project Documents and Records Table

Document	Where Maintained
Final Work Plan and SAP	CB&I Project file (Concord, California) NAVFAC SW Environmental Restoration Program Record Files
Field notes/logbook	CB&I Project file (Concord, California) NAVFAC SW Environmental Restoration Program Record Files
chain-of-custody forms	CB&I Project file (Concord, California) NAVFAC SW Environmental Restoration Program Record Files
Laboratory raw data package	CB&I Project file (Concord, California) NAVFAC SW Environmental Restoration Program Record Files
Audit/assessment checklists/reports	CB&I Project file and laboratory NAVFAC SW Environmental Restoration Program Record Files
Corrective action forms/reports	CB&I Project file and laboratory
Laboratory equipment calibration logs	Laboratory—EMAX, Pace
Sample preparation logs	Laboratory—EMAX, Pace
Run logs	Laboratory—EMAX, Pace
Sample disposal records	Laboratory—EMAX, Pace
Data Validation Reports	CB&I Project file (Concord, California) NAVFAC SW Environmental Restoration Program Record Files

SAP Worksheet #30: Analytical Services Table

Matrix	Analytical Group	Sample Locations/ID Numbers	Analytical Method	Data Package Turnaround Time	Laboratory/Organization (Name, Address, Contact, and Telephone #)	Backup Laboratory (Name, Address, Contact, and Telephone #)
Water	VOCs TOC Anions Alkalinity Metals	Groundwater listed in WS #18	8260 5310 300.0 2320B 6010B	14 to 21 Business Days	EMAX[1] 1835 W. 205th St. Torrance, California 90501 Ye Myint 310.618.8889	Curtis and Tompkins 2323 5th Street Berkeley, California 94710 510.204.2225
Water	DHC DNA	Groundwater listed in WS #18	qPCR	14 to 21 Business Days	CB&I Lab 17 Princess Road Lawrenceville, New Jersey 08648	None
Water	Dissolved Gases	Groundwater listed in WS #18	AM20GAX	21 Business Days	Pace 220 William Pitt Way Pittsburg, Pennsylvania 15238 Robin Robyl 412.826.5245	None
Waste soil or water	VOC SVOC Metals	Waste samples listed in WS #18	8260 8270 6010B	14 to 21 Business Days	EMAX 1835 W. 205th St. Torrance, California 90501 Ye Myint 310.618.8889	Curtis and Tompkins 2323 5th Street Berkeley, California 94710 510.204.2225

Notes:

[1]EMAX and Curtis and Tompkins laboratories are State of California Environmental Laboratory Accreditation Program- and DoD Environmental Laboratory Accreditation Program-accredited.

SAP Worksheet #31: Planned Project Assessments Table

Assessment Type	Frequency	Internal (I) or External (E)	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA)	Person(s) Responsible for Monitoring Effectiveness of CA
Field audits	At least once at the beginning of sampling activities and then as needed as the project progresses	I	CB&I and/or Navy QAO	CB&I Project Chemist; Program Chemist; or Navy QAO	CB&I Project Chemist or Program Chemist	CB&I Project Chemist or Program Chemist	CB&I Project Chemist or Program Chemist
Field documentation review	At least once at the beginning of sampling activities and then as needed as the project progresses	I	CB&I	CB&I Program Chemist or Project QC Manager	CB&I Technical Manager; Field Sampling Technician or Project Chemist	CB&I Technical Manager; Field Sampling Technician or Project Chemist	CB&I Program Chemist or Field QC Manager
Laboratory Data Review Findings	At least once at the beginning of sampling activities and then as needed as the project progresses	I	CB&I	Program Chemist or Project QC Manager	Technical Manager; Field Sampling Technician or Project Chemist	Technical Manager; Field Sampling Technician or Project Chemist	Program Chemist or Field QC Manager

SAP Worksheet #32: Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Field sampling technical system audit	Written audit report	PM	48 hours after audit	Email or letter	Field Technician, CB&I Project Chemist, CB&I Program Chemist	24 hours after notification
Field documentation audits	Written audit report	PM, Field Technicians, Project QC Manager, Project Chemist	48 hours after audit	Email or letter	Field Technician, CB&I Project Chemist, CB&I Program Chemist	24 hours after notification
Laboratory data review findings	Memo	Laboratory QA Manager, Laboratory PM	48 hours after audit	Email or letter	CB&I Project Chemist, CB&I Program Chemist	3 days after notification

SAP Worksheet #33: Quality Assurance Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Field Sampling Technical Audit Report Initial and Follow-up inspections	At least once at the beginning of sampling activities and then as needed as the project progresses	Within 24 hours of Field Sampling Audit	CB&I Project QC Manager or CB&I Project Chemist	CB&I PM
Data Review Report	After all sample data reviewed by Project Chemist	As received from laboratory	CB&I Project Chemist or CB&I Program Chemist	CB&I Project Engineer or CB&I PM
Final Project Report	After completion of all field work	Project document delivery schedule is provided in the Work Plan	CB&I PM	Navy RPM and regulatory agencies (see distribution list, WS #3)

SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process

Data Review Input	Description	Responsible for Verification	Step I/IIa/IIb[1]	Internal/External
chain-of-custody	Chain of Custody Forms will be reviewed internally upon their completion and verified against the packed sample coolers they represent. A copy of the Chain of Custody Form will be retained in the project file, and the original and remaining copies taped inside the cooler for shipment.	Field sampling team leader (CB&I) or Project Chemist	Step I	Internal
Sample Receipt	The sample cooler will be checked for compliance with preservative, temperature and packaging requirements. Sample containers will be reviewed against the chain-of-custody for agreement. Sample receipt will be documented by the laboratory on a login sheet and sample information will be entered into the Laboratory Information Management System.	Laboratory sample receiving and PM	Step I	External
Field Notes/Logbook	Field notes will be reviewed internally and placed in the project file upon project completion.	CB&I Project Chemist and Field QC Manager	Step I	Internal
Audit Reports	If an audit is conducted, upon report completion, a copy of all audit reports will be placed in the project file. If corrective actions are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the project file. At the beginning of each week, and at the completion of the site work, project file audit reports will be reviewed internally to ensure that all appropriate corrective actions have been taken and that corrective action reports are attached. If corrective actions have not been taken, the PM will be notified to ensure action is taken.	CB&I Project Technical Manager or CB&I PM	Step I	Internal
Laboratory Data Packages	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal. All received data packages will be verified by the CB&I chemist or a third party reviewer according to the data validation procedures specified in this SAP.	Laboratory PM, CB&I Project Chemist or data validation company	Step I	Internal/External
EDD	All EDDs will be verified internally by the subcontract laboratory for completeness and technical accuracy prior to submittal to CB&I. All received EDDs will be verified by CB&I and/or the validation company against the hardcopy laboratory reports.	Laboratory, CB&I chemist and a third party data validation company	Step I	Internal/External
Sampling Methods and Procedures	Ensure that the required sampling methods were used to collect samples, any field changes or deviations are noted in the field logbook. Review field sample collection logbooks for compliance with the approved SAP.	CB&I Project Chemist and Field QC Manager	Step IIa	Internal

SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process (continued)

Data Review Input	Description	Responsible for Verification	Step I/IIa/IIb[1]	Internal/External
Holding Times	Ensure the samples were analyzed within the EPA holding times. If holding times were not met, verify that deviations were documented and proper notifications were made.	Laboratory PM	Step IIa	External
Analytes and Project LODs Met	Ensure that the required list of analytes and that project-specific quantitation limits specified in this SAP are met and reported per project requirements.	Laboratory PM and Project Chemist	Step IIa	Internal/External
Hardcopy Data Packages	Review data package for compliance with EPA method requirements (1996, 2008) and DoD QSM (2013) requirements, and approved SAP.	Third Party Data Validation Company	Step IIa	External
Documentation of All EPA Method QC Sample Results; 90 Percent Level III Data Review	Determine if all EPA Method required QC samples were analyzed and met required control limits per SAP and DoD QSM (2013) requirements when applicable.	Third Party Data Validation Company	Step IIa	External
10 Percent Level IV Raw Data Review	Recalculation of laboratory raw data to confirm laboratory calculation of final results.	Third Party Data Validation Company	Step IIa	External
Documentation of all SAP QC Sample Results	Determine if all SAP required QC samples were collected and met required control limits per SAP and DoD QSM (2013) requirements when applicable.	CB&I Project Chemist and Third Party Data Validation Company	Step IIa	Internal/External
Sampling Plan	Determine whether the SAP was executed as specified (number, location, type of field samples collected).	CB&I Project QC Manager or Project Chemist	Step IIba	Internal
Field Duplicate Precision	Compare results for groundwater and soil gas field duplicates with criteria established in this SAP.	CB&I Project Chemist and Third Party Data Validation Company	Step IIb	Internal/External
VOCs—Water	In accordance with validation company SOPs, DoD QSM (2013), and EPA Level III and IV guidance (WS #14).	CB&I Project Chemist and Third Party Data Validation Company	Step IIb	Internal/External
Anions, Alkalinity, Metals, Dissolved gases—Water	In accordance with DoD QSM (2013) and EPA Level II review (WS #14).	CB&I Project Chemist or Third Party Data Validation Company	Step IIb	Internal/External

Notes:

[1] *IIa=compliance with methods, procedures, and contracts (Table 10, page 117, Uniform Federal Policy for Quality Assurance Plans [UFP/QAPP] [EPA, 2005])*
IIb=comparison with measurement performance criteria in the SAP (Table 11, page 118, Uniform Federal Policy for Quality Assurance Plans [UFP/QAPP] [EPA, 2005])

SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process (continued)

VALIDATION OF LABORATORY DATA

Data validation is a systematic, independent process of reviewing a body of data to determine the analytical limitations of that data based on specific QC criteria. A third party data validation company will validate definitive level project laboratory data and a CB&I Project Chemist will review waste data and bioremediation monitoring parameters as described below.

- VOCs baseline and performance monitoring samples—90 percent EPA Level 3 and 10 percent EPA Level 4
- Bioremediation parameters and Waste samples—100 percent EPA Level 2

The CB&I Project Chemist will specify the sample and sample groups using a random selection process for the 10 percent Level 4 reporting and validation. Critical samples, if identified, or other samples determined to be of decision-making significance (as determined by the Project Chemist or Project Technical Lead), will be included in the 10 percent.

Data review and validation will be in accordance with the QA requirements and control limits specified in this project-specific QAPP and the following guidance, as appropriate to the analytical methods used.

- DoD QSM (2013)
- *National Functional Guidelines for Superfund Organic Methods Data Review, EPA 540-R-014-002* (EPA, 2014b)
- *National Functional Guidelines for Inorganic Superfund Data Review, EPA-540-R-013-001* (EPA, 2014a)

The chemist or reviewer's professional judgment will be used to evaluate data quality when called for in the National Functional Guidelines. Professional judgment will also be used where no clear policy exists, or when there is conflicting guidance on how data should be qualified.

LEVEL III AND LEVEL IV DATA VALIDATION CRITERIA AND CHECKLIST

For a Level III data validation effort, the data values for routine and QC samples are generally assumed to be correctly reported by the laboratory. Data quality is assessed by comparing the parameters listed below to the appropriate criteria (or limits) as specified in the project SAP, DoD QSM (2013), or by EPA method-specific requirements. If calculations for quantitation are verified, it is done on a limited basis requires raw data (Level 4) in addition to the standard data forms normally present in a data package.

Data review/validation may include the following QC elements shown in the example validation checklist shown below (depending on the analysis being reviewed):

Pass/Fail QC Criteria	Review/Validation Criteria (Level 3 and Level 4)
	Sample Receipt and Preservation met requirements
	Sample Holding Times
	Laboratory MBs/Calibration Blanks/Instrument Blanks
	Surrogate Recoveries meet QAPP Requirements
	LCS/LCSD Recoveries meet QAPP Requirements
	MS/MSD Sample Recoveries meet QAPP Requirements
	RPD Evaluation meet QAPP Requirements
	Sample Duplicate Evaluation
	Breakdown check standards (Pesticides/SVOCs)
	ICALs
	CCV
	Second Column Confirmation
	Retention Time Evaluation (GC Methods)
	ICSs (Metals)
	Serial Dilutions and Post Digestion Spikes (Metals)
	Field Blanks
	Field Duplicate RPD
	Internal standard recoveries—Level 4 Validation only
	Instrument tuning and system performance (GC/MS)—Level 4 Validation only
	Analyte identification (e.g., spectra and chromatograms)—Level 4 Validation only
	Analyte quantitation (calculation check)—Level 4 Validation only

SAP Worksheet #37: Usability Assessment

37.1 DATA QUALITY ASSESSMENT REPORT

Based on the data validation/review, the Project Chemist will determine if the project quality objectives have been met, and will calculate data completeness. To reconcile the collected data with project quality objectives and to establish and document data quality and usability, the data will be reviewed against DQIs (Section 37.2) and the Project Chemist will prepare a data quality assessment (DQA) report. The DQA report will cover the following topics:

- Implementation of sampling design and analysis according to the approved SAP (or sample completeness and representativeness)
- Proper frequency of field QC samples and the adequacy of field decontamination procedures
- Accuracy and precision of the data collected
- Data comparability, if appropriate
- Data usability for project decisions

The DQA report will be included in the final project report.

37.2 DATA QUALITY INDICATORS

This section defines the DQIs and their use for assessment of data quality.

37.2.1 Precision

Precision measures the reproducibility of measurements under a given set of conditions. The following equation illustrates the method for calculating RPD to assess a method's precision:

$$\textit{Precision as RPD} = \frac{2 \times |\textit{Result} - \textit{Duplicate Result}| \times 100\%}{\textit{Result} + \textit{Duplicate Result}}$$

The laboratory uses MS/MSD pairs to assess the precision of analytical procedures, with one MS/MSD pair analyzed for every batch of up to 20 samples. This allows determining whether matrix interferences may be present.

The laboratory uses LCS/LCD pairs when MS are not practical due to the nature of the sample or analytical method used, and they are prepared and analyzed with each batch of samples instead of MS/MSD. LCS/LCD may also be prepared in place of MS/MSD in the case that a sufficient sample volume was not obtained in the field to perform the MS/MSD analysis. For inorganic analyses, analytical precision is usually calculated based on the sample and sample duplicate results.

Analytical laboratory will use DoD QSM (2013) acceptability limits for RPDs if available. If DoD limits are not available, then the laboratory will established statistically based acceptability limits for RPDs for each method of analysis and sample matrix. The laboratory will review the QC samples to ensure that internal QC data lies within the limits of acceptability. Any suspect trends will be investigated and corrective actions taken.

The variability of the contaminant distribution in the sampled matrix is evaluated by collecting and analyzing "blind" field duplicate samples (field QC samples) at a rate of one for every 20 samples. Field sample collection and handling precision can be evaluated based on the RPD for field duplicate sample pairs. Although field precision will reviewed during the data validation process, sample results will not be qualified based on the field precision values.

37.2.2 Accuracy

Accuracy measures the bias of an analytical system by comparing the difference of a measurement with a reference value. The percent recovery of an analyte, which has been added to the environmental samples at a known concentration before extraction and analysis, provides a quantitation tool for analytical accuracy. The spiking solutions used for accuracy determinations are not used for instrument calibrations. The following equation illustrates how accuracy is evaluated:

$$\textit{Accuracy as percent recovery} = \frac{\textit{Spiked Sample Result - Sample Result x 100\%}}{\textit{Spiked Sample True Value}}$$

Percent recoveries for MS, MSD, and LCS that are analyzed for every batch of up to 20 samples serve as a measure of analytical accuracy. Surrogate standards are added to all samples, blanks, MSs, MSDs, and LCSs analyzed for organic contaminants to evaluate the method's accuracy and to help determine matrix interferences.

The analytical laboratory will use DoD QSM (2013) acceptability limits for percent recoveries of surrogates and MS/MSD samples if available. If DoD limits are not available, then the laboratory will established statistically based acceptability limits for percent recovery for each method of analysis and sample matrix. The laboratory will review the QC samples to ensure that internal QC data lies within the limits of acceptability. The laboratory will investigate any suspect trends and take appropriate corrective actions.

37.2.3 Representativeness

Unlike precision and accuracy, which can be expressed in quantitative terms, representativeness is a qualitative parameter. Representativeness is the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or

an environmental condition. It is a qualitative parameter that depends on proper design of the sampling program.

Field personnel will be responsible for ensuring that samples are representative of field conditions by collecting and handling samples according to the approved site-specific SAP. Errors in sample collection, packaging, preservation, or chain-of-custody procedures may result in samples being judged nonrepresentative and may form a basis for rejecting the data.

Data generated by the laboratory must be representative of the laboratory database of accuracy and precision measurements for analytes in different matrices. Laboratory procedures for sample preparation will ensure that aliquots used for analysis are representative of the whole sample. Aliquots to be analyzed for volatile parameters will be removed before the laboratory composites/homogenizes the samples, to avoid losing volatile compounds during mixing.

37.2.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another, whether it was generated by a single laboratory or during inter-laboratory studies. The use of standardized field and analytical procedures ensures comparability of analytical data.

Sample collection and handling procedures will adhere to procedures described in WS #14. Laboratory procedures will follow standard analytical protocols, use standard units, standardized report formats, follow the calculations as referenced in approved analytical methods, and use a standard statistical approach for QC measurements.

37.2.5 Completeness

Completeness is a measure of whether all the data necessary to meet the project have been collected. For the data to be considered complete they must meet all acceptance criteria including accuracy and precision and other criteria specified for an analytical method. The data will be reviewed and/or validated to keep invalid data from being processed through data collection. Completeness will be evaluated for the target VOC compounds only and is evaluated using the following equation:

$$Completeness = \frac{Acceptable\ Results \times 100\%}{Total\ Results}$$

The goal for completeness for all QC parameters, except holding times, will be 90 percent. The goal for holding times will be 100 percent. If these goals are not achieved, the sources of nonconformances will be evaluated to determine whether re-sampling and reanalysis is necessary.

37.3 PROJECT REQUIRED REPORTING LIMITS

The laboratory will determine the DLs, LOQ, and LOD for each method, instrument, analyte and matrix using the procedure described DoD QSM (2013). The project quantitation limit goals will be at or above the LOQ.

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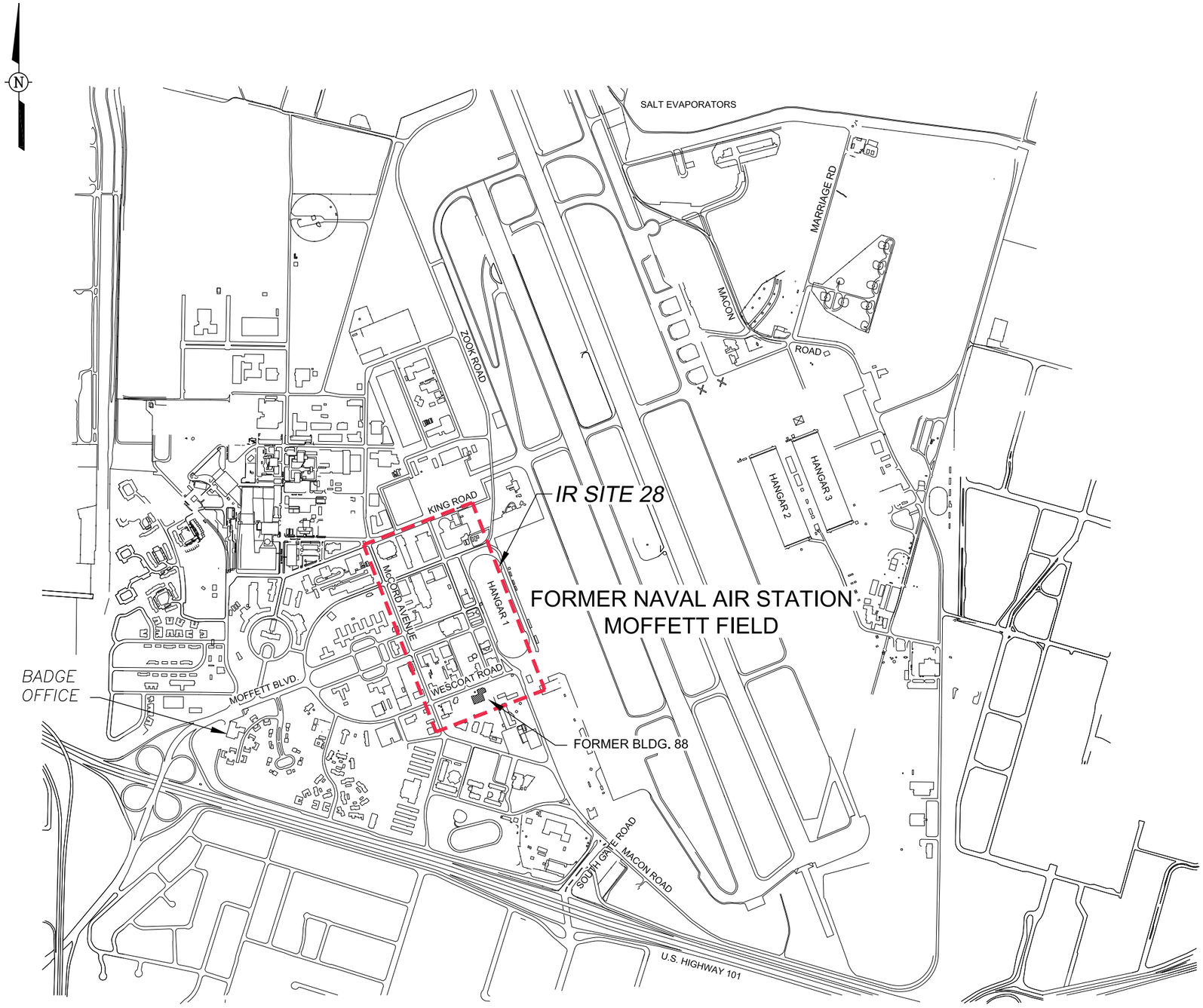
EPA, 2014b, *National Functional Guidelines for Superfund Organic Methods Data Review, EPA 540-R-014-002, August*.

FIGURES

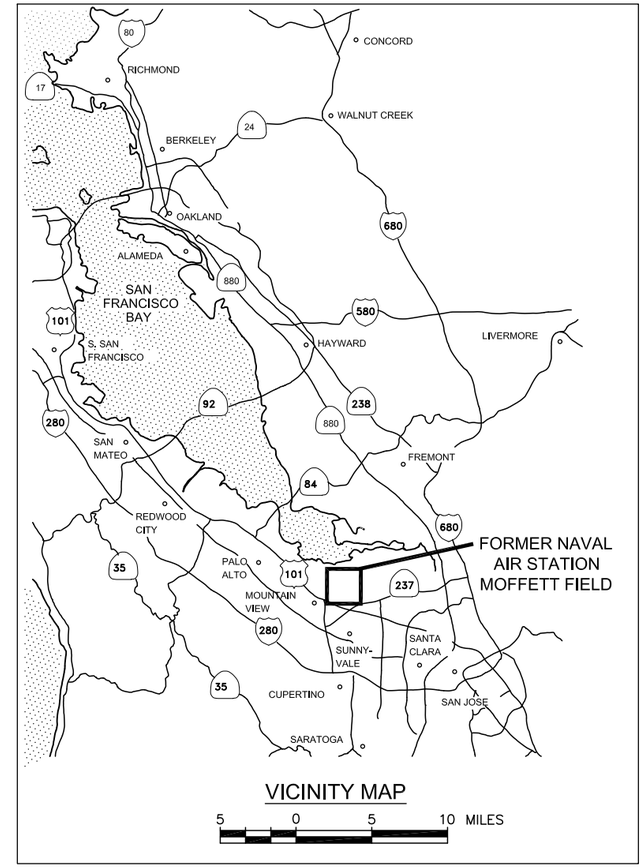
IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	---	CONCORD	KAB	AM	NH	500238-B1
			3-26-14	12-18-14	12-18-14	



SITE LOCATION MAP

600' 0 600' 1200'

Approximate Scale – Feet



VICINITY MAP

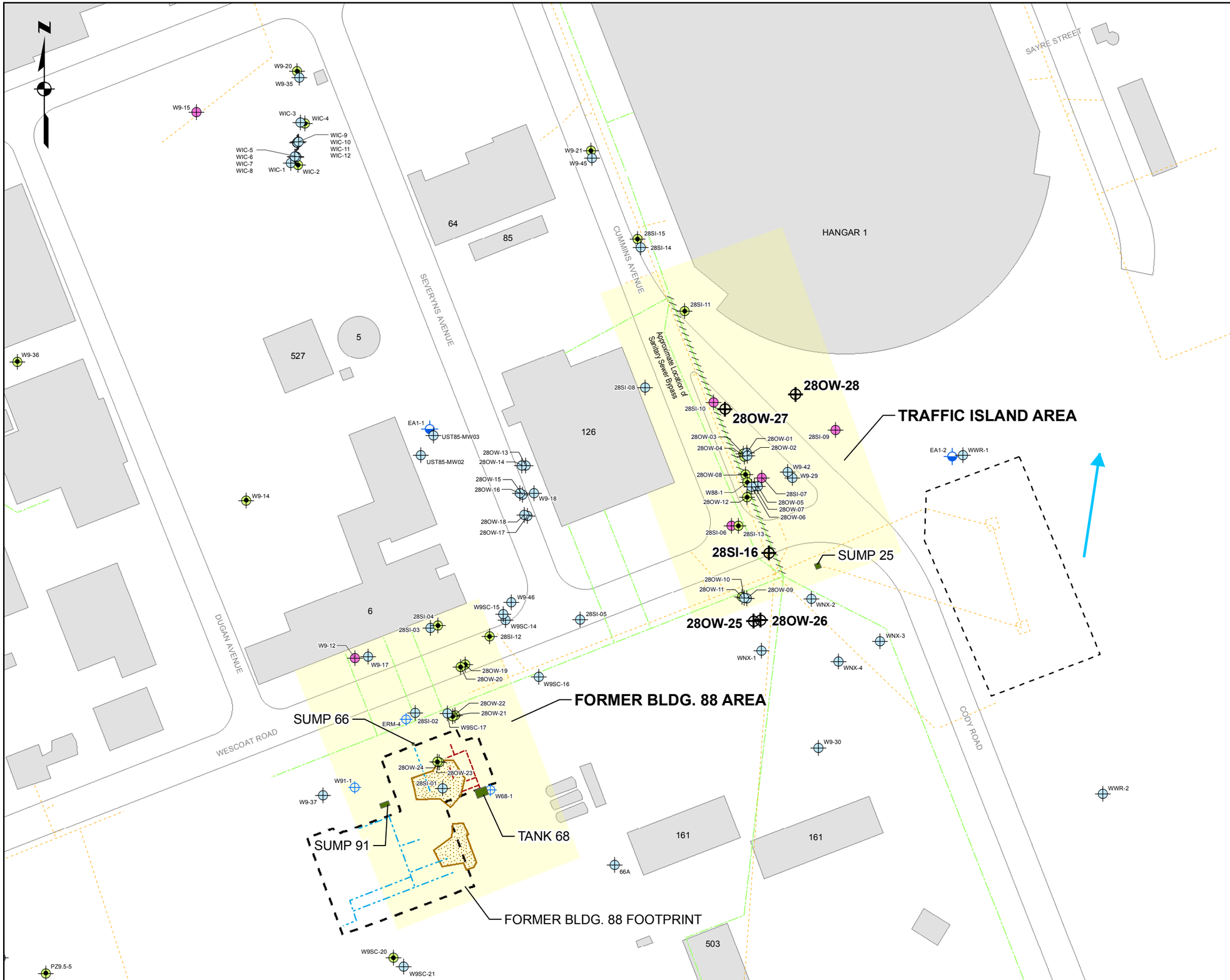
5 0 5 10 MILES

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE A-1

SITE LOCATION MAP

IR SITE 28, FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA



Legend

- PROPOSED GROUNDWATER MONITORING WELL
- UPPER A-AQUIFER MONITORING WELL
- LOWER A-AQUIFER MONITORING WELL
- B2-AQUIFER MONITORING WELL
- A-AQUIFER EXTRACTION WELL
- FORMER GROUNDWATER MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION[1]
- STORM DRAIN LINE
- SANITARY SEWER LINE
- SECTION OF THE SANITARY SEWER LINE THAT REPORTEDLY COLLAPSED [2]
- CONCRETE-LINED WASTEWATER COLLECTION TRENCH (REMOVED)
- FLOOR DRAIN PIPING (REMOVED)
- FORMER AIRCRAFT WASH RACK
- PREVIOUS REMEDIAL EXCAVATION AREA (7 TO 8 FT. BGS)
- AREA OF INTEREST
- SUMP, TANK, OR OIL/WATER SEPARATOR (REMOVED)
- 503 BUILDING AND BUILDING NUMBER

[1] Brown and Caldwell, 2011 - March 2010 Potentiometric Surface Data for the Upper A-Aquifer

[2] PRC, 1995 - *Final Horizontal Conduit Study Technical Memorandum Text, Tables, and Figures*, August 4

0 80 160

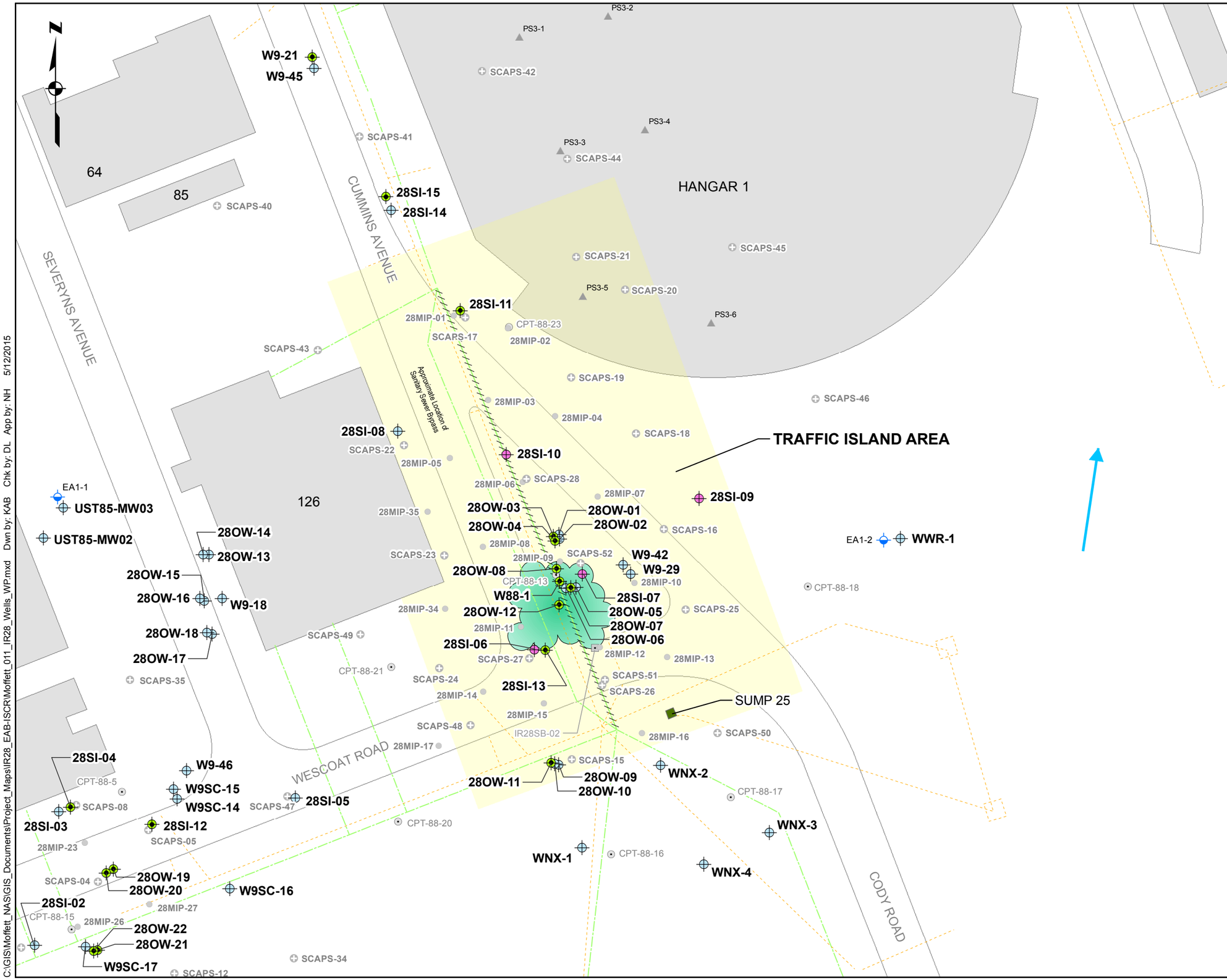
Approximate Scale - Feet

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE A-2
EXISTING AND PROPOSED
GROUNDWATER MONITORING WELL MAP

IR SITE 28, FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

C:\GIS\Moffett_NAS\GIS_Documents\Project_Maps\IR28_EAB-ISCR\Moffett_016_IR28_Site_SAP.mxd 5/12/2015



Legend

- UPPER A-AQUIFER MONITORING WELL
- LOWER A-AQUIFER MONITORING WELL
- B2-AQUIFER MONITORING WELL
- A-AQUIFER EXTRACTION WELL
- SCAPS LOCATION
- MIP LOCATION
- CPT LOCATION
- CONTINUOUS CORE LOCATION
- NASA SAMPLE LOCATION [1]
- GROUNDWATER FLOW DIRECTION [2]
- STORM DRAIN LINE
- SANITARY SEWER LINE
- SECTION OF THE SANITARY SEWER LINE THAT REPORTEDLY COLLAPSED [3]
- IN SITU BIOREMEDIATION TREATMENT TEST AREA (10 to 65 ft bgs) [4]
- AREA OF INTEREST
- SUMP, TANK, OR OIL/WATER SEPARATOR (REMOVED)
- 503 BUILDING AND BUILDING NUMBER

[1] NASA Sensitive but Unclassified Information

[2] Brown and Caldwell, 2011 - March 2010 Potentiometric Surface Data for the Upper A-Aquifer

[3] PRC, 1995. *Final Horizontal Conduit Study Technical Memorandum Text, Tables, and Figures,* August 4

[4] Shaw, 2010. *Final Progress Report, In Situ Anaerobic Biotic/Abiotic Treatability Study, IR Site 28*

0 50 100

Approximate Scale - Feet

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE A-3
SCAPS, MIP, CPT AND
CONTINUOUS CORE LOCATION MAP

IR SITE 28, FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

C:\GIS\Moffett_NAS\GIS_Documents\Project_Maps\IR28_EAB-ISCR\Moffett_011_IR28_Wells_WP.mxd Dwn by: KAB Chk by: DL App by: NH 5/12/2015

Figure A-1
Site Location Map

Figure A-2
Existing and Proposed Groundwater Monitoring Well Map

Figure A-3
SCAPS, MIP, CPT, and Continuous Core Location Map

Attachment 1
Field Forms

PAGE	1 OF 50
DATE	

SAMPLE COLLECTION LOG

Project Name: Moffett Field Well ID: _____

Project Number: 500238 Sample Collected By: _____

Project Location: IR Site 28 - Traffic Island

Purging Method/Equipment: Micropurge

Sampling Equipment: Non-dedicated QED Portable Bladder Pump /dedicated tubing

Flow Rate During Purging : 300 - 500 ml/min with water level drawdown less than 0.3 feet

Note: Flowrate for VOC sampling should be no greater than 100 ml/min

Daily field instrument calibration verification performed? Yes ___ No ___

Pump Start Time: _____

Measuring Point Top of Casing

Drawdown depth limit (DDL) = DTWi + 0.3 (ft)

Casing ID (in.) _____

depth of pump inlet (ft): _____

Depth to Water - Initial (DTWi) (ft) _____

Depth to Well Bottom (ft) _____

Screen Interval (ft): _____

FIELD CONDITIONS

Weather Conditions: ☐ Sunny ☐ Rain ☐ Wind Temperature: _____

PURGING INFORMATION

Time	Purge Rate (ml/min)	Depth to Water (DTW) (feet)	Specific Conductance (mS or µS /cm)	pH pH Units	Temp (˚C / F)	Turbidity (NTU)	ORP mV	DO (µg or mg/L)
Stabilization criteria:		drawdown limit 0.3 ft	± 10%	± 0.1	± 1	No Criteria	± 10 mV	± 10%

SAMPLING INFORMATION

Sample Number:		
Sample Date/Time:	/	
QC Sample Collected:	___ MS/MSD	_____ Field Duplicate Collected
Analyses / Bottles:	VOC (8260B) - 3 VOA - HCl ☐	☐
	Dissolved Gases - 3 VOA ☐	**Field Test: Ferrous Iron (HACH)**
	Alkalinity / Sulfate/Nitrate - ☐	**Result mg/L** _____
	TOC ☐	
	Dissolved - As, Mn, Fe ☐	

CHAIN OF CUSTODY

Reference Document #: 500238-001
Page: 1 of 1

CB&I
4005 Port Chicago Hwy
Concord, CA 94520

Project Manager: *Neil Hey*

Send Report To: *Rose Condit*
925.288.2151
4005 Port Chicago Hwy
Concord, CA 94520

Project Number: 500238
Project Name: Moffett Field
Project Location: IR S28 -Traffic Island
Purchase Order #: 1113293

Lab Destination: EMAX
1835 W 205th Street
Torrance, CA 90501
Lab Contact: Ye Myint
310.618.8889 x 121
ymyint@emaxlabs.com

Sampler(s): A. Martin / K Oleary

Sample ID	Location ID	Collection Information Date	Time	Method	Matrix	# of Containers	Preservative / Container Type	VOCs (EPA 8260B)	TOC (2310C)	SO4 & NO3 (300.0)	Alkalinity (2320B)	Dissolved Metals (As, Fe, Mn) 6010B				Cooler Temperature
							Preservative	HCl	HCl	Ice		HNO3				
							Container Type	3x VOA	1 x 125 ml Poly	1 x 500 ml poly		1 x 250ml poly				
28SI15-10/ /14	28SI-15	10/ /14		LF	GW	6		X	X	X	X	X				
TB-10/ /14	Trip Blank	10/ /14		LF	GW	1		X								
Temperature Blank																X

Special Instructions: Notes: Treatment design information samples
Metals are field filtered through 0.45µm in-line filter cartridge

Turn Around Time
☐ 24-hr ☐ 48-hr ☐ 5-day ☑ **10-day**

Level of QC Required
I | **III** | ☐

Project Specific
Level 3 report

Relinquished By:	Date: / Time:	Received By:	Date: / Time:
Relinquished By:	Date: / Time:	Received By:	Date: / Time:

Method Codes
LF Low Flow
G Grab

Matrix Codes
DW Drinking Water
SO Soil
GW Ground Water
BW Blank Water
WW Waste Water
WP Wsste Product

CHAIN OF CUSTODY

Reference Document #: 500238-100
Page: 1 of 1

CB&I
4005 Port Chicago Hwy
Concord, CA 94520

Project Manager: *Neil Hey*

Send Report To: *Rose Condit*
925.288.2314
4005 Port Chicago Hwy
Concord, CA 94520

Project Number: 500238
Project Name: Moffett Field
Project Location: IR S28 -Traffic Island
Purchase Order #:

Lab Destination: Pace
220 William Pitt Way
Pittsburgh, PA 15238
Lab Contact: Robbin Robl
412.826.5245
rrobl@microseeps.com

Sampler(s): A. Martin / K Oleary

Sample ID	Location ID	Collection Information Date	Time	Method	Matrix	# of Containers	Preservative	Container Type	Methane, Ethane, Ethene, Acetylene (low level)							Cooler Temperature
								Preservative	TSP							
								Container Type	2 x VOA							
28SI06-10/ /14	28SI-06	10/ /14		LF	GW	2			X							
28SI07-10/ /14	28SI-07	10/ /14		LF	GW	2			X							
28SI09-10/ /14	28SI-09	10/ /14		LF	GW	2			X							
28SI10-10/ /14	28SI-10	10/ /14		LF	GW	2			X							
28SI13-10/ /14	28SI-13	10/ /14		LF	GW	2			X							
28SI14-10/ /14	28SI-14	10/ /14		LF	GW	2			X							
28SI15-10/ /14	28SI-15	10/ /14		LF	GW	2			X							
Temperature Blank																X

Special Instructions:

Turn Around Time	Level of QC Required	Project Specific
☐ 24-hr ☐ 48-hr ☐ 5-da ☑ **10-day**	I II **III**	

Relinquished B	Date:	Received By:	Date:
	Time:	UPS -	Time:
Relinquished By:	Date:	Received By:	Date:
	Time:		Time:

Method Codes
LF Low Flow G Grab

Matrix Codes
DW Drinking Water SO Soil
GW Ground Water BW Blank Water
WW Waste Water WP Wsste Product

Attachment 2
Laboratory Certifications and Standard Operating Procedures

(Standard operating procedures provided with the final version only.)

