FINAL

WORK PLAN

BIOREMEDIATION TREATABILITY STUDY AT PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7

For

ALAMEDA POINT, ALAMEDA, CALIFORNIA

July 2015

Prepared for

NAVFAC SOUTHWEST

Naval Facilities Engineering Command Southwest
San Diego, California

Contract N62473-12-D-2012
Task Order 0069

DCN: MMEC-2012-0069-0004

Prepared by

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EXECUTIVE SUMMARY

The Multimedia Environmental Compliance Group (MMEC Group), a joint venture between AMEC Foster Wheeler (AMEC) and KMEA, is supporting the Naval Facilities Engineering Command Southwest (NAVFAC SW) by conducting a Treatability Study (TS) at Corrective Action Area (CAA) 4C and CAA 7 at the former Naval Air Station Alameda (Alameda Point), Alameda, California. This work is being performed under NAVFAC SW Contract Number N62473-12-D-2012, Task Order Number 0069.

The primary objective of this TS is to evaluate the efficacy of enhanced aerobic in-situ bioremediation (EISB-a) to treat fuel-related petroleum hydrocarbon compounds in groundwater at CAA 4C and CAA 7. The effectiveness of the EISB-a treatment will be measured on the basis of meeting preliminary remediation criteria (PRC), or meeting the requirements of the State of California Water Resources Control Board (SWRCB) *Low-Threat Underground Storage Tank Case Closure Policy*. If the treatment does not meet either of these criteria, treatment optimizations or alternatives will be recommended.

Based on an evaluation of the current nature and extent of petroleum-impacted groundwater, an EISB-a TS will be conducted using direct push technology (DPT) to deliver a sustained oxygen-releasing compound to the target treatment zones (TTZs) at CAA 4C and CAA 7. EISB-a treatment at CAA 4C will be augmented with a limited application of in-situ chemical oxidation (ISCO) in two focused areas to address residual total petroleum hydrocarbon (TPH) concentrations that have persisted above 10,000 micrograms per liter (µg/L).

The Petroleum Closure Decision Tree (Figure 3) outlines the investigation and closure strategy for open petroleum sites that have fuel-related petroleum hydrocarbon compounds in groundwater and soil as described in Alameda Point's Petroleum Strategy (Battelle, 2009) and the 2012 update to Petroleum Management Plan (PMP) (Battelle, 2012). EISB-a groundwater treatment performance criteria were selected based on Step 5 of the Petroleum Closure Decision Tree.

CAA 4C is located in Southeast Alameda Point and shallow groundwater meets the exception criteria in Resolution 88-63, Sources of Drinking Water (U.S. Department of the Navy [Navy], 2012). CAA 4C is planned for commercial-mixed use. CAA 7 is not part of the Navy's Exception to Drinking Water Policy and is planned for residential reuse (ARRA, 2006). For evaluation purposes, each site will be screened against residential PRCs.

CAA 4C petroleum hydrocarbon compounds remaining in groundwater at concentrations greater than screening criteria include the following (Table 1):

- TPH
- Benzene, toluene, ethylbenzene, xylenes (BTEX)
- Naphthalene
- 1-Methylnaphthalene
- 2-Methylnaphthalene

CAA 7 petroleum hydrocarbon compounds remaining in groundwater at concentrations greater than screening criteria include the following (Table 2):

- TPH
- Methyl tert-butyl ether (MTBE)
- Naphthalene

EISB-a, with focused ISCO at CAA 4C only, were selected for CAA 4C and CAA 7 on the basis of the site-specific geochemical conditions in groundwater and the types of petroleum compounds present. Sustained oxygen-releasing compounds will be delivered to the TTZs to provide extended aerobic biodegradation of petroleum hydrocarbon compounds. At CAA 4C only, a focused ISCO application will be used to target two small areas of elevated hydrocarbon concentrations. In addition to treating the saturated zone at CAA 4C, both ISCO and EISB-a will target the capillary fringe and “smear zone” resulting from seasonal fluctuation of the water table by extending the vertical TTZ to 2 feet above the average groundwater elevation, approximately 2-feet below ground surface (bgs).

Prior to delivery of the EISB-a reagents, select wells at each site will be sampled to establish baseline groundwater conditions. Groundwater samples will be analyzed at a fixed laboratory using the following methods:

- TPH fractions using United States Environmental Protection Agency (U.S. EPA) Modified Method 8015B with silica gel clean up
- BTEX (and MTBE at CAA 7 only) using U.S. EPA Method 8260B
- Polycyclic aromatic hydrocarbons (PAHs) using U.S. EPA Method 8270C Selected Ion Monitoring (SIM)
- Total dissolved solids using U.S. EPA Method 160.1
- Arsenic and lead at select wells using U.S. EPA Method 6010B
- Inorganic anions using U.S. EPA Method 300.1

After groundwater treatment has been performed, three rounds of quarterly groundwater sampling will be performed to assess EISB-a (and ISCO at CAA 4C) treatment performance. Groundwater samples will be analyzed using the same methods listed above.

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ACRONYMS AND ABBREVIATIONS

%	percent
AMEC	AMEC Foster Wheeler
APP	Accident Prevention Plan
ARRA	Alameda Reuse and Redevelopment Authority
AS	air sparge
bgs	below ground surface
BRAC	Base Realignment and Closure
BSU	Bay Sediment Unit
BTEX	benzene, toluene, ethylbenzene, xylene
BMP	Best management practices
CAA	corrective action area
COD	chemical oxygen demand
CQC	Contractor Quality Control
CSM	conceptual site model
DO	dissolved oxygen
DPT	direct-push technology
DVE	dual vacuum extraction
EBS	Environmental Baseline Survey
EISB-a	enhanced in-situ bioremediation (aerobic)
EPP	Environmental Protection Plan
ERM	Environmental Resources Management-West, Inc.
FWBZ	first water-bearing zone
IDW	investigation-derived waste
ISCO	in-situ chemical oxidation
ITRC	Interstate Technology & Regulatory Council
ITSI	Innovative Technical Solutions, Inc.
µg/L	micrograms per liter
mL/min	milliliters per minute
MMEC Group	Multimedia Environmental Compliance Group
MTBE	methyl tertiary butyl ether
mV	millivolts
NAS	Naval Air Station
NAVFAC SW	Naval Facilities Engineering Command Southwest
Navy	U.S. Department of the Navy
NPL	National Priorities List
OB	observation
OU	Operable Unit
ORP	oxidation-reduction potential

ACRONYMS AND ABBREVIATIONS (CONTINUED)

PAH	polycyclic aromatic hydrocarbon
PMP	Petroleum Management Plan
POC	point of contact
PRC	preliminary remediation criteria
psi	pounds per square inch
PWC	Public Works Center
QA	quality assurance
RI	Remedial Investigation
ROI	radius of influence
ROICC	Resident Officer in Charge of Construction
SAP	Sampling and Analysis Plan
SIM	Selected Ion Monitoring
SSHP	Site Safety and Health Plan
SVE	soil vapor extraction
SWBZ	second water-bearing zone
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
TPH	total petroleum hydrocarbon
TPH-g	total petroleum hydrocarbon as gasoline
TOC	total organic carbon
TS	Treatability Study
TtEC	Tetra Tech, EC, Inc.
TTZ	target treatment zone
U.S. EPA	United States Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound
Water Board	Regional Water Quality Control Board - San Francisco Bay Region
WMP	Waste Management Plan

1 INTRODUCTION

This Work Plan describes the technical approach for implementing an enhanced in-situ bioremediation (aerobic) (EISB-a) Treatability Study (TS) and performance monitoring at petroleum sites Corrective Action Area (CAA) 4C and CAA 7, at former Naval Air Station Alameda (Alameda Point), Alameda, California. This work is being performed under Naval Facilities Engineering Command Southwest (NAVFAC SW) Contract Number N62473-12-D-2012, Task Order Number 0069, by the Multimedia Environmental Compliance Group (MMEC Group).

This Work Plan includes the following project plans:

- A Work Plan that describes in detail how the EISB-a TS and performance monitoring will be conducted.
- A Sampling and Analysis Plan (SAP) to provide guidance on sampling, analysis, and quality assurance (QA) during the TS for groundwater contamination (United States Environmental Protection Agency [U.S. EPA], 2005).
- A Waste Management Plan (WMP) that describes investigation-derived waste (IDW) generated by the contractor and the method for its disposal.
- An Environmental Protection Plan (EPP) identifies known or potential environmental issues that may be encountered while conducting the TS activities and presents mitigation measures and best management practices (BMPs) that will be implemented.
- An Accident Prevention Plan (APP) with a Site Safety and Health Plan (SSHP) that includes Activity Hazard Analyses.

1.1 OBJECTIVE

The primary objective of this TS is to evaluate the efficacy of EISB-a to treat fuel-related petroleum hydrocarbon compounds in groundwater at CAA 4C and CAA 7. The effectiveness of the EISB-a treatment will be measured on the basis of meeting applicable preliminary remediation criteria (PRC), or meeting the requirements of the State of California Water Resources Control Board (SWRCB) *Low-Threat Underground Storage Tank Case Closure Policy*.

Groundwater treatment performance criteria are the PRCs as described in Alameda Point's Petroleum Strategy (Battelle, 2009) and the 2012 update to Petroleum Management Plan (PMP) (Battelle, 2012). The Petroleum Closure Decision Tree (Figure 3) outlines the strategy for open petroleum sites that have fuel-related petroleum hydrocarbon compounds in groundwater and soil. CAA 4C is located in Southeast Alameda Point where shallow groundwater meets the exception criteria in Resolution 88-63, Sources of Drinking Water. CAA 4C is planned for commercial-mixed reuse. CAA 7 is not part of the Navy's Exception to Drinking Water Policy and is planned for residential reuse (ARRA, 2006). For evaluation purposes, both sites will be screened against residential PRCs.

1.2 REGULATORY FRAMEWORK

The former Naval Air Station (Alameda Point), Alameda, California, is a National Priorities List (NPL) facility; however, the NPL does not apply to petroleum sites. Therefore, the Navy is the lead agency, and the Regional Water Quality Control Board–San Francisco Bay Region (Water Board) is the lead regulatory agency for this project.

1.3 WORK PLAN ORGANIZATION

This Work Plan was prepared in accordance with Alameda Point's Petroleum Strategy (Battelle, 2009) and the 2012 Update to the Petroleum Management Plan (Battelle, 2012). It is organized as follows:

- **Section 1**, **Introduction** (scope of work, project objectives, identification of the regulatory agencies and regulatory requirements, and outline of the Work Plan)
- **Section 2**, **Site Description and Updated Conceptual Site Model (CSM)**
- **Section 3, TS Design and Approach** (the design and technical approach for conducting EISB-a and in-situ chemical oxidation [ISCO] at CAA 4C and EISB-a at CAA 7)
- **Section 4, Field Implementation** (field activities that will be conducted as part of the EISB-a TS and groundwater monitoring implementation)
- **Section 5, TS Performance Monitoring Plan** (the plan to monitor and evaluate the effectiveness of the EISB-a TS and groundwater monitoring at CAA 4C and CAA 7)
- **Section 6, Reporting and Scheduling** (the overall project schedule and plans to report the results of the EISB-a TS)
- **Section 7, References**

Appendices to this Work Plan for CAA 4C and CAA 7 are as follows:

- **Appendix A** is the Sampling and Analysis Plan (SAP), which describes the data quality objectives, the analytical methods, and the laboratory analytical quality standards to support adequate data collection.
- **Appendix B** is the Waste Management Plan (WMP), which describes the contractual, legal, and risk management requirements in the generation, storage, sampling and analysis, waste-typing, transportation, treatment, and ultimate disposal of waste generated during field activities.
- **Appendix C** is the Environmental Protection Plan (EPP), which describes best management practices to be adhered to during field work to ensure protection of the environment.
- **Appendix D** presents the ISCO and EISB-a reagent dosing parameters and calculations.
- **Appendix E** will contain the Navy's responses to regulatory agency comments on the Draft Work Plan.

2 SITE DESCRIPTION AND UPDATED CONCEPTUAL SITE MODEL

This section presents site background information, site-specific environmental investigations, results of previous corrective actions implemented by others, and the updated CSM that describes the current nature and extent of petroleum impacts and potential exposure scenarios.