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM
Accredited Fields of Testing

EMAX Laboratories, Inc.
1835 West 205th Street
Torrance, CA 90501
Phone: (310) 618-8889

Certificate No.: **2672**
Renew Date: **6/30/2015**

Field of Testing: 102 - Inorganic Chemistry of Drinking Water

102.020	001	Turbidity	EPA 180.1
102.022	001	Turbidity	SM2130B
102.030	001	Bromide	EPA 300.0
102.030	003	Chloride	EPA 300.0
102.030	005	Fluoride	EPA 300.0
102.030	006	Nitrate	EPA 300.0
102.030	007	Nitrite	EPA 300.0
102.030	008	Phosphate, Ortho	EPA 300.0
102.030	010	Sulfate	EPA 300.0
102.045	001	Perchlorate	EPA 314.0
102.100	001	Alkalinity	SM2320B
102.120	001	Hardness	SM2340B
102.121	001	Hardness	SM2340C
102.130	001	Conductivity	SM2510B
102.140	001	Total Dissolved Solids	SM2540C
102.145	001	Total Dissolved Solids	EPA 160.1
102.150	001	Chloride	SM4110B
102.150	002	Fluoride	SM4110B
102.150	003	Nitrate	SM4110B
102.150	004	Nitrite	SM4110B
102.150	005	Phosphate, Ortho	SM4110B
102.150	006	Sulfate	SM4110B
102.170	001	Chloride	SM4500-Cl- B
102.190	001	Cyanide, Total	SM4500-CN E
102.200	001	Fluoride	SM4500-F C
102.210	001	Hydrogen Ion (pH)	SM4500-H+ B
102.212	001	Hydrogen Ion (pH)	EPA 150.1
102.220	001	Nitrite	SM4500-NO2 B
102.232	002	Nitrate	SM4500-NO3 E
102.240	001	Phosphate, Ortho	SM4500-P E
102.260	001	Total Organic Carbon	SM5310B
102.520	001	Calcium	EPA 200.7
102.520	002	Magnesium	EPA 200.7
102.520	003	Potassium	EPA 200.7
102.520	005	Sodium	EPA 200.7
102.520	006	Hardness (calculation)	EPA 200.7

102.564	001	Cyanide	Quickchem 10-204-00-1-X

Field of Testing: 103 - Toxic Chemical Elements of Drinking Water

103.130	001	Aluminum	EPA 200.7
103.130	003	Barium	EPA 200.7
103.130	004	Beryllium	EPA 200.7
103.130	005	Cadmium	EPA 200.7
103.130	007	Chromium	EPA 200.7
103.130	008	Copper	EPA 200.7
103.130	009	Iron	EPA 200.7
103.130	011	Manganese	EPA 200.7
103.130	012	Nickel	EPA 200.7
103.130	015	Silver	EPA 200.7
103.130	017	Zinc	EPA 200.7
103.140	001	Aluminum	EPA 200.8
103.140	002	Antimony	EPA 200.8
103.140	003	Arsenic	EPA 200.8
103.140	004	Barium	EPA 200.8
103.140	005	Beryllium	EPA 200.8
103.140	006	Cadmium	EPA 200.8
103.140	007	Chromium	EPA 200.8
103.140	008	Copper	EPA 200.8
103.140	009	Lead	EPA 200.8
103.140	010	Manganese	EPA 200.8
103.140	012	Nickel	EPA 200.8
103.140	013	Selenium	EPA 200.8
103.140	014	Silver	EPA 200.8
103.140	015	Thallium	EPA 200.8
103.140	016	Zinc	EPA 200.8
103.160	001	Mercury	EPA 245.1
103.310	001	Chromium (VI)	EPA 218.6

Field of Testing: 104 - Volatile Organic Chemistry of Drinking Water

104.030	001	1,2-Dibromoethane	EPA 504.1
104.030	002	1,2-Dibromo-3-chloropropane	EPA 504.1
104.030	004	EDB and DBCP	EPA 504.1
104.040	000	Volatile Organic Compounds	EPA 524.2
104.040	001	Benzene	EPA 524.2
104.040	002	Bromobenzene	EPA 524.2
104.040	003	Bromochloromethane	EPA 524.2
104.040	006	Bromomethane	EPA 524.2
104.040	007	n-Butylbenzene	EPA 524.2
104.040	008	sec-Butylbenzene	EPA 524.2
104.040	009	tert-Butylbenzene	EPA 524.2
104.040	010	Carbon Tetrachloride	EPA 524.2

104.040	011	Chlorobenzene	EPA 524.2
104.040	012	Chloroethane	EPA 524.2
104.040	014	Chloromethane	EPA 524.2
104.040	015	2-Chlorotoluene	EPA 524.2
104.040	016	4-Chlorotoluene	EPA 524.2
104.040	018	Dibromomethane	EPA 524.2
104.040	019	1,3-Dichlorobenzene	EPA 524.2
104.040	020	1,2-Dichlorobenzene	EPA 524.2
104.040	021	1,4-Dichlorobenzene	EPA 524.2
104.040	022	Dichlorodifluoromethane	EPA 524.2
104.040	023	1,1-Dichloroethane	EPA 524.2
104.040	024	1,2-Dichloroethane	EPA 524.2
104.040	025	1,1-Dichloroethene	EPA 524.2
104.040	026	cis-1,2-Dichloroethene	EPA 524.2
104.040	027	trans-1,2-Dichloroethene	EPA 524.2
104.040	028	Dichloromethane	EPA 524.2
104.040	029	1,2-Dichloropropane	EPA 524.2
104.040	030	1,3-Dichloropropane	EPA 524.2
104.040	031	2,2-Dichloropropane	EPA 524.2
104.040	032	1,1-Dichloropropene	EPA 524.2
104.040	033	cis-1,3-Dichloropropene	EPA 524.2
104.040	034	trans-1,3-Dichloropropene	EPA 524.2
104.040	035	Ethylbenzene	EPA 524.2
104.040	036	Hexachlorobutadiene	EPA 524.2
104.040	037	Isopropylbenzene	EPA 524.2
104.040	038	4-Isopropyltoluene	EPA 524.2
104.040	039	Naphthalene	EPA 524.2
104.040	040	Nitrobenzene	EPA 524.2
104.040	041	N-propylbenzene	EPA 524.2
104.040	042	Styrene	EPA 524.2
104.040	043	1,1,1,2-Tetrachloroethane	EPA 524.2
104.040	044	1,1,2,2-Tetrachloroethane	EPA 524.2
104.040	045	Tetrachloroethene	EPA 524.2
104.040	046	Toluene	EPA 524.2
104.040	047	1,2,3-Trichlorobenzene	EPA 524.2
104.040	048	1,2,4-Trichlorobenzene	EPA 524.2
104.040	049	1,1,1-Trichloroethane	EPA 524.2
104.040	050	1,1,2-Trichloroethane	EPA 524.2
104.040	051	Trichloroethene	EPA 524.2
104.040	052	Trichlorofluoromethane	EPA 524.2
104.040	053	1,2,3-Trichloropropane	EPA 524.2
104.040	054	1,2,4-Trimethylbenzene	EPA 524.2
104.040	055	1,3,5-Trimethylbenzene	EPA 524.2

104.040	056	Vinyl Chloride	EPA 524.2
104.040	057	Xylenes, Total	EPA 524.2
104.040	059	Federal regulated VOCs, excluding vinyl chloride	EPA 524.2
104.040	060	Federal unregulated VOCs	EPA 524.2
104.045	001	Bromodichloromethane	EPA 524.2
104.045	002	Bromoform	EPA 524.2
104.045	003	Chloroform	EPA 524.2
104.045	004	Dibromochloromethane	EPA 524.2
104.045	005	Trihalomethanes	EPA 524.2
104.050	011	Oxygenates	EPA 524.2

Field of Testing: 108 - Inorganic Chemistry of Wastewater

108.020	001	Conductivity	EPA 120.1
108.110	001	Turbidity	EPA 180.1
108.112	001	Boron	EPA 200.7
108.112	002	Calcium	EPA 200.7
108.112	003	Hardness (calculation)	EPA 200.7
108.112	004	Magnesium	EPA 200.7
108.112	005	Potassium	EPA 200.7
108.112	007	Sodium	EPA 200.7
108.113	001	Boron	EPA 200.8
108.113	002	Calcium	EPA 200.8
108.113	003	Magnesium	EPA 200.8
108.113	004	Potassium	EPA 200.8
108.113	006	Sodium	EPA 200.8
108.120	001	Bromide	EPA 300.0
108.120	002	Chloride	EPA 300.0
108.120	003	Fluoride	EPA 300.0
108.120	004	Nitrate	EPA 300.0
108.120	005	Nitrite	EPA 300.0
108.120	006	Nitrate-nitrite, Total	EPA 300.0
108.120	007	Phosphate, Ortho	EPA 300.0
108.120	008	Sulfate	EPA 300.0
108.323	001	Chemical Oxygen Demand	EPA 410.4
108.360	001	Phenols, Total	EPA 420.1
108.381	002	Oil & Grease Total	EPA 1664 Rev. B
108.385	001	Color	SM2120B-2001
108.390	001	Turbidity	SM2130B-2001
108.400	001	Acidity	SM2310B-1997
108.410	001	Alkalinity	SM2320B-1997
108.420	001	Hardness (calculation)	SM2340B-1997
108.421	001	Hardness	SM2340C-1997
108.430	001	Conductivity	SM2510B-1997
108.440	001	Residue, Total	SM2540B-1997

108.441	001	Residue, Filterable TDS	SM2540C-1997
108.442	001	Residue, Non-filterable TSS	SM2540D-1997
108.443	001	Residue, Settleable	SM2540F-1997
108.448	001	Bromide	SM4110B or C-2000
108.448	002	Chloride	SM4110B or C-2000
108.448	003	Fluoride	SM4110B or C-2000
108.448	004	Nitrate	SM4110B or C-2000
108.448	005	Nitrite	SM4110B or C-2000
108.448	006	Nitrate-nitrite	SM4110B or C-2000
108.448	007	Phosphate, Ortho	SM4110B or C-2000
108.448	008	Sulfate	SM4110B or C-2000
108.450	001	Chloride	SM4500-ChlorideB-1997
108.460	001	Chlorine, Total	SM4500-Cl B-2000
108.472	001	Cyanide, Total	SM4500-CN E-1999
108.473	001	Cyanide, amenable	SM4500-CN G-1999
108.480	001	Fluoride	SM4500-F B,C-1997
108.490	001	Hydrogen Ion (pH)	SM4500-H+ B-2000
108.504	002	Ammonia (as N)	SM4500-NH3 F-1997
108.505	002	Kjeldahl Nitrogen, Total (as N)	SM4500-NH3 F-1997
108.512	001	Kjeldahl Nitrogen, Total (as N)	SM4500-Norg C-1997
108.514	001	Nitrite as N	SM4500-NO2- B-2000
108.528	001	Nitrate-Nitrite (as N)	SM4500-NO3- E-2000
108.528	002	Nitrite as N	SM4500-NO3- E-2000
108.528	003	Nitrate (as N)	SM4500-NO3- E-2000
108.540	001	Phosphate, Ortho	SM4500-P E-1999
108.541	001	Phosphorus, Total	SM4500-P E-1999
108.552	001	Silica, Dissolved	SM4500-SiO2 C-1997
108.580	001	Sulfide	SM4500-S= D
108.584	001	Sulfide (as S)	SM4500-S= D-2000
108.585	001	Sulfide (as S)	SM4500-S= F-2000
108.592	001	Biochemical Oxygen Demand	SM5210B-2001
108.595	001	Chemical Oxygen Demand	SM5220D-1997
108.596	001	Organic Carbon-Total (TOC)	SM5310B-2000
108.603	001	Oil & Grease Total	SM5520B-2001
108.605	001	Surfactants	SM5540C-2000
108.926	001	Cyanide	Quickchem 10-204-00-1-X

Field of Testing: 109 - Toxic Chemical Elements of Wastewater

109.010	001	Aluminum	EPA 200.7
109.010	002	Antimony	EPA 200.7
109.010	003	Arsenic	EPA 200.7
109.010	004	Barium	EPA 200.7
109.010	005	Beryllium	EPA 200.7
109.010	007	Cadmium	EPA 200.7

109.010	009	Chromium	EPA 200.7
109.010	010	Cobalt	EPA 200.7
109.010	011	Copper	EPA 200.7
109.010	012	Iron	EPA 200.7
109.010	013	Lead	EPA 200.7
109.010	015	Manganese	EPA 200.7
109.010	016	Molybdenum	EPA 200.7
109.010	017	Nickel	EPA 200.7
109.010	019	Selenium	EPA 200.7
109.010	021	Silver	EPA 200.7
109.010	023	Thallium	EPA 200.7
109.010	024	Tin	EPA 200.7
109.010	026	Vanadium	EPA 200.7
109.010	027	Zinc	EPA 200.7
109.020	001	Aluminum	EPA 200.8
109.020	002	Antimony	EPA 200.8
109.020	003	Arsenic	EPA 200.8
109.020	004	Barium	EPA 200.8
109.020	005	Beryllium	EPA 200.8
109.020	006	Cadmium	EPA 200.8
109.020	007	Chromium	EPA 200.8
109.020	008	Cobalt	EPA 200.8
109.020	009	Copper	EPA 200.8
109.020	010	Lead	EPA 200.8
109.020	011	Manganese	EPA 200.8
109.020	012	Molybdenum	EPA 200.8
109.020	013	Nickel	EPA 200.8
109.020	014	Selenium	EPA 200.8
109.020	015	Silver	EPA 200.8
109.020	016	Thallium	EPA 200.8
109.020	017	Vanadium	EPA 200.8
109.020	018	Zinc	EPA 200.8
109.020	021	Iron	EPA 200.8
109.020	022	Tin	EPA 200.8
109.020	023	Titanium	EPA 200.8
109.104	001	Chromium (VI)	EPA 218.6
109.190	001	Mercury	EPA 245.1
109.824	001	Iron	SM3500-Fe B (20th)

Field of Testing: 110 - Volatile Organic Chemistry of Wastewater

110.040	000	Purgeable Organic Compounds	EPA 624
110.040	042	Oxygenates	EPA 624
110.040	043	Other Volatile Organics	EPA 624

Field of Testing: 111 - Semi-volatile Organic Chemistry of Wastewater

111.101	032	Polynuclear Aromatic Hydrocarbons	EPA 625
111.101	034	Phthalates	EPA 625
111.101	036	Other Extractables	EPA 625
111.170	030	Organochlorine Pesticides & PCBs	EPA 608
111.170	031	PCBs	EPA 608
111.272	001	Oil and Grease	SM5520B (20th)
111.273	001	Oil and Grease	EPA 1664A

Field of Testing: 114 - Inorganic Chemistry of Hazardous Waste

114.010	001	Antimony	EPA 6010B
114.010	002	Arsenic	EPA 6010B
114.010	003	Barium	EPA 6010B
114.010	004	Beryllium	EPA 6010B
114.010	005	Cadmium	EPA 6010B
114.010	006	Chromium	EPA 6010B
114.010	007	Cobalt	EPA 6010B
114.010	008	Copper	EPA 6010B
114.010	009	Lead	EPA 6010B
114.010	010	Molybdenum	EPA 6010B
114.010	011	Nickel	EPA 6010B
114.010	012	Selenium	EPA 6010B
114.010	013	Silver	EPA 6010B
114.010	014	Thallium	EPA 6010B
114.010	015	Vanadium	EPA 6010B
114.010	016	Zinc	EPA 6010B
114.020	001	Antimony	EPA 6020
114.020	002	Arsenic	EPA 6020
114.020	003	Barium	EPA 6020
114.020	004	Beryllium	EPA 6020
114.020	005	Cadmium	EPA 6020
114.020	006	Chromium	EPA 6020
114.020	007	Cobalt	EPA 6020
114.020	008	Copper	EPA 6020
114.020	009	Lead	EPA 6020
114.020	010	Molybdenum	EPA 6020
114.020	011	Nickel	EPA 6020
114.020	012	Selenium	EPA 6020
114.020	013	Silver	EPA 6020
114.020	014	Thallium	EPA 6020
114.020	015	Vanadium	EPA 6020
114.020	016	Zinc	EPA 6020
114.103	001	Chromium (VI)	EPA 7196A
114.106	001	Chromium (VI)	EPA 7199
114.140	001	Mercury	EPA 7470A

114.141	001	Mercury	EPA 7471A
114.222	001	Cyanide	EPA 9014
114.230	001	Sulfides, Total	EPA 9034
114.240	001	Corrosivity - pH Determination	EPA 9040B
114.241	001	Corrosivity - pH Determination	EPA 9045C
114.250	001	Fluoride	EPA 9056
114.270	001	Fluoride	EPA 9214
114.280	001	Organic Lead	HML 939-M

Field of Testing: 115 - Extraction Test of Hazardous Waste

115.020	001	Toxicity Characteristic Leaching Procedure (TCLP)	EPA 1311
115.030	001	Waste Extraction Test (WET)	CCR Chapter11, Article 5, Appendix II
115.040	001	Synthetic Precipitation Leaching Procedure (SPLP)	EPA 1312

Field of Testing: 116 - Volatile Organic Chemistry of Hazardous Waste

116.010	000	EDB and DBCP	EPA 8011
116.020	011	Ethylene Glycol	EPA 8015B
116.020	031	Ethanol and Methanol	EPA 8015B
116.030	001	Gasoline-range Organics	EPA 8015B
116.080	000	Volatile Organic Compounds	EPA 8260B
116.080	120	Oxygenates	EPA 8260B
116.100	010	BTEX and MTBE	LUFT GC/MS
116.110	001	Total Petroleum Hydrocarbons - Gasoline	LUFT

Field of Testing: 117 - Semi-volatile Organic Chemistry of Hazardous Waste

117.010	001	Diesel-range Total Petroleum Hydrocarbons	EPA 8015B
117.015	001	Diesel-range Total Petroleum Hydrocarbons	LUFT GC/MS
117.016	001	Diesel-range Total Petroleum Hydrocarbons	LUFT
117.017	001	TRPH Screening	EPA 418.1
117.110	000	Extractable Organics	EPA 8270C
117.111	073	Polynuclear Aromatic Hydrocarbons	EPA 8270C
117.111	075	Phthalates	EPA 8270C
117.111	076	Other Extractables	EPA 8270C
117.140	000	Polynuclear Aromatic Hydrocarbons	EPA 8310
117.171	000	Nitroaromatics and Nitramines	EPA 8330A
117.190	001	Nitroglycerine	EPA 8332
117.210	000	Organochlorine Pesticides & PCBs	EPA 8081A
117.220	000	PCBs	EPA 8082
117.250	000	Chlorinated Herbicides	EPA 8151A

Field of Testing: 120 - Physical Properties of Hazardous Waste

120.010	001	Ignitability	EPA 1010
120.040	001	Reactive Cyanide	Section 7.3 SW-846
120.050	001	Reactive Sulfide	Section 7.3 SW-846
120.070	001	Corrosivity - pH Determination	EPA 9040B
120.080	001	Corrosivity - pH Determination	EPA 9045C

LABORATORY ACCREDITATION BUREAU a division of A-S-B

Certificate of Accreditation

ISO/IEC 17025:2005 Certificate Number L2278

EMAX Laboratories, Inc.

1835 W. 205th St.
Torrance CA 90501

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation valid through: January 10, 2017

R. Douglas Leonard, Jr., President, COO
Laboratory Accreditation Bureau
Presented the 9th of January 2014

*See the laboratory's Scope of Accreditation for details of accredited parameters
**Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).
Form 403.14 – Rev 1 7/3/13

LABORATORY ACCREDITATION BUREAU

Certificate # L2278

Scope of Accreditation
For
EMAX Laboratories, Inc.

1835 W 205th Street
Torrance, CA 90501
Kenette Pimentel
310-618-8889

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (LABPR 403 DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM V5) based on the TNI Standard - Environmental Laboratory Sector, Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis, Sept 2009 (EL-V1-2009); accreditation is granted to **EMAX Laboratories, Inc.** to perform the following tests:

Accreditation granted through: **January 10, 2017**

Testing - Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	AK101	GRO
GC	AK102	DRO
GFAA	CA 939M	Organo Lead
Platinum Electrode	EPA 120.1	Specific Conductance
Titrimetric	EPA 130.2	Hardness
Electrode	EPA 150.1	pH
Gravimetric	EPA 160.1	TDS
Gravimetric	EPA 160.2	TSS
Gravimetric	EPA 160.3	Total Residue
Turbidimetric	EPA 180.1	Turbidity
ICP	EPA 200.7	Aluminum
ICP	EPA 200.7	Antimony
ICP	EPA 200.7	Arsenic
ICP	EPA 200.7	Barium
ICP	EPA 200.7	Beryllium
ICP	EPA 200.7	Boron
ICP	EPA 200.7	Cadmium
ICP	EPA 200.7	Calcium
ICP	EPA 200.7	Chromium
ICP	EPA 200.7	Cobalt
ICP	EPA 200.7	Copper
ICP	EPA 200.7	Iron

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP	EPA 200.7	Lead
ICP	EPA 200.7	Magnesium
ICP	EPA 200.7	Manganese
ICP	EPA 200.7	Molybdenum
ICP	EPA 200.7	Nickel
ICP	EPA 200.7	Potassium
ICP	EPA 200.7	Selenium
ICP	EPA 200.7	Silver
ICP	EPA 200.7	Sodium
ICP	EPA 200.7	Strontium
ICP	EPA 200.7	Thallium
ICP	EPA 200.7	Tin
ICP	EPA 200.7	Titanium
ICP	EPA 200.7	Vanadium
ICP	EPA 200.7	Zinc
ICP-MS	EPA 200.8	Aluminum
ICP-MS	EPA 200.8	Antimony
ICP-MS	EPA 200.8	Arsenic
ICP-MS	EPA 200.8	Barium
ICP-MS	EPA 200.8	Beryllium
ICP-MS	EPA 200.8	Boron
ICP-MS	EPA 200.8	Cadmium
ICP-MS	EPA 200.8	Calcium
ICP-MS	EPA 200.8	Chromium
ICP-MS	EPA 200.8	Cobalt
ICP-MS	EPA 200.8	Copper
ICP-MS	EPA 200.8	Iron
ICP-MS	EPA 200.8	Lead
ICP-MS	EPA 200.8	Lithium
ICP-MS	EPA 200.8	Magnesium
ICP-MS	EPA 200.8	Manganese
ICP-MS	EPA 200.8	Molybdenum
ICP-MS	EPA 200.8	Nickel
ICP-MS	EPA 200.8	Potassium
ICP-MS	EPA 200.8	Selenium
ICP-MS	EPA 200.8	Silver
ICP-MS	EPA 200.8	Sodium
ICP-MS	EPA 200.8	Strontium
ICP-MS	EPA 200.8	Thallium
ICP-MS	EPA 200.8	Tin
ICP-MS	EPA 200.8	Titanium
ICP-MS	EPA 200.8	Uranium
ICP-MS	EPA 200.8	Vanadium

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP-MS	EPA 200.8	Zinc
IC	EPA 218.6	Hexavalent Chromium
COLD VAPOR	EPA 245.1	Mercury
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Chloride
IC	EPA 300.0	Nitrite
IC	EPA 300.0	Bromide
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Phosphate
IC	EPA 300.0	Sulfate
IC	EPA 300.0	Bromate
IC	EPA 300.0	Chlorate
IC	EPA 300M	Lactate
IC	EPA 300M	Acetate
IC	EPA 300M	Propionate
IC	EPA 300M	Butyrate
IC	EPA 300M	Pyruvate
IC	EPA 310.1	Alkalinity
IC	EPA 314.0	Perchlorate
Titrimetric	EPA 330.3	Total Residual Chlorine
Spectrometric	EPA 352.1	Nitrate-N
Spectrometric	EPA 353.3	Nitrate-N
Spectrometric	EPA 354.1	Nitrite-N
Spectrometric	EPA 365.2	Ortho-phosphate
Spectrometric	EPA 335.2	Cyanide
Spectrometric	EPA 350.2	Ammonia
Spectrometric	EPA 351.3	TKN
Spectrometric	EPA 365.2	Phosphorus
Spectrometric	EPA 370.1	Silica
Titrimetric	EPA 376.1	Sulfide
Spectrometric	EPA 376.2	Sulfide
Electrode	EPA 405.1	BOD
Spectrometric	EPA 410.4	COD
Combustion-IR	EPA 415.1	TOC
Spectrometric	EPA 420.1	Phenols
Spectrometric	EPA 425.1	MBAS
GC	EPA 504.1	DBCP
GC	EPA 504.1	EDB
GC	EPA 608	Aldrin
GC	EPA 608	alpha-BHC
GC	EPA 608	beta-BHC
GC	EPA 608	delta-BHC
GC	EPA 608	gamma-BHC (Lindane)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 608	DDD (4,4)
GC	EPA 608	DDE (4,4)
GC	EPA 608	DDT (4,4)
GC	EPA 608	Dieldrin
GC	EPA 608	Endosulfan I
GC	EPA 608	Endosulfan II
GC	EPA 608	Endosulfan sulfate
GC	EPA 608	Endrin
GC	EPA 608	Endrin Aldehyde
GC	EPA 608	Heptachlor
GC	EPA 608	Heptachlor epoxide
GC	EPA 608	Methoxychlor
GC	EPA 608	alpha-Chlordane
GC	EPA 608	gamma-Chlordane
GC	EPA 608	Endrin Ketone
GC	EPA 608	Toxaphene
GC	EPA 608	Technical Chlordane
GC	EPA 608	cis-Nonachlor
GC	EPA 608	DDD (2,4)
GC	EPA 608	DDE (2,4)
GC	EPA 608	DDT (2,4)
GC	EPA 608	Mirex
GC	EPA 608	Oxychlordane
GC	EPA 608	trans-Nonachlor
GC	EPA 608	PCB1016
GC	EPA 608	PCB1221
GC	EPA 608	PCB1232
GC	EPA 608	PCB1242
GC	EPA 608	PCB1248
GC	EPA 608	PCB1254
GC	EPA 608	PCB1260
GC	EPA 608	PCB1262
GC	EPA 608	PCB1268
GC-MS	EPA 624	Acrolein
GC-MS	EPA 624	Acrylonitrile
GC-MS	EPA 624	Benzene
GC-MS	EPA 624	Bromodichloromethane
GC-MS	EPA 624	Bromoform
GC-MS	EPA 624	Bromomethane
GC-MS	EPA 624	Carbon tetrachloride
GC-MS	EPA 624	Chlorobenzene
GC-MS	EPA 624	2-Chloroethyl vinyl ether
GC-MS	EPA 624	Chloroethane

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 624	Chloroform
GC-MS	EPA 624	Chloromethane
GC-MS	EPA 624	Dibromochloromethane
GC-MS	EPA 624	1,1-Dichloroethane
GC-MS	EPA 624	1,2-Dichloroethane
GC-MS	EPA 624	1,2-Dichlorobenzene
GC-MS	EPA 624	1,3-Dichlorobenzene
GC-MS	EPA 624	1,4-Dichlorobenzene
GC-MS	EPA 624	Dichlorodifluoromethane
GC-MS	EPA 624	1,1-Dichloroethene
GC-MS	EPA 624	cis-1,2-Dichloroethene
GC-MS	EPA 624	trans-1,2-Dichloroethene
GC-MS	EPA 624	1,2-Dichloropropane
GC-MS	EPA 624	cis-1,3-Dichloropropene
GC-MS	EPA 624	trans-1,3-Dichloropropene
GC-MS	EPA 624	Ethylbenzene
GC-MS	EPA 624	Methylene Chloride
GC-MS	EPA 624	tert-Butyl methyl ether
GC-MS	EPA 624	Styrene
GC-MS	EPA 624	1,1,2,2-Tetrachloroethane
GC-MS	EPA 624	Tetrachloroethene
GC-MS	EPA 624	Toluene
GC-MS	EPA 624	1,1,1-Trichloroethane
GC-MS	EPA 624	1,1,2-Trichloroethane
GC-MS	EPA 624	1,2,4-Trichlorobenzene
GC-MS	EPA 624	Trichloroethene
GC-MS	EPA 624	Trichlorofluoromethane
GC-MS	EPA 624	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	EPA 624	Vinyl Chloride
GC-MS	EPA 624	m-Xylene & p-xylene
GC-MS	EPA 624	o-Xylene
GC-MS	EPA 625	Acenaphthene
GC-MS	EPA 625	Acenaphthylene
GC-MS	EPA 625	Aniline
GC-MS	EPA 625	Anthracene
GC-MS	EPA 625	Azobenzene
GC-MS	EPA 625	Benzidine
GC-MS	EPA 625	Benzo(a)anthracene
GC-MS	EPA 625	benzo(a)pyrene
GC-MS	EPA 625	Benzo(b)fluoranthene
GC-MS	EPA 625	Benzo(e)pyrene
GC-MS	EPA 625	Benzo(g,h,i)perylene
GC-MS	EPA 625	Benzo(k)fluoranthene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 625	Benzoic Acid
GC-MS	EPA 625	Benzyl Alcohol
GC-MS	EPA 625	Biphenyl
GC-MS	EPA 625	bis(2-chloroethoxy)methane
GC-MS	EPA 625	bis(2-chloroethyl)ether
GC-MS	EPA 625	bis(2-chloroisopropyl)ether
GC-MS	EPA 625	bis(2-Ethylhexyl)adipate
GC-MS	EPA 625	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 625	4-Bromophenyl-phenylether
GC-MS	EPA 625	Butylbenzylphthalate
GC-MS	EPA 625	Carbazole
GC-MS	EPA 625	4-Chloro-3-methylphenol
GC-MS	EPA 625	4-Chloroaniline
GC-MS	EPA 625	2-Chloronaphthalene
GC-MS	EPA 625	2-Chlorophenol
GC-MS	EPA 625	4-Chlorophenyl-phenylether
GC-MS	EPA 625	Chrysene
GC-MS	EPA 625	Dibenzo(a,h)anthracene
GC-MS	EPA 625	Dibenzofuran
GC-MS	EPA 625	1,2-Dichlorobenzene
GC-MS	EPA 625	1,3-Dichlorobenzene
GC-MS	EPA 625	1,4-Dichlorobenzene
GC-MS	EPA 625	3,3'-Dichlorobenzidine
GC-MS	EPA 625	2,4-Dichlorophenol
GC-MS	EPA 625	Diethylphthalate
GC-MS	EPA 625	2,6-Dimethylnaphthalene
GC-MS	EPA 625	2,4-Dimethylphenol
GC-MS	EPA 625	Dimethylphthalate
GC-MS	EPA 625	Di-n-butylphthalate
GC-MS	EPA 625	4,6-Dinitro-2-methylphenol
GC-MS	EPA 625	2,4-Dinitrophenol
GC-MS	EPA 625	2,4-Dinitrotoluene
GC-MS	EPA 625	2,6-Dinitrotoluene
GC-MS	EPA 625	Di-n-octylphthalate
GC-MS	EPA 625	1,2-Diphenylhydrazine
GC-MS	EPA 625	Fluoranthene
GC-MS	EPA 625	Fluorene
GC-MS	EPA 625	Hexachlorobenzene
GC-MS	EPA 625	Hexachlorobutadiene
GC-MS	EPA 625	Hexachlorocyclopentadiene
GC-MS	EPA 625	Hexachloroethane
GC-MS	EPA 625	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 625	Isophorone

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 625	1-Methylnaphthalene
GC-MS	EPA 625	2-Methylnaphthalene
GC-MS	EPA 625	1-Methylphenanthrene
GC-MS	EPA 625	2-Methylphenol
GC-MS	EPA 625	4-Methylphenol
GC-MS	EPA 625	Naphthalene
GC-MS	EPA 625	2-Nitroaniline
GC-MS	EPA 625	3-Nitroaniline
GC-MS	EPA 625	4-Nitroaniline
GC-MS	EPA 625	Nitrobenzene
GC-MS	EPA 625	2-Nitrophenol
GC-MS	EPA 625	4-Nitrophenol
GC-MS	EPA 625	n-Nitrosodimethylamine
GC-MS	EPA 625	n-Nitroso-di-n-propylamine
GC-MS	EPA 625	n-Nitrosodiphenylamine
GC-MS	EPA 625	Pentachlorophenol
GC-MS	EPA 625	Perylene
GC-MS	EPA 625	Phenanthrene
GC-MS	EPA 625	Phenol
GC-MS	EPA 625	Pyrene
GC-MS	EPA 625	Pyridine
GC-MS	EPA 625	2,3,4,6-Tetrachlorophenol
GC-MS	EPA 625	1,2,4-Trichlorobenzene
GC-MS	EPA 625	2,3,4-Trichlorophenol
GC-MS	EPA 625	2,3,5-Trichlorophenol
GC-MS	EPA 625	2,4,5-Trichlorophenol
GC-MS	EPA 625	2,4,6-Trichlorophenol
GC-MS	EPA 625	2,3,5-Trimethylnaphthalene
Gravimetric	EPA 1664A / 1664 B	Oil & Grease
Pensky-Martens	EPA 1010 / 1010A	Ignitability
ICP	EPA 6010B / 6010C	Aluminum
ICP	EPA 6010B / 6010C	Antimony
ICP	EPA 6010B / 6010C	Arsenic
ICP	EPA 6010B / 6010C	Barium
ICP	EPA 6010B / 6010C	Beryllium
ICP	EPA 6010B / 6010C	Boron
ICP	EPA 6010B / 6010C	Cadmium
ICP	EPA 6010B / 6010C	Calcium
ICP	EPA 6010B / 6010C	Chromium
ICP	EPA 6010B / 6010C	Cobalt
ICP	EPA 6010B / 6010C	Copper
ICP	EPA 6010B / 6010C	Iron
ICP	EPA 6010B / 6010C	Lead

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP	EPA 6010B / 6010C	Magnesium
ICP	EPA 6010B / 6010C	Manganese
ICP	EPA 6010B / 6010C	Molybdenum
ICP	EPA 6010B / 6010C	Nickel
ICP	EPA 6010B / 6010C	Potassium
ICP	EPA 6010B / 6010C	Selenium
ICP	EPA 6010B / 6010C	Silver
ICP	EPA 6010B / 6010C	Sodium
ICP	EPA 6010B / 6010C	Strontium
ICP	EPA 6010B / 6010C	Thallium
ICP	EPA 6010B / 6010C	Tin
ICP	EPA 6010B / 6010C	Titanium
ICP	EPA 6010B / 6010C	Vanadium
ICP	EPA 6010B / 6010C	Zinc
ICP-MS	EPA 6020A	Aluminum
ICP-MS	EPA 6020A	Antimony
ICP-MS	EPA 6020A	Arsenic
ICP-MS	EPA 6020A	Barium
ICP-MS	EPA 6020A	Beryllium
ICP-MS	EPA 6020A	Boron
ICP-MS	EPA 6020A	Cadmium
ICP-MS	EPA 6020A	Calcium
ICP-MS	EPA 6020A	Chromium
ICP-MS	EPA 6020A	Cobalt
ICP-MS	EPA 6020A	Copper
ICP-MS	EPA 6020A	Iron
ICP-MS	EPA 6020A	Lead
ICP-MS	EPA 6020A	Magnesium
ICP-MS	EPA 6020A	Manganese
ICP-MS	EPA 6020A	Molybdenum
ICP-MS	EPA 6020A	Nickel
ICP-MS	EPA 6020A	Potassium
ICP-MS	EPA 6020A	Selenium
ICP-MS	EPA 6020A	Silver
ICP-MS	EPA 6020A	Sodium
ICP-MS	EPA 6020A	Strontium
ICP-MS	EPA 6020A	Thallium
ICP-MS	EPA 6020A	Tin
ICP-MS	EPA 6020A	Titanium
ICP-MS	EPA 6020A	Tungsten
ICP-MS	EPA 6020A	Uranium
ICP-MS	EPA 6020A	Vanadium
ICP-MS	EPA 6020A	Zinc

Non-Potable Water		
Technology	**Method**	**Analyte**
HPLC-MS	EPA 6850	Perchlorate
Spectrometric	EPA 7196A	Hex. Chromium
IC	EPA 7199	Hex. Chromium
Cold-Vapor	EPA 7470A	Mercury
GC	EPA 8015B / 8015C / 8015D	Gasoline
GC	EPA 8015B / 8015C / 8015D	Diesel
GC	EPA 8015B / 8015C / 8015D	Motor Oil
GC	EPA 8015B / 8015C	Diethylene Glycol
GC	EPA 8015B / 8015C	Ethanol
GC	EPA 8015B / 8015C	Ethylene Glycol
GC	EPA 8015B / 8015C	Isopropanol
GC	EPA 8015B / 8015C / 8015D	JP4
GC	EPA 8015B / 8015C	Methanol
GC	EPA 8015B / 8015C	Propylene Glycol
GC	EPA 8015B / 8015C / 8015D	JP5
GC	EPA 8015B / 8015C	Triethylene Glycol
GC	EPA 8081A / 8081B	Aldrin
GC	EPA 8081A / 8081B	alpha-BHC
GC	EPA 8081A / 8081B	beta-BHC
GC	EPA 8081A / 8081B	delta-BHC
GC	EPA 8081A / 8081B	gamma-BHC (Lindane)
GC	EPA 8081A / 8081B	DDD (4,4)
GC	EPA 8081A / 8081B	DDE (4,4)
GC	EPA 8081A / 8081B	DDT (4,4)
GC	EPA 8081A / 8081B	Dieldrin
GC	EPA 8081A / 8081B	Endosulfan I
GC	EPA 8081A / 8081B	Endosulfan II
GC	EPA 8081A / 8081B	Endosulfan sulfate
GC	EPA 8081A / 8081B	Endrin
GC	EPA 8081A / 8081B	Endrin Aldehyde
GC	EPA 8081A / 8081B	Heptachlor
GC	EPA 8081A / 8081B	Heptachlor epoxide
GC	EPA 8081A / 8081B	Methoxychlor
GC	EPA 8081A / 8081B	alpha-Chlordane
GC	EPA 8081A / 8081B	gamma-Chlordane
GC	EPA 8081A / 8081B	Endrin Ketone
GC	EPA 8081A / 8081B	Toxaphene
GC	EPA 8081A / 8081B	Technical Chlordane
GC	EPA 8081A / 8081B	cis-Nonachlor
GC	EPA 8081A / 8081B	DDD (2,4)
GC	EPA 8081A / 8081B	DDE (2,4)
GC	EPA 8081A / 8081B	DDT (2,4)
GC	EPA 8081A / 8081B	Mirex

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 8081A / 8081B	Oxychlordane
GC	EPA 8081A / 8081B	trans-Nonachlor
GC	EPA 8082 / 8082A	PCB1016
GC	EPA 8082 / 8082A	PCB1221
GC	EPA 8082 / 8082A	PCB1232
GC	EPA 8082 / 8082A	PCB1242
GC	EPA 8082 / 8082A	PCB1248
GC	EPA 8082 / 8082A	PCB1254
GC	EPA 8082 / 8082A	PCB1260
GC	EPA 8082 / 8082A	PCB1262
GC	EPA 8082 / 8082A	PCB1268
GC	EPA 8082 / 8082A	PCB 8
GC	EPA 8082 / 8082A	PCB 18
GC	EPA 8082 / 8082A	PCB 28
GC	EPA 8082 / 8082A	PCB 44
GC	EPA 8082 / 8082A	PCB 52
GC	EPA 8082 / 8082A	PCB 66
GC	EPA 8082 / 8082A	PCB 77
GC	EPA 8082 / 8082A	PCB 81
GC	EPA 8082 / 8082A	PCB 101
GC	EPA 8082 / 8082A	PCB 105
GC	EPA 8082 / 8082A	PCB 114
GC	EPA 8082 / 8082A	PCB 118
GC	EPA 8082 / 8082A	PCB 123
GC	EPA 8082 / 8082A	PCB 126
GC	EPA 8082 / 8082A	PCB 128
GC	EPA 8082 / 8082A	PCB 138
GC	EPA 8082 / 8082A	PCB 153
GC	EPA 8082 / 8082A	PCB 156
GC	EPA 8082 / 8082A	PCB 157
GC	EPA 8082 / 8082A	PCB 167
GC	EPA 8082 / 8082A	PCB 169
GC	EPA 8082 / 8082A	PCB 170
GC	EPA 8082 / 8082A	PCB 180
GC	EPA 8082 / 8082A	PCB 187
GC	EPA 8082 / 8082A	PCB 189
GC	EPA 8082 / 8082A	PCB 195
GC	EPA 8082 / 8082A	PCB 206
GC	EPA 8082 / 8082A	PCB 209
GC	EPA 8082 / 8082A	PCB 110
GC	EPA 8141A / 8141B	Azinphos-methyl
GC	EPA 8141A / 8141B	Bolstar
GC	EPA 8141A / 8141B	Chlorpyrifos

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 8141A / 8141B	Coumaphos
GC	EPA 8141A / 8141B	Demeton
GC	EPA 8141A / 8141B	Diazinon
GC	EPA 8141A / 8141B	Dichlorvos
GC	EPA 8141A / 8141B	Disulfoton
GC	EPA 8141A / 8141B	Ethoprop
GC	EPA 8141A / 8141B	Fensulfothion
GC	EPA 8141A / 8141B	Fenthion
GC	EPA 8141A / 8141B	Merphos
GC	EPA 8141A / 8141B	Mevinphos
GC	EPA 8141A / 8141B	Naled
GC	EPA 8141A / 8141B	Methyl Parathion
GC	EPA 8141A / 8141B	Phorate
GC	EPA 8141A / 8141B	Ronnel
GC	EPA 8141A / 8141B	Stirophos
GC	EPA 8141A / 8141B	Tokuthion
GC	EPA 8141A / 8141B	Trichloronate
GC	EPA 8141A / 8141B	Dimethoate
GC	EPA 8141A / 8141B	EPN
GC	EPA 8141A / 8141B	Famphur
GC	EPA 8141A / 8141B	Malathion
GC	EPA 8141A / 8141B	Ethyl Parathion
GC	EPA 8141A / 8141B	O,O,O-Triethylphosphorothioate
GC	EPA 8141A / 8141B	Sulfotepp
GC	EPA 8141A / 8141B	Thionazin
GC	EPA 8141A / 8141B	Tributyl Phosphate
GC	EPA 8151A	Acifluorfen
GC	EPA 8151A	Bentazon
GC	EPA 8151A	Chloramben
GC	EPA 8151A	2,4-D
GC	EPA 8151A	2,4-DB
GC	EPA 8151A	Dacthal
GC	EPA 8151A	Dalapon
GC	EPA 8151A	Dicamba
GC	EPA 8151A	3,5-Dichlorobenzoic acid
GC	EPA 8151A	Dichlorprop
GC	EPA 8151A	Dinoseb
GC	EPA 8151A	MCPA
GC	EPA 8151A	MCPP
GC	EPA 8151A	4-Nitrophenol
GC	EPA 8151A	Pentachlorophenol
GC	EPA 8151A	Picloram
GC	EPA 8151A	Silvex

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 8151A	2,4,5-T
GC-MS	EPA 8260B / 8260C	Acetone
GC-MS	EPA 8260B / 8260C	Acrolein
GC-MS	EPA 8260B / 8260C	Acrylonitrile
GC-MS	EPA 8260B / 8260C	Benzene
GC-MS	EPA 8260B / 8260C	Bromobenzene
GC-MS	EPA 8260B / 8260C	Bromochloromethane
GC-MS	EPA 8260B / 8260C	Bromodichloromethane
GC-MS	EPA 8260B / 8260C	Bromoform
GC-MS	EPA 8260B / 8260C	Bromomethane
GC-MS	EPA 8260B / 8260C	tert-Butyl alcohol
GC-MS	EPA 8260B / 8260C	2-Butanone (MEK)
GC-MS	EPA 8260B / 8260C	n-Butylbenzene
GC-MS	EPA 8260B / 8260C	sec-Butylbenzene
GC-MS	EPA 8260B / 8260C	tert-Butylbenzene
GC-MS	EPA 8260B / 8260C	Carbon disulfide
GC-MS	EPA 8260B / 8260C	Carbon tetrachloride
GC-MS	EPA 8260B / 8260C	Chlorobenzene
GC-MS	EPA 8260B / 8260C	2-Chloroethyl vinyl ether
GC-MS	EPA 8260B / 8260C	Chloroethane
GC-MS	EPA 8260B / 8260C	Chloroform
GC-MS	EPA 8260B / 8260C	1-Chlorohexane
GC-MS	EPA 8260B / 8260C	Chloromethane
GC-MS	EPA 8260B / 8260C	2-Chlorotoluene
GC-MS	EPA 8260B / 8260C	4-Chlorotoluene
GC-MS	EPA 8260B / 8260C	Isopropyl ether (DIPE)
GC-MS	EPA 8260B / 8260C	Dibromochloromethane
GC-MS	EPA 8260B / 8260C	1,2-Dibromo-3-chloropropane
GC-MS	EPA 8260B / 8260C	1,2-Dibromoethane
GC-MS	EPA 8260B / 8260C	Dibromomethane
GC-MS	EPA 8260B / 8260C	1,1-Dichloroethane
GC-MS	EPA 8260B / 8260C	1,2-Dichloroethane
GC-MS	EPA 8260B / 8260C	1,2-Dichlorobenzene
GC-MS	EPA 8260B / 8260C	1,3-Dichlorobenzene
GC-MS	EPA 8260B / 8260C	trans-1,4-Dichloro-2-Butene
GC-MS	EPA 8260B / 8260C	1,4-Dichlorobenzene
GC-MS	EPA 8260B / 8260C	Dichlorodifluoromethane
GC-MS	EPA 8260B / 8260C	1,1-Dichloroethene
GC-MS	EPA 8260B / 8260C	cis-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C	trans-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C	Dichlorofluoromethane
GC-MS	EPA 8260B / 8260C	1,1-Dichloropropene
GC-MS	EPA 8260B / 8260C	1,2-Dichloropropane

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B / 8260C	1,3-Dichloropropane
GC-MS	EPA 8260B / 8260C	2,2-Dichloropropane
GC-MS	EPA 8260B / 8260C	cis-1,3-Dichloropropene
GC-MS	EPA 8260B / 8260C	trans-1,3-Dichloropropene
GC-MS	EPA 8260B / 8260C	tert-Butyl ethyl ether (ETBE)
GC-MS	EPA 8260B / 8260C	Ethyl Methacrylate
GC-MS	EPA 8260B / 8260C	Ethylbenzene
GC-MS	EPA 8260B / 8260C	2-Hexanone (MBK)
GC-MS	EPA 8260B / 8260C	Hexachlorobutadiene
GC-MS	EPA 8260B / 8260C	Iodomethane
GC-MS	EPA 8260B / 8260C	Isopropylbenzene
GC-MS	EPA 8260B / 8260C	p-Isopropyltoluene
GC-MS	EPA 8260B / 8260C	Methylene Chloride
GC-MS	EPA 8260B / 8260C	4-Methyl-2-pentanone (MIBK)
GC-MS	EPA 8260B / 8260C	tert-Butyl methyl ether
GC-MS	EPA 8260B / 8260C	Naphthalene
GC-MS	EPA 8260B / 8260C	n-Propylbenzene
GC-MS	EPA 8260B / 8260C	Styrene
GC-MS	EPA 8260B / 8260C	tert-Amyl methyl ether (TAME)
GC-MS	EPA 8260B / 8260C	1,1,1,2-Tetrachloroethane
GC-MS	EPA 8260B / 8260C	1,1,2,2-Tetrachloroethane
GC-MS	EPA 8260B / 8260C	Tetrachloroethene
GC-MS	EPA 8260B / 8260C	Toluene
GC-MS	EPA 8260B / 8260C	1,1,1-Trichloroethane
GC-MS	EPA 8260B / 8260C	1,1,2-Trichloroethane
GC-MS	EPA 8260B / 8260C	1,2,3-Trichlorobenzene
GC-MS	EPA 8260B / 8260C	1,2,4-Trichlorobenzene
GC-MS	EPA 8260B / 8260C	Trichloroethene
GC-MS	EPA 8260B / 8260C	Trichlorofluoromethane
GC-MS	EPA 8260B / 8260C	1,2,3-Trichloropropane
GC-MS	EPA 8260B / 8260C	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	EPA 8260B / 8260C	1,2,4-Trimethylbenzene
GC-MS	EPA 8260B / 8260C	1,3,5-Trimethylbenzene
GC-MS	EPA 8260B / 8260C	Vinyl Acetate
GC-MS	EPA 8260B / 8260C	Vinyl Chloride
GC-MS	EPA 8260B / 8260C	m-Xylene & p-xylene
GC-MS	EPA 8260B / 8260C	o-Xylene
GC-MS	EPA 8260B / 8260C	2-Butanol
GC-MS	EPA 8260B / 8260C	Cyclohexane
GC-MS	EPA 8260B / 8260C	1,4-Dioxane
GC-MS	EPA 8260B / 8260C	2-Chloro-1,1,1-trifluoroethane
GC-MS	EPA 8260B / 8260C	Chlorotrifluoroethylene
GC-MS	EPA 8260B / 8260C	cis-1,4-Dichloro-2-butene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B / 8260C	Ethanol
GC-MS	EPA 8260B / 8260C	Ethyl Methacrylate
GC-MS	EPA 8260B / 8260C	Isobutyl Alcohol
GC-MS	EPA 8260B / 8260C	Methacrylonitrile
GC-MS	EPA 8260B / 8260C	Methyl Methacrylate
GC-MS	EPA 8260B / 8260C	Pentachloroethane
GC-MS	EPA 8260B / 8260C	Propionitrile
GC-MS	EPA 8260B / 8260C	Sec-Propyl alcohol
GC-MS	EPA 8260B / 8260C	Tetrahydrofuran
GC-MS	EPA 8260B / 8260C	trans-1,4-Dichloro-2-butene
GC-MS	EPA 8260B / 8260C SIM	Benzene
GC-MS	EPA 8260B / 8260C SIM	Carbon tetrachloride
GC-MS	EPA 8260B / 8260C SIM	Chloroform
GC-MS	EPA 8260B / 8260C SIM	Chloromethane
GC-MS	EPA 8260B / 8260C SIM	1,2-Dibromo-3-chloropropane
GC-MS	EPA 8260B / 8260C SIM	1,2-Dibromoethane
GC-MS	EPA 8260B / 8260C SIM	1,2-Dichloroethane
GC-MS	EPA 8260B / 8260C SIM	1,1-Dichloroethene
GC-MS	EPA 8260B / 8260C SIM	cis-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C SIM	trans-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C SIM	1,1,2,2-Tetrachloroethane
GC-MS	EPA 8260B / 8260C SIM	Tetrachloroethene
GC-MS	EPA 8260B / 8260C SIM	1,1,1-Trichloroethane
GC-MS	EPA 8260B / 8260C SIM	1,1,2-Trichloroethane
GC-MS	EPA 8260B / 8260C SIM	Trichloroethene
GC-MS	EPA 8260B / 8260C SIM	1,2,3-Trichloropropane
GC-MS	EPA 8260B / 8260C SIM	Vinyl Chloride
GC-MS	EPA 8260B / 8260C SIM	1,4-Dioxane
GC-MS	EPA 8270C / 8270D	Acenaphthene
GC-MS	EPA 8270C / 8270D	Acenaphthylene
GC-MS	EPA 8270C / 8270D	Aniline
GC-MS	EPA 8270C / 8270D	Anthracene
GC-MS	EPA 8270C / 8270D	Azobenzene
GC-MS	EPA 8270C / 8270D	Benzidine
GC-MS	EPA 8270C / 8270D	Benzo(a)anthracene
GC-MS	EPA 8270C / 8270D	benzo(a)pyrene
GC-MS	EPA 8270C / 8270D	Benzo(b)fluoranthene
GC-MS	EPA 8270C / 8270D	Benzo(e)pyrene
GC-MS	EPA 8270C / 8270D	Benzo(g,h,i)perylene
GC-MS	EPA 8270C / 8270D	Benzo(k)fluoranthene
GC-MS	EPA 8270C / 8270D	Benzoic Acid
GC-MS	EPA 8270C / 8270D	Benzyl Alcohol
GC-MS	EPA 8270C / 8270D	Biphenyl

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	bis(2-chloroethoxy)methane
GC-MS	EPA 8270C / 8270D	bis(2-chloroethyl)ether
GC-MS	EPA 8270C / 8270D	bis(2-chloroisopropyl)ether
GC-MS	EPA 8270C / 8270D	bis(2-Ethylhexyl)adipate
GC-MS	EPA 8270C / 8270D	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 8270C / 8270D	4-Bromophenyl-phenylether
GC-MS	EPA 8270C / 8270D	Butylbenzylphthalate
GC-MS	EPA 8270C / 8270D	Carbazole
GC-MS	EPA 8270C / 8270D	4-Chloro-3-methylphenol
GC-MS	EPA 8270C / 8270D	4-Chloroaniline
GC-MS	EPA 8270C / 8270D	2-Chloronaphthalene
GC-MS	EPA 8270C / 8270D	2-Chlorophenol
GC-MS	EPA 8270C / 8270D	4-Chlorophenyl-phenylether
GC-MS	EPA 8270C / 8270D	Chrysene
GC-MS	EPA 8270C / 8270D	Dibenzo(a,h)anthracene
GC-MS	EPA 8270C / 8270D	Dibenzofuran
GC-MS	EPA 8270C / 8270D	1,2-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	1,3-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	1,4-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	3,3'-Dichlorobenzidine
GC-MS	EPA 8270C / 8270D	2,4-Dichlorophenol
GC-MS	EPA 8270C / 8270D	Diethylphthalate
GC-MS	EPA 8270C / 8270D	2,6-Dimethylnaphthalene
GC-MS	EPA 8270C / 8270D	2,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D	Dimethylphthalate
GC-MS	EPA 8270C / 8270D	Di-n-butylphthalate
GC-MS	EPA 8270C / 8270D	4,6-Dinitro-2-methylphenol
GC-MS	EPA 8270C / 8270D	2,4-Dinitrophenol
GC-MS	EPA 8270C / 8270D	2,4-Dinitrotoluene
GC-MS	EPA 8270C / 8270D	2,6-Dinitrotoluene
GC-MS	EPA 8270C / 8270D	Di-n-octylphthalate
GC-MS	EPA 8270C / 8270D	Fluoranthene
GC-MS	EPA 8270C / 8270D	Fluorene
GC-MS	EPA 8270C / 8270D	Hexachlorobenzene
GC-MS	EPA 8270C / 8270D	Hexachlorobutadiene
GC-MS	EPA 8270C / 8270D	Hexachlorocyclopentadiene
GC-MS	EPA 8270C / 8270D	Hexachloroethane
GC-MS	EPA 8270C / 8270D	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 8270C / 8270D	Isophorone
GC-MS	EPA 8270C / 8270D	1-Methylnaphthalene
GC-MS	EPA 8270C / 8270D	2-Methylnaphthalene
GC-MS	EPA 8270C / 8270D	1-Methylphenanthrene
GC-MS	EPA 8270C / 8270D	2-Methylphenol

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	4-Methylphenol
GC-MS	EPA 8270C / 8270D	Naphthalene
GC-MS	EPA 8270C / 8270D	2-Nitroaniline
GC-MS	EPA 8270C / 8270D	3-Nitroaniline
GC-MS	EPA 8270C / 8270D	4-Nitroaniline
GC-MS	EPA 8270C / 8270D	Nitrobenzene
GC-MS	EPA 8270C / 8270D	2-Nitrophenol
GC-MS	EPA 8270C / 8270D	4-Nitrophenol
GC-MS	EPA 8270C / 8270D	n-Nitrosodimethylamine
GC-MS	EPA 8270C / 8270D	n-Nitroso-di-n-propylamine
GC-MS	EPA 8270C / 8270D	n-Nitrosodiphenylamine
GC-MS	EPA 8270C / 8270D	Pentachlorophenol
GC-MS	EPA 8270C / 8270D	Perylene
GC-MS	EPA 8270C / 8270D	Phenanthrene
GC-MS	EPA 8270C / 8270D	Phenol
GC-MS	EPA 8270C / 8270D	Pyrene
GC-MS	EPA 8270C / 8270D	Pyridine
GC-MS	EPA 8270C / 8270D	2,3,4,6-Tetrachlorophenol
GC-MS	EPA 8270C / 8270D	1,2,4-Trichlorobenzene
GC-MS	EPA 8270C / 8270D	2,3,4-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,3,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,4,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,4,6-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,3,5-Trimethylnaphthalene
GC-MS	EPA 8270C / 8270D	1,2,4,5-Tetrachlorobenzene
GC-MS	EPA 8270C / 8270D	1,3,5-Trinitrobenzene
GC-MS	EPA 8270C / 8270D	1,3-Dinitrobenzene
GC-MS	EPA 8270C / 8270D	1,4-Dioxane
GC-MS	EPA 8270C / 8270D	1,4-Naphthoquinone
GC-MS	EPA 8270C / 8270D	1-Chloronaphthalene
GC-MS	EPA 8270C / 8270D	1-Naphthylamine
GC-MS	EPA 8270C / 8270D	2,6-Dichlorophenol
GC-MS	EPA 8270C / 8270D	2-acetylaminofluorene
GC-MS	EPA 8270C / 8270D	2-Naphthylamine
GC-MS	EPA 8270C / 8270D	2-Picoline
GC-MS	EPA 8270C / 8270D	3,3-Dimethylbenzidine
GC-MS	EPA 8270C / 8270D	3,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D	3,5-Dimethylphenol
GC-MS	EPA 8270C / 8270D	3-Methylchlolanthrene
GC-MS	EPA 8270C / 8270D	4-Aminobiphenyl
GC-MS	EPA 8270C / 8270D	4-Nitroquinoline-N-oxide
GC-MS	EPA 8270C / 8270D	5-Nitro-o-toluidine
GC-MS	EPA 8270C / 8270D	7,12-Dimethylbenz(a)anthracene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	a,a-dimethylphenethylamine
GC-MS	EPA 8270C / 8270D	Acetophenone
GC-MS	EPA 8270C / 8270D	Aramite
GC-MS	EPA 8270C / 8270D	Atrazine
GC-MS	EPA 8270C / 8270D	Biphenyl
GC-MS	EPA 8270C / 8270D	Chlorobenzilate
GC-MS	EPA 8270C / 8270D	Diallate
GC-MS	EPA 8270C / 8270D	Dibenzo(a,j)acridine
GC-MS	EPA 8270C / 8270D	Dimethoate
GC-MS	EPA 8270C / 8270D	Dinoseb
GC-MS	EPA 8270C / 8270D	Diphenyl ether
GC-MS	EPA 8270C / 8270D	Disulfoton
GC-MS	EPA 8270C / 8270D	Ethyl methacrylate
GC-MS	EPA 8270C / 8270D	Ethyl methanesulfonate
GC-MS	EPA 8270C / 8270D	Ethyl parathion
GC-MS	EPA 8270C / 8270D	Famphur
GC-MS	EPA 8270C / 8270D	Hexachlorophene
GC-MS	EPA 8270C / 8270D	Hexachloropropene
GC-MS	EPA 8270C / 8270D	Isodrin
GC-MS	EPA 8270C / 8270D	Isosafrole
GC-MS	EPA 8270C / 8270D	kepone
GC-MS	EPA 8270C / 8270D	Methapyrilene
GC-MS	EPA 8270C / 8270D	Methyl methanesulfonate
GC-MS	EPA 8270C / 8270D	Methyl parathion
GC-MS	EPA 8270C / 8270D	N-nitrosodiethylamine
GC-MS	EPA 8270C / 8270D	N-Nitrosodi-n-butylamine
GC-MS	EPA 8270C / 8270D	N-Nitrosomethylethylamine
GC-MS	EPA 8270C / 8270D	N-Nitrosomorpholine
GC-MS	EPA 8270C / 8270D	N-Nitrosopiperdine
GC-MS	EPA 8270C / 8270D	N-Nitrosopyrrolidine
GC-MS	EPA 8270C / 8270D	O,O,O-triethyl phosphorothi
GC-MS	EPA 8270C / 8270D	o-toluidine
GC-MS	EPA 8270C / 8270D	p-Dimethylaminoazobenze
GC-MS	EPA 8270C / 8270D	Pentachlorobenzene
GC-MS	EPA 8270C / 8270D	Pentachloroethane
GC-MS	EPA 8270C / 8270D	Pentachloronitrobenzene
GC-MS	EPA 8270C / 8270D	Phenacetin
GC-MS	EPA 8270C / 8270D	Phorate
GC-MS	EPA 8270C / 8270D	p-phenylenediamine
GC-MS	EPA 8270C / 8270D	Pronamide
GC-MS	EPA 8270C / 8270D	Safrole
GC-MS	EPA 8270C / 8270D	Sulfotepp
GC-MS	EPA 8270C / 8270D	Thionazin

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D SIM	Acenaphthene
GC-MS	EPA 8270C / 8270D SIM	Acenaphthylene
GC-MS	EPA 8270C / 8270D SIM	Anthracene
GC-MS	EPA 8270C / 8270D SIM	Azobenzene
GC-MS	EPA 8270C / 8270D SIM	Benzo(a)anthracene
GC-MS	EPA 8270C / 8270D SIM	benzo(a)pyrene
GC-MS	EPA 8270C / 8270D SIM	Benzo(b)fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Benzo(e)pyrene
GC-MS	EPA 8270C / 8270D SIM	Benzo(g,h,i)perylene
GC-MS	EPA 8270C / 8270D SIM	Benzo(k)fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Biphenyl
GC-MS	EPA 8270C / 8270D SIM	bis(2-chloroethyl)ether
GC-MS	EPA 8270C / 8270D SIM	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 8270C / 8270D SIM	Carbazole
GC-MS	EPA 8270C / 8270D SIM	4-Chloro-3-methylphenol
GC-MS	EPA 8270C / 8270D SIM	2-Chlorophenol
GC-MS	EPA 8270C / 8270D SIM	Chrysene
GC-MS	EPA 8270C / 8270D SIM	Dibenzo(a,h)anthracene
GC-MS	EPA 8270C / 8270D SIM	2,4-Dichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,6-Dimethylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	2,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D SIM	Fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Fluorene
GC-MS	EPA 8270C / 8270D SIM	Hexachlorobenzene
GC-MS	EPA 8270C / 8270D SIM	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 8270C / 8270D SIM	1-Methylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	2-Methylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	1-Methylphenanthrene
GC-MS	EPA 8270C / 8270D SIM	Naphthalene
GC-MS	EPA 8270C / 8270D SIM	n-Nitrosodimethylamine
GC-MS	EPA 8270C / 8270D SIM	n-Nitroso-di-n-propylamine
GC-MS	EPA 8270C / 8270D SIM	Pentachlorophenol
GC-MS	EPA 8270C / 8270D SIM	Perylene
GC-MS	EPA 8270C / 8270D SIM	Phenanthrene
GC-MS	EPA 8270C / 8270D SIM	Phenol
GC-MS	EPA 8270C / 8270D SIM	Pyrene
GC-MS	EPA 8270C / 8270D SIM	2,4,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,4,6-Trichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,3,5-Trimethylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	1,4-Dioxane
GC-MS	EPA 8270C / 8270D SIM	Butylbenzylphthalate
GC-MS	EPA 8270C / 8270D SIM	Diethylphthalate
GC-MS	EPA 8270C / 8270D SIM	Dimethylphthalate

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D SIM	Di-n-butylphthalate
GC-MS	EPA 8270C / 8270D SIM	Di-n-octylphthalate
HPLC	EPA 8310	Acenaphthene
HPLC	EPA 8310	Acenaphthylene
HPLC	EPA 8310	Anthracene
HPLC	EPA 8310	Benzo(a)anthracene
HPLC	EPA 8310	Benzo(a)pyrene
HPLC	EPA 8310	Benzo(b)fluoranthene
HPLC	EPA 8310	Benzo(g,h,i)perylene
HPLC	EPA 8310	Benzo(k)fluoranthene
HPLC	EPA 8310	Chrysene
HPLC	EPA 8310	Dibenzo(a,h)anthracene
HPLC	EPA 8310	Fluoranthene
HPLC	EPA 8310	Fluorene
HPLC	EPA 8310	Indeno(1,2,3-cd)pyrene
HPLC	EPA 8310	1-Methylnaphthalene
HPLC	EPA 8310	2-Methylnaphthalene
HPLC	EPA 8310	Naphthalene
HPLC	EPA 8310	Phenanthrene
HPLC	EPA 8310	Pyrene
HPLC	EPA 8330A / 8330 B	HMX
HPLC	EPA 8330A / 8330 B	RDX
HPLC	EPA 8330A / 8330 B	1,3,5-TNB
HPLC	EPA 8330A / 8330 B	1,3-DNB
HPLC	EPA 8330A / 8330 B	Tetryl
HPLC	EPA 8330A / 8330 B	Nitrobenzene
HPLC	EPA 8330A / 8330 B	2,4,6-TNT
HPLC	EPA 8330A / 8330 B	4-AM-2,6-DNT
HPLC	EPA 8330A / 8330 B	2-AM-4,6-DNT
HPLC	EPA 8330A / 8330 B	2,6-DNT
HPLC	EPA 8330A / 8330 B	2,4-DNT
HPLC	EPA 8330A / 8330 B	2-Nitrotoluene
HPLC	EPA 8330A / 8330 B	4-Nitrotoluene
HPLC	EPA 8330A / 8330 B	3-Nitrotoluene
HPLC	EPA 8330A	3,5-Dinitroaniline
HPLC	EPA 8330A	2,4-Diamino-6-nitrotoluene
HPLC	EPA 8330A	2,6-Diamino-4-nitrotoluene
HPLC	EPA 8330A	Picric Acid
HPLC	EPA 8332	Nitroglycerine
HPLC	EPA 8332	PETN
Spectrometric	EPA 9014	Cyanide
Electrode	EPA 9040 B / 9040C	pH
IC	EPA 9056 / 9056A	Bromate

Non-Potable Water		
Technology	**Method**	**Analyte**
IC	EPA 9056 / 9056A	Bromide
IC	EPA 9056 / 9056A	Chloride
IC	EPA 9056 / 9056A	Fluoride
IC	EPA 9056 / 9056A	Nitrate
IC	EPA 9056 / 9056A	Nitrite
IC	EPA 9056 / 9056A	Phosphate
IC	EPA 9056 / 9056A	Sulfate
IC	EPA 9056 / 9056A	Chlorate
Combustion-IR	EPA 9060A	TOC
Spectrometric	EPA 9065	Phenols
Gravimetric	EPA 9070A	Oil & Grease
Gravimetric	EPA 9071B	Oil & Grease
GC	RSK175	Methane
GC	RSK175	Acetylene
GC	RSK175	Ethylene
GC	RSK175	Ethane
GC	RSK175	Propane
GC	RSK175	Carbon dioxide
Spectrometric	SM 4500-NH3C	Ammonia
Spectrometric	SM 4500-NH3F	Ammonia
Spectrometric	SM 4500-NOrgC	TKN
Spectrometric	SM 4500-PE	Phosphorus
Turbidimetric	SM 2130B	Turbidity
Titrimetric	SM 2310B	Acidity
Titrimetric	SM 2320B	Alkalinity
Titrimetric	SM 2340C	Hardness
Platinum Electrode	SM 2510B	Specific Conductance
Gravimetric	SM 2540C	TDS
Gravimetric	SM 2540D	TSS
Gravimetric	SM 2540B	Total Residue
Spectrometric	SM 3500-FeB	Ferrous iron
IC	SM 4110B	Bromate
IC	SM 4110B	Bromide
IC	SM 4110B	Chloride
IC	SM 4110B	Fluoride
IC	SM 4110B	Nitrate
IC	SM 4110B	Nitrite
IC	SM 4110B	Phosphate
IC	SM 4110B	Sulfate
IC	SM 4110B	Chlorate
Titrimetric	SM 4500-Cl-B	Chloride
Titrimetric	SM 4500-Cl B	Total Residual Chlorine
Spectrometric	SM 4500CNE	Cyanide

Non-Potable Water		
Technology	**Method**	**Analyte**
Electrode	SM 4500-FC	Fluoride
Electrode	SM 4500 HB	pH
Spectrometric	SM4500-NO2B	Nitrite-N
Spectrometric	SM4500-NO3E	Nitrate-N
Spectrometric	SM4500PE	Ortho-phosphate
Spectrometric	SM4500-PE(PB5)	Phosphorus
Spectrometric	SM4500-S2D	Sulfide
Titrimetric	SM4500-S2F	Sulfide
Spectrometric	SM4500-SiO2C	Silica
Electrode	SM5210B	BOD
Spectrometric	SM 5220D	COD
Combustion-IR	SM 5310B	TOC
Spectrometric	SM5540C	Surfactants (MBAS)
Distillation	EPA 9010C	Cyanide
MicroDistillation	QuickChem 10-204-00-1-X	Cyanide
ICP/ICP-MS	SM2340B	Hardness
Preparation	**Method**	**Type**
Purge & Trap	EPA 5030B / 5030C	Volatiles Prep
Acid Digestion	EPA 3005A / EPA 3010A / EPA 200.8 / EPA 200.7	Metals Prep
Continuous Liquid-Liquid	EPA 3520C	Organic Extraction
Waste Dilution	EPA 3580A	Organic Extraction
TCLP	EPA 1311	Leaching
SPLP	EPA 1312	Leaching

Drinking Water		
Technology	**Method**	**Analyte**
Platinum Electrode	EPA 120.1	Specific Conductance
Electrode	EPA 150.1	pH
Gravimetric	EPA 160.1	TDS
Gravimetric	EPA 160.2	TSS
Gravimetric	EPA 160.3	Total Residue
ICP-MS	EPA 200.8	Aluminum
ICP-MS	EPA 200.8	Antimony
ICP-MS	EPA 200.8	Arsenic
ICP-MS	EPA 200.8	Barium
ICP-MS	EPA 200.8	Beryllium
ICP-MS	EPA 200.8	Boron
ICP-MS	EPA 200.8	Cadmium
ICP-MS	EPA 200.8	Calcium
ICP-MS	EPA 200.8	Chromium

Drinking Water		
Technology	**Method**	**Analyte**
ICP-MS	EPA 200.8	Cobalt
ICP-MS	EPA 200.8	Copper
ICP-MS	EPA 200.8	Iron
ICP-MS	EPA 200.8	Lithium
ICP-MS	EPA 200.8	Lead
ICP-MS	EPA 200.8	Magnesium
ICP-MS	EPA 200.8	Manganese
ICP-MS	EPA 200.8	Molybdenum
ICP-MS	EPA 200.8	Nickel
ICP-MS	EPA 200.8	Potassium
ICP-MS	EPA 200.8	Selenium
ICP-MS	EPA 200.8	Silver
ICP-MS	EPA 200.8	Sodium
ICP-MS	EPA 200.8	Strontium
ICP-MS	EPA 200.8	Thallium
ICP-MS	EPA 200.8	Tin
ICP-MS	EPA 200.8	Titanium
ICP-MS	EPA 200.8	Uranium
ICP-MS	EPA 200.8	Vanadium
ICP-MS	EPA 200.8	Zinc
IC	EPA 218.6	Hexavalent Chromium
Cold Vapor	EPA 245.1	Mercury
IC	EPA 300.0	Bromate
IC	EPA 300.0	Bromide
IC	EPA 300.0	Chloride
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Nitrite
IC	EPA 300.0	Phosphate
IC	EPA 300.0	Sulfate
IC	EPA 300.0	Chlorate
IC	EPA 300M	Acetate
IC	EPA 300M	Butyrate
IC	EPA 300M	Lactate
IC	EPA 300M	Propionate
IC	EPA 300M	Pyruvate
IC	EPA 314.0	Perchlorate
Spectrometric	EPA 335.2	Cyanide
Spectrometric	EPA 350.2	Ammonia
Spectrometric	EPA 351.3	TKN
Spectrometric	EPA 352.1	Nitrate-N

Drinking Water		
Technology	**Method**	**Analyte**
Spectrometric	EPA 353.3	Nitrate-N
Spectrometric	EPA 354.1	Nitrite-N
Spectrometric	EPA 365.2	Ortho-phosphate
Spectrometric	EPA 365.2	Phosphorus
Spectrometric	EPA 370.1	Silica
Titrimetric	EPA 376.1	Sulfide
Spectrometric	EPA 410.4	COD
Combustion-IR	EPA 415.1	TOC
Spectrometric	EPA 420.1	Phenols
GC	EPA 504.1	DBCP
GC	EPA 504.1	EDB
GC-MS	EPA 524.2	Acetone
GC-MS	EPA 524.2	Benzene
GC-MS	EPA 524.2	Bromobenzene
GC-MS	EPA 524.2	Bromochloromethane
GC-MS	EPA 524.2	Bromodichloromethane
GC-MS	EPA 524.2	Bromoform
GC-MS	EPA 524.2	Bromomethane
GC-MS	EPA 524.2	tert-Butyl alcohol
GC-MS	EPA 524.2	2-Butanone (MEK)
GC-MS	EPA 524.2	n-Butylbenzene
GC-MS	EPA 524.2	sec-Butylbenzene
GC-MS	EPA 524.2	tert-Butylbenzene
GC-MS	EPA 524.2	Carbon disulfide
GC-MS	EPA 524.2	Carbon tetrachloride
GC-MS	EPA 524.2	Chlorobenzene
GC-MS	EPA 524.2	Chloroethane
GC-MS	EPA 524.2	Chloroform
GC-MS	EPA 524.2	Chloromethane
GC-MS	EPA 524.2	2-Chlorotoluene
GC-MS	EPA 524.2	4-Chlorotoluene
GC-MS	EPA 524.2	Dibromochloromethane
GC-MS	EPA 524.2	1,2-Dibromo-3-chloropropane
GC-MS	EPA 524.2	1,2-Dibromoethane
GC-MS	EPA 524.2	Dibromomethane
GC-MS	EPA 524.2	1,1-Dichloroethane
GC-MS	EPA 524.2	1,2-Dichloroethane
GC-MS	EPA 524.2	1,2-Dichlorobenzene
GC-MS	EPA 524.2	1,3-Dichlorobenzene
GC-MS	EPA 524.2	1,4-Dichlorobenzene
GC-MS	EPA 524.2	Dichlorodifluoromethane

Drinking Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 524.2	1,1-Dichloroethene
GC-MS	EPA 524.2	cis-1,2-Dichloroethene
GC-MS	EPA 524.2	trans-1,2-Dichloroethene
GC-MS	EPA 524.2	1,1-Dichloropropene
GC-MS	EPA 524.2	1,2-Dichloropropane
GC-MS	EPA 524.2	1,3-Dichloropropane
GC-MS	EPA 524.2	2,2-Dichloropropane
GC-MS	EPA 524.2	cis-1,3-Dichloropropene
GC-MS	EPA 524.2	trans-1,3-Dichloropropene
GC-MS	EPA 524.2	tert-Butyl ethyl ether (ETBE)
GC-MS	EPA 524.2	Ethylbenzene
GC-MS	EPA 524.2	2-Hexanone (MBK)
GC-MS	EPA 524.2	Hexachlorobutadiene
GC-MS	EPA 524.2	Isopropyl ether (DIPE)
GC-MS	EPA 524.2	Isopropylbenzene
GC-MS	EPA 524.2	p-Isopropyltoluene
GC-MS	EPA 524.2	Methylene Chloride
GC-MS	EPA 524.2	4-Methyl-2-pentanone (MIBK)
GC-MS	EPA 524.2	tert-Butyl methyl ether
GC-MS	EPA 524.2	Naphthalene
GC-MS	EPA 524.2	n-Propylbenzene
GC-MS	EPA 524.2	Styrene
GC-MS	EPA 524.2	tert-Amyl methyl ether (TAME)
GC-MS	EPA 524.2	1,1,1,2-Tetrachloroethane
GC-MS	EPA 524.2	1,1,2,2-Tetrachloroethane
GC-MS	EPA 524.2	Tetrachloroethene
GC-MS	EPA 524.2	Toluene
GC-MS	EPA 524.2	1,1,1-Trichloroethane
GC-MS	EPA 524.2	1,1,2-Trichloroethane
GC-MS	EPA 524.2	1,2,3-Trichlorobenzene
GC-MS	EPA 524.2	1,2,4-Trichlorobenzene
GC-MS	EPA 524.2	Trichloroethene
GC-MS	EPA 524.2	Trichlorofluoromethane
GC-MS	EPA 524.2	1,2,3-Trichloropropane
GC-MS	EPA 524.2	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	EPA 524.2	1,2,4-Trimethylbenzene
GC-MS	EPA 524.2	1,3,5-Trimethylbenzene
GC-MS	EPA 524.2	Vinyl Chloride
GC-MS	EPA 524.2	m-Xylene & p-xylene
GC-MS	EPA 524.2	o-Xylene
Titrimetric	SM 2320B	Alkalinity