2.1 ALAMEDA POINT SETTING

Alameda Point is on the western tip of Alameda Island, which is on the eastern side of San Francisco Bay (Figure 1). Most of the northern portion of what is now Alameda Point was covered by the waters and tidal lands of San Francisco Bay. To create Alameda Point, fill material was dredged from San Francisco Bay. In 1930, the U.S. Army acquired Alameda Point from the City of Alameda. In 1936, the Navy acquired the land from the U.S. Army and built the former Naval Air Station (NAS) Alameda, which was operated as an active facility from 1940 to 1997. During the history of the former NAS Alameda, it housed approximately 60 military tenant commands for a combined military and civilian work force of over 18,000 personnel.

2.2 CORRECTIVE ACTION AREA 4C

CAA 4C consists of the former Annex Service Station (Building 567), located northeast of the intersection of Skylark Street and West Pacific Street (Figure 2). The site operated as a service station from 1971 until 1980 and included three underground storage tanks (USTs) (547-1 through 547-3), fuel distribution islands, and a car wash. CAA 4C is approximately 3,360 square feet in size.

Investigations conducted at CAA 4C have identified petroleum-impacted soil and groundwater. Previous corrective actions conducted at the site include: soil excavation, dual vacuum extraction (DVE), ISCO, and air sparge/soil vapor extraction (AS/SVE). Corrective actions were implemented from 2004 to 2006 using DVE along with a pilot-scale ISCO to treat residual contamination in soil. More recent corrective actions were performed in 2013 and 2014 using AS/SVE technology.

2.2.1 Previous Investigation Activities at CAA 4C

Since 1990, investigations conducted at CAA 4C have identified petroleum-impacted soil and groundwater associated with the former Annex Exchange Service Station. These investigations include the following:

- Phase 1 and 2A investigations performed by Canonie in 1990
- Phase I Environmental Baseline Survey (EBS) conducted by Environmental Resource Management-West, Inc. (ERM) in 1994
- Remedial Investigation (RI) for Operable Unit (OU)-2 conducted by PRC Environmental Management, Montgomery Watson, and Tetra Tech between 1994 and 1998
- UST removal effort conducted by Public Works Center (PWC) in 1994 and 1995
- Phase II EBS by International Technology Corporation in 1995
- Metal detector survey conducted by Precision Locating Services in 1998
- Free-phase floating product investigation conducted by Tetra Tech in 1999

- Data gap investigation for CAAs conducted by Tetra Tech in April 1999
- Storm sewer study conducted by Tetra Tech in 2001
- Data gap investigation for OU-1 and OU-2 conducted by Tetra Tech in 2001
- Supplemental data gap investigation for OU-1 and OU-2 conducted by Tetra Tech in 2000
- Dual vacuum extraction, biosparge and pilot-scale chemical oxidation injection conducted by Shaw Environmental, Inc. from 2004 to 2006
- Air sparge and soil vapor extraction conducted by Tetra Tech from 2013 to 2014

2.2.2 CAA 4C Current Status

Groundwater monitoring (spring and fall 2013 and spring 2014) data indicate that petroleum constituent concentrations exceeding the PRC remain at CAA 4C with benzene as high as 1,000 micrograms per liter (µg/L) and TTPH of 31,600 µg/L above their PRCs of 36 µg/L and 20,000 µg/L, respectively (TtEC, 2014). Petroleum constituents remain above their respective screening criteria following implementation of several active remediation strategies.

The current extent of petroleum hydrocarbons in groundwater at CAA 4C is presented on Figure 4 and includes results from spring 2013 to spring 2014. Additionally, Table 1 presents CAA 4C's petroleum hydrocarbon screening criteria and documented exceedances from August 2011 through March 2014.

2.3 CORRECTIVE ACTION AREA 7

CAA 7 operated as a Naval Exchange Service Station from at least 1951 to 1997 and is located near the corner of Main Street and West Tower Avenue (Figure 2). The site included a vehicle repair shop (Building 459), a small convenience store (former Building 284), and nine USTs storing automotive fuels, fuel oil, solvents, and lubricating oils. The USTs and their associated fuel distribution lines and fueling islands were removed from 1995 to 1998. CAA 7 is approximately 5,040 square feet in size.

Investigations conducted at CAA 7 identified free-phase and dissolved-phase fuel hydrocarbons in soil and groundwater. Remediation took place between 1996 and 2013 and consisted of soil excavation, DVE, and AS/SVE. Pre- and post-excavation confirmation samples indicated significant reductions in total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene, xylene (BTEX), and methyl tert-butyl ether (MTBE) concentrations. Monitoring conducted since 2012 has identified petroleum constituents in groundwater at concentrations exceeding PRCs. In 2013 and 2014, AS/SVE corrective action was conducted at CAA 7.

2.3.1 Previous Investigation Activities at CAA 7

Previous investigations conducted at CAA 7 identified free-phase and dissolved-phase fuel hydrocarbons in soil and groundwater. These investigations include the following:

- Final Summary Report USTs 459-5 Through 459-8, UST 506-1 (Navy PWC, 1997).
- Final Summary Report USTs 459-1 Through 459-4 (Tetra Tech, 1999).
- RI Report (Tetra Tech, 2004b).

- Report on Abandoned UST Investigation (Shaw, 2008a).

Based on the reports listed above, all of the USTs and dispensers at CAA 7 were reportedly removed from the site between 1995 and 1998.

A design data investigation was performed between December 2002 and February 2003 by Shaw to evaluate site conditions prior to remedial activities. A total of 14 piezometers were installed designated as IT013-CA07-0001 through IT013-CA07-0014 (Shaw, 2008a). Another 25 piezometers were installed, designated as 37IT-CA07-0001 through 37IT-CA07-0025 (Shaw, 2008a).

Remediation operations implemented at CAA 7 include:

- USTs and product piping removed between 1995-1998 (Shaw, 2008a).
- Free product removal using DVE with horizontal and vertical wells from to 2002 to 2003 (Shaw, 2008a).
- AS/SVE technology conducted by Tetra Tech from 2013 to 2014.

2.3.2 CAA 7 Current Status

Groundwater monitoring (spring and fall 2013 and spring 2014) data indicate that petroleum constituent concentrations exceeding the PRC persist at CAA 7 with MTBE and total TPH as gasoline (TPH-g) the primary constituents. The current extent of petroleum hydrocarbons in groundwater at CAA 7 is presented on Figure 5 and includes results from spring 2013 to spring 2014. Additionally, Table 2 presents CAA 7's petroleum hydrocarbon screening criteria and documented exceedances from August 2011 through March 2014.

2.4 CONCEPTUAL SITE MODEL

The following sections present the CSM for CAA 4C and CAA 7 at Alameda Point.

2.4.1 Geology and Hydrogeology - Alameda Point

Alameda Point is located along the eastern margin of San Francisco Bay. It occupies a depression between two uplifted areas: the Berkeley Hills to the east and the San Bruno and Santa Cruz Mountains to the west on the San Francisco Peninsula. The depression and uplifted areas are formed by two subparallel, active faults: the San Andreas and the Hayward Faults. Alameda Point and the surrounding San Francisco Bay are underlain by 400 to 500 feet of unconsolidated sediments that overlay the metamorphosed sandstone, siltstone, shale, greywacke, and igneous bedrock, which forms the Franciscan Formation (Bechtel, 2003).

Surface and near-surface soil at Alameda Point consists of artificial fill emplaced during historical filling of the tidal marshlands and the subtidal area of San Francisco Bay during site development. The fill material consists of sediments that were dredged from the tidal flats of San Francisco Bay and Oakland Inner Harbor and is characterized by sands, clays, and silts (Bechtel 2003). The unconsolidated sediments that lie beneath the artificial fill consist of the following five units, from top to bottom:

- Artificial Fill
- Bay Sediment Unit (BSU)
- Merritt Sand Formation

- The upper San Antonio Formation and lower San Antonio Formation
- The Alameda Formation

Groundwater across Alameda Point is usually encountered at depths of 3 to 8 feet below ground surface (bgs) in the artificial fill. Three hydrogeologic units are present in the unconsolidated sediment at Alameda Point. These units have been designated the unconfined first water-bearing zone (FWBZ), the semi-confined second water-bearing zone (SWBZ), and the deep, confined aquifer, known as the Alameda Aquifer.

2.4.2 Geology and Hydrogeology – CAA 4C

During previous investigations, two geologic formations have been encountered at CAA 4C, artificial fill and the Merritt Sand Formation.

The artificial fill material is described as consisting primarily of brownish fine sand intermixed with minor amounts of silt and clay, and is approximately 5 to 7 feet thick (Shaw, 2008b). Previous particle size analyses data collected indicate that the fill is composed of approximately 70 percent (%) sand, 20% silt, and 10% clay (Shaw, 2008b).

The Merritt Sand Formation underlies the artificial fill of an orangish-brown mottled gray, silty to clayey fine sand. Previous particle size analyses data collected indicate that the Merritt Sand Formation fill is composed of approximately 80% sand, 15% silt, and 5% clay (Shaw, 2008b). The contact between the Merritt Sand Formation and the artificial fill material is found between 8 and 12 feet below the existing ground surface (Shaw, 2008b).

Of the three hydrogeologic units encountered at Alameda Point, only the FWBZ has been encountered at CAA 4C (Shaw, 2008b). The FWBZ, an unconfined aquifer composed of artificial fill material and the Merritt Sand Formation, is typically encountered at CAA 4C at 5 to 6 feet below grade and may be 100 feet thick in this region of Alameda Point (Shaw, 2008b). As documented in the Draft Spring 2007 Alameda Basewide Annual Groundwater Monitoring Report (Innovative Technical Solutions, Inc. [ITSI], 2007), seasonally at CAA 4C, between 2002 and 2007, the groundwater surface fluctuated from as shallow as 2 feet bgs to as deep as 8 feet bgs. The groundwater flow direction is variable in the vicinity of CAA 4C, but generally trends toward the west with an average hydraulic gradient of approximately 0.0015 (ITSI, 2007).

2.4.3 Geology and Hydrogeology – CAA 7

During previous investigations, four geologic formations have been encountered at CAA 7, artificial fill, BSU, Merritt Sand Formation, and the upper San Antonio Formation.

Artificial fill materials beneath the site are characterized as sandy/gravelly backfill to a depth typically between 4 and 8 feet below grade (Shaw, 2008a). An organic silt or clay unit of the BSU is present below the fill material and extends to a depth of between 30 and 50 feet below grade (Shaw, 2008a). Discontinuous layers of higher permeability soils are present within the BSU (Shaw, 2008a). The Merritt Sand is present below the BSU, and the Upper San Antonio Formation underlies the Merritt Sand (Tetra Tech, 2004b).

There are three hydrogeologic units present beneath the CAA 7. These three units are the FWBZ, the BSU, and the SWBZ. The FWBZ is generally composed of artificial fill material, while the SWBZ is defined by the Merritt Sand and/or Upper San Antonio Formations (Shaw, 2008a). The BSU thus separates the FWBZ and SWBZ (Shaw, 2008a). The Merritt Sand Formation pinches out in the eastern portion of the site and the SWBZ in this area is composed uniquely by the Upper San Antonio Formation (Parsons, 2000). Underlying the SWBZ is the Yerba Buena Mud Aquitard (Parsons, 2000).

Depth to the water table varies at CAA 7 from approximately 2 feet below grade in the winter to from 3 to 6 feet below grade in the summer (Shaw, 2008a). A northerly groundwater flow direction was reported by Tetra Tech with a velocity of 0.5 to 0.7 feet per year (Tetra Tech, 2004b). There is no reported tidal influence in monitoring wells at CAA 7 (Parsons, 2000).

2.4.4 Nature and Extent of Groundwater Contamination at CAA 4C

The petroleum hydrocarbons reported in groundwater at CAA 4C in March 2014 are primarily benzene and TPH. Petroleum-impacted groundwater at CAA 4C likely resulted from inadvertent spills during service station operations, and/or possible UST and associated distribution line leaks.

Based on 14 years of previous investigations and results of corrective actions, petroleum hydrocarbons are confined to the FWBZ from approximately 4 feet to 16 feet bgs, are limited in lateral extent, and are not expected to impact San Francisco Bay. Groundwater monitoring (spring and fall 2013 and spring 2014) data indicate that petroleum hydrocarbon concentrations exceed the PRC, with benzene concentrations reported as high as 1,000 µg/L and TPH concentrations at 31,600 µg/L; both exceed their PRCs of 36 µg/L and 20,000 µg/L, respectively (TtEC, 2014).