Drinking Water		
Technology	**Method**	**Analyte**
HPLC-MS	EPA 6850	Perchlorate
ICP/ICP-MS by Calculation	SM 2340B	Hardness
Titrimetric	SM 2340C	Hardness
Platinum Electrode	SM 2510B	Specific Conductance
Gravimetric	SM 2540B	Total Residue
Gravimetric	SM 2540C	TDS
Gravimetric	SM 2540D	TSS
Spectrometric	SM 3500- FeB	Ferrous Iron
Spectrometric	SM 4500-CNE	Cyanide
Electrode	SM 4500 HB	pH
Spectrometric	SM 4500-NH3C	Ammonia
Spectrometric	SM 4500-NH3F	Ammonia
Spectrometric	SM 4500-NO2B	Nitrite-N
Spectrometric	SM 4500-NO3E	Nitrate-N
Spectrometric	SM 4500-NOrgC	TKN
Spectrometric	SM 4500-PE	Ortho-phosphate
Spectrometric	SM 4500-PE(PB5)	Phosphorus
Titrimetric	SM 4500-S2F	Sulfide
Spectrometric	SM 4500-SiO2C	Silica
Spectrometric	SM 5220D	COD
Combustion-IR	SM 5310B	TOC
Spectrometric	SM 5540C	Surfactants
MicroDistillation	QuickChem 10-204-00-1-X	Cyanide

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC	AK101	GRO
GC	AK102	DRO
GC	AK103	RRO
GC	AZ8015	DRO (C10-C22)
GC	AZ8015	ORO (C22-C32)
GC	RSK175	Methane
GC	RSK175	Acetylene
GC	RSK175	Ethylene
GC	RSK175	Ethane
GC	RSK175	Propane
GC	RSK175	Carbon dioxide
Spectrometric	SM4500-NH3C	Ammonia
Spectrometric	SM4500-NH3F	Ammonia
Spectrometric	SM4500-NOrgC	TKN

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
Spectrometric	SM4500-PE(PB5)	Phosphorus
Titrimetric	Walkley Black	TOC
Electrode	EPA 9045C / 9045D	pH
Spectrometric	EPA 9065	Phenols
Penskey-Martens	EPA 1010/ 1010A	Ignitability
ICP	EPA 6010B / 6010C	Aluminum
ICP	EPA 6010B / 6010C	Antimony
ICP	EPA 6010B / 6010C	Arsenic
ICP	EPA 6010B / 6010C	Barium
ICP	EPA 6010B / 6010C	Beryllium
ICP	EPA 6010B / 6010C	Boron
ICP	EPA 6010B / 6010C	Cadmium
ICP	EPA 6010B / 6010C	Calcium
ICP	EPA 6010B / 6010C	Chromium
ICP	EPA 6010B / 6010C	Cobalt
ICP	EPA 6010B / 6010C	Copper
ICP	EPA 6010B / 6010C	Iron
ICP	EPA 6010B / 6010C	Lead
ICP	EPA 6010B / 6010C	Lithium
ICP	EPA 6010B / 6010C	Magnesium
ICP	EPA 6010B / 6010C	Manganese
ICP	EPA 6010B / 6010C	Molybdenum
ICP	EPA 6010B / 6010C	Nickel
ICP	EPA 6010B / 6010C	Potassium
ICP	EPA 6010B / 6010C	Selenium
ICP	EPA 6010B / 6010C	Silver
ICP	EPA 6010B / 6010C	Sodium
ICP	EPA 6010B / 6010C	Strontium
ICP	EPA 6010B / 6010C	Thallium
ICP	EPA 6010B / 6010C	Tin
ICP	EPA 6010B / 6010C	Titanium
ICP	EPA 6010B / 6010C	Vanadium
ICP	EPA 6010B / 6010C	Zinc
IPC-MS	EPA 6020A	Aluminum
IPC-MS	EPA 6020A	Antimony
IPC-MS	EPA 6020A	Arsenic
IPC-MS	EPA 6020A	Barium
IPC-MS	EPA 6020A	Beryllium
IPC-MS	EPA 6020A	Boron
IPC-MS	EPA 6020A	Cadmium
IPC-MS	EPA 6020A	Calcium
IPC-MS	EPA 6020A	Chromium
IPC-MS	EPA 6020A	Cobalt

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
IPC-MS	EPA 6020A	Copper
ICP-MS	EPA 6020A	Iron
ICP-MS	EPA 6020A	Lead
ICP-MS	EPA 6020A	Lithium
ICP-MS	EPA 6020A	Magnesium
ICP-MS	EPA 6020A	Manganese
ICP-MS	EPA 6020A	Molybdenum
ICP-MS	EPA 6020A	Nickel
ICP-MS	EPA 6020A	Potassium
ICP-MS	EPA 6020A	Selenium
ICP-MS	EPA 6020A	Silver
ICP-MS	EPA 6020A	Sodium
ICP-MS	EPA 6020A	Strontium
ICP-MS	EPA 6020A	Thallium
ICP-MS	EPA 6020A	Tin
ICP-MS	EPA 6020A	Titanium
ICP-MS	EPA 6020A	Tungsten
ICP-MS	EPA 6020A	Uranium
ICP-MS	EPA 6020A	Vanadium
ICP-MS	EPA 6020A	Zinc
HPLC-MS	EPA 6850	Perchlorate
Spectrometric	EPA 7196A	Hex. Chromium
IC	EPA 7199	Hex. Chromium
Cold-Vapor	EPA 7471A / 7471B	Mercury
GC	EPA 8011	DBCP
GC	EPA 8011	EDB
GC	EPA 8015B / 8015C / 8015D	Gasoline
GC	EPA 8015B / 8015C / 8015D	Diesel
GC	EPA 8015B / 8015C / 8015D	Motor Oil
GC	EPA 8015B / 8015C / 8015D	JP5
GC	EPA 8015B / 8015C	Ethanol
GC	EPA 8015B / 8015C	Isopropanol
GC	EPA 8015B / 8015C	Diethylene Glycol
GC	EPA 8015B / 8015C	Ethylene Glycol
GC	EPA 8015B / 8015C	Triethylene Glycol
GC	EPA 8015B / 8015C / 8015D	JP4
GC	EPA 8015B / 8015C	Methanol
GC	EPA 8015B / 8015C	Propylene Glycol
GC	EPA 8081A / 8081B	Aldrin
GC	EPA 8081A / 8081B	alpha-BHC
GC	EPA 8081A / 8081B	beta-BHC
GC	EPA 8081A / 8081B	delta-BHC
GC	EPA 8081A / 8081B	gamma-BHC (Lindane)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC	EPA 8081A / 8081B	DDD (4,4)
GC	EPA 8081A / 8081B	DDE (4,4)
GC	EPA 8081A / 8081B	DDT (4,4)
GC	EPA 8081A / 8081B	Dieldrin
GC	EPA 8081A / 8081B	Endosulfan I
GC	EPA 8081A / 8081B	Endosulfan II
GC	EPA 8081A / 8081B	Endosulfan sulfate
GC	EPA 8081A / 8081B	Endrin
GC	EPA 8081A / 8081B	Endrin Aldehyde
GC	EPA 8081A / 8081B	Heptachlor
GC	EPA 8081A / 8081B	Heptachlor epoxide
GC	EPA 8081A / 8081B	Methoxychlor
GC	EPA 8081A / 8081B	alpha-Chlordane
GC	EPA 8081A / 8081B	gamma-Chlordane
GC	EPA 8081A / 8081B	Endrin Ketone
GC	EPA 8081A / 8081B	Toxaphene
GC	EPA 8081A / 8081B	Technical Chlordane
GC	EPA 8081A / 8081B	cis-Nonachlor
GC	EPA 8081A / 8081B	DDD (2,4)
GC	EPA 8081A / 8081B	DDE (2,4)
GC	EPA 8081A / 8081B	DDT (2,4)
GC	EPA 8081A / 8081B	Mirex
GC	EPA 8081A / 8081B	Oxychlordane
GC	EPA 8081A / 8081B	trans-Nonachlor
GC	EPA 8082 / 8082A	PCB1016
GC	EPA 8082 / 8082A	PCB1221
GC	EPA 8082 / 8082A	PCB1232
GC	EPA 8082 / 8082A	PCB1242
GC	EPA 8082 / 8082A	PCB1248
GC	EPA 8082 / 8082A	PCB1254
GC	EPA 8082 / 8082A	PCB1260
GC	EPA 8082 / 8082A	PCB1262
GC	EPA 8082 / 8082A	PCB1268
GC	EPA 8082 / 8082A	PCB 8
GC	EPA 8082 / 8082A	PCB 18
GC	EPA 8082 / 8082A	PCB 28
GC	EPA 8082 / 8082A	PCB 44
GC	EPA 8082 / 8082A	PCB 52
GC	EPA 8082 / 8082A	PCB 66
GC	EPA 8082 / 8082A	PCB 77
GC	EPA 8082 / 8082A	PCB 81
GC	EPA 8082 / 8082A	PCB 101
GC	EPA 8082 / 8082A	PCB 105

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC	EPA 8082 / 8082A	PCB 110
GC	EPA 8082 / 8082A	PCB 114
GC	EPA 8082 / 8082A	PCB 118
GC	EPA 8082 / 8082A	PCB 123
GC	EPA 8082 / 8082A	PCB 126
GC	EPA 8082 / 8082A	PCB 128
GC	EPA 8082 / 8082A	PCB 138
GC	EPA 8082 / 8082A	PCB 153
GC	EPA 8082 / 8082A	PCB 156
GC	EPA 8082 / 8082A	PCB 157
GC	EPA 8082 / 8082A	PCB 167
GC	EPA 8082 / 8082A	PCB 169
GC	EPA 8082 / 8082A	PCB 170
GC	EPA 8082 / 8082A	PCB 180
GC	EPA 8082 / 8082A	PCB 187
GC	EPA 8082 / 8082A	PCB 189
GC	EPA 8082 / 8082A	PCB 195
GC	EPA 8082 / 8082A	PCB 206
GC	EPA 8082 / 8082A	PCB 209
GC	EPA 8141A / 8141B	Azinphos-methyl
GC	EPA 8141A / 8141B	Bolstar
GC	EPA 8141A / 8141B	Chlorpyrifos
GC	EPA 8141A / 8141B	Coumaphos
GC	EPA 8141A / 8141B	Demeton
GC	EPA 8141A / 8141B	Diazinon
GC	EPA 8141A / 8141B	Dichlorvos
GC	EPA 8141A / 8141B	Disulfoton
GC	EPA 8141A / 8141B	Ethoprop
GC	EPA 8141A / 8141B	Fensulfothion
GC	EPA 8141A / 8141B	Fenthion
GC	EPA 8141A / 8141B	Merphos
GC	EPA 8141A / 8141B	Mevinphos
GC	EPA 8141A / 8141B	Naled
GC	EPA 8141A / 8141B	Methyl Parathion
GC	EPA 8141A / 8141B	Phorate
GC	EPA 8141A / 8141B	Ronnel
GC	EPA 8141A / 8141B	Stirophos
GC	EPA 8141A / 8141B	Tokuthion
GC	EPA 8141A / 8141B	Trichloronate
GC	EPA 8141A / 8141B	Dimethoate
GC	EPA 8141A / 8141B	EPN
GC	EPA 8141A / 8141B	Famphur
GC	EPA 8141A / 8141B	Malathion

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC	EPA 8141A / 8141B	Ethyl Parathion
GC	EPA 8141A / 8141B	O,O,O-Triethylphosphorothioate
GC	EPA 8141A / 8141B	Sulfotepp
GC	EPA 8141A / 8141B	Thionazin
GC	EPA 8141A / 8141B	Tributyl Phosphate
GC-MS	EPA 8260B / 8260C	Acetone
GC-MS	EPA 8260B / 8260C	Acrolein
GC-MS	EPA 8260B / 8260C	Acrylonitrile
GC-MS	EPA 8260B / 8260C	Benzene
GC-MS	EPA 8260B / 8260C	Bromobenzene
GC-MS	EPA 8260B / 8260C	Bromochloromethane
GC-MS	EPA 8260B / 8260C	Bromodichloromethane
GC-MS	EPA 8260B / 8260C	Bromoform
GC-MS	EPA 8260B / 8260C	Bromomethane
GC-MS	EPA 8260B / 8260C	tert-Butyl alcohol
GC-MS	EPA 8260B / 8260C	2-Butanone (MEK)
GC-MS	EPA 8260B / 8260C	n-Butylbenzene
GC-MS	EPA 8260B / 8260C	sec-Butylbenzene
GC-MS	EPA 8260B / 8260C	tert-Butylbenzene
GC-MS	EPA 8260B / 8260C	Carbon disulfide
GC-MS	EPA 8260B / 8260C	Carbon tetrachloride
GC-MS	EPA 8260B / 8260C	Chlorobenzene
GC-MS	EPA 8260B / 8260C	2-Chloroethyl vinyl ether
GC-MS	EPA 8260B / 8260C	Chloroethane
GC-MS	EPA 8260B / 8260C	Chloroform
GC-MS	EPA 8260B / 8260C	1-Chlorohexane
GC-MS	EPA 8260B / 8260C	Chloromethane
GC-MS	EPA 8260B / 8260C	2-Chlorotoluene
GC-MS	EPA 8260B / 8260C	4-Chlorotoluene
GC-MS	EPA 8260B / 8260C	Isopropyl ether (DIPE)
GC-MS	EPA 8260B / 8260C	Dibromochloromethane
GC-MS	EPA 8260B / 8260C	1,2-Dibromo-3-chloropropane
GC-MS	EPA 8260B / 8260C	1,2-Dibromoethane
GC-MS	EPA 8260B / 8260C	Dibromomethane
GC-MS	EPA 8260B / 8260C	1,1-Dichloroethane
GC-MS	EPA 8260B / 8260C	1,2-Dichloroethane
GC-MS	EPA 8260B / 8260C	1,2-Dichlorobenzene
GC-MS	EPA 8260B / 8260C	1,3-Dichlorobenzene
GC-MS	EPA 8260B / 8260C	trans-1,4-Dichloro-2-Butene
GC-MS	EPA 8260B / 8260C	1,4-Dichlorobenzene
GC-MS	EPA 8260B / 8260C	Dichlorodifluoromethane
GC-MS	EPA 8260B / 8260C	1,1-Dichloroethene
GC-MS	EPA 8260B / 8260C	cis-1,2-Dichloroethene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B / 8260C	trans-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C	Dichlorofluoromethane
GC-MS	EPA 8260B / 8260C	1,1-Dichloropropene
GC-MS	EPA 8260B / 8260C	1,2-Dichloropropane
GC-MS	EPA 8260B / 8260C	1,3-Dichloropropane
GC-MS	EPA 8260B / 8260C	2,2-Dichloropropane
GC-MS	EPA 8260B / 8260C	cis-1,3-Dichloropropene
GC-MS	EPA 8260B / 8260C	trans-1,3-Dichloropropene
GC-MS	EPA 8260B / 8260C	tert-Butyl ethyl ether (ETBE)
GC-MS	EPA 8260B / 8260C	Ethyl Methacrylate
GC-MS	EPA 8260B / 8260C	Ethylbenzene
GC-MS	EPA 8260B / 8260C	2-Hexanone (MBK)
GC-MS	EPA 8260B / 8260C	Hexachlorobutadiene
GC-MS	EPA 8260B / 8260C	Iodomethane
GC-MS	EPA 8260B / 8260C	Isopropylbenzene
GC-MS	EPA 8260B / 8260C	p-Isopropyltoluene
GC-MS	EPA 8260B / 8260C	Methylene Chloride
GC-MS	EPA 8260B / 8260C	4-Methyl-2-pentanone (MIBK)
GC-MS	EPA 8260B / 8260C	tert-Butyl methyl ether
GC-MS	EPA 8260B / 8260C	Naphthalene
GC-MS	EPA 8260B / 8260C	n-Propylbenzene
GC-MS	EPA 8260B / 8260C	Styrene
GC-MS	EPA 8260B / 8260C	tert-Amyl methyl ether (TAME)
GC-MS	EPA 8260B / 8260C	1,1,1,2-Tetrachloroethane
GC-MS	EPA 8260B / 8260C	1,1,2,2-Tetrachloroethane
GC-MS	EPA 8260B / 8260C	Tetrachloroethene
GC-MS	EPA 8260B / 8260C	Toluene
GC-MS	EPA 8260B / 8260C	1,1,1-Trichloroethane
GC-MS	EPA 8260B / 8260C	1,1,2-Trichloroethane
GC-MS	EPA 8260B / 8260C	1,2,3-Trichlorobenzene
GC-MS	EPA 8260B / 8260C	1,2,4-Trichlorobenzene
GC-MS	EPA 8260B / 8260C	Trichloroethene
GC-MS	EPA 8260B / 8260C	Trichlorofluoromethane
GC-MS	EPA 8260B / 8260C	1,2,3-Trichloropropane
GC-MS	EPA 8260B / 8260C	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	EPA 8260B / 8260C	1,2,4-Trimethylbenzene
GC-MS	EPA 8260B / 8260C	1,3,5-Trimethylbenzene
GC-MS	EPA 8260B / 8260C	Vinyl Acetate
GC-MS	EPA 8260B / 8260C	Vinyl Chloride
GC-MS	EPA 8260B / 8260C	m-Xylene & p-xylene
GC-MS	EPA 8260B / 8260C	o-Xylene
GC-MS	EPA 8260B / 8260C	2-Butanol
GC-MS	EPA 8260B / 8260C	Cyclohexane

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B / 8260C	1,4-Dioxane
GC-MS	EPA 8260B / 8260C	2-Chloro-1,1,1-trifluoroethane
GC-MS	EPA 8260B / 8260C	Chlorotrifluoroethylene
GC-MS	EPA 8260B / 8260C	cis-1,4-Dichloro-2-butene
GC-MS	EPA 8260B / 8260C	Ethanol
GC-MS	EPA 8260B / 8260C	Ethyl Methacrylate
GC-MS	EPA 8260B / 8260C	Isobutyl Alcohol
GC-MS	EPA 8260B / 8260C	Methacrylonitrile
GC-MS	EPA 8260B / 8260C	Methyl Methacrylate
GC-MS	EPA 8260B / 8260C	Pentachloroethane
GC-MS	EPA 8260B / 8260C	Propionitrile
GC-MS	EPA 8260B / 8260C	Sec-Propyl alcohol
GC-MS	EPA 8260B / 8260C	Tetrahydrofuran
GC-MS	EPA 8260B / 8260C	trans-1,4-Dichloro-2-butene
GC-MS	EPA 8260B / 8260C SIM	Benzene
GC-MS	EPA 8260B / 8260C SIM	Carbon tetrachloride
GC-MS	EPA 8260B / 8260C SIM	Chloroform
GC-MS	EPA 8260B / 8260C SIM	Chloromethane
GC-MS	EPA 8260B / 8260C SIM	1,2-Dibromo-3-chloropropane
GC-MS	EPA 8260B / 8260C SIM	1,2-Dibromoethane
GC-MS	EPA 8260B / 8260C SIM	1,2-Dichloroethane
GC-MS	EPA 8260B / 8260C SIM	1,1-Dichloroethene
GC-MS	EPA 8260B / 8260C SIM	cis-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C SIM	trans-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C SIM	1,1,2,2-Tetrachloroethane
GC-MS	EPA 8260B / 8260C SIM	Tetrachloroethene
GC-MS	EPA 8260B / 8260C SIM	1,1,1-Trichloroethane
GC-MS	EPA 8260B / 8260C SIM	1,1,2-Trichloroethane
GC-MS	EPA 8260B / 8260C SIM	Trichloroethene
GC-MS	EPA 8260B / 8260C SIM	1,2,3-Trichloropropane
GC-MS	EPA 8260B / 8260C SIM	Vinyl Chloride
GC-MS	EPA 8260B / 8260C SIM	1,4-Dioxane
GC-MS	EPA 8270C / 8270D	Acenaphthene
GC-MS	EPA 8270C / 8270D	Acenaphthylene
GC-MS	EPA 8270C / 8270D	Aniline
GC-MS	EPA 8270C / 8270D	Anthracene
GC-MS	EPA 8270C / 8270D	Azobenzene
GC-MS	EPA 8270C / 8270D	Benzidine
GC-MS	EPA 8270C / 8270D	Benzo(a)anthracene
GC-MS	EPA 8270C / 8270D	benzo(a)pyrene
GC-MS	EPA 8270C / 8270D	Benzo(b)fluoranthene
GC-MS	EPA 8270C / 8270D	Benzo(e)pyrene
GC-MS	EPA 8270C / 8270D	Benzo(g,h,i)perylene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	Benzo(k)fluoranthene
GC-MS	EPA 8270C / 8270D	Benzoic Acid
GC-MS	EPA 8270C / 8270D	Benzyl Alcohol
GC-MS	EPA 8270C / 8270D	Biphenyl
GC-MS	EPA 8270C / 8270D	bis(2-chloroethoxy)methane
GC-MS	EPA 8270C / 8270D	bis(2-chloroethyl)ether
GC-MS	EPA 8270C / 8270D	bis(2-chloroisopropyl)ether
GC-MS	EPA 8270C / 8270D	bis(2-Ethylhexyl)adipate
GC-MS	EPA 8270C / 8270D	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 8270C / 8270D	4-Bromophenyl-phenylether
GC-MS	EPA 8270C / 8270D	Butylbenzylphthalate
GC-MS	EPA 8270C / 8270D	Carbazole
GC-MS	EPA 8270C / 8270D	4-Chloro-3-methylphenol
GC-MS	EPA 8270C / 8270D	4-Chloroaniline
GC-MS	EPA 8270C / 8270D	2-Chloronaphthalene
GC-MS	EPA 8270C / 8270D	2-Chlorophenol
GC-MS	EPA 8270C / 8270D	4-Chlorophenyl-phenylether
GC-MS	EPA 8270C / 8270D	Chrysene
GC-MS	EPA 8270C / 8270D	Dibenzo(a,h)anthracene
GC-MS	EPA 8270C / 8270D	Dibenzofuran
GC-MS	EPA 8270C / 8270D	1,2-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	1,3-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	1,4-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	3,3'-Dichlorobenzidine
GC-MS	EPA 8270C / 8270D	2,4-Dichlorophenol
GC-MS	EPA 8270C / 8270D	Diethylphthalate
GC-MS	EPA 8270C / 8270D	2,6-Dimethylnaphthalene
GC-MS	EPA 8270C / 8270D	2,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D	Dimethylphthalate
GC-MS	EPA 8270C / 8270D	Di-n-butylphthalate
GC-MS	EPA 8270C / 8270D	4,6-Dinitro-2-methylphenol
GC-MS	EPA 8270C / 8270D	2,4-Dinitrophenol
GC-MS	EPA 8270C / 8270D	2,4-Dinitrotoluene
GC-MS	EPA 8270C / 8270D	2,6-Dinitrotoluene
GC-MS	EPA 8270C / 8270D	Di-n-octylphthalate
GC-MS	EPA 8270C / 8270D	Fluoranthene
GC-MS	EPA 8270C / 8270D	Fluorene
GC-MS	EPA 8270C / 8270D	Hexachlorobenzene
GC-MS	EPA 8270C / 8270D	Hexachlorobutadiene
GC-MS	EPA 8270C / 8270D	Hexachlorocyclopentadiene
GC-MS	EPA 8270C / 8270D	Hexachloroethane
GC-MS	EPA 8270C / 8270D	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 8270C / 8270D	Isophorone

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	1-Methylnaphthalene
GC-MS	EPA 8270C / 8270D	2-Methylnaphthalene
GC-MS	EPA 8270C / 8270D	1-Methylphenanthrene
GC-MS	EPA 8270C / 8270D	2-Methylphenol
GC-MS	EPA 8270C / 8270D	4-Methylphenol
GC-MS	EPA 8270C / 8270D	Naphthalene
GC-MS	EPA 8270C / 8270D	2-Nitroaniline
GC-MS	EPA 8270C / 8270D	3-Nitroaniline
GC-MS	EPA 8270C / 8270D	4-Nitroaniline
GC-MS	EPA 8270C / 8270D	Nitrobenzene
GC-MS	EPA 8270C / 8270D	2-Nitrophenol
GC-MS	EPA 8270C / 8270D	4-Nitrophenol
GC-MS	EPA 8270C / 8270D	n-Nitrosodimethylamine
GC-MS	EPA 8270C / 8270D	n-Nitroso-di-n-propylamine
GC-MS	EPA 8270C / 8270D	n-Nitrosodiphenylamine
GC-MS	EPA 8270C / 8270D	Pentachlorophenol
GC-MS	EPA 8270C / 8270D	Perylene
GC-MS	EPA 8270C / 8270D	Phenanthrene
GC-MS	EPA 8270C / 8270D	Phenol
GC-MS	EPA 8270C / 8270D	Pyrene
GC-MS	EPA 8270C / 8270D	Pyridine
GC-MS	EPA 8270C / 8270D	2,3,4,6-Tetrachlorophenol
GC-MS	EPA 8270C / 8270D	1,2,4-Trichlorobenzene
GC-MS	EPA 8270C / 8270D	2,3,4-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,3,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,4,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,4,6-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,3,5-Trimethylnaphthalene
GC-MS	EPA 8270C / 8270D	1,2,4,5-Tetrachlorobenzene
GC-MS	EPA 8270C / 8270D	1,3,5-Trinitrobenzene
GC-MS	EPA 8270C / 8270D	1,3-Dinitrobenzene
GC-MS	EPA 8270C / 8270D	1,4-Dioxane
GC-MS	EPA 8270C / 8270D	1,4-Naphthoquinone
GC-MS	EPA 8270C / 8270D	1-Chloronaphthalene
GC-MS	EPA 8270C / 8270D	1-Naphthylamine
GC-MS	EPA 8270C / 8270D	2,6-Dichlorophenol
GC-MS	EPA 8270C / 8270D	2-acetylaminofluorene
GC-MS	EPA 8270C / 8270D	2-Naphthylamine
GC-MS	EPA 8270C / 8270D	2-Picoline
GC-MS	EPA 8270C / 8270D	3,3-Dimethylbenzidine
GC-MS	EPA 8270C / 8270D	3,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D	3,5-Dimethylphenol
GC-MS	EPA 8270C / 8270D	3-Methylchlolanthrene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	4-Aminobiphenyl
GC-MS	EPA 8270C / 8270D	4-Nitroquinoline-N-oxide
GC-MS	EPA 8270C / 8270D	5-Nitro-o-toluidine
GC-MS	EPA 8270C / 8270D	7,12-Dimethylbenz(a)anthracene
GC-MS	EPA 8270C / 8270D	Acetophenone
GC-MS	EPA 8270C / 8270D	Aramite
GC-MS	EPA 8270C / 8270D	Atrazine
GC-MS	EPA 8270C / 8270D	Biphenyl
GC-MS	EPA 8270C / 8270D	Chlorobenzilate
GC-MS	EPA 8270C / 8270D	Diallate
GC-MS	EPA 8270C / 8270D	Dibenzo(a,j)acridine
GC-MS	EPA 8270C / 8270D	Dimethoate
GC-MS	EPA 8270C / 8270D	Dinoseb
GC-MS	EPA 8270C / 8270D	Diphenyl ether
GC-MS	EPA 8270C / 8270D	Disulfoton
GC-MS	EPA 8270C / 8270D	Ethyl methacrylate
GC-MS	EPA 8270C / 8270D	Ethyl methanesulfonate
GC-MS	EPA 8270C / 8270D	Ethyl parathion
GC-MS	EPA 8270C / 8270D	Famphur
GC-MS	EPA 8270C / 8270D	Hexachlorophene
GC-MS	EPA 8270C / 8270D	Hexachloropropene
GC-MS	EPA 8270C / 8270D	Isodrin
GC-MS	EPA 8270C / 8270D	Isosafrole
GC-MS	EPA 8270C / 8270D	kepone
GC-MS	EPA 8270C / 8270D	Methapyrilene
GC-MS	EPA 8270C / 8270D	Methyl methanesulfonate
GC-MS	EPA 8270C / 8270D	Methyl parathion
GC-MS	EPA 8270C / 8270D	N-nitrosodiethylamine
GC-MS	EPA 8270C / 8270D	N-Nitrosodi-n-butylamine
GC-MS	EPA 8270C / 8270D	N-Nitrosomethylethylamine
GC-MS	EPA 8270C / 8270D	N-Nitrosomorpholine
GC-MS	EPA 8270C / 8270D	N-Nitrosopiperdine
GC-MS	EPA 8270C / 8270D	N-Nitrosopyrrolidine
GC-MS	EPA 8270C / 8270D	O,O,O-triethyl phosphorothi
GC-MS	EPA 8270C / 8270D	o-toluidine
GC-MS	EPA 8270C / 8270D	p-Dimethylaminoazobenze
GC-MS	EPA 8270C / 8270D	Pentachlorobenzene
GC-MS	EPA 8270C / 8270D	Pentachloroethane
GC-MS	EPA 8270C / 8270D	Pentachloronitrobenzene
GC-MS	EPA 8270C / 8270D	Phenacetin
GC-MS	EPA 8270C / 8270D	Phorate
GC-MS	EPA 8270C / 8270D	p-phenylenediamine
GC-MS	EPA 8270C / 8270D	Pronamide

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	Safrole
GC-MS	EPA 8270C / 8270D	Sulfotepp
GC-MS	EPA 8270C / 8270D	Thionazin
GC-MS	EPA 8270C / 8270D SIM	Acenaphthene
GC-MS	EPA 8270C / 8270D SIM	Acenaphthylene
GC-MS	EPA 8270C / 8270D SIM	Anthracene
GC-MS	EPA 8270C / 8270D SIM	Azobenzene
GC-MS	EPA 8270C / 8270D SIM	Benzo(a)anthracene
GC-MS	EPA 8270C / 8270D SIM	benzo(a)pyrene
GC-MS	EPA 8270C / 8270D SIM	Benzo(b)fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Benzo(e)pyrene
GC-MS	EPA 8270C / 8270D SIM	Benzo(g,h,i)perylene
GC-MS	EPA 8270C / 8270D SIM	Benzo(k)fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Biphenyl
GC-MS	EPA 8270C / 8270D SIM	bis(2-chloroethyl)ether
GC-MS	EPA 8270C / 8270D SIM	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 8270C / 8270D SIM	Carbazole
GC-MS	EPA 8270C / 8270D SIM	4-Chloro-3-methylphenol
GC-MS	EPA 8270C / 8270D SIM	2-Chlorophenol
GC-MS	EPA 8270C / 8270D SIM	Chrysene
GC-MS	EPA 8270C / 8270D SIM	Dibenzo(a,h)anthracene
GC-MS	EPA 8270C / 8270D SIM	2,4-Dichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,6-Dimethylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	2,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D SIM	Fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Fluorene
GC-MS	EPA 8270C / 8270D SIM	Hexachlorobenzene
GC-MS	EPA 8270C / 8270D SIM	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 8270C / 8270D SIM	1-Methylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	2-Methylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	1-Methylphenanthrene
GC-MS	EPA 8270C / 8270D SIM	Naphthalene
GC-MS	EPA 8270C / 8270D SIM	n-Nitrosodimethylamine
GC-MS	EPA 8270C / 8270D SIM	n-Nitroso-di-n-propylamine
GC-MS	EPA 8270C / 8270D SIM	Pentachlorophenol
GC-MS	EPA 8270C / 8270D SIM	Perylene
GC-MS	EPA 8270C / 8270D SIM	Phenanthrene
GC-MS	EPA 8270C / 8270D SIM	Phenol
GC-MS	EPA 8270C / 8270D SIM	Pyrene
GC-MS	EPA 8270C / 8270D SIM	2,4,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,4,6-Trichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,3,5-Trimethylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	1,4-Dioxane

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D SIM	Butylbenzylphthalate
GC-MS	EPA 8270C / 8270D SIM	Diethylphthalate
GC-MS	EPA 8270C / 8270D SIM	Dimethylphthalate
GC-MS	EPA 8270C / 8270D SIM	Di-n-butylphthalate
GC-MS	EPA 8270C / 8270D SIM	Di-n-octylphthalate
HPLC	EPA 8310	Acenaphthene
HPLC	EPA 8310	Acenaphthylene
HPLC	EPA 8310	Anthracene
HPLC	EPA 8310	Benzo(a)anthracene
HPLC	EPA 8310	Benzo(a)pyrene
HPLC	EPA 8310	Benzo(b)fluoranthene
HPLC	EPA 8310	Benzo(g,h,i)perylene
HPLC	EPA 8310	Benzo(k)fluoranthene
HPLC	EPA 8310	Chrysene
HPLC	EPA 8310	Dibenzo(a,h)anthracene
HPLC	EPA 8310	Fluoranthene
HPLC	EPA 8310	Fluorene
HPLC	EPA 8310	Indeno(1,2,3-cd)pyrene
HPLC	EPA 8310	1-Methylnaphthalene
HPLC	EPA 8310	2-Methylnaphthalene
HPLC	EPA 8310	Naphthalene
HPLC	EPA 8310	Phenanthrene
HPLC	EPA 8310	Pyrene
HPLC	EPA 8330A	HMX
HPLC	EPA 8330A	RDX
HPLC	EPA 8330A	1,3,5-TNB
HPLC	EPA 8330A	1,3-DNB
HPLC	EPA 8330A	Tetryl
HPLC	EPA 8330A	Nitrobenzene
HPLC	EPA 8330A	2,4,6-TNT
HPLC	EPA 8330A	4-AM-2,6-DNT
HPLC	EPA 8330A	2-AM-4,6-DNT
HPLC	EPA 8330A	2,6-DNT
HPLC	EPA 8330A	2,4-DNT
HPLC	EPA 8330A	2-Nitrotoluene
HPLC	EPA 8330A	4-Nitrotoluene
HPLC	EPA 8330A	3-Nitrotoluene
HPLC	EPA 8330A	3,5-Dinitroaniline
HPLC	EPA 8330A	2,4-Diamino-6-nitrotoluene
HPLC	EPA 8330A	2,6-Diamino-4-nitrotoluene
HPLC	EPA 8330A	Picric Acid

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
HPLC	EPA 8332	Nitroglycerine
HPLC	EPA 8332	PETN
Combustion-IR	EPA 9060A	TOC
IC	EPA 9056 / 9056A	Bromate
IC	EPA 9056 / 9056A	Bromide
IC	EPA 9056 / 9056A	Chloride
IC	EPA 9056 / 9056A	Fluoride
IC	EPA 9056 / 9056A	Nitrate
IC	EPA 9056 / 9056A	Nitrite
IC	EPA 9056 / 9056A	Phosphate
IC	EPA 9056 / 9056A	Sulfate
IC	EPA 9056 / 9056A	Chlorate
GC	EPA 8151A	Acifluorfen
GC	EPA 8151A	Bentazon
GC	EPA 8151A	Chloramben
GC	EPA 8151A	2,4-D
GC	EPA 8151A	2,4-DB
GC	EPA 8151A	Dacthal
GC	EPA 8151A	Dalapon
GC	EPA 8151A	Dicamba
GC	EPA 8151A	3,5-Dichlorobenzoic acid
GC	EPA 8151A	Dichlorprop
GC	EPA 8151A	Dinoseb
GC	EPA 8151A	MCPA
GC	EPA 8151A	MCPP
GC	EPA 8151A	Pentachlorophenol
GC	EPA 8151A	Picloram
GC	EPA 8151A	Silvex
GC	EPA 8151A	2,4,5-T
Spectrometric	EPA 9014	Cyanide
Gravimetric	EPA 9071B	Oil & Grease
GFAA	CA 939M	Organo Lead
Preparation	**Method**	**Type**
Purge &Trap	EPA 5030B / EPA 5035	Volatiles Prep
Acid Digestion	EPA 3050B	Metals Prep
Alkaline Digestion	EPA 3060A	Hexavalent Chrom
Soxhlet	EPA 3540C	Organic Extraction
Sonication	EPA 3550C	Organic Extraction
Waste Dilution	EPA 3580A	Organic Extraction
Microwave	EPA 3546	Organic Extraction
TCLP	EPA 1311	Leaching

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
SPLP	EPA 1312	Leaching
Floricil Clean-up	EPA 3620C	Extract Clean-Up
GPC Clean-up	EPA 3640A	Extract Clean-Up
Sulfur Clean-up	EPA 3660B	Extract Clean-Up
Acid/Permanganate Clean-up	EPA 3665A	Extract Clean-Up

Air and Emissions		
Technology	**Method**	**Analyte**
GC-MS	TO-15	1,1,1-trichloroethane
GC-MS	TO-15	1,1,2,2-tetrachloroethane
GC-MS	TO-15	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	TO-15	1,1,2-trichloroethane
GC-MS	TO-15	1,1-dichloroethane
GC-MS	TO-15	1,1-Dichloroethene
GC-MS	TO-15	1,2,4-trichlorobenzene
GC-MS	TO-15	1,2,4-trimethylbenzene
GC-MS	TO-15	1,2-dibromoethane
GC-MS	TO-15	1,2-dichlorobenzene
GC-MS	TO-15	1,2-dichloroethane
GC-MS	TO-15	1,2-dichloroethene
GC-MS	TO-15	1,2-dichloropropane
GC-MS	TO-15	1,3,5-trimethylbenzene
GC-MS	TO-15	1,3-Butadiene
GC-MS	TO-15	1,3-Butadiene, 1,1,2,3,4,Hexachloro
GC-MS	TO-15	1,3-dichlorobenzene
GC-MS	TO-15	1,4-dichlorobenzene
GC-MS	TO-15	1,4-Dioxane
GC-MS	TO-15	2,2,4-Trimethylpentane
GC-MS	TO-15	4-Ethyltoluene
GC-MS	TO-15	Acetone
GC-MS	TO-15	Acrylonitrile
GC-MS	TO-15	Allyl Chloride
GC-MS	TO-15	Benzene
GC-MS	TO-15	Benzyl Chloride
GC-MS	TO-15	Bromodichloromethane
GC-MS	TO-15	Bromoform
GC-MS	TO-15	Bromomethane
GC-MS	TO-15	Carbon Disulfide
GC-MS	TO-15	Carbon Tetrachloride

LABORATORY ACCREDITATION BUREAU

Certificate # L2278

Air and Emissions		
Technology	**Method**	**Analyte**
GC-MS	TO-15	Chlorobenzene
GC-MS	TO-15	Chloroethane
GC-MS	TO-15	Chloroethene
GC-MS	TO-15	Chloroform
GC-MS	TO-15	Chloromethane
GC-MS	TO-15	cis-1,3-Dichloropropene
GC-MS	TO-15	Cyclohexane
GC-MS	TO-15	Dibromochloromethane
GC-MS	TO-15	Dichlorodifluoromethane
GC-MS	TO-15	Dichlorotetrafluoroethane
GC-MS	TO-15	Ethyl Acetate
GC-MS	TO-15	Ethylbenzene
GC-MS	TO-15	Isopropyl Alcohol
GC-MS	TO-15	m+p-Xylene
GC-MS	TO-15	Methyl butyl Ketone
GC-MS	TO-15	Methyl Ethyl Ketone
GC-MS	TO-15	Methyl Isobutyl Ketone
GC-MS	TO-15	Methyl Tert-Butyl Ether
GC-MS	TO-15	Methylene Chloride
GC-MS	TO-15	n-Heptane
GC-MS	TO-15	n-Hexane
GC-MS	TO-15	o-Xylene
GC-MS	TO-15	Styrene
GC-MS	TO-15	Tetrachloroethylene
GC-MS	TO-15	Tetrahydrofuran
GC-MS	TO-15	Toluene
GC-MS	TO-15	Trans-1,2-Dichloroethene
GC-MS	TO-15	trans-1,3-Dichloropropene
GC-MS	TO-15	Trichloroethylene
GC-MS	TO-15	Trichloromonofluoromethan
GC-MS	TO-15	Vinyl Acetate
GC-MS	TO-15	Vinyl Bromide

Notes:

1) This laboratory offers commercial testing service.

Approved by: _____ Date: September 25, 2014

R. Douglas Leonard
Chief Technical Officer

Reissued: 1/9/14 Revised: 9/25/14

Appendix B
Contractor Quality Control Plan

APPENDIX B

PRELIMINARY DRAFT
CONTRACTOR QUALITY CONTROL PLAN
Combined Enhanced Anaerobic Bioremediation/ In Situ Chemical Reduction Treatability Study Traffic Island Area, Installation Restoration Site 28 Former Naval Air Station Moffett Field Moffett Field, California

Environmental Services Contract Number: N62473-10-D-4009
Contract Task Order: 0104

Document Control Number: CBI-4009-0104-2086

April 2015

Submitted to:

Base Realignment and Closure
Program Management Office West Naval Facilities Engineering Command
1455 Frazee Road, Suite 900
San Diego, California 92108

Submitted by:

CB&I Federal Services LLC
4005 Port Chicago Highway, Suite 200
Concord, California 94520-1120

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April 2015

Approved by: _____ Date: _____
Steve Massey
Program Quality Control Manager

Approved by: _____ Date:_____
Neil Hey
Project Manager

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Attachment 3 Project Quality Control Manager Letter of Designation, Resume, and Construction Quality Management Training Certificate
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Attachment 5 Outside Organizations
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Attachment 7 Testing Plan and Log
Attachment 8 Definable Features of Work Matrix
Attachment 9 Organization and Personnel Certifications
Attachment 10 Procedures

Acronyms and Abbreviations

CB&I	CB&I Federal Services LLC
COR	contracting officer representative
CQC	contractor quality control
CTO	contract task order
DFOW	definable feature of work
DPT	direct-push technology
EPA	U.S. Environmental Protection Agency
IWCT	injection water conditioning tank
KO	contracting officer
Navy	U.S. Department of the Navy
ORP	oxidation-reduction potential
PM	project manager
QC	quality control
QCD	quality control directive
ROICC	Resident Officer in Charge of Construction
SAP	sampling and analysis plan
TDR	target distribution radius
TS	treatability study
VOC	volatile organic compound
WATS	Westside Aquifer Treatment System
WP	work plan
ZVI	zero-valent iron

1.0 Introduction

CB&I Federal Services LLC (CB&I) has prepared this Contractor Quality Control (CQC) Plan to describe the quality control (QC) actions that will be implemented in the performance of this Task. This document is Appendix B to the Work Plan (WP), which describes the technical approach and activities to perform a treatability study (TS) of enhanced anaerobic bioremediation combined with in situ chemical reduction for remediating chlorinated ethenes in the A-Aquifer zone and the B2-Aquifer zone at the Traffic Island Area of Installation Restoration Site 28, former Naval Air Station Moffett Field, California (see WP Figure 1).

This plan has been prepared by CB&I on behalf of the U.S. Department of the Navy (Navy) under Environmental Services Contract No. N62473-10-D-4009, Contract Task Order (CTO) 0104.

This project-specific CQC Plan will be used in conjunction with the following:

- *Final Construction Quality Management Plan, Contract N62473-12-D-2005, Unrestricted Environmental Multiple Contract Award Contract for Environmental Remediation Services at Various U.S. Department of the Navy, Marine Corps, and U.S. Department of Defense Installations within the NAVFAC Southwest and NAVFAC Atlantic Areas of Responsibility to Include the US Trust Territories of Puerto Rico and Guam* (Shaw Environmental & Infrastructure, Inc., 2012), which includes quality control directives (QCDs)

This project-specific CQC Plan was developed to ensure project activities are conducted in a planned and controlled manner, to ensure that the product of these activities conforms to contract requirements, and to ensure that appropriate documentation exists to support each activity for which CB&I is responsible.

A Project QC Manager will be present at the work site to implement and manage the QC Program. The Project QC Manager will work closely with the Project Manager (PM) and with the U.S. Department of the Navy (Navy) quality assurance representatives to assure that the work is performed in compliance with specifications contained in the approved WP and this CQC Plan. The Project QC Manager has the authority to stop work if contract requirements are not being met. In the event that the Project QC Manager is unavailable, an alternate QC Manager will assume this responsibility.

The Program QC Manager for this Navy contract is responsible for developing, maintaining, and enforcing the QC Program for the contract, and will work directly with the PM and the Project QC Manager to assure that all work is performed in compliance with the contract. The Program

QC Manager will serve as an alternate contact for the Project QC Manager if questions arise regarding acceptability of materials or performance during the project.

The PM reports to the Program Manager for the contract, who has the responsibility and authority to ensure that the work is performed according to the approved specifications and to the Navy's satisfaction.

Attachment 1 depicts CB&I's project organization for this CTO. Attachments 2 through 9 are documents from the QCDs tailored to this CTO, which will help achieve statement CTO objectives. If additional project-specific quality procedures are required as the project progresses, these procedures will be inserted into Attachment 10.

2.0 Quality Control Organization

CB&I structures its corporate QC organization to support the Program Managers and PMs who have ultimate responsibility for the quality of services CB&I provides. The Program Managers and PMs are responsible for ensuring that personnel in their organizations understand the corporate and contract-specific QC programs and that their organizations' functions are set up and maintained effectively.

Quality issues are resolved at the lowest possible organizational level at each project site, to enable timely corrective action development and implementation. Issues that cannot be satisfactorily resolved at the project level are elevated to and resolved at the corporate level.

CB&I's project organization chart, including QC personnel, is shown in Attachment 1. The chart illustrates the reporting and communication relationships between QC personnel, the CB&I field team, subcontractors, and Navy representatives. This structure provides the organizational freedom for personnel to identify and evaluate quality problems and discrepancies, provide recommended solutions, and ensure that appropriate corrective actions are taken.

The specific responsibilities and qualifications associated with each QC-related position are outlined in Attachment 2. The qualifications and experience of the proposed key appointees for this project are summarized in Attachments 3 and 4.

2.1 Quality Control Personnel and Qualifications

Key QC personnel for CB&I projects are assigned on the basis of appropriate experience and the determination that these individuals meet the contract and CTO-specific requirements. The Project QC Manager and Alternate Project QC Manager are appointed by the Program QC Manager. The following paragraphs identify the QC team for this CTO and highlight their responsibilities. Copies of appointees' resumes, certifications, and letters of designation are included in Attachments 3 and 4.

2.1.1 Project Quality Control Manager

The Project QC Manager, who reports directly to the Program QC Manager, will work closely with the PM, Site Safety and Health Officer, and Navy QC representatives to assure that the work is performed in compliance with the specifications contained in the approved WP. The Project QC Manager has the authority to stop work if contract requirements are not being met. The Project QC Manager's responsibilities are listed in Attachment 2. In the event the Project QC Manager is unavailable, an Alternate Project QC Manager will assume this responsibility.

2.1.2 Alternate Project Quality Control Manager

In the event the Project QC Manager is unavailable, an Alternate Project QC Manager will assume the QC responsibilities outlined in Attachment 2 and described in this CQC Plan. The Alternate Project QC Managers designated for this project are identified in Attachment 4.

The project team, including subcontractors, will use procedures in this section to ensure quality and achieve project objectives.

2.2 Quality Control Directives

The following CB&I QCDs (Shaw Environmental & Infrastructure, Inc., 2012) apply to this CTO:

- QCD 1.0, “Project Quality Control Personnel Duties, Qualifications, and Authority”
- QCD 2.0, “Project Quality Control Plans”
- QCD 3.0, “Design Review”
- QCD 4.0, “Coordination and Mutual Understanding Meeting”
- QCD 5.0, “Project Quality Control Meetings”
- QCD 6.0, “Submittals”
- QCD 7.0, “Documentation”
- QCD 8.0, “Quality Control Certifications”
- QCD 9.0, “Three Phases of Control”
- QCD 10.0, “Completion Inspections”
- QCD 11.0, “Testing”
- QCD 12.0, “Corrective Action Requests and Non-compliance”
- QCD 13.0, “Rework”
- QCD 14.0, “Change Control”
- QCD 15.0, “Organization and Personnel Certifications Log”
- QCD 16.0, “Field Startup”
- QCD 17.0, “PM Turnover”
- QCD 18.0, “Training”
- QCD 19.0 “Quality Audits”
- QCD 21.0 “Quality Control for Geophysical Surveys”

3.0 Outside Organizations

To manage subcontractors and vendors effectively, CB&I carefully selects and prequalifies each firm. CB&I continuously and aggressively manages subcontractor costs, schedule, safety, and quality performance. The pre-qualification process ensures that subcontractors bring the same focus on quality, cost control, schedule discipline, and commitment to customer satisfaction as CB&I. Once an award is made to a subcontractor, CB&I manages the quality of the subcontractor's performance through the three-phase inspection process outlined in Section 9.0.

Laboratories providing environmental analyses are accredited as noted in the SAP (WP Appendix A).

Names and qualifications of subcontractors proposed for this project are summarized in Attachment 5. Subcontractors will be subject to CB&I QC procedures. Testing and inspection procedures will be monitored by CB&I as described in Section 5.0.

4.0 Submittal Procedures

Submittals will be managed by CB&I as required by contract. The Project QC Manager will review and approve items prior to submittal. The Project QC Manager will certify that submittals are in compliance with contract requirements. Submittals are further discussed under QCD 6.0.

5.0 Testing

In addition to implementing the three phases of control system to ensure the overall quality of each definable feature of work (DFOW), CB&I will make use of formal testing procedures where applicable, including tests performed by subcontractors and/or off-site laboratories, to ensure conformance to applicable specifications and verify that control measures are adequate to provide a finished product which conforms to contract requirements. The Project QC Manager will ensure that sampling and testing are managed and performed as required by contract.

5.1 Testing Plan and Log

The Project QC Manager will use the Testing Plan and Log, contained in Attachment 7, to manage project testing. As tests are performed, the Project QC Manager will record on the log the date the test was performed and the date the test results were forwarded to the Contracting Officer (KO) or Contracting Officer Representative (COR) as applicable. The Project QC Manager will attach a copy of the updated log to the last Daily Contractor QC Report of each month. Chemical sampling and analyses are normally not included in the log, since requirements are implemented by the Sampling and Analysis Plan (SAP; Appendix A of the WP).

5.2 Testing and Documentation

CB&I will submit test reports, containing test results to the KO and/or COR as required by contract. Test reports will cite applicable contract requirements, tests or analytical procedures used, and include a statement that the item tested or analyzed conforms or fails to conform to specified requirements. If the item fails to conform, CB&I will notify the KO and/or COR immediately. CB&I will submit the signed test reports, certifications, and other documentation to the KO and/or COR via the Project QC Manager. The Project QC Manager shall submit a summary report of field tests in the Daily Contractor QC Report. Testing is further discussed under QCD 11.0.

6.0 Rework Items, Non-Compliances, and Corrective Action Requests

The Project QC Manager will review any instances where materials, equipment, or activities fail to meet the specified requirements, and will take appropriate action to prevent future occurrences.

6.1 Rework

A rework item is work that does not comply with the contract. There is no requirement to report a rework item that is corrected the same day it is discovered. All CB&I and subcontractor personnel will be responsible for identifying rework items and reporting them to the Project QC Manager. The Project QC Manager will coordinate with the Field Team Leader to ensure rework items are corrected in a timely manner. The Project QC Manager shall maintain a Rework Items List of work that does not comply with the contract, including those identified by the KO or his/her representative. The Project QC Manager will report identified and corrected items in the Daily Contractor QC Report and during Project QC meetings and will attach a copy of the Rework Items List to the last Daily Contractor QC Report of each month. Rework items are further discussed under QCD 13.0.

6.2 Non-Compliances

The KO may also notify CB&I of any detected non-compliance with the contract. CB&I will take immediate corrective action after receipt of such notice. Such notice, when delivered to CB&I at the work site, shall be deemed sufficient for the purpose of notification. Non-compliances are further discussed under QCD 12.0.

6.3 Corrective Action Requests

CB&I will identify, track, and correct items, processes, and services that do not meet established requirements. Correction will focus on determining the cause of the deficiency and corrective actions the deficiency and prevent recurrence. Corrective action requests are further discussed under QCD 12.0.

6.4 Procedures for Tracking Laboratory Deficiencies

Laboratory testing requirements for radiological analyses and procedures for identifying and managing any deficiencies are addressed under the SAP (Appendix A of the WP).

7.0 Documentation

A variety of documents will be developed at specified points or intervals during the course of this project to support the QC process. These items will be submitted to the government or maintained by CB&I and made available for review as required. QC-related project documentation may include:

- Testing plan and log
- Daily CQC reports
- Three-phase control inspection checklists (preparatory, initial, and follow-up)
- QC meeting minutes
- Rework items list
- Non-compliance/corrective action reports
- As-built drawings
- Material receipt inspections

Documentation is further discussed under QCD 7.0.

7.1 Daily Reports

CB&I shall submit reports for each day that work is performed as required by contract. Reports will be attached to the Daily Contractor QC Report. The reporting of work shall be identified by terminology consistent with the construction schedule. The “remarks” section of reports will include directions received, construction deficiencies and problems, QC problems, deviations from project plans, conflicts or errors in the drawings or specifications, field changes, instructions given and corrective actions taken, work progress and delays, safety hazards, meetings held, and visitors to the work site.

7.1.1 Daily Contractor Quality Control Report

The Project QC Manager is responsible for preparing and signing the Daily Contractor QC Report. Attachments contain this report. Other QC, production, and health and safety documents may be attached to this report. The Project QC Manager will submit the report by 10:00 a.m. to the Navy the next working day after each day that work is performed and for every seven consecutive calendar days of no-work.

7.1.2 Daily Contractor Production Report

The Field Team Leader is responsible for preparing and signing the Daily Contractor Production Report. Attachments contain this report. The report will be attached to the Daily Contractor QC Report.

7.1.3 Quality Control Specialist Report

If a QC Specialist is assigned, he/she shall prepare, sign, and date a report for each day that work is performed in his/her area of responsibility. This report shall include the same documentation requirements as are submitted with the Daily Contractor QC Report.

7.2 Quality Control Meeting Minutes

After the start of construction, the Project QC Manager will commence holding weekly QC meetings with the Field Team Leader, QC staff, and Site Safety and Health Officer. The Navy Remedial PM/COR, Caretaker Site Office, and Resident Officer in Charge of Construction may also attend these meetings as required.

As a minimum, the following will be accomplished at each QC meeting as needed:

- Review the minutes of the previous meeting
- Review the status of work , inspections, testing, rework, and submittals
- Review the work, inspections, and testing to be accomplished in the next two weeks and documentation required
- Resolve QC, production, and safety concerns
- Address items that may require revising the project plans, including this CQC plan
- Review the accident prevention plan and/or activity hazard analyses as necessary
- Review environmental requirements and procedures as necessary
- Review the schedule
- Review the following, as applicable
  - Waste management plan
  - Environmental management plan
  - Status of training completion and progress

The Project QC Manager will prepare the minutes of the meetings and provide a copy to the COR within two working days after the meeting.

7.3 Quality Control Validation

CB&I shall maintain files of original documents in a home office, including project documents. Copies of project documents will also be filed in the field office. Project files include, but are not limited to, inspection reports and checklists, Testing Plan and Log, Rework Items List, and punch lists. Reports are required from the QC Specialists (if assigned) for each day that work is performed in their area of responsibility. QC Specialist reports shall include the same documentation requirements as the Daily Contractor QC Report for their area of responsibility. QC Specialist reports are to be prepared, signed, and dated by the QC Specialists and shall be attached to the Daily Contractor QC Report prepared for the same day.

7.4 As-Built Drawings

The Project QC Manager shall ensure the as-built drawings are kept current on a daily basis and marked to show deviations from the contract drawings identified with the appropriate modifying documentation. The Project QC Manager or QC Specialist assigned to that area of responsibility shall initial each revision. Upon completion of work, the Project QC Manager will certify the drawings, attesting to their accuracy, and ensure that they are submitted to the KO per QCD 8.0.

8.0 Definable Features of Work

A DFOW is a representative portion of work that is separate and distinct from any other stage of work. Eighteen DFOWs have been identified for this project, as outlined in the following subsections and further described in the WP. Activities associated with the project will be conducted in accordance with the following:

- WP
- SAP (Appendix A of the WP)
- *Accident Prevention Plan, Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study, Traffic Island Area, Installation Restoration Site 28, Former Moffett Naval Air Station, Moffett Field, California* (CB&I, 2015)
- Traffic Control Plan (Appendix C of the WP)

8.1 Definable Feature of Work 1: Utility Clearance

Utility clearance surveys will be conducted to help locate and avoid subsurface hazards (e.g., encounters with live utility lines) during drilling activities. Once Underground Service Alert has coordinated with area utility companies to locate and mark the utility lines, a CB&I subcontracted private underground utility locator will clear the proposed boring locations by searching within a 10-foot radius for underground utilities using geophysical detection equipment. Surface geophysical methods that may be used include, but are not limited to, electromagnetic induction and geomagnetics. Clearance will be performed at every well boring and injection point location.

Prior to utility clearance, existing site utility maps will be obtained from National Aeronautics and Space Administration via the Resident Officer in Charge of Construction (ROICC) office and reviewed with due diligence. All preliminary boring and subsurface work areas will be marked. Marking will consist of painting or staking the ground surface or pavement at the proposed locations. The stake or ground marking will identify the boring by number. Marking will be done using either a permanent waterproof marker or paint.

The subcontractor will note each cleared sampling location with paint or with a stake immediately upon clearing it. All suspected underground utility conduits and structures will be marked with color-coded marking paint according to standards established by the American Public Works Association. If utilities or other obstructions or hazards are identified at any proposed intrusive location, CB&I's field representative will identify a new location to be surveyed.

In addition to the utility clearance surveys, prior to drilling or driving any tools into the subsurface, each borehole shall be cleared using vacuum excavating/air knife methods to a minimum depth of 5 feet below ground surface.

8.2 Definable Feature of Work 2: Land Surveying

The new monitoring wells and injection points will be located using a Global Positioning System receiver to within approximately 1-foot accuracy prior to their installation. Upon completion of the substrate injections, the new wells and injection points will be surveyed under the supervision or direction of a State of California-certified land surveyor. Vertical elevations of each survey point will be determined to the nearest 0.01 foot and referenced to the North American Vertical Datum of 1988. For wells, the measurement point will be clearly and permanently marked on the rim of the well casing. The horizontal location of each point will be determined to the nearest 0.1 foot, and referenced to the California State Plane Coordinate System, Zone III (North American Datum of 1983), as published by the National Geodetic Survey. If not already present, a minimum of one permanent control monument will be installed within a distance of 1,000 feet of each point to be surveyed.

8.3 Definable Feature of Work 3: Traffic Control

Traffic control procedures will be followed as described in the Traffic Control Plan, Appendix C to the WP.

Traffic travelling northbound on Cody Road will be detoured to the northbound one-way lane of Cummins Avenue west of the traffic island. Signs, indicating “Roadwork Ahead,” “Detour Ahead,” “Detour,” and “Road Closed” will be placed at the southern approach to the work area on Cody Road and at the western approach on Wescoat Road. Traffic cones, signage and water filled barricades with reflectors will be used to direct traffic around the work area (see Traffic Control Plan, Figure C-2 for planned signage, cones, and barricade locations). This lane closure is expected to remain in place day and night for the duration of the TS.

As the TS activity progresses westward from the staging area, it will be become necessary to temporarily close the northbound one-way lane of Cummins Avenue west of the traffic island (Traffic Control Plan, Figure C-3). Traffic travelling northbound on Cody Road or eastbound on Wescoat Road will be detoured to head westbound on Wescoat Road, then turning right onto McCord Avenue and heading northbound. The detour continues by turning right onto S. Akron Road and heading eastbound to return to the northbound Cummins Avenue. Signs, indicating “Roadwork Ahead”, “Detour Ahead”, “Detour” “No Left Turn” and “Road Closed” will be placed at the approach to the work area from each direction. Traffic cones, signage, and barricades with reflectors will be used to direct traffic around the work area (see Traffic Control Plan Figure C-3 for planned signage, cones, and barricade locations). The Cummins Avenue—

West of Traffic Island northbound lane closure is expected to be in place during daytime work hours only and will be removed upon completion of work or at the end of the work day.

The southern portion of the treatment test area requires undisturbed access to Wescoat Road between Cummins Avenue and Severyns Avenue. To protect worker and public safety it is necessary to close Cody Road at its Edquiba Road intersection to prevent traffic from approaching the work area from the south and closing the eastbound lane of Wescoat Road at its intersection with McCord Road to prevent traffic from approaching from the west (Traffic Control Plan Figure C-4). Traffic travelling northbound on Cody Road will be detoured to turn left and head westbound on Edquiba Road. Following detour signs, traffic will be directed to head northbound on McCord Avenue, then turning right on South Akron Road and heading eastbound to the northbound Cummins Avenue. Traffic heading eastbound on Wescoat Road will be detoured to turn left and head northbound onto McCord Avenue. Turning right onto South Akron Road heading eastbound completes this detour to northbound Cummins Avenue.

For additional details, see Traffic Control Plan, Appendix C to the WP.

8.4 Definable Feature of Work 4: Waste Management

Waste management activities will be performed as described in Section 4.5 of the WP. The Site Safety and Health Officer (Mr. Kevin O'Leary) is primarily responsible for this project's waste management program.

All nonexpendable equipment and materials, such as skid units, tanks, hoses, and pipes that come in contact with site contaminants will be decontaminated in the equipment decontamination area. Primary waste streams will be generated during the implementation of the treatability tests, including the following:

- Personal protective equipment
- Soil cuttings from boring and well installation
- Asphalt concrete and debris generated during boring and well installation
- Well development and sampling purge water
- Water generated during equipment decontamination

These waste materials will be segregated and temporarily stored on site in labeled drums or roll-off bins. After being characterized and profiled, the solid waste materials will be transported off-site by a licensed waste hauler for disposal to a permitted disposal facility or facilities. Well development, decontamination, and sampling purge water will be accumulated in drums located at the Westside Aquifer Treatment System (WATS) before being treated through the WATS.

Waste sampling and analysis procedures are described in the SAP (Appendix A). In addition to the solid and liquid waste streams, all the empty drums and totes that contained the food-grade reagents will be rinsed out onsite and shipped offsite for recycling. Similarly, the wood pallets and Super Sack®-type containers will also be shipped off site for recycling. Storage locations will be designated by the Navy ROICC office in consultation with National Aeronautics and Space Administration Ames.

Prior to disposal off site, the CB&I Transportation and Disposal Coordinator will prepare one manifest package for each waste stream. Each manifest package will be signed by a representative of the Navy (ROICC or Caretaker Site Office).

8.5 Definable Feature of Work 5: Monitoring Well Drilling

Monitoring well drilling will be performed as described in Section 5.1.1 of the WP. The task lead for this DFOW will be the lead field geologist; Mr. Kevin O'Leary will perform three-phase inspections for this DFOW.

Prior to treatment reagent injection, five new groundwater monitoring wells will be installed to augment the existing monitoring well network. The wells will be installed using sonic drilling techniques by a State of California C-57 Licensed Water Well Contractor. While drilling, the ground surface around each well boring will be covered with plastic to prevent soil or fluids from contacting the surrounding ground surface. For wells that will be installed in the A-Aquifer zone, a minimum 6-inch diameter drive casing will be used to create the well borehole. For wells that will be installed in the B2-Aquifer, a combination of minimum 6-inch diameter and 8-inch diameter drive casings will be used in a telescoping approach to isolate A-Aquifer zone contaminants from the B-Aquifer during well construction. The telescoping approach entails advancing the 8-inch diameter drive casing into the A/B-Aquitard, setting a bentonite plug, allowing the plug to adequately hydrate for one hour, and then advancing the 6-inch diameter drive casing through the 8-inch diameter casing and bentonite plug down to the total planned well depth. Each well boring will be continuously cored to total depth with 4-inch diameter core barrels advanced ahead of the outer drive casing. The soil cores will be logged by a field geologist with oversight by a State of California-licensed Professional Geologist. The logs will include Unified Soil Classification System descriptions, soil color, depth of first encountered groundwater, and any field indications of contamination (odor or staining). A photoionization detector will be used to screen the soil core for volatile organic compounds (VOCs). The core material and any other potential soil waste will be properly containerized, labeled, and stored for waste characterization and future disposal in accordance with Section 4.5 of the WP.

8.6 Definable Feature of Work 6: Monitoring Well Construction

Monitoring well construction will be performed as described in Section 5.1.2 of the WP. The task lead for this DFOW will be the lead field geologist; Mr. Kevin O'Leary will perform three-phase inspections for this DFOW.

Each well will be constructed of 2-inch diameter Schedule 40 polyvinyl chloride with a maximum 10-foot long, 0.010-inch slotted screen. A filter pack consisting of #2/16 (16 × 30 sieve size) clean silica sand will be placed in the borehole annulus from the bottom of the well screen up to 2 feet above the top of the screen interval. A minimum 2-foot layer of 3/8-inch bentonite pellets will then be placed above the filter pack and hydrated. Next, cement bentonite grout will be tremied and pumped in place from the top of the bentonite seal up to 1 foot below ground surface to leave room to install a well box. Every well will be completed at the surface with a traffic-rated, flush mounted, well box and concrete collar. WP Figure 7 presents the preliminary design details for the wells to be installed.

8.7 Definable Feature of Work 7: Monitoring Well Development

Monitoring well drilling will be performed as described in Section 5.1.1 of the WP. The task lead for this DFOW will be the lead field geologist; Mr. Kevin O'Leary will perform three-phase inspections for this DFOW.

Following installation, each well will be developed no sooner than 48 hours after construction of the grout seal. The wells will be developed by a process of surging, bailing, and purging. A surge block will be lowered into the well and gently moved up and down within the saturated zone to induce movement of residual fine-grained material from the filter pack through the well screen where it can be removed by bailing or pumping. The well will be bailed periodically during the surging process. During development, general water quality parameters, including turbidity, pH, temperature, conductivity, dissolved oxygen, and oxidation-reduction potential (ORP), will be measured (at a minimum every 15 minutes) and recorded. Development will continue until a minimum of three well volumes have been removed; the well water is free of excessive turbidity (5 nephelometric turbidity units or less); and the indicator water quality parameters (pH, temperature, and conductivity) have stabilized. Additionally, the final measured well depth should be in reasonable agreement with the estimated well completion depth. Monitoring and sampling of new wells shall be performed no sooner than 72 hours following well development activities.

8.8 Definable Feature of Work 8: Baseline Groundwater Sampling

Groundwater sampling activities will be performed as described in the SAP (Appendix A of the WP), and as further described in Section 5.2 of the WP. Ms. Rose Condit is the task lead for this DFOW. Mr. Kevin O'Leary will perform three-phase inspections for this DFOW.

Prior to substrate injection, baseline groundwater monitoring will be performed to define the pretreatment water quality conditions across the treatment area. Baseline groundwater samples will be collected for laboratory analysis from nine existing wells (28OW-03, 28OW-04, 28OW-11, 28SI-06, 28SI-07, 28SI-09, 28SI-10, 28SI-13, and W88-1) and the five new groundwater monitoring wells after installation (WP Figures 6a through 6c). The samples will be analyzed for the following analytes:

- VOCs by U.S. Environmental Protection Agency (EPA) Method 8260C
- Dissolved gases (methane, ethane, ethene, and acetylene) by AM20GAX
- Dissolved metals (manganese, arsenic, and iron) by EPA Method 6010/6020
- Anions (nitrate and sulfate) by EPA Method 300
- Iron II (using an on-site Hach colorimeter)
- Total organic carbon by SM5310
- Alkalinity by SM2320B

Three select samples from treatment area wells will be additionally analyzed for dehalococcoides deoxyribonucleic acid by quantitative polymerase chain reaction analysis. In addition, general water quality parameters (pH, temperature, conductivity, turbidity, ORP, and dissolved oxygen) and depth to groundwater will also be measured in the field during sampling.

Measuring metal concentrations will help monitor reducing conditions that develop as a result of substrate injection. Manganese and iron levels will be used to evaluate the extent of reducing conditions established upon injection of the substrates. The solubility of these metals increase as they transform from their relatively oxidized forms to reduced forms as reducing conditions are established. The increased concentrations of these metals and methane as well as decreased concentrations of oxygen, nitrate, and sulfate will be used to geochemically confirm the ORP level that will be established after introducing the reagents.

Groundwater sampling will be performed using low-flow purging and sampling techniques. Further details of the sampling and analytical requirements are provided in the SAP (Appendix A).

8.9 Treatability Test Implementation

Following completion of the baseline sampling event, the treatment component of the TS will be initiated. The following activities will be performed in support of the treatability test:

8.9.1 Definable Feature of Work 9: Establish Temporary Facilities and Work Areas

Temporary Facilities and Work Areas will be established as described in Section 6.1 of the WP. The Field Team Leader is the task lead, and Mr. Kevin O'Leary will perform three-phase inspections for this DFOW.

Temporary facilities will be established adjacent to the treatment area within a fenced equipment staging and storage area that will include the reagent mixing/injection plant, a 250-kilowatt diesel generator, a bermed area with three 20,000-gallon water conditioning tanks, a bermed decontamination area, a reagent storage area, a waste storage area, and office/storage containers. The dimensions of the area needed to accommodate all these items and to allow safe forklift operations is at least 100 feet by 250 feet.

8.9.2 Definable Feature of Work 10: Groundwater Extraction

Groundwater extraction will be performed as described in Section 6.2 of the WP. The Field Team Leader is the task lead, and Mr. Kevin O'Leary will perform three-phase inspections for this DFOW.

Approximately 190,000 gallons of groundwater will be needed to prepare the reagents for the treatability test. Groundwater will be obtained from WATS extraction well EA1-2 via a flow valve connected to the wellhead so that groundwater can be diverted to above-ground injection water conditioning tanks (IWCTs) for the TS. Well EA1-2 is estimated as being able to provide groundwater continuously at a rate of approximately 8 gallons per minute for the duration of each field day. However, even at this flow rate, more groundwater may be needed; therefore, influent to WATS will be collected and transported to the water conditioning tanks on a biweekly basis to make up the difference, as necessary.

8.9.3 Definable Feature of Work 11: Water Conditioning

Water conditioning will be performed as described in Section 6.3 of the WP. The Field Team Leader is the task lead, and Mr. Kevin O'Leary will perform three-phase inspections for this DFOW.

The extracted groundwater will be pumped into the IWCTs where lactate will be added for quickly establishing anaerobic and strongly reducing conditions necessary for the viability of the bioaugmentation culture. The tanks will be located within the temporary Equipment and Materials Staging Area that will be established adjacent to the treatment area, as described in Section 6.1 of the WP.

Lactate will be added to the IWCTs at a rate sufficient to maintain a concentration of 0.5 grams of lactate per liter of stored water. Using a product that is 60 percent by weight (sodium) lactate and 40 percent by weight water, approximately 0.0008 gallons of product per 1 gallon of stored

water will be used to sustain the target concentration for conditioning. The sodium lactate will be added to the IWCTs daily to keep up with the volume of extracted groundwater being added to the tanks. Gauges on the IWCTs will identify the approximate volume of water in the tanks for calculating proper volumes of lactate required. Small low-flow chemical metering pumps may be used to compliment the hand-fed dosages and centrifugal or submersible pumps may be used to mix the contents of the IWCTs.

ELS™ and dry zero-valent iron (ZVI)/guar gum will NOT be added to the IWCTs. These materials will be added to the reagent mixing tanks (ELS™ solution and ZVI slurry) immediately prior to injection.

8.9.4 Definable Feature of Work 12: Reagent Mixing and Bioaugmentation

Reagent mixing and bioaugmentation will be performed as described in Section 6.4 of the WP. The Field Team Leader is the task lead, and Mr. Kevin O'Leary will perform three-phase inspections for this DFOW.

The conditioned water from the IWCTs will be pumped into smaller reagent mixing tanks stationed adjacent to the injection pump within the reagent mixing plant of the Equipment and Materials Staging Area shown on WP Figure 8. The reagents, namely the ELS™ solution amended with SDC 9™ and the ZVI slurry, will be prepared in separate mixing tanks immediately prior to injection. The tanks are to be named:

- ELS™ solution tank
- ZVI slurry tank

The ELS™ solution tank will be used to blend conditioned water with ELS™ and SDC 9™. The ZVI slurry tank will be used to blend conditioned water with ZVI and guar gum. The reagents will be fed directly from these tanks to the injection pump for emplacement. Prescribed dosages for each of the reagent types are discussed in WP Section 6.4.1.

8.9.5 Definable Feature of Work 13: Material Handling and Storage

The ELS™ and lactate will be delivered to the site in 55-gallon drums and 275-gallon totes, respectively. The ZVI and guar gum will be delivered in 1-ton super sacks and 50-pound bags, respectively. All materials will be stored under ambient temperature in the Equipment and Materials Staging Area (see WP Figure 8).

The lactate will be transferred into the IWCTs via a pump with a hose connected to the bung at the bottom of the tote, or via a high viscosity drum pump. The ELS™ will be transferred into the mixing plant system using a drum pump. ZVI is a dry powder.

Guar gum will be delivered to the site as a dry mix powder in 50-pound sacks. It will be added to the ZVI slurry tank as a dry material or mixed with a small amount of conditioned water and transferred using a high viscosity pump.

The bioaugmentation culture, SDC-9™, will arrive in 5-gallon stainless steel canisters. The culture will be certified free of human pathogens. Although it is nontoxic, the culture has a slightly unpleasant odor. If overnight storage of the culture is required, it will be maintained on ice or within a refrigerator. The culture may be stored for up to two weeks. Immediately prior to injection, SDC-9™ will be added to the substrate solution tank. The shipping containers for the SDC-9™ will be outfitted with quick-connect ports clearly labeled as "in" and "out" and the associated quick-connect fittings for the transfer tubing will accompany the SDC-9™ shipment. An inert gas, either argon or nitrogen, will be used to "push" the SDC-9™ from the shipping containers into the mixing tanks via ¼-inch internal diameter flexible polyethylene tubing. A small cylinder of the pressurized gas outfitted with a pressure regulator will be used to supply the pressure.

8.9.6 Definable Feature of Work 14: Hydraulic Fracturing and Reagent Injection

The injection process will rely on hydraulic fracturing and high-pressure/flow rate delivery of the reagents using direct-push techniques. Hydraulic fracturing is anticipated to cause a larger reagent distribution radius, because the aquifer will have a greater, fracture-increased permeability, and the reagents will be "jetted" into the aquifer. High flow delivery is preferred over low-flow delivery, because it requires less mix water and generally reduces the potential for expansion of the plume. Conversely, low-flow injection essentially requires complete replacement of the aquifer pore volume. Under the high flow rate scenario, it is anticipated that the injected materials will replace only 10 percent of the aquifer's effective pore space. To further minimize the potential for plume migration, the injection locations on the exterior portion of the treatment area will be treated first. Simply stated, injections will proceed from the outside of the treatment area towards the center. The reagents will be direct injected using a variable speed positive displacement pump (piston type) capable of generating up to 2,000 pounds per square inch of pressure at a flow rate of up to 50 gallons per minute.

Hydraulic fracturing and reagent injections will be performed in a top-down approach on 2.5-foot intervals. The reagents will be injected at each interval in three stages, beginning with injecting half of the prescribed ELS™ solution to notch the formation and initiate the fracture, followed by injecting the full ZVI slurry dose and ending with injection of the remaining ELS™ solution to chase the ZVI slurry into the aquifer. The injection borings will be abandoned by tremie grouting a neat cement/bentonite grout in accordance with Santa Clara Valley Water District requirements.

8.9.7 Definable Feature of Work 15: Direct-Push Injection Procedures

The treatment reagents will be injected into the aquifer using the following "top-down" injection procedure at each location:

1. Using a direct-push technology (DPT) rig, advance the injection rod to the depth of the first injection interval. Use a pressure activated injection tip with a check valve to allow lateral delivery of the reagent(s) and to prevent backflow.

2. Once the target injection depth has been reached, connect the reagent(s) delivery hose to the DPT rod header using an injection cap and ensure proper hose restraints are in place to prevent hose whip in the case of fitting or hose failure.

3. Once the reagent(s) delivery hose has been securely attached to the DPT rod header, activate the injection pump and begin the hydraulic fracturing process using the ELS™ solution. A pressure gauge will be used to monitor the injection pressure. Increase the pressure to achieve fracture of the aquifer matrix as indicated by a sudden decrease in pressure and increase in flow rate. Injection volume(s) will be determined based on changes in tank volume. Due to the physical characteristics of the reagents that commonly plug flow meters, reagent flow cannot be monitored continuously.

4. Inject the initial volume (prescribed per injection interval and desired target distribution radius [TDR]) of ELS™ solution to notch and fracture the aquifer.

5. After fracturing and injecting the initial volume of ELS™ solution, immediately switch to injecting the prescribed volume (per injection interval and TDR) of ZVI slurry at a high flow rate.

6. Upon injecting the total prescribed volume of ZVI slurry, immediately switch to injecting the final volume (per injection interval and TDR) of ELS™ solution at a high flow rate.

7. After injecting the final volume of ELS™ solution, isolate the DPT rod from the reagent delivery hose by shutting the appropriate isolation valve on the injection cap, depressurize the DPT rod at the injection cap, confirm the pressure has dissipated prior to removing the injection cap, remove the injection cap from the DPT rod, and then drive the DPT rod to the next injection interval, 2.5 feet below the previous completed injection interval. While depressurizing the DPT rod and proceeding to the next interval, backflow of reagents from the rod may occur and shall be contained. If the amount of reagents is significant, the volume will be recorded to correct the actual amount of reagent(s) injected into that interval.

8. Repeat the hydraulic fracture and injection Steps 2 through 7 until the final injection interval has been completed for the injection point.

9. Upon completing reagent injection at each point, abandon each injection borehole by backfilling with a cement/bentonite grout. The grout will be pumped through a tremie pipe from the bottom injection interval to within 6 inches of the ground surface.