The current extent of petroleum hydrocarbons in groundwater at CAA 4C is presented on Figure 4 and includes results from spring 2013 to spring 2014. Additionally, Table 1 presents CAA 4C’s petroleum hydrocarbon screening criteria and reported exceedances from August 2011 through March 2014.

2.4.5 Nature and Extent of Groundwater Contamination at CAA 7

The petroleum hydrocarbons reported in groundwater at CAA 7 in March 2014 are MTBE, TPH-g, and BTEX. Petroleum-impacted soil and groundwater at CAA 7 likely resulted from inadvertent spills during service station operations, and/or possible UST and associated distribution line leaks.

Based on 10 years of previous investigations and corrective actions, petroleum hydrocarbons are confined to the FWBZ from approximately 2 feet to 16 feet bgs, are limited in lateral extent, and are not expected to impact San Francisco Bay. The current extent of petroleum hydrocarbons in groundwater at CAA 7 is presented on Figure 5 and includes results from spring 2013 to spring 2014. Additionally, Table 2 presents CAA 7’s petroleum hydrocarbon screening criteria and reported exceedances from August 2011 through March 2014.

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3 IN-SITU BIOREMEDIATION DESIGN AND APPROACH

EISB-a treatment at CAA 4C will be augmented with ISCO at two focused areas to address persistent residual petroleum hydrocarbons in soil and groundwater. This section presents the selected oxygen-releasing and ISCO reagents and the delivery method. CAA 7 will only have EISB-a treatment.

3.1 REAGENT DESCRIPTIONS

The location, type, and distribution of petroleum hydrocarbons at CAA 4C and CAA 7 require different approaches for in-situ treatment to maximize treatment effectiveness. EISB-a, with a focused ISCO application, is planned at CAA 4C because of existing elevated hydrocarbon concentrations, while EISB-a only is planned at CAA 7. EISB-a involves the delivery of oxygen and/or other nutrients and co-metabolites to the subsurface in order to stimulate the growth and activity of indigenous microbes which enhance the degradation of hydrocarbons. ISCO involves the subsurface delivery of a chemical oxidant for complete oxidation reactions of hydrocarbons, resulting in benign compounds, such as carbon dioxide, water, and mineral salts. The following sections describe the proposed reagents at each site.

3.1.1 Enhanced In-Situ Biodegradation (Aerobic)

EISB-a uses terminal electron acceptors such as dissolved oxygen to enhance natural attenuation of fuel hydrocarbons, including gasoline constituents BTEX and MTBE, by indigenous microorganisms in the subsurface (Wiedemeier et al., 1999; U.S .EPA, 2004). In this process, supplemental oxygen is provided to the subsurface and becomes available to aerobic bacteria (aerobes) capable of degrading petroleum hydrocarbons. The general stoichiometry ratio of oxygen per hydrocarbon of 3 moles oxygen per 1 mole of hydrocarbon is recommended to maximize biodegradation potential (U.S. EPA, 2004). Aerobes utilize the hydrocarbons as part of their metabolic processes and convert them into carbon dioxide, water, and microbial cell mass. Overall, the limiting factor for aerobic bioremediation is the supply of oxygen. As such, enhanced aerobic bioremediation relies on effective delivery of oxygen to the target treatment zone (TTZ) to maintain an aerobic environment. Aerobic bioremediation technologies are particularly efficient in treating petroleum hydrocarbons and some fuel oxygenates that are dissolved in groundwater or are sorbed to aquifer material in the saturated zone. These techniques are typically employed outside heavily contaminated source areas (where free-phase product exists), which are usually addressed by more aggressive remedial approaches (e.g., ISCO) until the free-phase product diminishes significantly. At this point, aerobic biodegradation becomes the preferred remedial approach.

3.1.2 Focused In-Situ Chemical Oxidation

Klozur® CR is proposed as the ISCO reagent to treat two relatively small locations with persistent, elevated TPH concentrations (>10,000 µg/L) at CAA 4C. Klozur® CR is an engineered “hybrid” ISCO product consisting of pH-activated Klozur® Persulfate and PermeOx® engineered calcium peroxide. The oxidant persulfate will degrade hydrocarbons rapidly and desorb residual TPH mass from the soil matrix, while the calcium peroxide provides sustained oxygen to bolster biodegradation of desorbed TPH mass. Klozur® CR provides self-activating Klozur persulfate oxidation technology, utilizing the alkalinity generated by calcium peroxide to achieve a pH in the range of 10 to 11. In addition, the calcium peroxide will slowly generate hydrogen peroxide, allowing for peroxide activation of persulfate. The persulfate-based ISCO provides the advantage of high oxidant strength similar to that of hydroxyl radical, and yet is very stable with a higher solubility than permanganate, and without the safety hazard associated with peroxide and ozone. The Klozur® CR couples chemical oxidation with aerobic bioremediation processes that can last up to one year following application. Additionally, because the persulfate anion is kinetically slow in oxidation, its interaction with naturally occurring organic matter is more limited than that of peroxide or permanganate (Interstate Technology & Regulatory Council [ITRC], 2005).

3.1.3 Reagent Selection Criteria

The factors considered in selection of an oxygen-releasing reagent for EISB-a at CAA 4C and CAA 7 include hydrocarbon concentrations, location, and distribution in the subsurface; aquifer geochemistry; potential longevity of the reagent in the TTZ; possible presence of residual sorbed mass; cost of reagent per volume of amount of oxygen delivered; and demonstrated performance of the reagent at other sites with similar characteristics. These selection criteria provide comprehensive evaluation guidelines for site-specific selection of electron acceptors.

3.1.3.1 CAA 4C

The concentrations of fuel-related components reported above the PRCs at CAA 4C from April 2013, October 2013 and March 2014 include an average concentration of reported total TPH of 3,400 µg/L (with a gasoline fraction of 3,000 µg/L), benzene of 150 µg/L, toluene of 130 µg/L, ethylbenzene of 130 µg/L, xylenes of 480 µg/L, and naphthalenes (naphthalene, 1- and 2-methylnaphthalenes) of 100 µg/L. These concentrations persisted after recent corrective actions performed in 2013 and 2014 using AS/SVE technology. Additionally, review of fall 2013 and spring 2014 monitoring reports shows that both the oxidation reduction potential (ORP) and dissolved oxygen (DO) average values of –150 millivolts (mV) and 100 µg/L, respectively, are indicative of an anaerobic geochemical environment.

The site-specific geology, hydrogeology, groundwater geochemistry, and hydrocarbon compound concentrations were considered to estimate sufficient dosage of the reagent for the proposed duration of the TS. The estimation of reagent dosage for the proposed TS at CAA 4C used geochemical data such as reduced metals (iron and manganese), chemical oxygen demand (COD), effective porosity, and hydraulic conductivity, as well as the treatment depth. The COD and dissolved metals levels allow for estimation of the site-specific oxygen demand, and may be revised as necessary following the proposed baseline sampling event. The EISB-a reagent dosage estimations for CAA 4C are presented in Appendix D.

The proposed technology consists of injection of a slow-release oxygen compound (PermeOx Ultra®) into the TTZ using direct-push technology (DPT). PermeOxUltra® provides engineered calcium peroxide, which provides a sustained release of oxygen and nutrients into groundwater to support aerobic biodegradation of the petroleum hydrocarbons present. The reagent is available as a powder and will be mixed at approximately 10 to 30% by volume with extracted groundwater from the site for delivery to the TTZ. PermeOx Ultra® will typically release 18% oxygen by weight over an estimated 12-month period, and nutrients to support biological processes.

ISCO treatment at CAA 4C will consist of injecting Klozur® CR into two focused areas located near observation (OB) well 04 (OB-04) and DVE-07 (Figure 4). The hydrocarbon concentrations above PRCs during the 2013 and 2014 monitoring rounds were as high as 31,600 µg/L for TPH at OB-04, and 8,300 µg/L for BTEX (collectively) at OB-04. The ISCO component (persulfate) will effectively treat the high hydrocarbon concentrations, and the oxygen-producing compound (PermeOx® Ultra) will provide sustained aerobic bioremediation following application. Klozur®

CR is available as a powder and will be mixed at 10 to 30% by volume with extracted site groundwater to create a slurry for subsurface injections. Because the TTZ at CAA 4C is relatively small, a single phase of ISCO injections is planned. The ISCO reagent dosage estimations for CAA 4C are presented in Appendix D.

3.1.3.2 CAA 7

The fuel-related compounds reported at concentrations above PRCs at CAA 7 in April 2013, October 2013 or March 2014 include benzene, MTBE, and naphthalene. The maximum reported concentrations during this period for benzene, MTBE, 1-methylnaphthalene, and naphthalene are 4.2 µg/L, 4,500 µg/L, 2.7 µg/L, and 1.5 µg/L, respectively. Average reported values during the above reporting period, are 2.6 µg/L, 700 µg/L, 2.7 µg/L, and 0.8 µg/L for benzene, MTBE, 1-methlnaphthalene, and naphthalene. Additionally, review of fall 2013 and spring 2014 monitoring reports shows that both the ORP and DO, with values of -200 mV and 150 µg/L, respectively, are indicative of an anaerobic geochemical environment.

The site-specific geology, hydrogeology, groundwater geochemistry, and hydrocarbon concentrations and distribution were evaluated to estimate the reagent dosage requirements for the proposed duration of the TS. The reagent dosage estimation for the proposed TS at CAA 7 was based on geochemical data (reduced metals iron and manganese), chemical oxygen demand (COD), effective porosity and hydraulic conductivity, and treatment depth. The EISB-a reagent dosage estimations for CAA 7 are presented in Appendix D.

As is the case for CAA 4C, PermeOx Ultra® is the proposed reagent for injection into the TTZ using DPT. PermeOx Ultra® was found to be effective in treating fuel components in groundwater at CAA 7, as it provides engineered calcium peroxide for the slow release of oxygen and nutrients into groundwater to sustain aerobic biodegradation of the fuel-related compounds present. The reagent is available as a powder and will be mixed at 10 to 30% by volume with extracted groundwater from the site for injections. PermeOx Ultra® will typically release 18% oxygen by weight over an estimated 12-month period, and nutrients to support biological processes.

3.2 AEROBIC EISB-A DELIVERY METHOD

The EISB-a groundwater treatment delivery method consists of introducing the reagents using approximately 43 DPT injection points at CAA 4C, and approximately 64 DPT injection points at CAA 7. During delivery, reagent distribution will be monitored by physical measurements (e.g., injection pressure and flow rates) at each injection point. Geochemical parameters will be measured during post-injection performance at nine permanent monitoring wells at CAA 4C (Figure 4) and six permanent wells at CAA 7 (Figure 5) as shown on Table 3.

The in-situ treatment consists of the following tasks:

- Groundwater extraction
- Groundwater amendment (i.e., mix reagent/oxidant with extracted groundwater)
- Amended groundwater injection
- Performance monitoring

Groundwater will be extracted from the existing monitoring wells to provide the mixing water for the oxygen amendment. The advantages of using site groundwater to the extent practicable for the treatment are that (1) plume displacement is minimized by removing site groundwater and thus avoiding increases to the overall volume of water in the treatment area, and (2) favorable geochemistry is maintained by avoiding use municipal water that has been treated with sanitation chemicals (such as chlorine or chloramines) intended to kill microorganisms.

As a contingency, water from a nearby fire hydrant may be used as an alternate water supply if the extraction of aquifer water fails to achieve targeted flow/volume requirements to support the planned injection. Water obtained from the fire hydrant for amendment and injection will be filtered using an in-line carbon filter to remove chloramines and chlorine sanitation products that may be detrimental to native bacteria.

Groundwater will be extracted from the existing monitoring wells using down-well electric submersible pumps and/or tubing connected to an above-grade water pump. The extraction will occur continuously during working hours (i.e., Monday through Friday, 0700 to 1730) to obtain enough water to mix the slurry to 10% to 30% reagent by volume. An anticipated volume of 2,500 gallons is required to complete the reagent injection at CAA 4C and 2,900 gallons are required for the injection at CAA 7. These volumes require a daily extraction of 300 gallons at CAA 4C and 270 gallons at CAA 7.

A portable mixing and injection system will be used for the reagent delivery; the system consists of trailer-mounted equipment and a water storage tank. The portable system allows effective and efficient reagent delivery to up to three injection points simultaneously. A total of 700 gallons of reagent can be stored on the trailer in two tanks. Dosing of reagent and water is automatically controlled by a metering pump. The reagent and groundwater mix are emulsified by an in-line static mixer. Options exist for storing reagent and groundwater mix either prior to or after mixing, depending on injection requirements.

At each injection location, the drive rods will be pushed to the desired depth and the slurry will be applied under pressure while the drive rods are slowly pulled up using a specialized fluid injection tooling. First, steel rods led by a "*drivepoint*" will be advanced to the target depths; amended groundwater will then be injected at a rate no higher than 8 gallons per minute, as the rods and drivepoint are slowly retracted from the boring (a bottom-up injection). Using DPT injection provides control on vertical placement of the reagent, and allows for field flexibility and adjustment to unanticipated field conditions. Amended groundwater will be injected at a sufficient pressure to distribute the reagent horizontally within a depth horizon. The injection tooling is attached to the drivepoint and will be equipped with a check valve assembly to prevent backflow that could occur as the drive rods are retracted form the borehole. Once the drivepoint and rods are removed, the injection borehole will be sealed with a bentonite grout slurry, and tremied to the surface. The surface will be completed to match the existing grade.

All injection system piping is portable and remains above grade; the design spacing between injection points is 5 feet, based on a reagent delivery radius of influence (ROI) of 5 feet. The proposed injection will uniformly deliver the reagent throughout the vertical extent of the TTZ, from approximately 4 to 16 feet bgs at CAA 4C, and 2 to 14 feet bgs at CAA 7.

The proposed injections are designed with relatively high volumes of 38 to 45 gallons per injection point for PermeOx®Ultra, and up to 116 gallons per injection point for the more soluble ISCO amendment with a target concentration of 10 to 30% by weight. High-volume injection ensures a sufficient emplacement volume (i.e., pore volume displaced by the injected liquid) to achieve good contact between the reagent solution and the groundwater and sorbed contamination. The persulfate component of Klozur® CR stays active for 3 to 6 months, while the oxygen-releasing component typically lasts up to 12 months. During that time, advection and dispersion may increase its ROI up to an additional 50% of the original emplacement volume. Thus, a larger emplacement volume would result in greater ROI and longer contact with the hydrocarbon components. Additionally, the design takes into account that very high injection volumes could lead to increased hydraulic pressures and initiation of hydraulic fractures with potential short-circuiting of the reagent. To avoid the negative effects of high-volume injections, the injection pressure will be monitored constantly during delivery, and will not be allowed to exceed 25 pounds per square inch (psi). In the event that localized pressure is observed to build, the injection will be modified to provide adequate spatial separation between consecutive injection points. Further, the injections will not occur in a *side-by-side* method, but will be separated to allow groundwater to naturally dissipate the hydrostatic pressure.

After the EISB-a injection is completed, the effectiveness of the treatment will be evaluated over three quarters of performance monitoring, as specified in Section 4.

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4 FIELD IMPLEMENTATION

The section summarizes the general site activities to be completed in support of the EISB-a treatment of petroleum hydrocarbons in groundwater at each site. These activities include permitting and notification, baseline groundwater sampling, mobilization, utility clearance, DPT reagent delivery, and performance monitoring.

4.1 PERMITTING AND NOTIFICATION

Before beginning field work, the MMEC Group will inform the Navy of the nature and schedule of the planned field work. The MMEC Group will coordinate site access through the Base Realignment and Closure (BRAC) Caretaker or Activity Point of Contact (POC), and will notify the Resident Officer in Charge of Construction (ROICC) of the upcoming schedule for field work in addition to subsequent field mobilizations for groundwater monitoring and sampling. Current tenants, if any, on and adjacent to CAA 4C and CAA 7 will also be notified of impending field activities. The Navy is conducting this project in accordance with Alameda Point's Petroleum Strategy which was updated in the PMP for Alameda Point (Battelle, 2012). The PMP identifies the ongoing sampling requirements at each CAA.

4.2 BASELINE GROUNDWATER SAMPLING

To remain consistent with the current PMP monitoring plan, groundwater samples will be collected from 16 existing groundwater monitoring wells within CAA 4C and 8 existing groundwater monitoring wells within CAA 7. Monitoring well geochemistry results from each TTZ will provide baseline conditions of hydrocarbon concentrations and geochemical conditions. Only wells within the TTZ will be used to evaluate EISB-a performance (Table 3). The methods by which groundwater sampling will be performed are outlined in the SAP (Appendix A).The following tasks are associated with groundwater sampling.

4.2.1 Water Level Measurements

Measurements of groundwater levels will be conducted at the monitoring wells identified for sampling located at CAA 4C and CAA 7. The water level will be measured immediately prior to sampling of each well during every sampling event.

4.2.2 Monitoring Well Sampling

Groundwater from monitoring wells will be sampled for offsite analysis by a Department of Defense and California-approved laboratory, as described in the SAP (Appendix A). Table 3 lists the monitoring wells for each site and the analytical methods for each well. Monitoring wells will be purged and sampled in accordance with the U.S. EPA groundwater sampling operating procedure (U.S. EPA, 2010). The low-flow (*low-stress*) groundwater sampling purge rate is between 100 to 500 milliliters per minute (mL/min) with a preference for the lower end of this range during the initial stages of purging. The overall goal of low-flow purging is to minimize water table drawdown, and appropriate procedures will be followed during low-flow purging operations. A submersible pump (Sample Pro® bladder pump or similar) with a flow controller and disposable tubing and bladders will be used for sample collection.

4.3 MOBILIZATION AND SITE PREPARATION

Prior to intrusive activities, the MMEC Group Site Supervisor will identify the proposed DPT injection locations on the ground. Marking paint will be used to mark each proposed temporary well and a unique identification number (as described in Worksheet # 27 in the SAP [Appendix A]) will be assigned. DPT injections will be spaced approximately 5 feet apart and distributed throughout the plume footprint. Because the work perimeter for this project is enclosed within a chain-link fence, no temporary fencing will be required to protect the work area. The MMEC Group will work with the Navy ROICC and Caretaker Site Office to establish and identify appropriate laydown areas for all equipment, materials, and vehicles required to implement the remaining field tasks. However, all injection equipment is portable and resides onboard DPT drill rigs, trucks, and trailers; consequently, the MMEC Group does not foresee the need for overnight laydown areas.

4.4 UTILITY CLEARANCE

Prior to intrusive activities, each proposed DPT injection location will be cleared for utilities by a private utility-locating service, using handheld equipment, to ensure that no subsurface utilities are present. The MMEC Group will notify Underground Services Alert at least 72 hours prior to initiation of any subsurface drilling activities. All locations will be marked and cleared for proposed DPT injection. A minimum clearance of 2 feet from the closest observed utility will be maintained at all drilling locations; additionally, a minimum distance of 20 feet will be maintained from all overhead power lines. Prior to drilling activities, each injection location will be cleared to 5 feet bgs with a non-intrusive method (i.e., hand-auger) to ensure clearance from subsurface utilities.

4.5 INJECTIONS: IN-SITU CHEMICAL OXIDATION AND IN-SITU BIOREMEDIATION TREATMENT

CAA 4C

Approximately 43 DPT injections at CAA 4C targeting a treatment zone from 4 to 16 feet bgs will be installed in a single injection event (Figure 4). Approximately 10 of the 43 DPT injections will consist of ISCO treatment and these will be placed in the vicinity of wells OB-04 and DVE-07. The remaining 33 DPT injections will consist of EISB-a treatment. Extracted groundwater will be mixed with the selected reagent and injected into the aquifer via the 43 injection locations.

CAA 7

Approximately 64 DPT injections at CAA 7 targeting a treatment zone from 2 to 16 feet bgs will be installed in a single injection event (Figure 5). Extracted groundwater will be mixed with PermeOx®Ultra and injected into the TTZ via the 64 injection locations.

Details regarding the tasks above and the EISB-a and ISCO treatments are presented in Section 3 and in the SAP (Appendix A).

5 AEROBIC EISB-A PERFORMANCE MONITORING PLAN

This post-treatment performance monitoring plan was prepared in accordance with the Alameda Point PMP (Battelle, 2012) and augmented to specifically measure EISB-a effectiveness. The following plan includes a detailed description of the proposed sampling and analyses, the monitoring wells used to evaluate EISB-a performance, sampling frequency, and periodic optimization for each site.

EISB-a performance will be assessed by evaluating trends in groundwater geochemistry and petroleum hydrocarbon concentrations with respect to each site's applicable PRCs and the SWRCB's *Low-Threat Underground Storage Tank Case Closure Policy*. Nine wells at CAA 4C and six wells at CAA 7 will be used to evaluate EISB-a treatment effectiveness. These 15 wells are identified in Table 3. For the purpose of this Treatability Study, the Navy will use site-specific PRC values for a site greater than 250 feet from the bay as presented in the Final 2012 Update to Petroleum Management Plan (Battelle, 2012). The performance treatment goals for CAA 4C and CAA 7 are shown in Tables 4 and 5, respectively.

5.1 REAGENT DISTRIBUTION

Field measurements and analytical data will be used to evaluate the radius of influence achieved at the different locations, and any changes in the groundwater quality (conditions), including geochemical parameters and degradation. During delivery, reagent distribution will be monitored in addition to physical field parameters (e.g., injection pressure and flow rates) at each injection point. The following field measurements will be performed:

- Injection pressure – To avoid the negative effects of high-volume injections, the injection pressure will be monitored constantly during field injection, and will not be allowed to exceed 25 psi.
- Water elevation – Groundwater "mounding," which indicates low hydraulic conductivity, will be assessed at and near injection points. If this mounding is observed, pressure will be reduced or ceased until mounding subsides.

5.2 EFFECTIVENESS OF IN-SITU BIOREMEDIATION

Following field data collection and sample analysis, the geochemical parameters will be used to evaluate whether conditions in the groundwater have been altered and are sufficient to sustain continued degradation. The following field measurements will be used for this purpose:

- ORP (by field meter), as an aerobic environment must be maintained to support bacteria (e.g., a minimum range of −100 mV should be achieved and maintained for aerobic degradation).
- Dissolved oxygen (by field meter and Hach Test Kit), in support of ORP measurements.
- pH (by field meter), as biological organisms are sensitive to subsurface conditions; an optimal range of 5 to 8 must be maintained.
- Specific conductivity (by field meter).

5.3 PERFORMANCE MONITORING

Assessment of EISB-a and ISCO performance objectives will be made on the basis of the evaluation of data collected as part of baseline characterization for comparison, and on three consecutive rounds of monitoring. Baseline groundwater samples and geochemical measurements will be collected prior to the injection treatments; this step will be followed by three quarterly events (3, 6, and 9 months) after the injection treatment is performed. The three quarterly events will be used to evaluate the effectiveness of treatment, incorporating the analytical protocols listed above to provide useful data on degradation reactions and redox conditions that reflect the system performance. Figure 6 presents the project schedule.

Immediately following injection and monthly thereafter until the first quarterly sampling, field parameters will be collected to document and evaluate EISB-a distribution and effects. The field parameters identified in Section 5.2 will be collected to assess EISB-a distribution and geochemical effects during the first three months following EISB-a delivery.

Groundwater samples will be collected from each of the existing monitoring wells presented in Table 3.

The samples will be collected via low-flow purging methods. Sampling methods and analytical parameters and procedures are presented in the SAP (Appendix A). The samples will be analyzed in a laboratory for the analytes listed below for the baseline sampling event and subsequent performance monitoring events:

- Volatile organic compounds (VOCs) (by U.S. EPA Method 8260B)
- TPH fractions (by U.S. EPA Method 8015B)
- BTEX (and MTBE at CAA 7 only) (by U.S. EPA Method 8260B)
- Polycyclic aromatic hydrocarbons (PAHs) (by U.S. EPA Method 8270C Selected Ion Monitoring [SIM])
- Total dissolved solids (TDS) (by U.S. EPA Method 160.1)
- Selected dissolved metals (arsenic and lead) (by U.S. EPA Method 6010B)
- EISB-a parameters:
    - ORP (by field meter)
    - pH (by field meter)
    - Dissolved oxygen (by field meter and Hach Test Kit)
    - Nitrate and sulfate (by U.S. EPA Method 300)
    - Total organic carbon (TOC) (by U.S. EPA Method 415.1)

Achieving effective reagent distribution within the TTZ (i.e., a sustained aerobic geochemical environment and decreased hydrocarbon concentrations) is the criterion used to evaluate the performance of the EISB-a treatment at each site. This criterion will be determined by evaluating the multiple lines of evidence using the analytical methods listed above. Post-EISB-a monitoring data will be used to determine whether PRCs have been met, and whether either site meets closure requirements in accordance with the SWRCB’s *Low Threat UST Closure Policy.*

Should post-EISB monitoring data not support closure requirements in accordance with the SWRCB's *Low Threat UST Closure Policy*, or if PRCs have not been met, treatment optimization may be recommended, including additional ISB injections, based on an evaluation of treatability study results (e.g., site specific geochemistry and residual petroleum compounds present). Post-monitoring recommendations will be made in accordance with the Alameda Point PMP (Battelle, 2012).