10. Finish the borehole appropriately in accordance with the surrounding surface materials (i.e., concrete or grout) and survey nail set flush-to-grade marking the injection point location for final survey. The boreholes must be finished flush-to-grade to allow vehicular traffic.

11. Upon completion of the reagent injections, clean the injection equipment and injection rods by circulating hot water and detergent through the pump and delivery hose.

12. Repeat the previous steps at each injection point.

8.10 Definable Feature of Work 16: Performance Monitoring

Groundwater samples will be collected immediately following completion of all the reagent injections and quarterly thereafter for a total of five sampling events to document and evaluate treatment performance. The events will occur approximately 7 days, 30 days, 120 days, 210 days, and 300 days after reagent injection. The samples will be collected from 13 groundwater monitoring wells in and around the treatment area as listed in Table 2 and shown on WP Figures 6b and 6c. The samples will be collected using low-flow purging and sampling techniques. The samples will be analyzed for the same analytes and field parameters as the baseline sampling event (Section 5.4):

- VOCs by EPA Method 8260C
- Dissolved gases (methane, ethane, ethene, and acetylene) by AM20GAX
- Dissolved metals (manganese, arsenic, and iron) by EPA Method 6010/6020
- Anions (nitrate and sulfate) by EPA Method 300
- Iron II (using an on-site Hach colorimeter)
- Total organic carbon by SM5310
- Alkalinity by SM2320B

Three select samples from treatment area wells will be additionally analyzed for dehalococcoides deoxyribonucleic acid by quantitative polymerase chain reaction analysis during the 30-day and 120-day sampling events. In addition, general water quality parameters (pH, temperature, conductivity, turbidity, ORP, and dissolved oxygen) and depth to groundwater will also be measured in the field during sampling. Further details of the sampling and analytical requirements are provided in the SAP (WP Appendix A).

8.11 Definable Feature of Work 17: Equipment Decontamination

Drilling, well development, and heavy construction equipment in contact with contaminated soil and/or groundwater will go through decontamination after use. Additionally, drill rigs and

equipment will be decontaminated before mobilization to the field, between boreholes, and prior to demobilization from the field. The drill rigs most often will have a decontamination area on the rig or pull trailer in the field with them. These mobile decontamination stations collect all of the rinsate for proper disposal. Clean equipment is kept segregated from contaminated equipment on the rigs, trailer, or on plastic sheeting prior to reuse. If needed, a decontamination station will be set up in an area exclusively for decontamination of drilling, well development, and heavy equipment. The station will be constructed such that all rinsate, liquid spray, soil, and other wastes are fully contained and collected for disposal. Fluids and sediment generated at the portable decontamination pad will be contained in portable tanks or drums. Nondisposable sampling equipment will also be decontaminated between uses to ensure the quality and integrity of the samples collected.

8.12 Definable Feature of Work 18: Demobilization

Demobilization will consist of removing all construction equipment and materials, cleaning the project site, inspecting the project site, and issuing a certification of completion. Demobilization activities will also involve collection and disposal of all contaminated materials, including decontamination water and disposable equipment for which decontamination is inappropriate.

9.0 Three Phases of Control

The Project QC Manager manages the three phases of control to adequately cover on-site and off-site DFOWs. The Project QC Manager may assign the Task Leader for DFOWs to other project personnel, including the, Project Geologist, Project Engineer, Field Team Leader, QC Specialist, etc.

9.1 Preparatory Phase

The Project QC Manager shall notify the KO and/or COR (as applicable) and ROICC at least two work days in advance of each preparatory phase meeting (two weeks for off-site work). The assigned lead shown on the project DFOW Matrix will conduct the meeting. At a minimum, the Project QC Manager, QC staff, Field Team Leader, and Site Safety and Health Officer will attend. When a subcontractor will perform work, that subcontractor's superintendent shall attend.

9.1.1 Preparatory Phase Activities

The following will occur during the preparatory phase:

- Review each paragraph of the applicable specification sections.
- Review the contract drawings.
- Verify that field measurements are as indicated on construction and/or shop drawings (if applicable) before confirming product orders, in order to minimize waste due to excessive materials.
- Verify that appropriate shop drawings and submittals for materials and equipment have been submitted and approved. Verify receipt of approved factory test results, when required.
- Review the Testing Plan and Log, and ensure that provisions have been made to provide the required QC testing.
- Examine the work area to ensure that the required preliminary work has been completed.
- Coordinate the schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- Examine the required materials, equipment, and sample work to ensure that they are on hand and conform to the approved shop drawings and submitted data.
- Discuss construction methods, construction tolerances, workmanship standards, and the approach that will be used to provide quality construction by planning ahead and identifying potential problems.

- Review appropriate activity hazard analyses, accident prevention plan and/or site safety and health plan to ensure that applicable safety requirements are met and that required material safety data sheets are submitted.

Results of the preparatory phase will be documented in the Inspection Report and attached to the Daily Contractor QC Report.

9.2 Initial Phase

The Project QC Manager shall notify the KO and/or COR (as applicable) and the ROICC at least two work days in advance of each initial phase meeting (two weeks for off-site work). The assigned lead shown on the project DFOW Matrix will perform the initial phase and he/she will observe the initial segment of the DFOW to ensure that the work complies with contract requirements. Results of the initial phase will be documented in the Inspection Report and attached to the Daily Contractor QC Report. Attachments contain this report. The following will be performed:

- Establish the quality of workmanship required
- Resolve conflicts
- Ensure that testing is performed by the approved laboratory
- Check work procedures for compliance with the *Accident Prevention Plan, Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study, Traffic Island Area, Installation Restoration Site 28, Former Moffett Naval Air Station, Moffett Field, California* (CB&I, 2015) and the appropriate activity hazard analysis to ensure that applicable safety requirements are met

Results of the initial phase will be documented in the Inspection Report and attached to the Daily Contractor QC Report.

9.3 Follow-up Phase

The assigned lead shown on the project DFOW Matrix will perform the follow-up phase for ongoing work daily, or more frequently as necessary, until the completion of the work. Results of the initial phase will be documented in the Inspection Report and attached to the Daily Contractor QC Report. Attachments contain this report. The following will be performed:

- Ensure the work is in compliance with contract requirements
- Maintain the quality of workmanship required
- Ensure that testing is performed by the approved laboratory
- Ensure that rework items are being corrected

- Perform safety inspections

9.4 Additional Preparatory and Initial Phases

Additional preparatory and initial phases will be conducted for any deficiency discovered, if the quality of ongoing work remains or becomes unacceptable; if there are changes in the applicable QC organization; if there are changes in the on-site production supervision or work crew; if the work is resumed after substantial period of inactivity; or if other problems develop. The three phases of control are further discussed under QCD 9.0.

10.0 Completion Inspections

The following subsections describe the completion inspections that will be performed to ensure that the project objectives or performance work statements are met and the fieldwork is complete.

10.1 Punch-Out Inspection

The Project QC Manager will manage completion inspections. Near the completion of all work or to verify that statement of objectives or performance work statements are met, the Project QC Manager will ensure work is inspected and a punch list developed. Punch list items include items that do not conform to the approved drawings, specifications and contract, and remaining rework items. The punch list will indicate the estimated correction dates of these items. A copy of the punch list will be provided to the COR, if required by contract. The Project QC Manager will ensure corrected items are verified. Once this is accomplished, he/she will schedule a pre-final inspection, if required by Navy.

10.2 Pre-Final Inspection

If requested by Navy, Navy will perform a pre-final inspection to verify that fieldwork is complete. A Navy punch list may be developed as a result of this inspection. The Project QC Manager will ensure that the items on this list are corrected prior to notifying the Navy that a final inspection with the client can be scheduled. Any items noted during the preliminary-final inspection must be corrected in a timely manner and be accomplished before the contract completion date for the work.

10.3 Final Acceptance Inspection

If required by contract, the Project QC Manager will notify the KO and/or COR at least 14 calendar days prior to the date a final acceptance inspection can be held, stating that all items previously identified during the pre-final will be corrected and acceptable, along with any other unfinished contract work, by the date of the inspection. The Project QC Manager, Field Team Leader, and others deemed necessary will be present during the inspection with the Navy. If deficiencies remain or are identified during the inspection, the parties will agree on a course of action. Completion inspections are further discussed under QCD 10.0.

10.4 Inspection Documentation

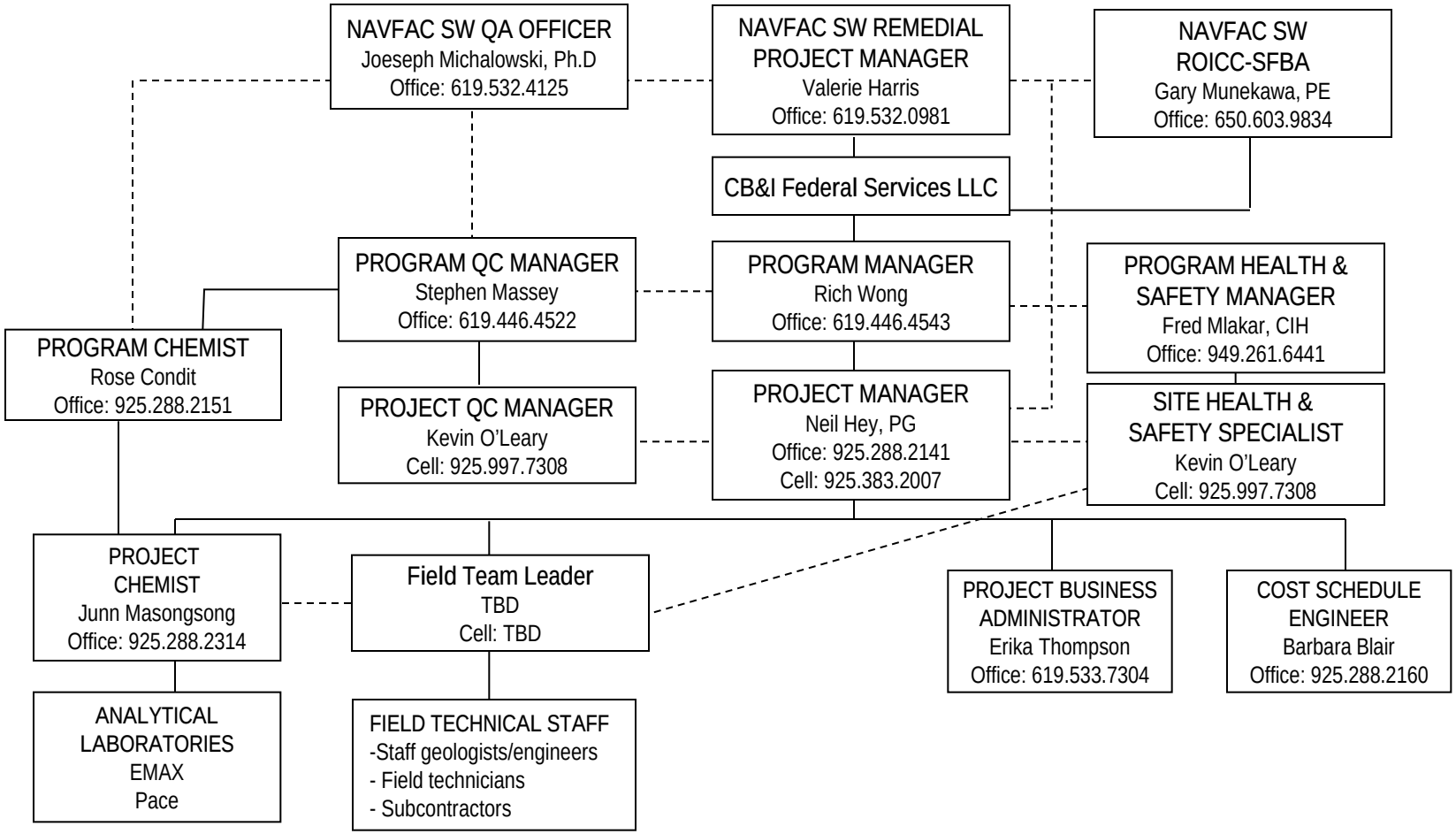
Inspection records will be maintained by the Project QC Manager in accordance with QCD 7.0.

11.0 References

CB&I Federal Services LLC, 2015, *Accident Prevention Plan, Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study, Traffic Island Area, Installation Restoration Site 28, Former Moffett Naval Air Station, Moffett Field, California*.

Shaw Environmental & Infrastructure, Inc., 2012, *Final Construction Quality Management Plan, Contract N62473-12-D-2005, Unrestricted Environmental Multiple Contract Award Contract for Environmental Remediation Services at Various U.S. Department of the Navy, Marine Corps, and U.S. Department of Defense Installations within the NAVFAC Southwest and NAVFAC Atlantic Areas of Responsibility to Include the US Trust Territories of Puerto Rico and Guam*, September.

Attachment 1
Quality Control Organization Chart



Organization Chart

Combined EAB/ISCR Treatability Study

Traffic Island Area, IR Site 28, Former NAS Moffett Field, Moffett Field, CA

CTO 0104

Attachment 2
Project Quality Control Duties and Responsibilities

Project Quality Control Duties and Responsibilities

Duty	Responsibility	QCD
Pre-Construction Phase		
Establish personnel requirements	PM or Delegate	1.0
Review personnel resumes	PM or Delegate	1.0
Prepare organization chart	PM or Delegate	1.0, 2.0
Prepare letters of designation	QC Manager or Delegate	1.0, 2.0
Assign duties	PM or Delegate	1.0, 2.0
Prepare submittal register	QC Manager or Delegate	2.0, 6.0
Prepare Definable Features of Work Matrix	QC Manager or Delegate	2.0, 9.0
Prepare Testing Plan and Log	QC Manager or Delegate	2.0, 7.0, 11.0
Prepare Rework Items List	QC Manager or Delegate	2.0, 7.0
Identify subcontractors	PM or Delegate	1.0, 2.0
Submit laboratory information	QC Manager or Delegate	1.0, 2.0
Assemble forms	QC Manager or Delegate	2.0
Conduct Coordination and Mutual Understanding Meeting	PM or Delegate	4.0
Construction Phase		
Review definable features of work	QC Manager or Delegate	9.0
Ensure submittals approved and submitted	QC Manager or Delegate	6.0
Conduct Preparatory Meeting	QC Manager or Delegate	9.0
Conduct Preparatory Inspection	QC Manager or Delegate	9.0
Conduct Initial Inspection	QC Manager or Delegate	9.0
Conduct Project QC meetings	QC Manager or Delegate	5.0
Prepare daily QC reports	QC Manager or Delegate	7.0
Conduct Follow-Up Inspection	QC Manager or Delegate	9.0
Conduct Completion Inspections	QC Manager or Delegate	10.0

Notes:

The Project QC Manager may assign the Lead for inspections to the other project personnel: Technical Task Leader (e.g., Project Engineer), or Operational Task Leader (e.g., Project Chemist).

QC — *quality control*

QCD — *quality control directive*

Attachment 3
Project Quality Control Manager Letter of Designation, Resume, and Construction Quality Management Training Certificate

Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study, Traffic Island Area, IR Site 28,
Former Naval Air Station Moffett Field
Moffett Field, CA

Contract Number N62473-10-D-4009
Contract Task Order 0104

Project Quality Control Manager
Letter of Designation

February 18, 2015

Mr. Kevin O'Leary:

This letter will serve to assign you as the CB&I Federal Services LLC Project Quality Control (QC) Manager for the above-captioned contract task order. In this capacity, you will report directly to me and will administer the established requirements of the contract and Contractor QC Plan. In the case where you are not able to perform the Project QC Manager's duties, Mr. Mark Vennemeyer, Mr. Lee Laws, or Mr. Mark Seibert will serve as your Alternate Project QC Manager. You will manage the three phases of control. You are authorized to stop work that is not in accordance with the contract and will exercise this authority consistent with CB&I Federal Services LLC policies and procedures. You are authorized to approve submittals that have been certified by qualified submittal reviewers as identified in the organization chart for this task order and as necessary to ensure the quality of the work, and direct the removal and/or replacement of nonconforming materials or work.

If you have any questions or require additional information, please contact me at 619.987.6557.

Sincerely,
CB&I Federal Services LLC

_____
Stephen Massey
Program QC Manager

U.S. ARMY CORPS OF ENGINEERS

USACE LEARNING CENTER
HUNTSVILLE, ALABAMA

NAVFAC

CERTIFICATE

KEVIN J. O'LEARY

#SPK511501065

has completed the Corps of Engineers and Naval Facility Engineering Command Training Course

CONSTRUCTION QUALITY MANAGEMENT FOR CONTRACTORS - #784

SACRAMENTO, CA	3/19-3/20/15	SACRAMENTO/SPK	DREW A. PERRY
Location	Training Date(s)	Instructional District/ NAVFAC	CQM-C Manager
DREW A. PERRY	DREW.A.PERRY@USACE.ARMY.MIL	(916) 557-7779	
Facilitator/Instructor	Email	Telephone	Facilitator/Instructor Signature

THIS CERTIFICATE EXPIRES FIVE YEARS FROM DATE OF ISSUE

Director, USACE Learning Center

Last Updated: 06Oct 2014

Kevin J. O'Leary

Professional Qualifications

Kevin J. O'Leary
Professional Qualifications

Mr. O'Leary has over twenty-six years of professional experience working on a variety of government and commercial environmental investigation/remediation projects. Past experience includes serving as project manager, field manager, technical engineering/scientist lead, construction quality manager and site safety officer for large and small government and commercial remedial investigation/feasibility study projects, providing project management for the removal and disposition of low-level radiological and mixed waste at a University of California research facility, conducting investigation and remediation of facilities at high-profile United States National Parks and California State Parks, development and feasibility analysis of project plans, adherence to strict quality assurance/quality control and health and safety programs and hydro-geologic data collection, interpretation and report writing. Mr. O'Leary has also gained experience supervising drilling and well installations for an in-situ potash solution mining project, oversight of groundwater treatment plant maintenance/operation, soil vapor extraction (SVE) and bioremediation systems, conducting soil density and compaction tests using a nuclear density gauge, the oversight of aboveground storage tank (AST), underground storage tank (UST), fuel pipeline and oil-water separator removals, the characterization, excavation and proper disposal of hazardous materials, the closure of RCRA Class 1 landfill facilities and CERCLA sites, the coordination and execution of sampling and analysis plans and as a liaison with local, state, and federal regulatory agencies.

Currently, Mr. O'Leary serves with Chicago Bridge & Iron Company (CB&I) as Site Superintendent and Site Safety Officer at the Former Naval Weapons Station - Detachment Concord, Concord, CA, Installation Restoration Site_29 Source Area – Non-Time Critical Removal Action for Groundwater and Soil Gas Remediation project in Concord, CA_while supporting government and commercial client projects as a project hydrogeologist, project manager, field operations manager, construction quality manager and site safety officer.

Education

Bachelor of Science, Physical Science-Hydrology, California State University-Chico, Chico, California, 1987

Additional Training/Continuing Education

Site Safety Officer Training, Findlay, OH, 2011
Construction Site Supervisor Training, Findlay, OH, 2011
US Army Corps of Engineers-Construction Quality Management (CQM) Training, Concord, CA, 2010
Bay Area Refinery Process Safety Orientation Program-Bay Area Training Corporation (BATC) , Martinez, CA, 2004

Excavation Competent Person Training, 29 CFR 1910.120, Martinez, CA, 1998
Nuclear Density Gauge Operator Training, 49 CFR 172H, Martinez, CA, 1998
Radiation Worker II Training, 29 CFR 1910.120, Davis, CA, 1997
Project Management Training , Martinez, CA, 1994 and Concord, CA, 2010
Principles of Integrated Solid Waste Management, UC Berkeley, 1993
Hazardous Materials in Groundwater: Hydrology, Monitoring, and Remediation, UC Berkeley, 1992
Confined Space/Qualified Person Training, 29 CFR 1910.120 , Martinez, CA, 1992
Hazardous Waste Supervisor Training, 29 CFR 1910.120 , Martinez, CA, 1992
40 Hour OSHA Hazardous Materials Health and Safety Training, 29 CFR 1910.120 (updated annually), Martinez, CA, 1988

Registrations/Certifications/Licenses

USACE Construction Quality Control Manager, 2010, Active, Nationwide, 01/2015
First Aid and CPR - Basic, 1988, Active, Nationwide, 12/2012
Radiological Worker Level II, 1997, Inactive, Nationwide, 05/2004
Cert Hazardous Waste Supervisor-OSHA/19CFR1910.120, 1992, Active, Nationwide
Certified HAZWOPER, 1988, Active, Nationwide
Competent Person/Drilling Oversight (CPDO), 2002, Active, Nationwide
Construction Site Safety Supervisor, 2011, Active, Nationwide
Excavation Competent Person, 1998, Active, Nationwide
Nuclear Soil Gauge, 1998, Active, Nationwide

Security Clearance

Other, Other, 2004, Active, 12/2005

Experience and Background

05/2002 – present
Project Manager/Field Site Manager, Chicago Bridge & Iron Company (CB&I) and Shaw Environmental & Infrastructure, Inc., Concord, California

Responsibilities include providing support to government and commercial client projects and office staff as a Project Manager/Field Site Manager. Also responsible for business development and managing and contributing to project proposals.

The following is a summary of key projects:
Field Site Manager/Superintendent and Site Safety Officer, Former Naval Weapons Station - Detachment Concord, Concord, CA, Installation Restoration Site 29 Source Area – Non-Time Critical Removal Action for Groundwater and Soil Gas Remediation, 147615, NAVFAC, Concord, CA, $10,000,000.00, 02-2014 – present
Field Site Manager/Superintendent and Site Safety Officer at the NAVFAC Former Naval Weapons Station - Detachment Concord, Concord, CA, Installation Restoration Site 29 Source Area – Non-Time Critical Removal Action for Groundwater and Soil Gas Remediation project in Concord, CA. Currently providing Field Management, Technical Oversight and serving as Site Safety Officer of Direct Push Drilling/Bio Injection for the Groundwater Remediation task and providing Field Management, Technical Oversight and Site Safety Officer duties of Hollow Stem Auger Well Drilling and Soil Gas Extraction System construction for the Soil Gas Remediation task.

Field Project Manager/Technical Lead/Site Safety Officer, Aerojet, 134058, Aerojet-General Corporation, Sacramento/Rancho Cordova, CA, $1,000,000.00, 03/2013 – 04/2014
Field Project Manager, Technical Lead and Site Safety Officer for Aerojet-General Corporation's Field Environmental Restoration Program in Sacramento/Rancho Cordova, CA. Responsibilities require the management and technical leadership of tasks related to the groundwater, surface water, soils/sediments and soil vapor remedial investigations being conducted at the Prairie City State Vehicular Recreation Area and Barton Ranch for Aerojet's Boundary Operable Unit-Site 39 Additional Investigation.

Accomplishments:
Zero lost work day incidents. Zero vehicle accidents.
Completed work scopes under budgets.

Awards/Client Commendations:
Client letters of commendation.

Project Manager, Kato Road L.L.C., 775929, Landbank, Fremont, CA, $1,000,000.00, 06/2002 – 04/2014
Conduct Groundwater Monitoring Program and provide site closure consulting.

Accomplishments:
Completed work scopes under budgets.
Assisted negotiations to reduce Groundwater Monitoring Program frequency and site closure.
Annual Contract Extensions.

Awards/Client Commendations:
Client letters of commendation.

Assistant Task Manager/Cost and Schedule Analyst/Assistant Construction Quality Manager/Technical Lead and Assistant Site Safety Officer, Fort Ord-Monterey, CA, Lead Removal, Munitions and Explosives of Concern (MEC) Field Reconnaissance, Munitions and Explosives of Concern (MEC) Removal and Operable Unit Carbon Tetrachloride Plume (OUCTP) projects, 846075 and 141234, US Army Corps of Engineers (USACE), Fort Ord-Monterey, CA, approximately $20,000,000.00, 11/2009 - 09/2010
Performed Assistant Task Management, Cost and Scheduling, Construction Quality Management, Technical Lead and Site Safety Officer functions for the US Army Corps of Engineers' (Total Environmental Restoration Contract) Fort Ord-Monterey, CA Lead Removal, Munitions and Explosives of Concern (MEC) Removal and Operable Unit Carbon Tetrachloride Plume (OUCTP) projects.

Accomplishments:
Zero lost work day incidents. Zero vehicle accidents.
Completed work scopes under budgets.
Contributed to Fort Ord project receiving Shaw President's Award for achieving 5,000 days without a lost workday incident.

Project Manager, Orton Development, 779332, Orton Development, Hayward, CA, $100,000.00, 06/2002 - 04/2014
Conduct Groundwater Monitoring Program and provide site closure consulting.

Accomplishments:
Zero lost work day incidents. Zero vehicle accidents.
Completed work scopes under budgets.
Annual contract extensions.

Field Project Manager/Technical Lead/Site Safety Officer, Aerojet, 127495, 134058, Aerojet-General Corporation, Sacramento/Rancho Cordova, CA, $16,000,000.00, 08/2005 - 06/2010
Field Project Manager,Technical Lead and Site Safety Officer for Aerojet-General Corporation's Field Environmental Restoration Program in Sacramento/Rancho Cordova, CA.
Responsibilities required the management and technical leadership of tasks related to the groundwater, surface water, soils/sediments and soil vapor remedial investigations being conducted at multiple sites for Aerojet's Boundary, Island and Eastern Operable Units. Also contributed on Aerojet's Boundary, Island and Eastern Operable Units RI/FS reports.

Accomplishments:
Zero lost work day incidents. Zero vehicle accidents.
Completed work scopes under budgets.
Annual contract extensions.

Awards/Client Commendations:
Client letters of commendation.

Project Manager/Technical Lead, Travis Air Force Base, 133028, United States Air Force/AFCEE, Travis, CA, $86,000.00, 11/2008 - 05/2009
Project Manager and Technical Lead for the Site Characterization at Facility 1514 and Reservoir 1518 Hydroflousalic Acids Spill at Travis AFB.

Accomplishments:
Zero lost work day incidents. Zero vehicle accidents.

Completed work scopes on schedule and under budgets.

Awards/Client Commendations:
Client letters of commendation

Project Manager, Laboratory for Energy-Related Health Research (LEHR), 770529, DOE-Oakland/Weiss Associates, Davis, CA, $14,000,000.00, 06/1997 - 11/2007
Managed multiple tasks related to the $14 million, performance-fee-driven, Environmental Restoration/Waste Management project at the United States Department of Energy's (DOE) former Laboratory for Energy-Related Health Research (LEHR) facility at the University of California, Davis.
Provided management, cost analysis, staff and technical supervision, oversight of project subcontractor contracts and providing the interface and coordination necessary to accomplish Shaw Environmental & Infrastructure commitments that were an essential contribution to a team of three contractors that are working together to meet the Department of Energy's aggressive overall project goals. The removal and disposal of laboratory-related radiological waste (Ra-226, Sr-90, Co-60, H-3, Pu-241, Am-241) and mixed waste from disposal trenches and septic systems, the decontamination and demolition of radiation contaminated facilities, the inventory, survey and shipment of radioactive biological wastes and radiological sources and standards to disposal facilities and the investigation and survey of potentially radiological contaminated facilities (Imhoff Ra-226/Sr-90 Treatment System, Mixed Waste Storage Facility, Western Dog Pens) and

environmental conditions (Southwest Trenches waste burial site) are among the ongoing/completed tasks during this period.

Accomplishments:
Awarded over $500K (over 95%) of available project Performance Incentive Fees.
Zero lost work day incidents. Zero vehicle accidents.

Awards/Client Commendations:
Awarded over $500K (over 95%) of available project Performance Incentive Fees.
Client Health and Safety performance awards.

Project Manager, Lawrence Livermore National Laboratory (LLNL), 109575, University of California, Livermore, CA, $150,000.00, 04/2004 - 07/2005
Project Manager for Low Level/Mixed Waste Technical Support for the University of California at Lawrence Livermore National Laboratory

Accomplishments:
Contract extended in November 2004

Awards/Client Commendations:
Client letters of commendation.

05/2002 - present
Project Engineer/Scientist IV-Hydrogeologist, Chicago Bridge & Iron Company (CB&I) and Shaw Environmental & Infrastructure, Inc., Concord, California

Responsibilities include providing technical support to government and commercial client projects and office staff as a Project Hydrogeologist. Also responsible for business development and managing and contributing to project proposals.

The following is a summary of key projects:
Project Hydrogeologist, Vandenberg AFB-Lompoc, CA, Installation Restoration Program -Site 3 and 50 Draft Groundwater Monitoring and Remedial Action Optimization Status Report, 01/2013 – 06/2014
Coauthor of Site 3 and 50 Draft Groundwater Monitoring and Remedial Action Optimization Status Reports for the Vandenberg AFB-Lompoc, CA, Installation Restoration Program

Project Hydrogeologist, Vandenberg AFB-Lompoc, CA, Installation Restoration Program – Site 60 Draft Groundwater Monitoring and Remedial Action Optimization Status Report, 03/2013
Author of Site 60 Draft Groundwater Monitoring and Remedial Action Optimization Status Report for the Vandenberg AFB-Lompoc, CA, Installation Restoration Program.

Project Hydrogeologist, Edwards AFB-Air Force Research Laboratory Groundwater Tracer Test for Bioremediation Feasibility, 146185, AFCEE, Edwards AFB, CA, approximately $1,000,000.00, 01/2013-03/2013
Project Hydrogeologist for the drilling and well installations at the Edwards AFB-Air Force Research Laboratory Groundwater Tracer Test for Bioremediation Feasibility. Performed Groundwater Tracer Test and data analysis for Bioremediation Feasibility.

Accomplishments:
Zero lost work day incidents, Zero vehicle accidents.

Wellsite/Operations Hydrogeologist, Intrepid Potash – New Mexico, L.L.C. HB In-Situ Project, 124303 and 146979, Intrepid Potash, Eddy County-Carlsbad, NM, approximately $20,000,000.00. 05/2012-10/2012
Wellsite/Operations Hydrogeologist for the drilling and well installations at the Intrepid Potash in-situ potash solution mining project in Eddy County-Carlsbad, NM.
Conducted geologic logging of reverse circulation drilling method boreholes and supervised drill crews, geophysical logging, casing and liner installations, design and pumping of cement jobs and well completions associated with the installation of high capacity brine injection and production wells. Advised on casing failures, fish jobs, circulation losses, gas kicks and selection of BHA's and drilling muds. Identified formation changes/tops and bottoms that aided in final well installation designs. Responsible for drill crew and visitor Health and Safety at drill sites.

Accomplishments:
Zero lost work day incidents, Zero vehicle accidents by crews and visitors at supervised drill sites.

Field Task Manager/Technical Lead/Report Coauthor, BLM/Fort Ord Reconnaissance-Site Assessments, 846075, 141234, USACE, Fort Ord-Monterey, CA, $800,000.00, 09/2010 - 01/2012
Field Task Manager and Technical Lead for the Reconnaissance-Site Assessments of Bureau of Land Management (BLM) Areas at the Former Fort Ord-Monterey, CA.
The Reconnaissance-Site Assessments of four (4) BLM areas totaling approximately 5,000 acres each consisted of either visual and/or instrument-aided field investigations to map site features that may have been related to past military training activities, map munitions and explosives of concern (MEC), map the path walked and identify subsurface anomalies where a magnetometer (Schonstedt GA-52/CX and EM-61) was used. Responsibilities included walking over 300 linear miles of regulatory agency preplanned routes, written and photo documentation of findings, data processing and coauthor of the Site Assessment Data Reports for each of the BLM areas.

Accomplishments:
Zero lost work day incidents, Zero vehicle accidents.
Contributed to Fort Ord project receiving Shaw President's Award for achieving 5,000 days without a lost workday incident.
Completed Reconnaissance-Site Assessments and Reports on schedule and within budgets.

Project Hydrogeologist, Dugway Proving Ground, 870502, US Army, Dugway, UT, 06/2004 - 10/2004
Performed as Project Hydrogeologist, Drilling Rig Supervisor and Sample Coordinator for monitoring well installation and soil/groundwater sample collection of deep borings at HWMU 55 and HWMU 58.
Coordinated storage, characterization and disposition of Investigation Derived Waste materials.

Project Hydrogeologist, Alameda Point, 101643, US Navy, Alameda, CA, 03/2004 - 10/2004
Technical Lead for the location and site characterization of approximately 500 linear feet of Industrial Waste Pipeline at IWTP 25.
Authored project plans and SOWs, performed as Project Hydrogeologist and Drilling Rig Supervisor for soil/groundwater sample collection from soil borings at former Industrial Waste Treatment Plants (IWTPT) at Buildings 25 and 32. Contributed as author for the project technical report.

Accomplishments:

Contributed to Alameda Point project receiving Shaw President's Award for achieving 1,500 days without a lost workday incident.

Project Hydrogeologist, Sandia National Laboratory-Bldg 913 Soil Sampling, 777674, Sandia National Laboratory, Livermore, CA, 02/2003 - 08/2003
Authored project plans and SOWs. Performed as Technical Lead, Project Hydrogeologist and Drilling Rig Supervisor for soil/groundwater sample collection from soil borings at Bldg 913. Contributed as author for the project technical report.

Accomplishments:
Zero lost work day incidents, Zero vehicle accidents.
Completed work scopes under budgets.

08/2011 - Present
Site Safety Officer, Chicago Bridge & Iron Company (CB&I) and Shaw Environmental & Infrastructure, Inc., Concord, California

Responsibilities include providing Site Safety oversight for government and commercial client projects.

Key projects:
Former Naval Weapons Station - Detachment Concord, Concord, CA, Installation Restoration Site 29 Source Area – Non-Time Critical Removal Action for Groundwater and Soil Gas Remediation, 147615, 10/2013 – present

Former Moffett Field, Moffett Field, CA – Supplemental Investigation, Former Building 88 and Traffic Island Areas – Installation Restoration Program Site 28, CTO-0046, 144002, 08/2013 – 02/2014

Aerojet-General Corporation, Sacramento/Rancho Cordova, CA, Boundary Operable Unit - Site 39 Additional Investigation, 134058, 08/2005 – 10/2013

Edwards AFB-Air Force Research Laboratory Groundwater Tracer Test for Bioremediation Feasibility, 146185, AFCEE, Edwards AFB, CA, 01/2013-03/2013

Fort Ord-Monterey, CA, US Army Corps of Engineers (USACE), Munitions and Explosives of Concern (MEC) Field Reconnaissance, 09/2010 - 01/2012

Fort Ord-Monterey, CA, US Army Corps of Engineers (USACE), Lead Removal, 11/2009 - 09/2010

11/2009 - Present
Construction Quality Control Manager, Chicago Bridge & Iron Company(CB&I) and Shaw Environmental & Infrastructure, Inc., Concord, California

Responsibilities include Construction Quality Control Management for government and commercial client projects. Includes managing quality aspects of field construction, field technical, analytical data, cost/schedule activities and technical report review.

Key projects:
Former Moffett Field, Moffett Field, CA – Supplemental Investigation, Former Building 88 and Traffic Island Areas – Installation Restoration Program Site 28, CTO-0046, 144002, 08/2013 – 02/2014

Former Naval Weapons Station - Detachment Concord, Concord, CA, Installation Restoration Site 29 Source Area – Non-Time Critical Removal Action for Groundwater and Soil Gas Remediation, 147615, 10/2013

Vandenberg AFB-Lompoc, CA, Installation Restoration Program -Site 24 Draft Groundwater Monitoring and Remedial Action Optimization Status Report, 07/2013

Vandenberg AFB-Lompoc, CA, Installation Restoration Program-Site 24 Draft Feasibility Study Report, 04/2012

Vandenberg AFB-Lompoc, CA, Installation Restoration Program-Site 50 Draft Feasibility Study Report, 03/2012

Fort Ord-Monterey, CA, US Army Corps of Engineers (USACE), Munitions and Explosives of Concern (MEC) Field Reconnaissance, 09/2010 - 01/2012

Fort Ord-Monterey, CA, US Army Corps of Engineers (USACE), Lead Removal, 11/2009 - 09/2010

05/1997 - 05/2002
Project Manager, IT Corporation (The Shaw Group Inc. acquired substantially all of the operating assets of the IT Group Inc. in May 2002), Martinez, California

Responsibilities included providing support to government and commercial client projects and office staff as a Project Manager. Also responsible for business development and managing and contributing to project proposals.

The following is a summary of key projects:
Project Manager, Laboratory for Energy-Related Health Research (LEHR), 770529, DOE-Oakland/Weiss Associates, Davis, CA, $7,000,000.00, 06/1997 - 05/2002
Managed multiple tasks related to the $14 million, performance-fee-driven, Environmental Restoration/Waste Management project at the United States Department of Energy's (DOE) former Laboratory for Energy-Related Health Research (LEHR) facility at the University of California, Davis.
Provided management, cost analysis, staff and technical supervision, oversight of project subcontractor contracts and providing the interface and coordination necessary to accomplish Shaw Environmental & Infrastructure commitments that are an essential contribution to a team of three contractors that are working together to meet the Department of Energy's aggressive overall project goals. The removal and disposal of laboratory-related radiological waste (Ra-226, Sr-90, Co-60, H-3, Pu-241, Am-241) and mixed waste from disposal trenches and septic systems, the decontamination and demolition of radiation contaminated facilities, the inventory, survey and shipment of radioactive biological wastes and radiological sources and standards to disposal facilities and the investigation and survey of potentially radiological contaminated facilities (Imhoff Ra/Sr Treatment System, Mixed Waste Storage Facility, Western Dog Pens) and environmental conditions (Southwest Trenches waste burial site) are among the ongoing/completed tasks during this period.

01/1988 - 05/2002
Project Engineer/Scientist I, II, III-Hydrogeologist, IT Corporation, Martinez, California

Responsibilities included providing support to government and commercial client projects and office staff as a Project Hydrogeologist. Also responsible for business development and managing and contributing to project proposals.

The following is a summary of key projects:
Lead Hydrogeologist, Mather Air Force Base, US Air Force (AFCEE), Sacramento, CA, $17,800,000.00, 01/1993 - 12/1994
Lead Hydrogeologist/Project Management Staff, Additional Field Investigation (AFI), Mather Air Force Base (AFB), Sacramento, California 1993-1994).
Responsible for providing technical oversight and supervision for the field investigation associated with the fixed-price $17.8-million AFCEE Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) RI/FS project. These responsibilities included technical oversight and supervision for a field staff of up to 25 associates during drilling operations as well as management, scheduling, and oversight of project subcontractors and their contracts. The investigation required accessing the subsurface with air rotary/casing hammer (ARCH), mud rotary, dual-tube percussion, hollow-stem auger and sonic core drilling methods. The borehole geophysical logging methods of spontaneous potential, resistivity, nuclear (natural gamma, gamma-gamma and neutron) and sonic were used locate areas (aquifers) of high subsurface contaminant transport. Upon completion of the field investigation, was responsible for providing evaluation and interpretation of soil and groundwater chemical data for presentation in the AFI RI report. The AFI project was successful in its task of delineating groundwater and soil contaminant (vinyl chloride, DCE, TCE, PCE, JP-4, diesel, gasoline, and BTEX) plume boundaries in the vicinity of Mather AFB.