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6 REPORTING AND SCHEDULING

Following completion of the third quarter of performance monitoring, the MMEC Group will prepare a technical memorandum documenting all field activities, analytical results, and an evaluation of the EISB-a and ISCO treatments. The content of the technical memorandum will include the following elements for each site:

- Summary of field activities
- Assessment of performance objectives and measurements
- Petroleum hydrocarbon trend analyses
- Site closure strategy and progress
- Optimization recommendations

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7 REFERENCES

Alameda Reuse and Redevelopment Authority (ARRA). 2006 Preliminary Development Concept for Alameda Point, Alameda, California. February.

Bechtel. 2003. Draft Work Plan for Assessment of PAH Contamination at Selected CERCLA Sites and EBS Parcels, Alameda Point, Alameda, California. May.

Battelle. 2009. Final Technical Memorandum, Update to Preliminary Remediation Criteria and Closure Strategy for Petroleum-Contaminated Sites, Petroleum Program at Alameda Point, Alameda, California. September.

———. 2012 (Update). Petroleum Management Plan, Alameda Point, Alameda, California. February.

Canonie Environmental Services, Inc. 1990. RI/FS Work Plan, NAS Alameda, Alameda, California, Volume I, prepared for NAVY-WEST-DIV. February.

Environmental Resources Management-West, Inc. (ERM). 1988. Report on Abandoned UST Investigation. October.

Innovative Technology Solutions, Inc. (ITSI) 2007. Spring 2007 Alameda Basewide Annual Groundwater Monitoring Report, Draft, Alameda Point, Alameda, California. September.

Parsons Engineering Science, Inc. 2000. Fuel Hydrocarbon Transport Modeling Report, Site 7and Area 37, Alameda Point, Alameda, California. August.

Shaw Environmental, Inc. (Shaw). 2008a. Final Petroleum Corrective Action Summary Report, Former Naval Exchange Service Station, Corrective Action Area 7, Alameda Point, Alameda, California. August.

———. 2008b. Final Petroleum Corrective Action Summary Report, Dual Vacuum Extraction, Biosparge, and Pilot-Scale Chemical Oxidation Injection, Corrective Action Area 4C, Alameda Point, Alameda, California. November.

Tetra Tech EC, Inc. (TtEC). 2014. Draft Spring 2014 Petroleum Program Groundwater Monitoring Technical Memorandum, Corrective Action Areas C, 4C, 5B West, 6, 7, AND Building 410, Alameda Point, Alameda, California. May.

Tetra Tech Environmental Management, Inc. 2004a. Corrective Action Plan for Corrective Action Area 4C, Alameda Point, Alameda, California. January.

———. 2004b. Final Remedial Investigation Report, Operable Unit 1, Sites 6, 7, 8, and 16, Alameda Point, Alameda, California. November.

———. 1999. Final Summary Report USTs 459-1 through 459-4, Alameda Point, Alameda, California. June.

The Interstate Technology and Regulatory Council (ITRC). 2005. Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater. January.

United States Department of the Navy Public Works Department. 1997. Final Summary Report USTs 459-5 Through 459-8, UST 506-1, January.

United States Environmental Protection Agency (U.S. EPA). 2004. How to Evaluate Alternative Cleanup Technologies For Underground Storage Tank Sites: A Guide For Corrective Action Plan Reviewers. Office of Solid Waste and Emergency Response. EPA 510-R-04-002. Washington, DC. May.

———. 2005. Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs, Part 1: UFP-QAPP Manual. March.

———. 2010. Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells. January.

Wiedemeier, T., Downey, D.C., Wilson, J.T., Kampbell, D.K., Miller, R.N., and Hansen, J.E. 1999. Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater, Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

FIGURES

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Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

0 1 2 3 4 Miles

0 1,000 2,000 3,000 Feet

N

PROJECT NO.:	5023-14-6069
DATE:	September 2014
DRAWN BY:	RMH
CHECKED BY:	CM

MMEC GROUP

Alameda Point, Alameda, California

ALAMEDA POINT LOCATION MAP

BIOREMEDIATION TREATABILITY STUDY AT PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7

FIGURE 1

PROJECT NO.: 5023-14-6069
DATE: September 2014
DRAWN BY: RMH
CHECKED BY: CM

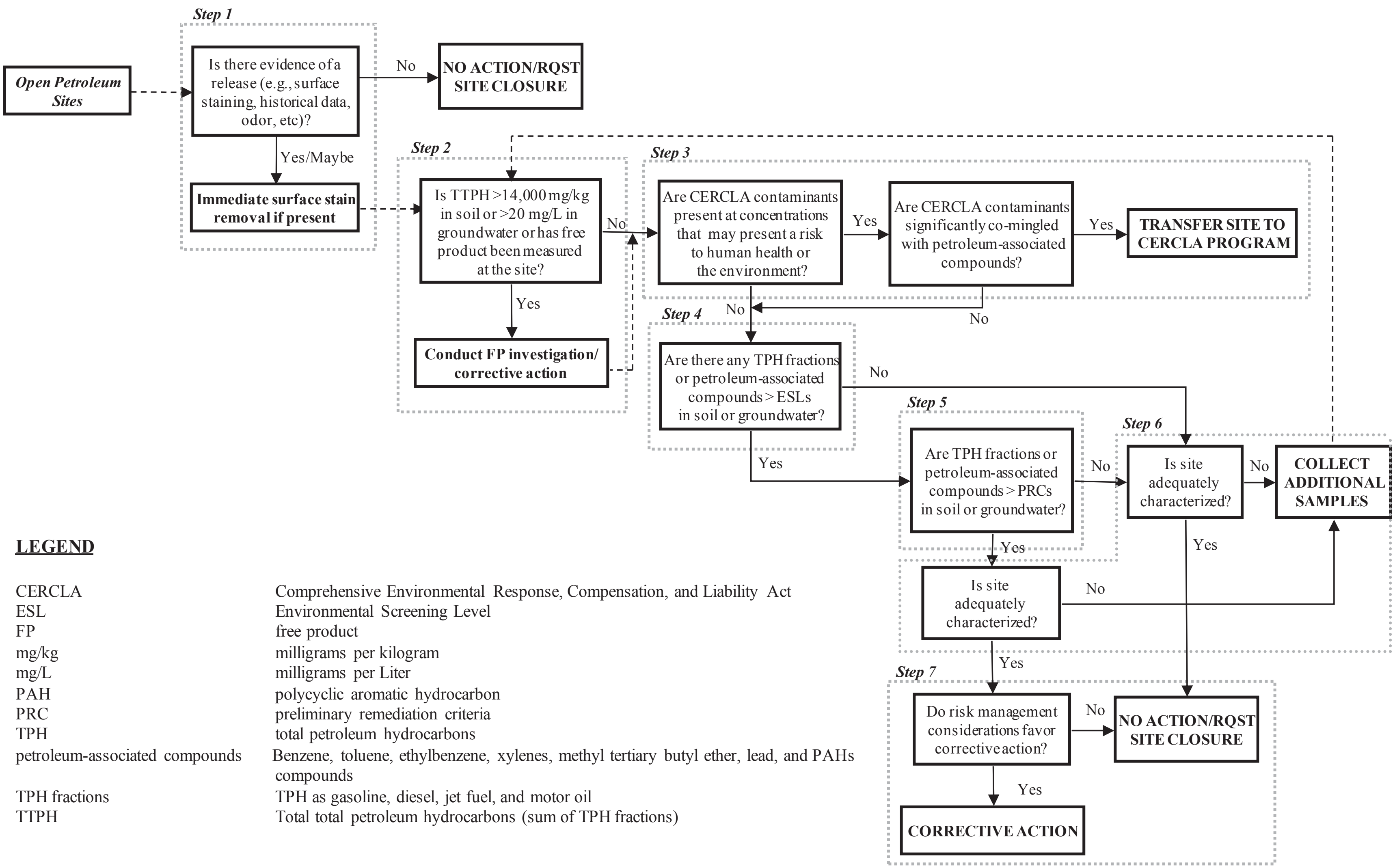
MMEC GROUP

Alameda Point, Alameda, California

CORRECTIVE ACTION AREAS (CAA) 4C AND 7 LOCATION MAP

BIOREMEDIATION TREATABILITY STUDY AT PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7

FIGURE 2



LEGEND

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
ESL	Environmental Screening Level
FP	free product
mg/kg	milligrams per kilogram
mg/L	milligrams per Liter
PAH	polycyclic aromatic hydrocarbon
PRC	preliminary remediation criteria
TPH	total petroleum hydrocarbons
petroleum-associated compounds	Benzene, toluene, ethylbenzene, xylenes, methyl tertiary butyl ether, lead, and PAHs compounds
TPH fractions	TPH as gasoline, diesel, jet fuel, and motor oil
TTPH	Total total petroleum hydrocarbons (sum of TPH fractions)

Figure 3. Petroleum Closure Decision Tree (Navy, 2009)

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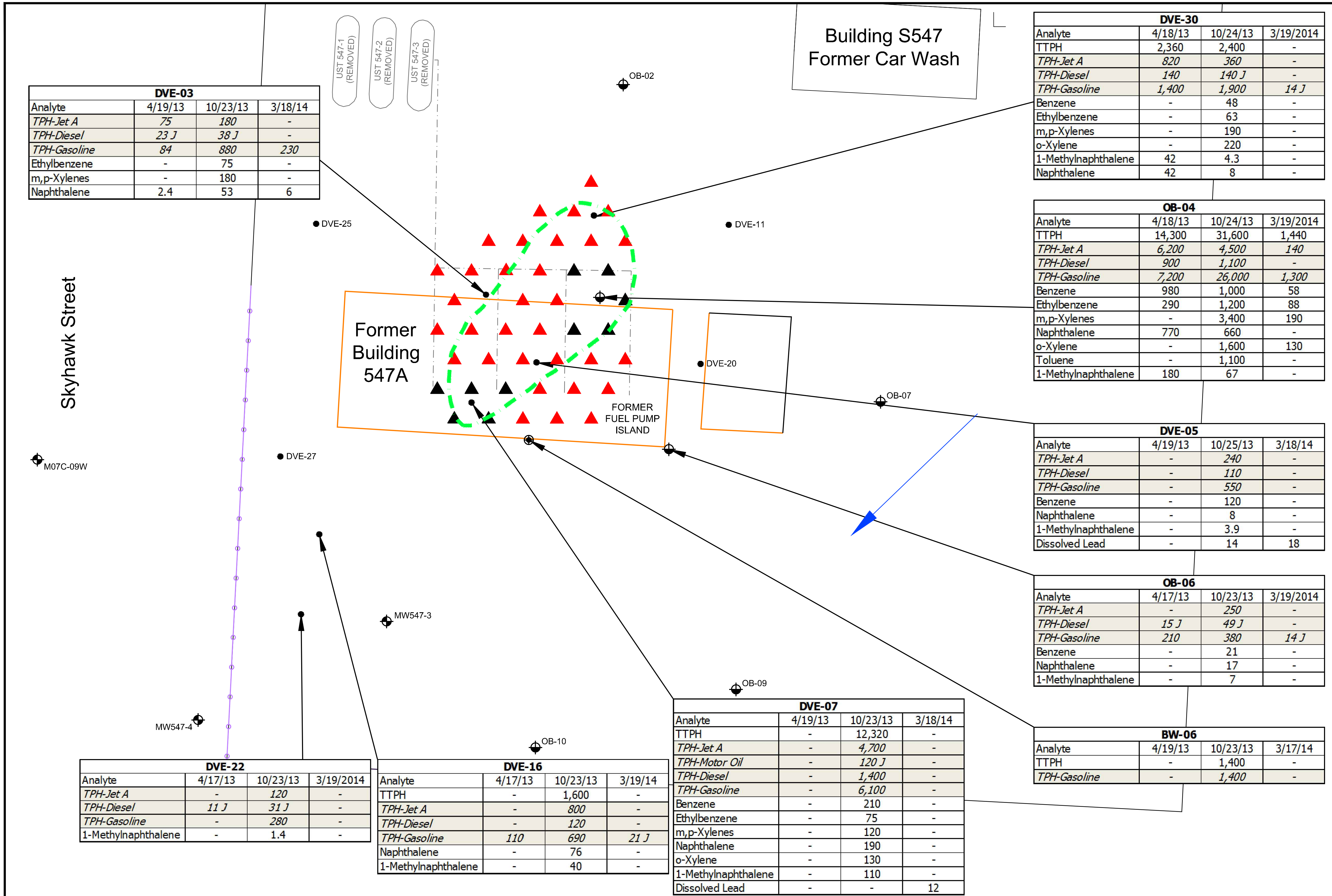