Accomplishments:
Greatly contributed to $17.8M fixed-price project being completed in under $10.0M resulting in approximately $7.8M company profit.

Lead Hydrogeologist, Mather Air Force Base, US Air Force (AFCEE), Sacramento, CA, $6,000,000.00, 06/1992 - 12/1992
Lead Field Hydrogeologist, Group 3 RI/FS Project, Mather AFB, Sacramento, California (June 1992-December 1992).
Provided technical oversight and supervision for the field investigation associated with the $6-million AFCEE CERCLA RI/FS project. This position included technical oversight of drilling operations and supervision for a field staff of up to ten associates as well as management, scheduling, and oversight of project subcontractors and their contracts.

Lead Hydrogeologist, Mather Air Force Base, US Air Force (AFCEE), San Francisco, 12/1991 - 06/1992
CERCLA Quarterly Monitoring Report, Mather AFB, Sacramento, California (December 1991-June 1992).
Preparation and submittal of the Mather AFB CERCLA quarterly monitoring report for AFCEE. Provided evaluation, interpretation, and presentation of contract laboratory analytical results and groundwater hydrogeologic data collected during Mather AFB quarterly groundwater sampling events. The Mather AFB CERCLA quarterly monitoring report provides an historical summary of Mather AFB groundwater contamination as well as providing a background to support future Mather AFB technical/management decisions.

Lead Hydrogeologist, Mather Air Force Base, US Air Force (AFCEE), Sacramento, CA, 08/1990 - 02/1991
Lead Field Hydrogeologist/Project Management Staff, RI/FS and SWAT Project, Mather AFB, Sacramento, California (1990-1991).
Provided technical oversight and supervision for the field investigation associated with the AFCEE CERCLA RI/FS and SWAT project. This included drilling operations, technical oversight and supervision for a field staff of up to ten associates, and management, scheduling, and oversight of project subcontractors and their contracts.

Project Hydrogeologist, McClellan AFB, US Air Force (AFCEE), Davis, CA, 12/1989 - 04/1990
Field Hydrogeologist, RI/FS Project, Castle AFB, Atwater, California (1988-1990).
Provided technical oversight and supervision for the field investigation associated with the AFCEE RI/FS project. This included drilling operations, aquifer testing, technical oversight and supervision for a field staff of up to ten associates, and management, scheduling, and oversight of project subcontractors and their contracts.

Project Hydrogeologist, Castle Air Force Base, US Air Force (AFCEE), Atwater, CA, 06/1988 - 03/1990
Field Hydrogeologist, RI/FS Project, Castle AFB, Atwater, California (1988-1990).
Provided technical oversight and supervision for the field investigation associated with the AFCEE RI/FS project. This included drilling operations, aquifer testing, technical oversight and supervision for a field staff of up to ten associates, and management, scheduling, and oversight of project subcontractors and their contracts.

Project Hydrogeologist, Champion International, Champion International, Salinas, CA, 10/1987 - 04/1989
Engineer/Scientist I, IT Corporation, Martinez, California.
As assistant project hydrogeologist/sample coordinator at the Champion International Groundwater Treatment Facility in Salinas, California, coordinated groundwater monitoring sampling and analysis program (SAP) for the industrial site remediation projects. Responsibilities also included collecting monitoring well and treatment plant samples, maintaining and operating treatment plant, conducting pump test aquifer studies, performing hydrogeologic data interpretation, contributing to the location, design, and installation of the intermediate aquifer groundwater extraction well system, performing monitoring well installation and abandonment; and serving as agricultural, domestic, industrial, and municipal well owner liaison.

Project Hydrogeologist, Firestone, Firestone, Salinas, CA, 10/1987 - 04/1989
Engineer/Scientist I, IT Corporation, Martinez, California
As assistant project hydrogeologist/sample coordinator at the Firestone Groundwater Treatment Facility in Salinas, California, coordinated groundwater monitoring sampling and analysis program (SAP) for the industrial site remediation projects. Responsibilities also included collecting monitoring well and treatment plant samples, maintaining and operating treatment plant, conducting pump test aquifer studies, performing hydrogeologic data interpretation, contributing to the location, design, and installation of the intermediate aquifer groundwater extraction well system, performing monitoring well installation and abandonment; and serving as agricultural, domestic, industrial, and municipal well owner liaison.

01/1994 - 06/1997
Task Manager, IT Corporation, Martinez, California

Responsibilities include providing support to government and commercial client projects and office staff as a Task Manager. Also responsible for business development and managing and contributing to project proposals.

The following is a summary of key projects:

Task Manager, Presidio of San Francisco,, United States Army Corps of Engineers (USACE), San Francisco, CA, $10,000,000.00, 03/1996 - 06/1997

As Task Manager of the $10 million United States Army Corps of Engineers (USACE) Fuel Distribution System (FDS). For the FDS Removal project at the Presidio of San Francisco National Park, was responsible for managing a technical and labor force of up to 40 associates to remove and dispose of over 40,000 linear feet of FDS pipeline and its associated petroleum-impacted (petroleum hydrocarbons, heating oil, BTEX) soils. Project responsibilities included cost analysis, technical oversight and supervision for a technical and labor force of up to 40 associates, as well as management, scheduling, oversight of project subcontractors and their contracts, and coordination and scheduling of removal operations to comply and cooperate with ongoing Presidio of San Francisco National Park Service (NPS) activities

Task Manager, Mather Air Force Base, , US Air Force (AFCEE), Sacramento, CA, $8,000,000.00, 01/1995 - 06/1996

Accomplished dual-role of Task Manager/Field Operations Coordinator for the $8 million AFCEE Additional Site Characterization (ASC) CERCLA RI/FS project at Mather AFB, Sacramento, CA. Position included managing a field staff of up to 20 associates, managing and overseeing project subcontractors and their contracts, performing Air Force/Client/Regulatory liaison, and QA/QC and Health and Safety program enforcement. Responsibilities also included generating bid proposals, writing work plans and assisting in the data evaluation and interpretation for proposed Mather AFB closure plans presented in the ASC report. The project accomplished AFCEE? s goal of locating the groundwater contaminants of concern (vinyl chloride, DCE, TCE, PCE, JP-4, diesel, gasoline, and BTEX) for future remediation. The characterization required accessing the subsurface with air rotary/casing hammer (ARCH), mud rotary, dual-tube percussion, hollow-stem auger and sonic core drilling methods. The borehole geophysical logging methods of spontaneous potential, resistivity, nuclear (natural gamma, gamma-gamma and neutron) and sonic were used locate areas (aquifers) of high subsurface contaminant transport.

Accomplishments:
Zero lost work day incidents. Zero vehicle accidents.

Task Manager/Project Hydrogeologist, Northern California Hazardous Waste Disposal Sites, International Technology Corporation (IT Corp), Martinez, CA, 01/1994 - 01/1995

Served as Project Hydrologist/Task Manager in the Northern California Sites Division, Groundwater Programs Group. Managed Comprehensive Groundwater Monitoring Evaluation (CME) and Class 1 landfill closure projects in compliance with California Department of Toxic Substances Control (DTSC) regulations. Position required continual hydrogeologic data monitoring and interpretation and report writing in a support of this division's efforts to close four Northern California area Class 1 landfill facilities under RCRA.

Accomplishments:
1994 National Quality Award

01/1991 - 12/1996
Field Operations Coordinator, IT Corporation, Martinez, California

Responsibilities include providing support to government and commercial client projects and office staff as a Field Operations Coordinator.

The following is a summary of key projects:
Field Operations Coordinator, Mather Air Force Base,, US Air Force (AFCEE), Sacramento, CA, $1,000,000.00, 01/1992 - 12/1992
Field Operations Coordinator/Lead Geologist, Project Management Staff, Mather AFB Landfill Gas Operable Unit/FS project in Sacramento, California Responsible for coordinating all aspects of the field investigation associated with the $1-million AFCEE landfill gas OU/FS project. Managed a field staff of up to 15 associates, managed and oversaw project subcontractors and their contracts, performed Air Force/client/regulatory liaison, and enforced QA/QC and Health and Safety program enforcement. Responsibilities also included generating bid proposals, writing work plans, and assisting in data evaluation and interpretation for the Mather AFB proposed landfill closure plans presented in the landfill gas OU/FS report.

Field Operations Coordinator, Mather Air Force Base,, US Air Force (AFCEE), Sacramento, CA, $20,000,000.00, 11/1990 - 03/1991
Field Operations Coordinator/Project Management Staff, Group 2 RI/FS and Solid Waste Water Quality Assessment Test (SWAT) Projects, Mather AFB, Sacramento, California
Responsible for coordinating all aspects of the field investigation associated with the $20-million AFCEE CERCLA RI/FS and SWAT projects. Position responsibilities included managing a field staff of up to 20 associates, managing and overseeing project subcontractors and their contracts, serving as Air Force/client/regulatory agency liaison, and enforcing QA/QC and health and safety programs. Responsibilities also included generating bid proposals, writing work plans, and providing hydro-geologic data evaluation, interpretation, and presentation for CERCLA RI/FS reports.

01/1987 - 06/1989
Sample Coordinator, IT Corporation, Martinez, California

Responsibilities include providing support to government and commercial client projects and office staff as a Sample Coordinator.

The following is a summary of key projects:
Sample Coordinator, Firestone, Firestone, Salinas, CA, 10/1987 - 04/1989
Engineer/Scientist I, IT Corporation, Martinez, California
As assistant project hydrogeologist/sample coordinator at the Firestone Groundwater Treatment Facility in Salinas, California, coordinated groundwater monitoring sampling and analysis program (SAP) for the industrial site remediation projects. Responsibilities also included collecting monitoring well and treatment plant samples, maintaining and operating treatment plant, conducting pump test aquifer studies, performing hydrogeologic data interpretation, contributing to the location, design, and installation of the intermediate aquifer groundwater extraction well system, performing monitoring well installation and abandonment; and serving as agricultural, domestic, industrial, and municipal well owner liaison.

Sample Coordinator, Champion International, Champion International, Salinas, CA, 10/1987 - 04/1989
Engineer/Scientist I, IT Corporation, Martinez, California
As assistant project hydrogeologist/sample coordinator at the Champion International Groundwater Treatment Facility in Salinas, California, coordinated groundwater monitoring

sampling and analysis program (SAP) for the industrial site remediation projects. Responsibilities also included collecting monitoring well and treatment plant samples, maintaining and operating treatment plant, conducting pump test aquifer studies, performing hydrogeologic data interpretation, contributing to the location, design, and installation of the intermediate aquifer groundwater extraction well system, performing monitoring well installation and abandonment; and serving as agricultural, domestic, industrial, and municipal well owner liaison.

05/1985 - 08/1987
Firefighter, US Forest Service, Mendocino County, California

Wild lands Firefighter

The following is a summary of key projects:
Firefighter, Wild lands Fire, Mendocino National Forest, CA, Western United States, 05/1985 - 10/1988
US Forest Service Firefighter throughout the Western United States.

01/1986 - 06/1987
Sample Coordinator, Butte County Planning Department, Oroville, California

Responsibilities include coordinating and collecting groundwater samples from domestic water wells as part of the Butte County Planning Department's groundwater study.

The following is a summary of key projects:
Sample Coordinator, Butte County Aquifer Study, Butte County Planning Department, Oroville, CA, 12/1986 - 06/1987
Responsibilities include coordinating and collecting groundwater samples from domestic water wells as part of the Butte County Planning Department's groundwater study.

Awards/Honors

President's Safety Award, Shaw Environmental and Infrastructure, Inc., 2010
President's Award, Shaw Environmental and Infrastructure, Inc, 2004
LEHR Project Health and Safety Award, Weiss Associates, 1999
Health and Safety-3rd Quarter 1995, International Technology Corporation, 1995
National Quality Award-Northern California Sites Groundwater Group, International Technology Corporation-Quality and Health Services, 1994
National Quality Award-Firestone Project, Salinas, CA, International Technology Corporation-Quality and Health Services, 1988

Publications/Presentations

Kevin O'Leary, William Schaal, Survival Techniques for Subcontractors, Association of Engineering Geologists 46th Annual Meeting, Vail, CO, 2003

Kevin O'Leary, William Schaal, Douglas Brown, Innovative Radioactive Contamination Controls in Rapid Site Assessments, University of Massachusetts 14th Annual Conference on Contaminated Soils, October 1998, Amherst, MA, 1998

Attachment 4
Alternate Project Quality Control Manager Letter of Designation, Resume, and Construction Quality Management Training Certificate

Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study, Traffic Island Area, IR Site 28,
Former Naval Air Station Moffett Field
Moffett Field, CA

Contract Number N62473-10-D-4009
Contract Task Order 0104

Alternate Project Quality Control Manager
Letter of Designation

February 18, 2015

Mr. Lee Laws, Mr. Mark Vennemeyer, or Mr. Mark Seibert:

This letter will serve to assign you as CB&I Federal Services LLC Alternate Project Quality Control (QC) Manager for the above-captioned contract task order. In the case where the designated Project QC Manager, Mr. Kevin O'Leary is unable to perform the Project QC Manager's duties, you will serve in that capacity with his responsibilities and authorities, report directly to me, and administer the established requirements of the contract and Contractor QC Plan. You will manage the three phases of control. You are authorized to stop work that is not in accordance with the contract and will exercise this authority consistent with CB&I Federal Services LLC policies and procedures. You are granted the authority to approve submittals that have been certified by qualified submittal reviewers as identified in the organization chart for this task order and as necessary to ensure the quality of the work, and direct the removal and/or replacement of nonconforming materials or work. You are authorized to act as an alternate for two weeks at one time and not more than 30 workdays during a calendar year. In the case where it is believed that these time periods will be exceeded, you must notify me.

If you have any questions or require additional information, please contact me at 619.987.6557.

Sincerely,
CB&I Federal Services LLC

_____
Stephen Massey
Program QC Manager

Lee H. Laws

Professional Qualifications

Mr. Laws has more than 16 years of QA/QC experience with IT Corporation and The Shaw Group (May 2002 - Present), functioning since 1996, as Project QC Manager on the Navy EFA West Remedial Action Contract (RAC). This project experience has encompassed all phases of CERCLA Removal and Remedial Action cleanups, Superfund and National Priority List (NPL) sites, and numerous petroleum cleanups (e.g., USTs, ASTs) at federal facilities, industrial and residential properties under contracts from the U.S. Navy, U.S. Army Corps of Engineers (USACE), and U.S. Department of Energy (DOE).

Since 1999, Mr. Laws has served as the Lead QC Manager at Naval Station Treasure Island/Yerba Buena Island, which is a top priority Base Realignment and Closure (BRAC) base on the $250M Navy EFA West RAC. During this time period, the project backlog has grown to 16 environmental cleanup Contract Task Orders (CTO's 006, 012, 016, 036, 039, 040, 043, 045, 046, 089, 099, 102, 105, 106, 131, 134) with a total budget of over $37M, including a current backlog of over $20M. Treasure Island CERCLA, RCRA and petroleum cleanup projects have been executed with a high degree of involvement and oversight from the Navy, City of San Francisco, State and County regulatory agencies and local citizen groups who occupy the impacted property.

In support of this growing basewide cleanup program, Mr. Laws has prepared all CTO QC plans, provided ongoing project team and subcontractor coordination of task-specific QC inspections (including interface with two Government QA Resident Officers in Charge of Construction), and maintained all project QC documentation in a cost-effective MS-Access database. Mr. Laws produces project deliverables, including QC records and technical reports, in Adobe (pdf) format on CD-ROM, which substantially reduces project cost. Navy EFA West RAC six-month performance evaluations have consistently rated the Treasure Island QC Program "Level 1 - Outstanding," which has translated into an additional $1,664,316 of award fee profit (to-date) to IT Corporation and The Shaw Group

Education

High School Diploma, General Education, Pittsburg High Schol, Pittsburg, California, 1983

Additional Training/Continuing Education

USACE CQM Training, Sacramento, 2004
DHS Lead Supervisor/Monitor, UC Berkeley, 2000

Registrations/Certifications/Licenses

USACE Construction Quality Control Manager, 2004, Active, Nationwide, 11/2008

Experience and Background

05/2002 - Present
Project QC Manager, Shaw Environmental & Infrastructure, Inc., Quality, Concord, California

2002 - Present IT Corporation/Shaw Environmental & Infrastructure, Concord, California. Project QC Manager on the Navy Engineering Field Activity (EFA) West, Remedial Action Contract (RAC)

Naval Station Treasure Island, San Francisco, California.

Currently serve as the Lead QC Manager. Responsible for the planning, development and project team implementation of Project QC Plans and documentation on 10 environmental cleanup contract task orders with a total budget of over $37M. Projects involve the design, construction, operation, optimization and maintenance of remediation action systems (e.g., Soil Vapor Extraction); soil sampling, analysis, excavation, treatment, transportation and disposal; and site restoration in sensitive public housing areas. Mr. Laws effectively plans, coordinates and verifies task-specific QC inspections with Task Leaders, the Site Health & Safety Officer, Navy Resident Officers in Charge of Construction (ROICCs) and subcontractors. Mr. Laws also performs independent quality assurance audits, surveillances, and inspections of laboratories and field project activities to verify compliance with established QA program requirements

10/1996 - 05/2002
Project QC Manager, IT Corporation, Martinez, California

1996 - 2002 IT Corporation/Shaw Environmental & Infrastructure, Concord, California. Project QC Manager on the Navy Engineering Field Activity (EFA) West, Remedial Action Contract (RAC)

Naval Station Treasure Island, San Francisco, California.

Currently serve as the Lead QC Manager. Responsible for the planning, development and project team implementation of Project QC Plans and documentation on 10 environmental cleanup contract task orders with a total budget of over $37M. Projects involve the design, construction, operation, optimization and maintenance of remediation action systems (e.g., Soil Vapor Extraction); soil sampling, analysis, excavation, treatment, transportation and disposal; and site restoration in sensitive public housing areas. Mr. Laws effectively plans, coordinates and verifies task-specific QC inspections with Task Leaders, the Site Health & Safety Officer, Navy Resident Officers in Charge of Construction (ROICCs) and subcontractors. Mr. Laws also performs independent quality assurance audits, surveillances, and inspections of laboratories and field project activities to verify compliance with established QA program requirements.

China Lake Naval Air Weapons Station, Ridgecrest, California.
Served as the Project QC Manager. Responsible for the implementation of the site specific work plans and the quality control plans. Also responsible for daily field inspections to ensure that all work was performed in accordance with the work plan, specifications and requirements based on the program contract. Responsibilities also included performing reviews of documentation and the preparation of daily CQC reports that were submitted to the Navy on the next business morning.

Naval Communication Station, Stockton, California.
Served as the Site Health and Safety Officer. Responsible for providing independent surveillance of the routine implementation of the site safety and health plan. Conducted daily Tailgate Safety Meetings, verified personnel had necessary training and medical clearance to enter work area, performed daily equipment calibrations, monitored personnel for compliance with site safety and health plans, and performed monthly safety inspections.

Yerba Buena Island Housing, Yerba Buena, California.
Served as the Project QC Manager for Lead Base Paint Abatement. Responsible for the implementation of the site specific work plans and the quality control plans. Also responsible for daily field inspections to ensure that all work was performed in accordance with the work plan specifications and requirements based on the program contract. Responsibilities included performing reviews of documentation and the preparation of daily CQC reports, which were submitted to the Navy on the next business morning.

Alameda Naval air Station, Alameda, California.
Served as the Project QC Manager and Site Superintendent. Responsibilities included implementation of the site specific work and quality control plans. Also responsible for daily field inspections to ensure that all work was performed in accordance with the work plan specifications and requirements based on the program contract. Also performed reviews of documentation and prepared daily CQC reports, which were submitted to the Navy on the next business morning. My responsibilities as Site Superintendent included daily production, scheduling activities, ordering equipment and site safety.

Department of Defense Housing, Novato, California.
Served as the Project QC Manager. Responsible for the implementation of the site specific work and quality control plans, as well as daily field inspections to ensure that all work was performed in accordance with the work plan specifications and requirements based on the program contract. Responsibilities included performing reviews of documentation and the preparation of daily CQC reports that were submitted to the Navy on the next business morning.

Naval Medical Center, Oakland, California.
Served as the Project QC Manager. Responsible for the implementation of the site specific work and quality control plans in addition to daily field inspections to ensure that all work was performed in accordance with the work plan specifications and requirements, which were based on the program contract. Responsibilities included performing reviews of documentation and the preparation of daily CQC reports which were submitted to the Navy on the next business

08/1995 - 10/1996
Quality Control Coordinator, IT Corporation, San Jose, California

1995 - 1996 IT Corporation, San Jose, California
Quality Control Coordinator, Engineers Services
Responsible for field QC activities, ensuring that fieldwork was being performed in accordance with the requirements written in the project work plans and procedures. Specific project experience and responsibilities included:

Hamilton Army Air Field, Novato, California.
Served as a Quality Control Inspector for the QC group. Responsible for daily field inspections and the preparation of daily QC reports. Performed reviews of documentation and other duties designated by the Program QC Manager.

07/1993 - 08/1995
Field Analytical Specialist II, IT Corporation, Field Analytical Services, Martines, California

1993 - 1995 IT Corporation, Martinez, California
Field Analytical Specialist II, Field Analytical and Sampling (FAS)
Responsible for organizing and participating in field analytical and sampling activities. Ensured sample protocols were followed, and coordinated between field and laboratory to meet project needs. Specific project experience and responsibilities included the following:

IBM, San Jose, California.
Served as a "lead man" for a demolition crew of three to six employees. Responsible for guidance and inspection of crew?s work. Insured health and safety around work area.

MCAGCC, Twenty Nine Palms, California.
Served as the sample coordinator working with the Jacobs Engineers Group Navy/Clean program at this DOE Superfund site. Acted as Liaison between the field and the laboratory: ordering glassware, coordinating sampling, documenting sampling, and maintaining the field database.

03/1989 - 07/1993
Assistant Field Analytical Specialist, IT Corporation, Martinez, California

1989 - 1993 IT Corporation, Martinez, California
Assistant Field Analytical Specialist, Field Analytical and Sampling (FAS)
Responsible for environmental monitoring on various RI/FS projects in the Western United States. Primary responsibilities were groundwater compliance, soil organic vapor sampling, and soil sampling. Some specific experience include the following:

Mather Air Force Base, Rancho Cordova, California.
Served as a sample team leader in the areas of SOV, soil, and groundwater sample collection. Trained new employees in proper sampling and documentation procedures. Responsible for providing instruction and performing tasks in the areas of monitoring well development, dedicated pump and packer installation, and proper operation of such equipment. Gained experience with sample collection around drill rigs and a clearance for work on military flight lines. Acted as liaison between the field and analytical laboratory. Fulfilled the Sample Coordinator's position in his absence.

Castle Air Force Base, Merced, California.
Served as Assistant Sample Coordina¬tor during this major RI/FS project. Acted as liaison between the field operations and the office. Helped supervise the groundwater sampling and pump installation phases of the project.

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CERTIFICATE

LEE LAWS

#SPK511400875

has completed the Corps of Engineers and Naval Facility Engineering Command Training Course

CONSTRUCTION QUALITY MANAGEMENT FOR CONTRACTORS - #784

SACRAMENTO, CA	7/17-7/18/14	SACRAMENTO/SPK	DREW A. PERRY
Location	Training Date(s)	Instructional District/ NAVFAC	CQM-C Manager

DREW A. PERRY	DREW.A.PERRY@USACE.ARMY.MIL	(916) 557-7779	
Facilitator/Instructor	Email	Telephone	Facilitator/Instructor Signature

Chief, USACE Learning Center

THIS CERTIFICATE EXPIRES FIVE YEARS FROM DATE OF ISSUE
CQM-C Recertification online course: https://www.myuln.net

Mark J. Vennemeyer

Professional Qualifications

Mr. Vennemeyer has performed waste management activities for twelve (12) years for a variety of clients. At present, he is a Construction Quality Control Manager and has served as Transportation and Disposal Coordinator for Shaw's Government Services division in California. He is responsible for ensuring quality standards of workmanship on various projects, inspection of activities and adherence with contractual requirements, waste characterization/classification, packaging, scheduling, regulatory oversight, providing technical assistance to the Procurement department in matters of Waste Transportation and Disposal Subcontracts, waste sampling, coordination and management of resources necessary to perform off-site transportation and disposal, preparation of waste profiles and shipping papers, and tracking waste shipments to ensure compliance with all applicable regulations.
Mr. Vennemeyer is experienced in "unknown" identification, Treatment Technology requirements, Federal and State (California) waste regulations, and database management. He has been involved in a multitude of waste shipments covering a wide variety of waste streams.

Education

Bachelor of Science, Chemistry, University of California, Irvine, Irvine, California, 1992

Additional Training/Continuing Education

First Aid / CPR, Concord, CA, 2007
Site Safety Officer, Irvine, CA, 2006
Construction Quality Management for Contractors, Sacramento, CA, 2005
Shipping Hazardous Materials by UPS, San Jose, CA, 2005
IATA Dangerous Goods Shipment, Emeryville, CA, 2004
Hazardous Waste Manifesting, Alameda, CA, 2002
Cyanide Training, Richmond, CA, 1998
Hazardous Waste Supervisor, Richmond, CA, 1998
Hazard Categorization, San Jose, CA, 1995
Emergency Response Training, San Jose, CA, 1995
Radiation Worker 2, Lawrence Livermore National Lab, 1994
40-Hour Hazardous Waste Operations, Sacramento, CA, 1992

Experience and Background

06/2007 - present
Quality Control Manager / Site Health and Safety Officer, Shaw Environmental & Infrastructure, Inc., Government Services, Alameda, California

Quality Control manager and Site Safety officer at the Alameda Point project(s). Pojects included contruction of in-situ Remediation systems (DVE for petroleum contamination, 6-phase underground heating for DNAPL plume).

04/2006 - 06/2007
Quality Control Manager, Shaw Environmental & Infrastructure, Inc., Government Services, San Francicso, California

Served as Quality Control Manager and T&D Coordinator at former Treasure Island naval base. Acted as liaison between Navy construction personnel (engineers, Construction technicians) and Shaw. Provided daily reporting and documentation of activities performed each day.

12/2005 - 04/2006
Quality Control Manager / Inspector, Shaw Environmental & Infrastructure, Inc., Government Services, San Diego, California

Worked with operations personnel to establish QC procedures and documentation of Navy owned Treatment, Storage and Disposal facility. Inspection of satellite facility(ies) for compliance to Navy and regulatory requirements.

02/2005 - 11/2005
Construction Quality Control Manager, Shaw Environmental & Infrastructure, Inc., Government Services, Concord, California

Responsibilities include support of client projects as quality control manager. Also responsible for interaction with client's technical representatives, preparing portions of reports, oversight of field work, inspection of materials and work performed.

The following is a summary of key projects:
Quality Control Manager, Crow's Landing Flight Facility, 836557, 100358, 101454, U.S. Navy, Crow's Landing Flight Facility, 02/2005 - Present
Quality Control manager for Crow's Landing Flight Facility in Crow's Landing, CA. The project involved several contract task orders (CTOs) to perform different remedial actions. The highlights included:
Removal action of waste soil and debris at former waste pits. Investigation of potential Munitions and Explosives of Concern sites using non-intrusive geophysical surveys and exploratory trenching.

Awards/Client Commendations:
President's Safety Award

05/2002 - 02/2005
Transportation and Disposal Coordinator, Shaw Environmental & Infrastructure, Inc., Government Technical Services, Concord, California

Responsibilities include providing technical support for clients as a transportation and disposal coordinator. Also responsible for waste characterization, profiling, manifesting, coordination of subcontractors and disposal facilties for remedial actions, waste tracking and technical documentation of removal / disposal actions.

The following is a summary of key projects:
T&D Coordinator, Carmel Valley Manor, , JM Electric, Carmel, CA, $20,000.00, 03/2005 - 03/2005
Removal and disposal of aged transformers and electrical equipment. Tasks included sampling, characterizing, profiling, manifesting, packaging of equipment according to all applicable federal,

state and local regulations.

Transportation and Disposal Coordinator, Hunters Point Shipyard, various, U.S. Navy, San Francisco, CA, 02/2002 - 02/2005
Transport and Disposal Coordinator for various projects at Hunters Point. Responsible for waste sampling, characterization, profiling, manifesting, coordination of waste shipments and technical documentation of disposal activities.
During the span of the project, over 20,000 tons of waste was removed from site and sent to various permitted treatment/disposal facilties.

Transportation and Disposal Coordinator, Alameda Point, former Alameda Naval Air Station, various, U.S. Navy, Alameda, CA, 02/2002 - 02/2005
Coordination of disposal activities for various remedial projects at the Former Alameda Naval Air Station. Tasks included Investigation Derived and Treatment by-product Waste sampling, characterization, profiling, manifesting and coordination of disposal.

Awards/Client Commendations:
President's Safety Award

Transport and Disposal Coordinator, ORC - Cyril, 100735, US EPA, Cyril, OK, $6,000,000.00, 09/2003 - 06/2004
Demolition of a shut-down oil refinery. Disposal of all wastes associated with the facility including petroleum by-products, chemical catalysts, construction demolition debris, abandoned drummed wastes and "laboratory size" chemical bottles.
Much of the structure was recycled as scrap metal, but the area was cleared of Asbestos prior to any demolition activites starting.

Transport and Disposal Coordinator, Hamilton Army Airfield, US Army Corp of Engineers, Novato, CA, 05/2002 - 12/2002
This project was the removal from site and disposal of several thousand tons of waste excavated soil that was staged on site at an Army Airfield that was in closure. Tasks included classification of waste based on analytical results of samples, profiling of waste to seleceted TSDFs, tracking of waste shipments (using the manifest shipping documents) and confirmation of costs associated with transportation and disposal of waste.

12/2000 - 02/2002
Transportation and Disposal Coordinator, IT Corporation (The Shaw Group Inc. acquired substantially all of the operating assets of The IT Group, Inc., on May 23, 2002), Government Services, Concord, California

Responsibilities included providing technical support to client projects as Transport and Disposal coordinator. Also responsible for field support of waste disposal operations, support of business development activities and composition of certain technical sections of reporting documents.

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NAVFAC

CERTIFICATE

Mark Vennemeyer

SW9-02-15-00049

has completed the Corps of Engineers and Naval Facility Engineering Command Training Course

CONSTRUCTION QUALITY MANAGEMENT FOR CONTRACTORS - #784

Concord, California	1/29/15 - 1/30/15	SW9 - NAVFAC Southwest	Michael Haliburton PMP , PE
Location	Training Date(s)	Instructional District/ NAVFAC	CQM-C Manager
Kugan Panchadsaram PE	kugan@kugan.com	858-212-2941	
Facilitator/Instructor	Email	Telephone	Facilitator/Instructor Signature

Jeffrey D. Dziedzic
Chief, USACE Learning Center
Jeffrey D. Dziedzic

THIS CERTIFICATE EXPIRES FIVE YEARS FROM DATE OF ISSUE
CQM-C Recertification online course: https://www.myuln.net

Mark J. Seibert

Professional Qualifications

Mr. Seibert has over 16 years of industrial services and hazardous waste management experience.

Currently Mr. Seibert is involved with construction, operation and maintanance of Thermal, CAT-OX, DVE/SVE, Bio-sparge systems at Alameda, CTO-11 CAA-C and CAA-3 projects.

Mr. Seibert has served as the Transportation and Disposal Coordinator for the EFA West Project at Treasure Island since 2002. In this capacity, his responsibilities have included; importing virgin material, waste characterization, labeling, profiling, manifesting, record keeping, procurement, interface with the Navy's Resident Officer in Charge of Construction (ROICC) and regulatory compliance. Mr. Seibert has worked closely with the ROICC to develop a detailed tracking, record keeping, and reporting system necessary for bi-annual and annual reporting. Mr. Seibert has had the opportunity to familiarize himself with bioremidaition of DNAPL and other projects at Tresure Island.

As Hazardous Waste Coordinator for government services, Mr. Seibert's responsibilities are focused on; hazardous waste identification/classification, profiling, manifesting, transportation and disposal issues. As well as direct contact with disposal facilities to perform profiling functions for waste acceptance, this position also necessitates direct interface with the Navy's ROICC. Client relations are an important aspect of this position as responsiveness to the clients needs are of the utmost importance.

As Task Manager for Commercial Services, Mr. Seibert's responsibilities are focused primarily on equipment, material and personnel acquisition, field operations, personnel oversight, client interface and regulatory compliance.

Additional Training/Continuing Education

Competent Person: Drilling Oversite, Shaw E&I, 2006
Rough Terrain/ Warehouse Forklift Training, Ahern, 2006
OSHA 10 Hour Construction Safey, Shaw E&I, 2005
Medic First Aid Training Program, Shaw E & I, 2004
Hazard Communication Training, Shaw E & I, 2003
Personal Protective Equipment, Shaw E & I, 2003
Respirator Program Requirements, Shaw E & I, 2003
HAZWOPER Supervisor Training, Shaw E & I, 2003
H&S Program Management for Project Managers and Supervisors, Shaw E & I, 2003
Hazmat Employee Training (HM 181), Ecology Control Industries, 2001
Confined Space Training, Ecology Control Industries, 2000
Powered Industrial Trucks, Ecology Control Industries, 2000
DOT Function Specific Training, Ecology Control Industries, 1999
Hazardous Materials Training and Testing (HM 126F), Erickson Inc., 1994

40 Hour SARA Hazardous Waste Site Workers Basic Training, Erickson Inc., 1990

Experience and Background

08/2002 - Present
Technical Support Specialist II, Shaw Environmental & Infrastructure, Inc., Concord, California

Responsibilities as a Hazardous Waste Coordinator for government services, are focused on; hazardous waste identification/classification, profiling, manifesting, transportation and disposal issues. As well as direct contact with disposal facilities to perform profiling functions for waste acceptance, this position also necessitates direct interface with the Navy's ROICC.

Responsibilities as a Task Manager for Commercial Services, are focused primarily on equipment, material and personnel acquisition, field operations, personnel oversight, client interface and regulatory compliance.

03/1998 - 08/2002
Senior Operations Supervisor, Ecology Control Industries, Technical Projects, Richmond, California

Responsibilities included serving as Site Superintendent for Lawrence Berkeley National Laboratory. In this capacity, I was responsible for chemical waste handling, segregation, bulking, packaging, labeling, profiling and manifesting of all hazardous and non-hazardous waste generated at LBNL's Berkeley facility. I supervised labor crews responsible for laboratory pick-ups (moving of chemicals from individual labs to accumulation areas), identification of unknown chemicals (haz-cat), laboratory decontamination and emergency spill response.

In addition to LBNL, I actively participated in servicing the system wide contract, which included; UC Berkeley, UC San Francisco, UC Davis, UC Fresno, UC Santa Cruz and all satellite locations associated with the University Systems hazardous waste accumulation program as well as servicing clients such as Santa Clara Valley Water District, Komag, Advanced Polymer, Compaq and Defense Micro Electronics Activity.

10/1988 - 03/1998
Field Technician-Foreman, Laborer, Erickson, Inc., Richmond, California

Responsibilities included supplying oversight and performing work such as industrial remedial services, refinery turn-around projects, chemical cleaning, chemical precipitation, vacuum services, underground and aboveground storage tank (UST/AST) processing, lab-packing, laboratory decontamination, demolition, hydro blasting, operations and maintenance of light duty equipment, equipment manager, inspection of respiratory equipment and emergency response.