DVE-03			
Analyte	4/19/13	10/23/13	3/18/14
TPH-Jet A	*75*	*180*	-
TPH-Diesel	*23 J*	*38 J*	-
TPH-Gasoline	*84*	*880*	*230*
Ethylbenzene	-	75	-
m,p-Xylenes	-	180	-
Naphthalene	2.4	53	6

DVE-30			
Analyte	4/18/13	10/24/13	3/19/2014
TTPH	2,360	2,400	-
TPH-Jet A	*820*	*360*	-
TPH-Diesel	*140*	*140 J*	-
TPH-Gasoline	*1,400*	*1,900*	*14 J*
Benzene	-	48	-
Ethylbenzene	-	63	-
m,p-Xylenes	-	190	-
o-Xylene	-	220	-
1-Methylnaphthalene	42	4.3	-
Naphthalene	42	8	-

OB-04			
Analyte	4/18/13	10/24/13	3/19/2014
TTPH	14,300	31,600	1,440
TPH-Jet A	*6,200*	*4,500*	*140*
TPH-Diesel	*900*	*1,100*	-
TPH-Gasoline	*7,200*	*26,000*	*1,300*
Benzene	980	1,000	58
Ethylbenzene	290	1,200	88
m,p-Xylenes	-	3,400	190
Naphthalene	770	660	-
o-Xylene	-	1,600	130
Toluene	-	1,100	-
1-Methylnaphthalene	180	67	-

DVE-05			
Analyte	4/19/13	10/25/13	3/18/14
TPH-Jet A	-	*240*	-
TPH-Diesel	-	*110*	-
TPH-Gasoline	-	*550*	-
Benzene	-	120	-
Naphthalene	-	8	-
1-Methylnaphthalene	-	3.9	-
Dissolved Lead	-	14	18

OB-06			
Analyte	4/17/13	10/23/13	3/19/2014
TPH-Jet A	-	*250*	-
TPH-Diesel	*15 J*	*49 J*	-
TPH-Gasoline	*210*	*380*	*14 J*
Benzene	-	21	-
Naphthalene	-	17	-
1-Methylnaphthalene	-	7	-

BW-06			
Analyte	4/19/13	10/23/13	3/17/14
TTPH	-	1,400	-
TPH-Gasoline	-	*1,400*	-

DVE-07			
Analyte	4/19/13	10/23/13	3/18/14
TTPH	-	12,320	-
TPH-Jet A	-	*4,700*	-
TPH-Motor Oil	-	*120 J*	-
TPH-Diesel	-	*1,400*	-
TPH-Gasoline	-	*6,100*	-
Benzene	-	210	-
Ethylbenzene	-	75	-
m,p-Xylenes	-	120	-
Naphthalene	-	190	-
o-Xylene	-	130	-
1-Methylnaphthalene	-	110	-
Dissolved Lead	-	-	12

DVE-16			
Analyte	4/17/13	10/23/13	3/19/14
TTPH	-	1,600	-
TPH-Jet A	-	*800*	-
TPH-Diesel	-	*120*	-
TPH-Gasoline	*110*	*690*	*21 J*
Naphthalene	-	76	-
1-Methylnaphthalene	-	40	-

DVE-22			
Analyte	4/17/13	10/23/13	3/19/2014
TPH-Jet A	-	*120*	-
TPH-Diesel	*11 J*	*31 J*	-
TPH-Gasoline	-	*280*	-
1-Methylnaphthalene	-	1.4	-

LEGEND

MW547-4 Monitoring Well

DVE-03 DVE Well

OB-06 Observation Well

BW-06 Biosparging Well

Former Fuel Line

Proposed Direct Push Technology (DPT) Injection Points Using PermeOx Ultra™

Proposed Direct Push Technology (DPT) Injection Points Using Klozur® CR

Approximate groundwater flow direction (FWBZ)

µg/L micrograms/liter

\- Concentration below PRC or non-detect

PRC Preliminary Remediation Criteria

Plume Boundary

NOTES:

All results presented in micrograms/liter (µg/L).

Analytes shown on the Figure exceeded the PRC presented in the 2012 updated Petroleum Management Plan unless "-" shown.

CAA 4C is in a Non-Drinking Water and Commercial Use Area.

Proposed direct push technology (DPT) injection points are approximate with an estimated 5' radius of influence.

Compounds in italics do not have a PRC.

Only wells associated with data tables will be included in the treatability study.

J indicates an estimated value in the data tables.

0 15 30 feet

APPROXIMATE SCALE: 1"= 30'

NOTE:
Site feature locations are taken from Figure 18, Proposed Quarterly Groundwater Monitoring Locations *in* Final Petroleum Corrective Action Summary Report, Dual Vacuum Extraction, Biosparge, and Pilot-Scale Chemical Oxidation Injection, Corrective Action Area 4C, Alameda Point, Alameda California, (Shaw Environmental 2008).

Individual constituent levels provided on the figure were provided from, Draft Spring 2014 Petroleum Program Groundwater Monitoring Technical Memorandum, Corrective Action Areas C, 4C, 5B West, 6, 7 AND Building 410, (TtEC Tetra Tech EC, Unc. 2014).

U.S. Department of the Navy
Base Realignment and Closure
Program Management Office West

MMEC Group
9177 Sky Park Court
San Diego, California 92123

DWN BY: RMH
CHK'D BY: RB
DATUM: NAD27
PROJECTION: CA SP Zone III
SCALE: 1" = 30'

Alameda Point, Alameda, California

BIOREMEDIATION TREATMENT LAYOUT CAA 4C

BIOREMEDIATION TREATABILITY STUDY AT PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7

DATE: NOVEMBER 2014
CONTRACT NO.:
REV. NO.:
FIGURE NO. 4

P:\Projects-South\CADGIS\AUTOCAD\5023-14\6069_ALAMEDA\DELIVERABLE_SOURCE_FILES\Figure 4-A-4 - revised_APRIL2015.dwg Jun 16,2015 9:11am

M07A-05			
Analyte	4/17/13	10/24/13	3/19/14
MTBE	-	-	18
TPH-Diesel	*19 J*	-	-
TPH-Gasoline	-	*62*	-

IT013-CA07-0014			
Analyte	4/18/13	10/24/13	3/18/14
Benzene	-	1 J	4.2
TPH-Jet A	*56*	*62*	-
TPH-Gasoline	*420*	*280*	*250*
Naphthalene	0.2 J	0.7 J	1.5 J

DVE-5			
Analyte	4/17/13	10/24/13	3/18/14
MTBE	58	46 J	75 J
TPH-Gasoline	*260*	*270*	*180*

DVE-3			
Analyte	4/17/13	10/24/13	3/18/14
MTBE	72	43	-
TPH-Gasoline	-	*150*	-

DVE-8			
Analyte	4/16/13	10/24/13	3/18/14
MTBE	1,800	4,500	1,500
TTPH	-	2,200	-
TPH-Gasoline	*78*	*2,200*	*73*
Naphthalene	0.5	0.4	1.2
1-Methylnaphthalene	-	-	2.7

DVE-9			
Analyte	4/16/13	10/24/13	3/19/14
MTBE	3,700	2,700	1,500
TPH-Gasoline	-	*1,300*	-

LEGEND

- M07A-08 Monitoring Well
- DVE-03 Dual Vacuum Extraction (DVE) Well
- 6H-11A Piezometer
- Former Excavation
- Former Fuel Line
- Proposed Direct Push Technology (DPT) Injection Points
- Approximate groundwater flow direction (FWBZ)
- µg/L micrograms/liter
- \- Concentration below PRC or non-detect
- PRC Preliminary Remediation Criteria
- Plume Boundary

NOTES:

All results presented in micrograms/liter (µg/L) .

Analytes shown on the Figure exceeded the PRC presented in the 2012 updated Petroleum Management Plan unless "-" shown.

CAA 7 is a Drinking Water and Residential Use Area.

Proposed direct push technology (DPT) injection points are approximate with an estimated 5' radius of influence.

Compounds in italics do not have a PRC.

Only wells associated with data tables will be included in the treatability study.

J indicates an estimated value in the data tables.

0 25 50 feet
APPROXIMATE SCALE: 1"= 50'

NOTE:
Site features taken from Figure 12, Dissolved TTPH/MtBE/Benzene Concentrations in Groundwater, 2004-2006 in Final Petroleum Corrective Action Summary Report, Former Naval Exchange Service Station, Corrective Action Area 7, Alameda Point, Alameda, California (Shaw Environmental 2008a).

Individual constituent levels provided on the figure were provided from, Draft Spring 2014 Petroleum Program Groundwater Monitoring Technical Memorandum, Corrective Action Areas C, 4C, 5B West, 6, 7 AND Building 410, (TtEC Tetra Tech EC, Unc. 2014).

U.S. Department of the Navy
Base Realignment and Closure
Program Management Office West

MMEC Group
9177 Sky Park Court
San Diego, California 92123

DWN BY: RMH
CHK'D BY: RB
DATUM: NAD27
PROJECTION: CA SP Zone III
SCALE: 1" = 50'

Alameda Point, Alameda, California

BIOREMEDIATION TREATMENT LAYOUT CAA 7

BIOREMEDIATION TREATABILITY STUDY AT PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7

DATE: NOVEMBER 2014
CONTRACT NO:
REV. NO.:
FIGURE NO. 5

Figure 6. CAA 4C and CAA 7 Project Schedule

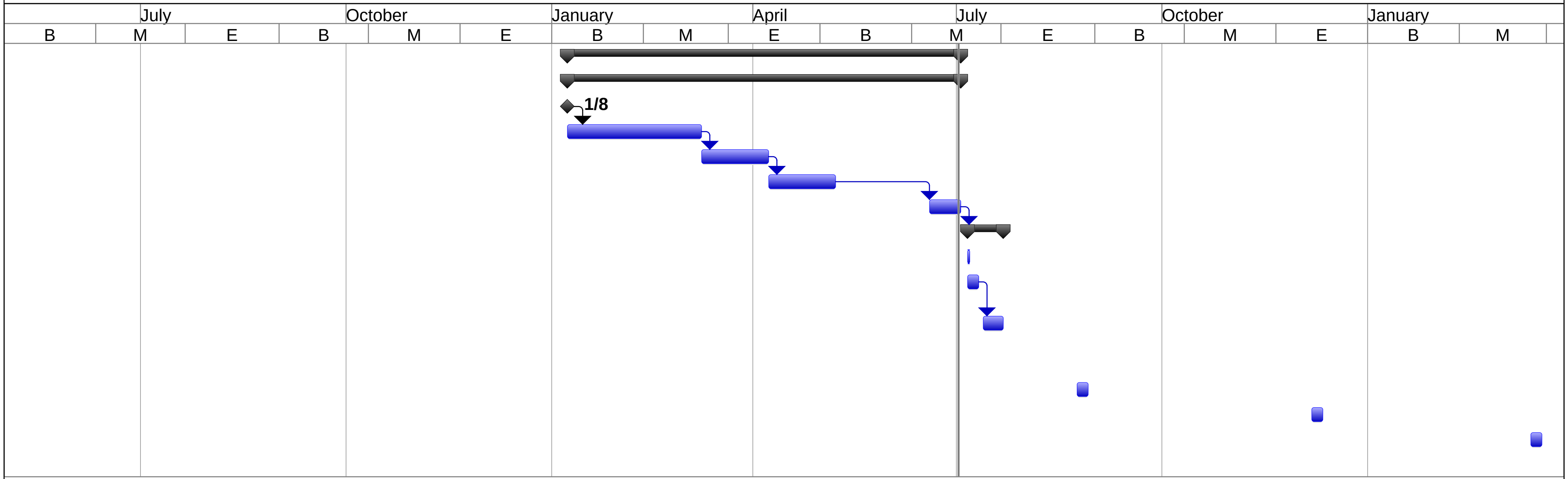
ID	Task Name	Duration	Start	Finish
1	**Work Plan Preparation**	**126 days**	**Thu 1/8/15**	**Thu 7/2/15**
2	**CAA 4C and 7 Work Plan**	**126 days**	**Thu 1/8/15**	**Thu 7/2/15**
3	Draft	0 days	Thu 1/8/15	Thu 1/8/15
4	Agency Review	60 edays	Thu 1/8/15	Mon 3/9/15
5	Draft Final	30 edays	Mon 3/9/15	Wed 4/8/15
6	Agency Review	30 edays	Wed 4/8/15	Fri 5/8/15
7	Final	14 edays	Thu 6/18/15	Thu 7/2/15
8	**CAA 4C & 7 ISB Field Work**	**12 days**	**Mon 7/6/15**	**Tue 7/21/15**
9	Field Readiness Meeting w/ROICC	1 day	Mon 7/6/15	Mon 7/6/15
10	Groundwater sampling, Geophysical Survey, Field Preparation	5 days	Mon 7/6/15	Fri 7/10/15
11	ISB DPT Injections both sites sequentially	7 days	Mon 7/13/15	Tue 7/21/15
12	**Quarterly performance monitoring**	**9 mons**	**Mon 8/10/15**	**Fri 4/15/16**
13	Q1	1 wk	Mon 8/24/15	Fri 8/28/15
14	Q2	1 wk	Mon 12/7/15	Fri 12/11/15
15	Q3	1 wk	Mon 3/14/16	Fri 3/18/16
16				

July October January April

M E B M E B M E

Date: Thu 7/2/15 | Task | Split | Milestone | Summary

Figure 6. CAA 4C and CAA 7 Project Schedule



Date: Thu 7/2/15	Task	Split	Milestone	Summary

TABLES

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Table 1
CAA 4C – Petroleum Hydrocarbon Performance Treatment Goals and Exceedances in µg/L, October 2011 through March 2014

CAA 4C			Metals by 6020		TPH by 8015B					VOCs by 8260						PAHs by 8270C SIM			
			Dissolved Arsenic	Dissolved Lead	TTPH[2]	*TPH-Jet A*	*TPH-Motor Oil*	*TPH-Diesel*	*TPH-gasoline*	Benzene	Ethylbenzene	m,p-Xylenes	Naphthalene	o-Xylene	Toluene	1-Methylnaphthalene	2-Methylnaphthalene	Benzo(b)fluoranthene	Naphthalene
PRC	Nonresidential Vapor Intrusion		—	—	—	—	—	—	—	36	94	58900	89	58900	427000	—	—	—	89
PRC	Marine Ecological Receptors		—	143	20000	—	—	—	—	1936	25	100	1.4	100	215	1.4	300	300	1.4
Well Identification	Sample ID	Sample Date																	
BW-06	04-2011-0102	10/27/2011						*26 J*											
BW-06	04-2012-0001	4/25/2012																	
BW-06	14-SA1-015	4/19/2013																	
BW-06	14-SA2-014	10/23/2013			1,400				*1400*										
BW-06	14-SA3-014	3/17/2014																	
DVE-03	04-2011-0103	10/27/2011						*68*					10						
DVE-03	04-2012-0002	4/25/2012				*71*		*150*	*510*				23 J						
DVE-03	14-SA1-005	4/19/2013				*75*		*23 J*	*84*				2.4						
DVE-03	14-SA2-004	10/23/2013				*180*		*38 J*	*880*		75	180	53						
DVE-03	14-SA3-004	3/18/2014							*230*				6						
DVE-05	04-2011-0104	10/27/2011			1970			*670*	*1300*	180			65			22			59
DVE-05	04-2012-0003	4/26/2012						*260*	*410*	82			33			5.8			5.5
DVE-05	14-SA1-006	4/19/2013																	
DVE-05	14-SA2-005	10/25/2013		14		*240*		*110*	*550*	120						3.9			8
DVE-05	14-SA3-005	3/18/2014		18															
DVE-07	04-2011-0100	10/18/2011			6800			*2600*	*4200*	150	83	180	140			40			130
DVE-07	04-2012-0004	4/26/2012							*160*				7.1						
DVE-07	14-SA1-007	4/19/2013																	
DVE-07	14-SA2-006	10/23/2013			12320	*4700*	*120 J*	*1400*	*6100*	210	75	120		130		110			190
DVE-07	14-SA3-006	3/18/2014		12															

Table 1 (continued)
CAA 4C – Petroleum Hydrocarbon Performance Treatment Goal and Exceedances in µg/L, October 2011 through March 2014

CAA 4C			Metals by 6020		TPH by 8015B					VOCs by 8260						PAHs by 8270C SIM			
			Dissolved Arsenic	Dissolved Lead	TTPH²	*TPH-Jet A*	*TPH-Motor Oil*	*TPH-Diesel*	*TPH-gasoline*	Benzene	Ethylbenzene	m,p-Xylenes	Naphthalene	o-Xylene	Toluene	1-Methylnaphthalene	2-Methylnaphthalene	Benzo(b)fluoranthene	Naphthalene
PRC	Nonresidential Vapor Intrusion		—	—	—	—	—	—	—	36	94	58900	89	58900	427000	—	—	—	89
PRC	Marine Ecological Receptors		—	143	20000	—	—	—	—	1936	25	100	1.4	100	215	1.4	300	300	1.4
Well Identification	Sample ID	Sample Date																	
DVE-16	04-2011-0005	10/18/2011						*150*	*180*				25			8			14
DVE-16	04-2012-0006	4/25/2012																	
DVE-16	14-SA1-008	4/17/2013							*110*										
DVE-16	14-SA2-007	10/23/2013			1600	*800*		*120*	*690*							40			76
DVE-16	14-SA2-007	3/19/2014							*21 J*										
DVE-20	04-2011-0105	10/27/2011						*8.6 J*					2.9						
DVE-20	04-2012-0007	4/26/2012																	
DVE-20	14-SA1-009	4/18/2013																	
DVE-20	14-SA2-008	10/24/2013																	
DVE-20	14-SA3-008	3/19/2014																	
DVE-22	04-2011-0007	10/18/2011						*18 J*											
DVE-22	04-2012-0008	4/25/2012																	
DVE-22	14-SA1-010	4/17/2013						*11 J*											
DVE-22	14-SA2-009	10/23/2013				*120*		*31 J*	*280*							1.4			
DVE-22	14-SA3-009	3/19/2014																	
DVE-30	04-2011-0106	10/27/2011			3700			*1600*	*2100*	75			130			20			76
DVE-30	04-2012-0011	4/26/2012						*160*	*140*				15						8.1
DVE-30	14-SA1-014	4/18/2013			2360	*820*		*140*	*1400*							42			42
DVE-30	14-SA2-013	10/24/2013			2400	*360*		*140 J*	*1900*	48	63	190		220		4.3			8
DVE-30	14-SA3-012	3/19/2014							*14 J*										

Table 1 (continued)
CAA 4C – Petroleum Hydrocarbon Performance Treatment Goal and Exceedances in µg/L, October 2011 through March 2014

CAA 4C			Metals by 6020		TPH by 8015B					VOCs by 8260						PAHs by 8270C SIM			
			Dissolved Arsenic	Dissolved Lead	TTPH[2]	*TPH-Jet A*	*TPH-Motor Oil*	*TPH-Diesel*	*TPH-gasoline*	Benzene	Ethylbenzene	m,p-Xylenes	Naphthalene	o-Xylene	Toluene	1-Methylnaphthalene	2-Methylnaphthalene	Benzo(b)fluoranthene	Naphthalene
PRC	Nonresidential Vapor Intrusion		—	—	—	—	—	—	—	36	94	58900	89	58900	427000	—	—	—	89
PRC	Marine Ecological Receptors		—	143	20000	—	—	—	—	1936	25	100	1.4	100	215	1.4	300	300	1.4
Well Identification	Sample ID	Sample Date																	
MW547-4	04-2011-0011	10/19/2011																	
MW547-4	04-2012-0012	4/26/2012						*43 J*											0.4
MW547-4	14-SA1-016	4/17/2013																	
MW547-4	14-SA2-015	10/23/2013							*17 J*										
MW547-4	14-SA3-015	3/19/2014																	
OB-04	04-2011-0109	10/27/2011			9960		*160 J*	*3000 J*	*6800 J*	1300	51		760			110			700
OB-04	04-2012-0014	4/26/2012			7700			*3000*	*4700*	910	160		720 J			120		0.04 J	470
OB-04	14-SA1-019	4/18/2013			14300	*6200*		*900*	*7200*	980	290					180			770
OB-04	14-SA2-017	10/24/2013			31600	*4500*		*1100*	*26000*	1000	1200	3400		1600	1100	67			660
OB-04	14-SA3-017	3/19/2014			1440	*140*			*1300*	58	88	190		130					
OB-06	04-2011-0110	10/27/2011			4010		*110 J*	*1500*	*2400*	130			370			46			250
OB-06	04-2012-0015	4/25/2012						*89*	*140*				4 J			3.1			5.1
OB-06	14-SA1-020	4/17/2013						*15 J*	*210*										
OB-06	14-SA2-019	10/23/2013				*250*		*49 J*	*380*	21						7			17
OB-06	14-SA3-018	3/19/2014							*14 J*										

Table 1 (continued)
CAA 4C – Petroleum Hydrocarbon Performance Treatment Goal and Exceedances in µg/L, October 2011 through March 2014

Notes:

[1]PRC are from the 2012 Update Petroleum Management Plan for Alameda Point (Battelle, 2012).

[2] CAA 4C is planned for commercial reuse. When defining remedial goal and target treatment area for this study, the Navy selected the appropriate Preliminary Remediation Criteria (PRC) for the planned reuse in Alameda Point in accordance with Table 5-2 and 5-3 in updated Petroleum Management Plan (PMP) (Battelle, 2012). CAA 4C applies commercial-mixed PRCs for a non-drinking water site. The site is greater than 250 feet from the shoreline when evaluation protection of marine ecological receptors from groundwater discharging to surface water. Therefore PRC concentration for TTPH at CAA is selected conservatively for a site at 250 feet to the shoreline from PMP Table 5-3 (Battelle, 2012).

Concentrations reported in µg/L.

PRC = Preliminary Remediation Criteria, shown in µg/L.

µg/L = micrograms per liter.

— = indicates that there is no value available.

Blank cell = indicates concentration below PRC or non-detect.

J = indicates the analyte was positively identified, the value is the estimated concentration of the analyte in the sample.