Awards/Honors

President's Award, Shaw E&I, 2005
President's Award, Shaw E & I, 2004

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NAVFAC

CERTIFICATE

MARK SEIBERT

#SPK511300600

has completed the Corps of Engineers and Naval Facility Engineering Command Training Course

CONSTRUCTION QUALITY MANAGEMENT FOR CONTRACTORS - #784

SACRAMENTO, CA	4/4-4/5/13	SACRAMENTO/SPK	LARRY J. SMITH, P.E.,CCM
Location	Training Date(s)	Instructional District/ NAVFAC	CQM-C Manager
DREW A. PERRY	DREW.A.PERRY@USACE.ARMY.MIL	(916) 557-7779	
Facilitator/Instructor	Email	Telephone	Facilitator/Instructor Signature

Chief, USACE Learning Center

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Attachment 5
Outside Organizations

Outside Organizations

Organization Name/Address/Phone	Description of Services
EMAX Laboratories 1835 W. 205th Street Torrance, California 90501 310.618.8889 Pace Analytical Energy Services LLC. 220 William Pitt Way Pittsburgh, Pennsylvania 15238 412.826.5245	Environmental Analytical Services
To Be Determined	Subsurface Utility Locating Services
To Be Determined	Land Surveying
Vironex US	Direct-Push Services Reagent Injection Services
National Exploration, Wells, and Pumps 1961 Meeker Avenue Richmond, California94804 510.236.6285	Monitoring Well Installation and Development
To Be Determined	Heavy Equipment Rental Services
Intrinsic Transportation, Inc. 3250A Dutton Avenue Santa Rosa, California 95407 707.578.0960	Waste Transport and Disposal Services

Attachment 6
Submittal Register

SUBMITTAL REGISTER

TITLE AND LOCATION: Combined Enhanced Bioremediation/In Situ Chemical Reduction Treatability Study, Traffic Island Area, IR Site 28, Former Naval Air Station, Moffett Field, Moffett Field, CA

CB&I Federal Services LLC

TRANS-MITTAL NO.	ITEM NO.	SPECIFICATION PARAGRAPH NO	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL									CLASSI-FICATION		REVIEWER	CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION	
				DATA	DRAWINGS	INSTRUCTIONS	SCHEDULES	STATEMENTS	REPORTS	CERTIFICATES	SAMPLES	RECORDS	INFORMATION ONLY	GOVERNMENT APPROVED		SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	CODE	DATE	SUBMIT TO GOVERN-MENT	CODE	DATE
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
001		SOW Work Element 1	Financial Summary					X						X	PM	MONTHLY							
002		SOW Work Element 1	Monthly Progress Report						X					X	PM	MONTHLY							
003		SOW Work Element 2	Internal Kick Off Mtg Agenda Topics						X					X	PM	(2)							
004		SOW Work Element 2	Internal Kick Off Mtg Minutes						X					X	PM	(2)							
005		SOW Work Element 2	CQC Meeting Agenda Topics						X					X	QCM	(2)							
006		SOW Work Element 2	CQC Meeting Minutes						X					X	PM	(2)							
007		SOW Work Element 2	Progress Update Meetings - Agenda						X					X	PM	(2)							
008		SOW Work Element 2	Progress Update Meeting Minutes						X					X	PM	(2)							
009		SOW Work Element 3	Preliminary Draft Work Plan/SAP[1]						X					X	QAO	(2)							
010		SOW Work Element 3	Draft Work Plan/SAP[1]					X	X				X	X	RPM/QAO	(2)							
011		SOW Work Element 3	Response to Comments on Draft						X					X	RPM	(2)							
012		SOW Work Element 3	Draft Final Work Plan/SAP[1]						X					X	RPM/QAO	(2)							
013		SOW Work Element 3	Final Work Plan/SAP[1]					X	X				X	X	RPM	(2)							
014		SOW Work Element 3	Draft Health & Safety Plan					X	X				X	X	PM	(2)							
015		SOW Work Element 3	Final Health & Safety Plan					X	X				X	X	PM	(2)							
016		SOW Work Element 5	Preliminary Draft Technical Memorandum	X					X				X	X	PM	(2)							
017		SOW Work Element 5	Draft Technical Memorandum	X					X					X	RPM	(2)							
018		SOW Work Element 5	Responses to Comments on Draft						X					X	RPM	(2)							
019		SOW Work Element 5	Draft Final Technical Memorandum	X X		X			X				X	X	PM	(2)							
020		SOW Work Element 5	Responses to Comments on Draft Final						X					X	RPM	(2)							
021		SOW Work Element 5	Final Technical Memorandum	X					X					X	RPM	(2)							

1 – Additional versions of the SAP will need to be prepared as necessary to meet requirements of the NAVFAC QAO. These are not included in this table, but will be incorporated into the schedule.
2 – See project schedule

Attachment 7
Testing Plan and Log

Testing Plan and Log

Contract No.: N62473-10-D-4009 CTO: 0104			Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study, Traffic Island Area IR Site 28, Former Naval Air Station Moffett Field					Contractor: CB&I Federal Services LLC	
Specification Section and Paragraph Number	Test Procedure	Test Name	Accredited/ Approved Lab Yes/No	Sampled By	Location of Test On Site/ Off Site	Frequency of Test	Date Completed	Date Forwarded to Contr. Officer	Remarks

Attachment 8
Definable Features of Work Matrix

DEFINABLE FEATURES OF WORK MATRIX
PROJECT QUALITY CONTROL PLAN
Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study, Traffic Island Area
IR Site 28, Former Naval Station Moffett Field, Moffett Field, California

Specification Section	Document Reference	Work Feature	Task Lead	Preparatory Meeting	Preparatory Inspection	Initial Inspection	Follow-up Inspection	Completion Inspection
General Site Activities								
4.2	Work Plan	Mobilization/Demobilization	Kevin O'Leary	N/A	N/A	N/A	N/A	Kevin O'Leary
4.6	Work Plan	Land Surveying	Field Team Leader	Field Team Leader	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary
4.3	Work Plan	Subsurface Utility Clearance	Field Team Leader	Field Team Leader	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary
4.7	Work Plan	Traffic Control	Field Team Leader	Field Team Leader	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary
4.5	Work Plan	Waste Management	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary
5.2 WS #14	Work Plan SAP	Baseline Groundwater Sampling	Rose Condit	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary
5.1.1 and 5.1.2	Work Plan	Monitoring Well Drilling & Construction	Lead Field Geologist	Lead Field Geologist	Kevin O'Leary	Allen Martin	Kevin O'Leary	Kevin O'Leary
5.1.3	Work Plan	Monitoring Well Development	Lead Field Geologist	Lead Field Geologist	Kevin O'Leary	Allen Martin	Kevin O'Leary	Kevin O'Leary
6.1	Work Plan	Establish Work Areas	Field Team Leader	Field Team Leader	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary
6.2	Work Plan	Groundwater Extraction	Field Team Leader	Field Team Leader	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary
6.3	Work Plan	Water Conditioning	Field Team Leader	Field Team Leader	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary

Specification Section	Document Reference	Work Feature	Task Lead	Preparatory Meeting	Preparatory Inspection	Initial Inspection	Follow-up Inspection	Completion Inspection
6.4	Work Plan	Reagent Mixing and Bioaugmentation	Field Team Leader	Field Team Leader	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary
6.4.2	Work Plan	Reagent Handling and Storage	Field Team Leader	Field Team Leader	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary
6.4.3	Work Plan	Hydraulic Fracturing and Reagent Injection	Field Team Leader	Field Team Leader	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary
6.4.4	Work Plan	Direct-Push Injection	Field Team Leader	Field Team Leader	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary
6.5	Work Plan	Performance Monitoring	Rose Condit	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary
4.4	Work Plan	Equipment Decontamination	Field Team Leader	Field Team Leader	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary
4.8	Work Plan	Demobilization	Field Team Leader	Field Team Leader	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary	Kevin O'Leary

Attachment 9
Organization and Personnel Certifications

Organization and Personnel Certifications Log

Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study, Traffic Island Area
IR Site 28, Former Naval Station Moffett Field, Moffett Field, California

Definable Feature of Work	Certification Requirement	Code	Organization	Individual	Verified by/Date Verified	Certificate Expires
All Project Tasks	40-Hour Occupational Safety and Health Administration Hazardous Waste Operations and Emergency Response, including 8-Hour Refresher	P	CB&I	(all Site personnel)		
Lab Analysis	U.S. Department of Defense Environmental Laboratory Accreditation Program	S	(see SAP)	Lab	(see SAP)	(see SAP)
Land Survey	State of California	S				

Legend:

Column 1, Definable Feature of Work: Refer to Construction Quality Control Plan table for list of definable features of work. List in order.

Column 2, Certification Requirement: State the certification required for the subcontractor, supplier, and/or individual.

Column 3, Code: S = Certificate required for the firm, that is, subcontractor or supplier; P = certificate required for the person performing the work.

Column 4, Organization: Subcontractor or supplier organization name.

Column 5, Individual: Name of certified individual (note: if certification requirement only applies to the firm, note name of person who provided certificate).

Column 6, Verified By/Date Verified:CB&I individual who verified certificates for organization and/or individuals. Verification required no later than Preparatory Inspection.

Column 7, Certificate Expires: Note the certificate expiration date.

Notes:

This log will be included in the Construction Quality Control Plan as an appendix with columns 1, 2, and 3 are filled in. Remaining columns will be completed when information becomes available.

CB&I *CB&I Federal Services LLC*

Attachment 10
Procedures

(Will be provided, if needed, as project progresses.)

Appendix C
Traffic Control Plan

DRAFT
TRAFFIC CONTROL PLAN
Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study
Traffic Island Area, Installation Restoration Site 28
Former Naval Air Station Moffett Field
Moffett Field, California

Environmental Services Contract Number: N62473-10-D-4009
Contract Task Order: 0104

Document Control Number: CBI-4009-0104-2086

April 2015

Submitted to:

Base Realignment and Closure
Program Management Office West Naval Facilities Engineering Command
1455 Frazee Road, Suite 900
San Diego, California 92108

Submitted by:

CB&I Federal Services LLC
4005 Port Chicago Highway, Suite 200
Concord, California 94520-1120

DRAFT
TRAFFIC CONTROL PLAN
Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study
Traffic Island Area, Installation Restoration Site 28
Former Naval Air Station Moffett Field
Moffett Field, California

Environmental Services Contract Number: N62473-10-D-4009
Contract Task Order: 0104

Document Control Number: CBI-4009-0104-2086

April 2015

Prepared by: _____ Date: _____
Kevin O'Leary
Site Safety and Health Officer

Approved by: _____ Date: _____
Neil Hey, California PG No. 8006
Project Manager

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1.0 Introduction

This Traffic Control Plan was prepared to describe traffic control measures that will be implemented during the Combined Enhanced Anaerobic Bioremediation/In Situ Chemical Reduction Treatability Study at the Traffic Island Area of Installation Restoration Site 28, former Naval Air Station Moffett Field, California. To enhance worker and public safety as well as meet the requirements of locating the mixing/injection plant and associated support facilities adjacent to the treatment area, the equipment staging and storage area will be located in the open, flat, smoothly paved area between Hangar 1 and West-Side Aquifers Treatment System extraction well EA1-2 away from public vehicle and foot traffic, as shown on Figure C-1.

Several injection points and wells will be installed either near or in roadways; therefore, parts of Wescoat Road, Cummins Avenue, and Cody Road will be either temporarily reduced to one lane or fully closed. To protect the health and safety of the reagent injection team and the public from work zone hazards, such as a highly pressurized injection hose (up to 2,000 pound per square inch), the segment of Cummins Avenue east of the traffic island will be closed for the duration of the injection effort (Figure C-2). This segment of Cummins Avenue will be closed-off with water-filled barriers outfitted with reflectors. Similarly, when reagent injections are being performed in Cummins Avenue west of the traffic island and in Wescoat Road, segments of Cummins Avenue west of the traffic island, Wescoat Road, and Cody Road will be fully closed during the work shift (approximately 9 hours) and then reopened (Figures C-3 and C-4). Traffic control will detour traffic around this area using signage and flag people. Upon completion of the field effort, the temporary facilities will be demobilized and the site returned to its original condition.

The traffic control measures are described in the following sections and are illustrated on Figures C-2, C-3, and C-4. Prior to implementing this plan, it shall be submitted to and approved by National Aeronautics and Space Administration Security and Fire Department. All road/lane closures shall be coordinated with National Aeronautics and Space Administration Security and Fire Department.

2.0 Lane Closure at Cummins Avenue, East of Traffic Island

Field activities associated with monitoring well installation, reagent mixing, and reagent injection will require the closure of the northbound one-way lane of Cummins Avenue east of the traffic island. Traffic travelling northbound on Cody Road will be detoured to the northbound one-way lane of Cummins Avenue west of the traffic island. Signs indicating “Roadwork Ahead,” “Detour Ahead,” “Detour,” and “Road Closed” will be placed at the southern approach to the work area on Cody Road and at the western approach on Wescoat Road. Traffic cones, signage, and water-filled barricades with reflectors will be used to direct traffic around the work area (see Figure C-2 for planned signage, cones, and barricade locations). This lane closure is expected to remain in place day and night for the duration of the treatability study.

3.0 Lane Closures at Cummins Avenue, East and West of Traffic Island

As the treatability study activity progresses westward from the staging area, it will be become necessary to temporarily close the northbound one-way lane of Cummins Avenue west of the traffic island (Figure C-3). Traffic travelling northbound on Cody Road or eastbound on Wescoat Road will be detoured to head westbound on Wescoat Road, then turning right onto McCord Avenue and heading northbound. The detour continues by turning right onto S. Akron Road and heading eastbound to return to the northbound Cummins Avenue. Signs indicating “Roadwork Ahead,” “Detour Ahead,” “Detour,” “No Left Turn,” and “Road Closed” will be placed at the approach to the work area from each direction. Traffic cones, signage, and barricades with reflectors will be used to direct traffic around the work area (see Figure C-3 for planned signage, cones, and barricade locations). The Cummins Avenue—west of the traffic island—northbound lane closure is expected to be in place during daytime work hours only and will be removed upon completion of work or at the end of the workday.

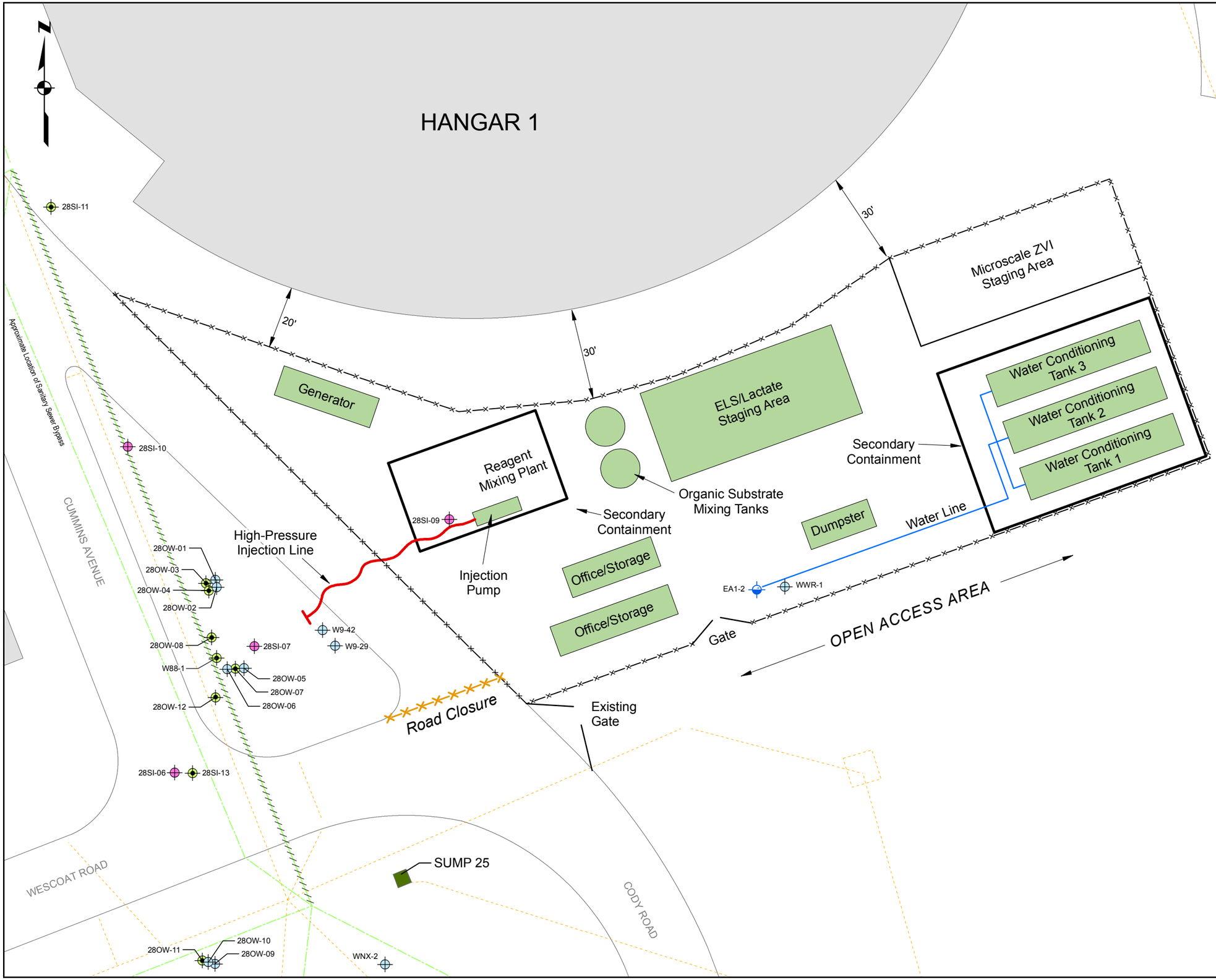
The Cummins Avenue—east of the traffic island—northbound lane closure is expected to remain in place day and night for the duration of the treatability study.

4.0 Road Closures at Cody Road / Edquiba Road and Wescoat Road / McCord Avenue

The southern portion of the treatment test area requires undisturbed access to Wescoat Road between Cummins Avenue and Severyns Avenue. To protect worker and public safety it is necessary to close Cody Road at its Edquiba Road intersection to prevent traffic from approaching the work area from the south and closing the eastbound lane of Wescoat Road at its intersection with McCord Road to prevent traffic from approaching from the west (Figure C-4). Traffic travelling northbound on Cody Road will be detoured to turn left and head westbound on Edquiba Road. Following detour signs, traffic will be directed to head northbound on McCord Avenue, then turning right on South Akron Road and heading eastbound to the northbound Cummins Avenue. Traffic heading eastbound on Wescoat Road will be detoured to turn left and head northbound onto McCord Avenue. Turning right onto South Akron Road heading eastbound completes this detour to northbound Cummins Avenue.

Both of these road closures will be temporary and will be in simultaneous use with the lane closures described in the previous sections and on Figures C-2 and C-3 for treatability study work extending south into Wescoat Road (Figure C-4). Access to Buildings 161, 503 and 554 can be achieved from either direction by following the detour to Severyns Avenue and heading southbound to these building's parking areas. Signage, barricades, and flagger(s) indicating the closures will be placed on the southern approach for Cody Road and the western approach for Wescoat Road. Signage will be placed for the northern approach of Severyns Avenue. Except for the work duration, day and night closure of the northbound one-way lane of Cody Road—east of the traffic island—all closures will be removed upon completion of the work or at the end of the day.

Figures



Legend

- TEMPORARY FENCE
- WATER-FILLED BARRIER
- UPPER A-AQUIFER MONITORING WELL
- LOWER A-AQUIFER MONITORING WELL
- B2-AQUIFER MONITORING WELL
- A-AQUIFER EXTRACTION WELL
- STORM DRAIN LINE
- SANITARY SEWER LINE
- SECTION OF THE SANITARY SEWER LINE THAT REPORTEDLY COLLAPSED (PRC, 1995)
- OIL/WATER SEPARATOR (REMOVED)
- 503 BUILDING AND BUILDING NUMBER

PRC, 1995 - *Final Horizontal Conduit Study Technical Memorandum Text, Tables, and Figures*, August 4

0 30 60

Approximate Scale - Feet

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE C-1
CONCEPTUAL EQUIPMENT AND MATERIALS STAGING AREA

IR SITE 28, FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

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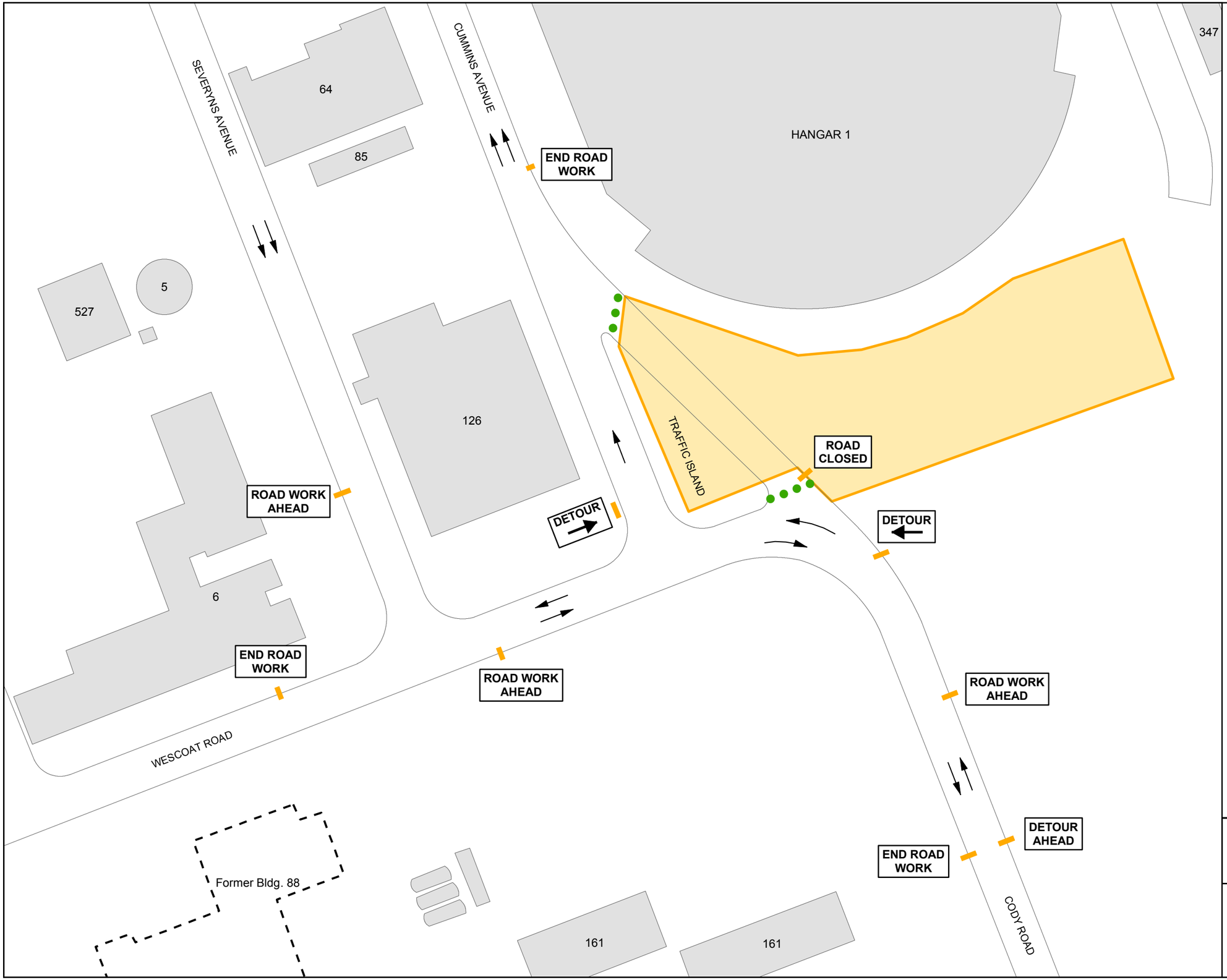

Legend

- WORK AREA
- SIGN
- CONES/BARRICADE
- TRAFFIC LANE DIRECTION
- 503 BUILDING AND BUILDING NUMBER

N

0 60 120

Approximate Scale - Feet

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE C-2

LANE CLOSURE AT CUMMINS AVE
EAST OF TRAFFIC ISLAND (TYPICAL)

FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

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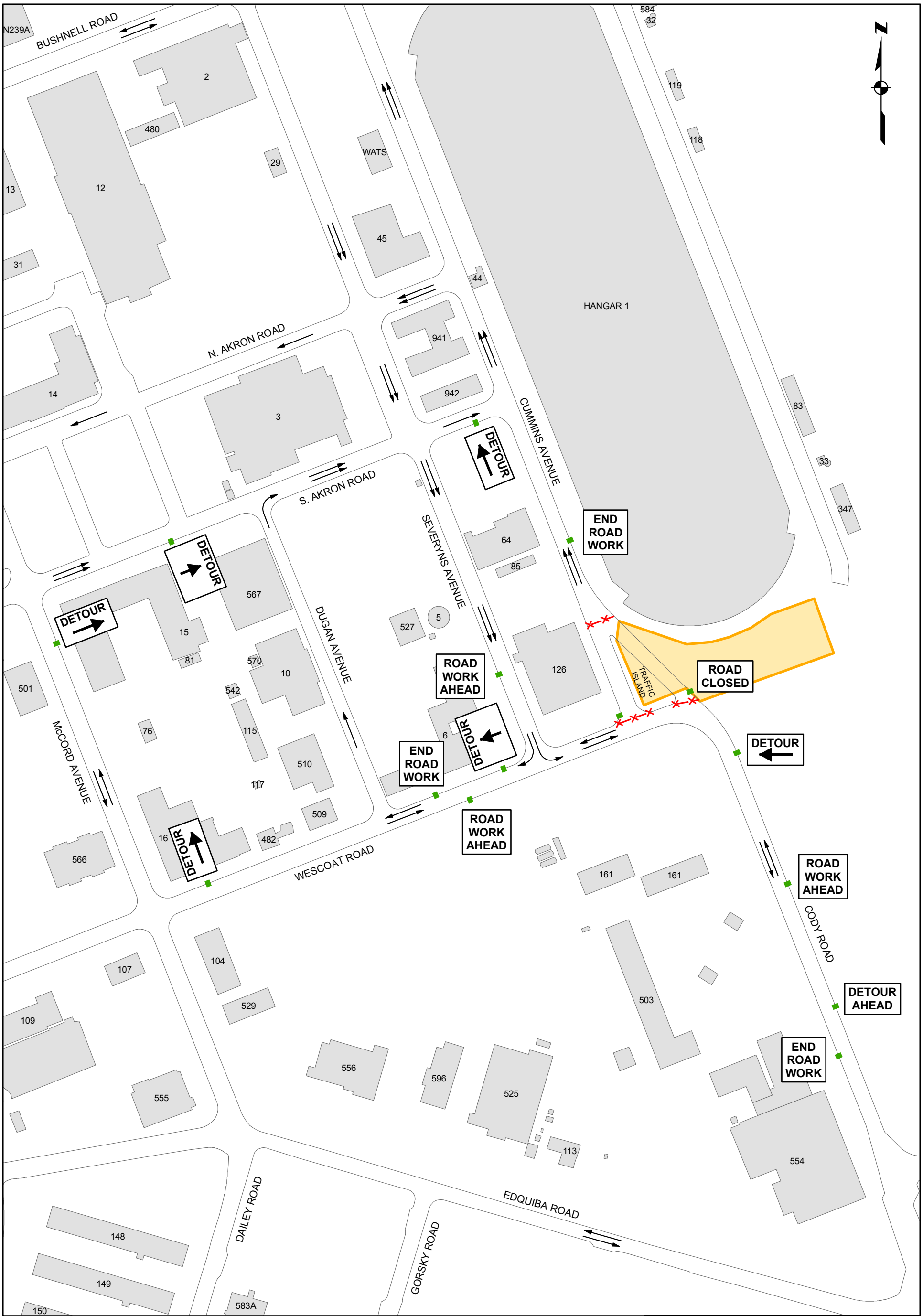

Legend

- WORK AREA
- SIGN
- TRAFFIC LANE DIRECTION
- TRAFFIC BARRICADE
- BUILDING AND BUILDING NUMBER

0 150 300

Approximate Scale - Feet

CB&I

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE C-3
LANE CLOSURES AT CUMMINS AVENUE
EAST AND WEST OF TRAFFIC ISLAND
(TYPICAL)

FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

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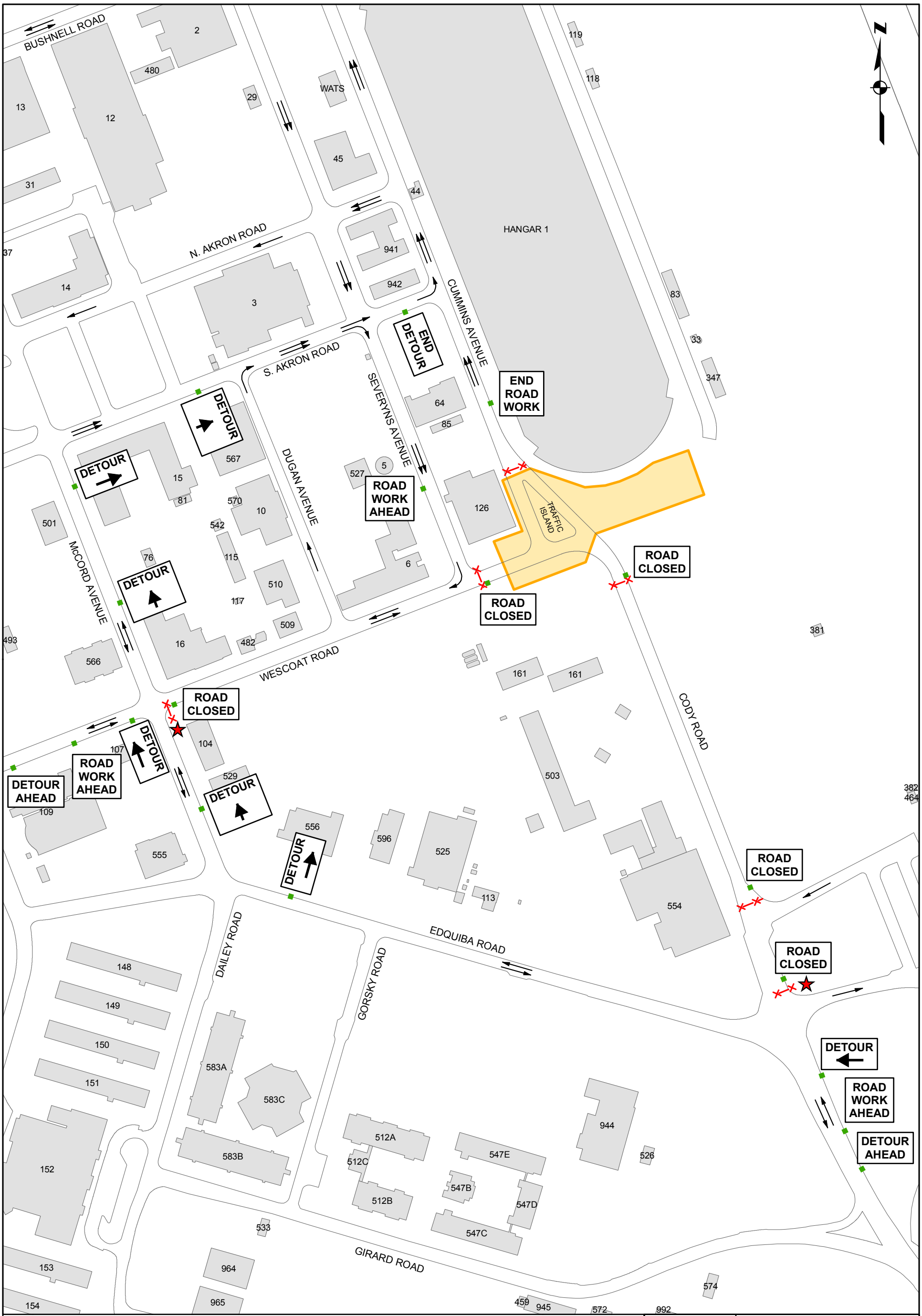

Legend

- WORK AREA
- SIGN
- TRAFFIC LANE DIRECTION
- TRAFFIC BARRICADE
- FLAGGER
- BUILDING AND BUILDING NUMBER

0 200 400
Approximate Scale - Feet

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
NAVAL FACILITIES
ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE C-4
ROAD CLOSURES AT CODY ROAD/
EDQUIBA ROAD AND WESCOAT ROAD/
McCORD AVENUE (TYPICAL)

FORMER NAS MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

Appendix D
Reagent Dosage Calculations

DRAFT
Dosage Calculations - 10 foot Target Distribution Radius
Combined EAB/ISCR Treatability Study
Traffic Island Area, IR Site 28, Former Naval Air Station Moffett Field

Treatment Interval Specs				
Target distribution radius (TDR)	10	ft		
Area of distribution per injection point	314	ft^2		
Injection interval thickness	2.5	ft		
Effective porosity - aquifer	20	%		
Total effective pore volume per injection interval	4,448	L	1,175	gals

Conversion Factors	
3.785332	L/gal
7.48052	gal/ft^3
453.5924277	g/lb
8.33	lb/gal - H2O at 70 F
3785.434	cm^3/gal

Amendment Water				
Volume as % of effective pore volume	10	%		
Volume per injection interval	445	L	117.5	gals

Sodium Lactate - 60% solution				
Target concentration of lactate in effective pore volume (and for water conditioning)	0.5	g/L		
Mass of lactate required per injection interval to achieve target concentration in effective pore volume	2,224	g	4.9	lbs
% of lactate in product	47.7	%		
Net weight of product required per injection interval	4,662	g	10.3	lbs
Specific weight of product	1,300	g/L	10.8	lbs/gal
Volume of product required per injection interval to condition amendment water volume	0.4	L	0.1	gals
Volume of product required per gallon of amendment water to achieve target conditioning concentration	0.003	L	0.0008	gals
Volume of product required per injection interval effective pore volume	3.6	L	0.9	gals
Volume of product required per injection interval (effective pore volume + amendment water volume)	3.9	L	1.0	gals
Volume of product required per gallon of conditioned water to achieve target in situ concentration	0.03	L	0.008	gals

ELS (100% by weight lecithin)				
Target concentration of ELS in effective pore volume of aquifer	6.0	g/L		
Mass of ELS required per injection interval to achieve target concentration in effective pore volume	26,687	g	58.8	lbs
% of lecithin in ELS	100	%		
Net weight of ELS required per injection interval	26,687	g	58.8	lbs
Specific weight of ELS	980	g/L	8.2	lbs/gal
Volume of ELS required per injection interval	27.2	L	7.2	gals
Volume of conditioned water available per interval to prepare ELS solution, following ZVI slurry preparation	263	L	69.5	gals
Volume of ELS required per gallon of conditioned water w/ lactate dose to achieve target in situ concentration	0.4	L	0.1	gals

SDC-9				
Target concentration of DHC in effective pore volume (and for water conditioning)	5.6E+06	cells/L	2.1E+07	cells/gal
Concentration of DHC in SDC-9	1.0E+11	cells/L	3.8E+11	cells/gal
Volume of SDC-9 required per injection interval to condition amendment water volume	0.025	L	0.007	gals
Volume of SDC-9 required per gallon of amendment water for conditioning	0.00021	L	0.000056	gals
Volume of SDC-9 required per injection interval effective pore volume	0.25	L	0.07	gals
Volume of SDC-9 required per gallon of conditioned water w/ lactate dose in the ELS solution to achieve target in situ concentr	0.0036	L	0.00095	gals

DRAFT
Dosage Calculations - 10 foot Target Distribution Radius
Combined EAB/ISCR Treatability Study
Traffic Island Area, IR Site 28, Former Naval Air Station Moffett Field

ZVI - Microscale				
Target concentration of ZVI in aquifer by soil mass			0.11	%
Assumed soil unit weight			115	lbs/ft^3
Target concentration of ZVI in effective pore volume of aquifer	10.4	g/L	0.09	lbs/gal
Mass of ZVI required per injection interval to achieve target concentration in effective pore volume	46,313	g	102.1	lbs
Percent solids in slurry (can be altered)	25	%		
Volume of conditioned water required to prepare ZVI slurry per injection interval	186	L	49.0	gals
Mass of ZVI required per gallon of conditioned water dosed w/ lactate to achieve target in situ concentration	945	g	2.1	lbs
Bulk density	2.16	g/cm^3	18	lbs/gal
Volume of ZVI per injection interval	21	L	5.7	gals
Total volume of ZVI slurry per injection interval	207	L	55	gals

Guar Gum - HV7000				
Target concentration of guar in ZVI slurry	7	g/L		
Mass of guar required per injection interval to achieve target concentration with 264.4 gals mix water	3.1	kg	6.9	lbs
Dry bulk density	0.64	g/cm^3	5.3	lbs/gal
Volume of guar per injection interval with 264.4 gals mix water (combined slurry-solution injection)	4.9	L	1.3	gals
Mass of guar required per injection interval to achieve target concentration with ZVI slurry	1.3	kg	2.9	lbs
Mass of guar required per gallon of injection water dosed w/ sodium lactate to achieve target concentration in ZVI slurry	0.03	kg	0.06	lbs
Volume of guar per injection interval with ZVI slurry (separate slurry & solution injection)	2.0	L	0.5	gals

Total Injectate Volume				
Total volume per interval of injectate with ZVI slurry and ELS solution injected separately	499	L	132	gals
Injectate volume as % of effective pore volume	11.2	%		

DRAFT
Dosage Calculations - 15 foot Target Distribution Radius
Combined EAB/ISCR Treatability Study
Traffic Island Area, IR Site 28, Former Naval Air Station Moffett Field

Treatment Interval Specs				
Target distribution radius (TDR)	15	ft		
Area of distribution per injection point	707	ft^2		
Injection interval thickness	2.5	ft		
Effective porosity - aquifer	20	%		
Total effective pore volume per injection interval	10,008	L	2,644	gals

Conversion Factors	
3.785332	L/gal
7.48052	gal/ft^3
453.5924277	g/lb
8.33	lb/gal - H2O at 70 F
3785.434	cm^3/gal

Amendment Water				
Volume as % of effective pore volume	10	%		
Volume per injection interval	1,001	L	264.4	gals

Sodium Lactate - 60% solution				
Target concentration of lactate in effective pore volume (and for water conditioning)	0.5	g/L		
Mass of lactate required per injection interval to achieve target concentration in effective pore volume	5,004	g	11.0	lbs
% of lactate in product	47.7	%		
Net weight of product required per injection interval	10,490	g	23.1	lbs
Specific weight of product	1,300	g/L	10.8	lbs/gal
Volume of product required per injection interval to condition amendment water volume	0.8	L	0.2	gals
Volume of product required per gallon of amendment water to achieve target conditioning concentration	0.003	L	0.0008	gals
Volume of product required per injection interval effective pore volume	8.1	L	2.1	gals
Volume of product required per injection interval (effective pore volume + amendment water volume)	8.9	L	2.3	gals
Volume of product required per gallon of conditioned water to achieve target in situ concentration	0.03	L	0.008	gals

ELS (100% by weight lecithin)				
Target concentration of ELS in effective pore volume of aquifer	6.0	g/L		
Mass of ELS required per injection interval to achieve target concentration in effective pore volume	60,047	g	132.4	lbs
% of lecithin in ELS	100	%		
Net weight of ELS required per injection interval	60,047	g	132.4	lbs
Specific weight of ELS	980	g/L	8.2	lbs/gal
Volume of ELS required per injection interval	61.3	L	16.2	gals
Volume of conditioned water available per interval to prepare ELS solution, following ZVI slurry preparation	592	L	156.4	gals
Volume of ELS required per gallon of conditioned water w/ lactate dose to achieve target in situ concentration	0.4	L	0.1	gals

SDC-9				
Target concentration of DHC in effective pore volume (and for water conditioning)	5.6E+06	cells/L	2.1E+07	cells/gal
Concentration of DHC in SDC-9	1.0E+11	cells/L	3.8E+11	cells/gal
Volume of SDC-9 required per injection interval to condition amendment water volume	0.056	L	0.015	gals
Volume of SDC-9 required per gallon of amendment water for conditioning	0.00021	L	0.000056	gals
Volume of SDC-9 required per injection interval effective pore volume	0.56	L	0.15	gals
Volume of SDC-9 required per gallon of conditioned water w/ lactate dose in the ELS solution to achieve target in situ concentr	0.0036	L	0.00095	gals

DRAFT
Dosage Calculations - 15 foot Target Distribution Radius
Combined EAB/ISCR Treatability Study
Traffic Island Area, IR Site 28, Former Naval Air Station Moffett Field

ZVI - Microscale				
Target concentration of ZVI in aquifer by soil mass			0.11	%
Assumed soil unit weight			115	lbs/ft^3
Target concentration of ZVI in effective pore volume of aquifer	10.4	g/L	0.09	lbs/gal
Mass of ZVI required per injection interval to achieve target concentration in effective pore volume	104,203	g	229.7	lbs
Percent solids in slurry (can be altered)	25	%		
Volume of conditioned water required to prepare ZVI slurry per injection interval	418	L	110.3	gals
Mass of ZVI required per gallon of conditioned water dosed w/ lactate to achieve target in situ concentration	945	g	2.1	lbs
Bulk density	2.16	g/cm^3	18	lbs/gal
Volume of ZVI per injection interval	48	L	12.8	gals
Total volume of ZVI slurry per injection interval	466	L	123	gals

Guar Gum - HV7000				
Target concentration of guar in ZVI slurry	7	g/L		
Mass of guar required per injection interval to achieve target concentration with 264.4 gals mix water	7.0	kg	15.4	lbs
Dry bulk density	0.64	g/cm^3	5.3	lbs/gal
Volume of guar per injection interval with 264.4 gals mix water (combined slurry-solution injection)	10.9	L	2.9	gals
Mass of guar required per injection interval to achieve target concentration with ZVI slurry	2.9	kg	6.4	lbs
Mass of guar required per gallon of injection water dosed w/ sodium lactate to achieve target concentration in ZVI slurry	0.03	kg	0.06	lbs
Volume of guar per injection interval with ZVI slurry (separate slurry & solution injection)	4.6	L	1.2	gals

Total Injectate Volume				
Total volume per interval of injectate with ZVI slurry and ELS solution injected separately	1,124	L	297	gals
Injectate volume as % of effective pore volume	11.2	%		

Notes:
%--percent
cm^3--cubic centimeter
F--Fahrenheit
ft--foot
ft^2--square foot
ft^3--cubic feet
g--gram
gal--gallon
H_2O--water
kg--kilogram
L--liter
lb--pound