Values in gray italics are compounds without established PRC

Table 2
CAA 7 – Petroleum Hydrocarbon Performance Treatment Goals and Exceedances in µg/L, October 2011 through March 2014

CAA 7			Metals by 6020		TPH by 8015B					VOCs by 8260			PAHs by 8270C SIM	
			Dissolved Arsenic	Dissolved Lead	TTPH[2]	*TPH-Jet A*	*TPH-Motor Oil*	*TPH-Diesel*	*TPH-gasoline*	Benzene	Methyl tert-Butyl Ether (MTBE)	Naphthalene	1-Methylnaphthalene	Naphthalene
PRC	Residential Vapor Intrusion		—	—	—	210	—	—	—	21	3520	53	—	53
	Residential Ingestion		—	15	—	—	—	—	—	1	13	0.14	2.3	0.14
	Marine Ecological Receptors		—	143	20000	—	—	—	—	1936	88021	1.4	1.4	1.4
Well Identification	Sample ID	Sample Date												
DVE-3	04-2011-0120	10/19/2011									54 J			
DVE-3	04-2012-0018	4/27/2012						*16 J*			67			
DVE-3	14-SA1-053	4/17/2013									72			
DVE-3	14-SA2-052	10/24/2013							*150*		43			
DVE-3	14-SA3-052	3/18/2014												
DVE-5	04-2011-0114	10/26/2011						*14 J*	*250*		82 J			
DVE-5	04-2012-0019	4/27/2012						*20 J*	*350*		77 J			
DVE-5	14-SA1-052	4/17/2013							*260*		58			
DVE-5	14-SA2-051	10/24/2013							*270*		46 J			
DVE-5	14-SA3-051	3/18/2014							*180*		75 J			
DVE-8	04-2011-0115	10/26/2011						*46 J*	*93*		3700 J			1.2
DVE-8	04-2012-0021	4/27/2012						*24 J*			1600			0.2
DVE-8	14-SA1-054	4/16/2013							*78*		1800			0.5
DVE-8	14-SA2-053	10/24/2013			2200				*2200*		4500			0.4
DVE-8	14-SA3-053	3/18/2014							*73*		1500		2.7	1.2
DVE-9	04-2011-0117	10/26/2011						*29 J*	*110*		4300 J			0.3
DVE-9	04-2012-0023	4/27/2012						*23 J*		6.1	7500			0.2
DVE-9	14-SA1-056	4/16/2013									3700			
DVE-9	14-SA2-054	10/24/2013							*1300*		2700			
DVE-9	14-SA3-054	3/19/2014									1500			

Table 2 (continued)
CAA 7 – Petroleum Hydrocarbon Performance Treatment Goal and Exceedances in µg/L, October 2011 through March 2014

CAA 7			Metals by 6020		TPH by 8015B					VOCs by 8260			PAHs by 8270C SIM	
			Dissolved Arsenic	Dissolved Lead	TTPH[2]	*TPH-Jet A*	*TPH-Motor Oil*	*TPH-Diesel*	*TPH-gasoline*	Benzene	Methyl tert-Butyl Ether (MTBE)	Naphthalene	1-Methylnaphthalene	Naphthalene
PRC	Residential Vapor Intrusion		—	—	—	210	—	—	—	21	3520	53	—	53
PRC	Residential Ingestion		—	15	—	—	—	—	—	1	13	0.14	2.3	0.14
PRC	Marine Ecological Receptors		—	143	20000	—	—	—	—	1936	88021	1.4	1.4	1.4
Well Identification	Sample ID	Sample Date												
IT013-CA07-0014	04-2011-0119	10/28/2011					*120 J*	*110*	*160*					
IT013-CA07-0014	04-2012-0027	4/27/2012						*85*	*230*	6.7				
IT013-CA07-0014	14-SA1-058	4/18/2013				*56*			*420*			0.2 J		
IT013-CA07-0014	14-SA2-058	10/24/2013				*62*			*280*	1 J		0.7 J		
IT013-CA07-0014	14-SA3-058	3/18/2014							*250*	4.2		1.5 J		
M07A-05	04-2011-0024	10/20/2011						*27 J*						
M07A-05	04-2012-0028	4/27/2012						*26 J*			18			
M07A-05	14-SA1-059	4/17/2013						*19 J*						
M07A-05	14-SA2-060	10/24/2013							*62*					
M07A-05	14-SA3-059	3/19/2014									18			

Notes:

[1]PRC are from the 2012 Update Petroleum Management Plan for Alameda Point (Battelle, 2012).

[2]CAA 7 is planned for residential reuse. When defining remedial goal and target treatment area for this study, the Navy selects the appropriate Preliminary Remediation Criteria (PRC) for the planned reuse in Alameda Point in accordance with Table 5-2 and 5-3 in updated Petroleum Management Plan (PMP) (Battelle, 2012). CAA 7 applies residential PRC for a drinking water site,. The site is greater than 250 feet from the shoreline when evaluating protection of marine ecological receptors from groundwater discharging to surface water. Therefore PRC concentration for TTPH at CAA 7 is selected conservatively for a site at 250 feet to the shoreline from PMP Table 5-3 (Battelle, 2012).

Table 2 (continued)
CAA 7 – Petroleum Hydrocarbon Performance Treatment Goal and Exceedances in µg/L, October 2011 through March 2014

Concentrations reported in µg/L.

PRC = Preliminary Remediation Criteria, shown in µg/L.

µg/L = micrograms per liter.

— = indicates that there is no value available.

Blank cell = indicates concentration below PRC or non-detect.

J = indicates the analyte was positively identified, the value is the estimated concentration of the analyte in the sample.

Values in gray italics are compounds without established PRC

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Table 3
Analytical Methods by Well at CAA 4C and CAA 7

Well ID	Arsenic by 6020	Lead by 6020	TPH by 8015B	BTEX by 8260B	MTBE by 8260B	PAHs by 6270C SIM	EISB-a Param.
CAA 4C							
BW-06			X	X			X
DVE-03			X	X			X
DVE-05		X	X	X		X	X
DVE-07		X	X	X		X	X
DVE-16		X	X	X		X	X
DVE-20		X	X	X	X	X	
DVE-22		X	X	X		X	X
DVE-25		X	X	X	X	X	
DVE-27		X	X	X	X	X	
DVE-30		X	X	X		X	X
MW547-4		X	X	X	X	X	
OB-02		X	X	X	X	X	
OB-04		X	X	X		X	X
OB-06		X	X	X		X	X
OB-07		X	X	X	X	X	
OB-09			X	X	X		
CAA 7							
DVE-28	X	X	X	X	X	X	
DVE-29	X	X	X	X	X	X	
DVE-3			X	X	X		X
DVE-5			X	X	X		X
DVE-8		X	X	X	X	X	X
DVE-9		X	X	X	X	X	X
IT013-CA07-0014			X	X	X		X
M07A-05			X	X	X		X

Note: Wells shaded in grey will be used to evaluate the effectiveness of the treatability study. All wells in this table will be sampled to support the Navy's ongoing basewide petroleum monitoring program.

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Table 4
CAA 4C Performance Treatment Goals

Category	Chemical	Nonresidential Vapor Intrusion from GW (µg/L)	Groundwater PRC for Protection of Marine Ecological in Groundwater Discharging to Surface Water Receptors (µg/L)	PRC for Protection of Marine Ecological Receptors in Groundwater Discharging to Surface Water at 250ft to Shoreline (µg/L)	Selected Performance Treatment Goals (µg/L)
Metals by 6020	Dissolved Arsenic	-	-		**-**
	Dissolved Lead	-	8.1	143	**143**
TPH by 8015B	TTPH	-	1400	20,000	**20,000**
	TPH-Jet A	-	-	-	**-**
	TPH-Motor Oil	-	-	-	**-**
	TPH-Diesel	-	-	-	**-**
	TPH-gasoline	-	-	-	**-**
VOCs by 8260	Benzene	36	110	1,936	**36**
	Ethylbenzene	94	25	-	**25**
	m,p-Xylenes	58,900	100	-	**100**
	Naphthalene	89	1.4	-	**1.4**
	o-Xylene	58,900	100	-	**100**
	Toluene	427,000	215	-	**215**
PAHs by 8270C SIM	1-Methylnaphthalene	-	1.4	-	**1.4**
	2-Methylnaphthalene	-	300	-	**300**
	Benzo(b)fluoranthene	-	300	-	**300**
	Naphthalene	89	1.4	-	**1.4**

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Table 5
CAA 7 Performance Treatment Goals

Category	Chemical	Residential Vapor Intrusion from GW (µg/L)	Residential Ingestion of Water (µg/L)	Groundwater PRC for Protection of Marine Ecological Receptors in Groundwater Discharging to Surface Water (µg/L)	PRC for Protection of Marine Ecological Receptors in Groundwater Discharging to Surface Water at 250ft to Shoreline (µg/L)	Selected Performance Treatment Goals (µg/L)
Metals by 6020	Dissolved Arsenic	-	-	-		**-**
	Dissolved Lead	-	15	8.1	143	**15**
TPH by 8015B	TTPH	-	-	1400	20,000	**20,000**
	TPH-Jet A	-	-	-	-	**-**
	TPH-Motor Oil	-	-	-	-	**-**
	TPH-Diesel	-	-	-	-	**-**
	TPH-gasoline	-	-	-	-	**-**
VOCs by 8260	Benzene	21	1	110	1,936	**1**
	MTBE	3,520	13	5,000	88,021	**13**
	Naphthalene	53	0.14	1.4	-	**0.14**
PAHs by 8270C SIM	1-Methylnaphthalene	-	2.3	1.4	-	**1.4**
	Naphthalene	53	0.14	1.4	-	**0.14**

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Appendix A
SAMPLING AND ANALYSIS PLAN

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Final

SAMPLING AND ANALYSIS PLAN

(Field Sampling Plan and Quality Assurance Project Plan)

BIOREMEDIATION TREATABILITY STUDY AT PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7

ALAMEDA POINT, ALAMEDA, CALIFORNIA

July 2015

Prepared for:

Department of the Navy

Naval Facilities Engineering Command Southwest
1220 Pacific Highway
San Diego, California 92132-5190

Prepared by:

Multimedia Environmental Compliance Group
9177 Sky Park Court
San Diego, California 92123

Prepared Under:

Contract Number: N62473-12-D-2012
Task Order Number: 0069
Document Control Number (DCN): MMEC-2012-0069-0004

SAP WORKSHEET #1 TITLE AND APPROVAL PAGE

FINAL

SAMPLING AND ANALYSIS PLAN
(Field Sampling Plan and Quality Assurance Project Plan)

June 2015

Bioremediation Treatability Study at
Petroleum Corrective Action Areas 4C And 7

Alameda Point, Alameda, California

Prepared for:

DEPARTMENT OF THE NAVY
Naval Facilities Engineering Command Southwest
1220 Pacific Highway
San Diego, California 92132-5190

Prepared by:

MMEC Group
9177 Sky Park Court
San Diego, California 92123

Prepared Under:

Contract Number: N62473-12-D-2012
Task Order Number: 0069
Document Control Number (DCN): MMEC-2012-0069-0004

Review Signature: Matt Brookshire — 6/30/2015
Matt Brookshire — Date
MMEC Group Quality Control Manager

Approval Signature: Kenneth Be for — 7/1/15
Joseph Michalowski — Date
NAVFAC SW Quality Assurance Officer

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EXECUTIVE SUMMARY

The Multimedia Environmental Compliance Group (MMEC Group), a joint venture between AMEC Environment & Infrastructure, Inc. (AMEC) and KMEA, is supporting the Naval Facilities Engineering Command Southwest (NAVFAC SW) by conducting a Treatability Study (TS) at Corrective Action Area (CAA) 4C and CAA 7 at former Naval Air Station Alameda (Alameda Point), Alameda, California. This work is being performed under NAVFAC SW Contract Number N62473-12-D-2012, Task Order Number 0069.

The primary objective of this TS is to evaluate the efficacy of enhanced aerobic in-situ bioremediation (EISB-a) to treat fuel-related petroleum hydrocarbon compounds in groundwater at CAA 4C and CAA 7. The effectiveness of the EISB-a treatment will be measured on the basis of meeting preliminary remediation criteria (PRC), or meeting the requirements of the State of California Water Resources Control Board (SWRCB) *Low-Threat Underground Storage Tank Case Closure Policy*.

Based on an evaluation of the current nature and extent of petroleum-impacted groundwater, an EISB-a TS will be conducted using direct push technology (DPT) to deliver a sustained oxygen-releasing compound to the target treatment zones (TTZs) at CAA 4C and CAA 7. EISB-a treatment at CAA 4C will be augmented with a limited application of in-situ chemical oxidation (ISCO) in two focused areas to address residual total petroleum hydrocarbons (TPH) concentrations that have persisted above 10,000 micrograms per liter (µg/L).

Groundwater treatment performance criteria are the PRCs as described in Alameda Point's Petroleum Strategy (Battelle, 2009) and the 2012 update to the Petroleum Management Plan (PMP) (Battelle, 2012). The Petroleum Closure Decision Tree (Figure A-3) outlines the strategy for open petroleum sites that have fuel-related petroleum hydrocarbon compounds in groundwater and soil. CAA 4C is located in Southeast Alameda Point where shallow groundwater meets the exception criteria in Resolution 88-63, Sources of Drinking Water. CAA 4C is planned for commercial-mixed reuse. CAA 7 is not part of the Navy's Exception to Drinking Water Policy and is planned for residential reuse (ARRA, 2006). For the purpose of this Treatability Study, PRC values presented in the Final 2012 Update to Petroleum Management Plan (Battelle, 2012) will be used as performance treatment goals.

CAA 4C petroleum hydrocarbon compounds remaining in groundwater at concentrations greater than the site-specific PRC include the following:

- TPH
- Benzene, toluene, ethylbenzene, xylenes (BTEX)
- Naphthalene
- 1-Methylnaphthalene
- 2-Methylnaphthalene

CAA 7 petroleum hydrocarbon compounds remaining in groundwater at concentrations greater than the site-specific PRC include the following:

- TPH

EXECUTIVE SUMMARY (CONTINUED)

- Methyl tert-butyl ether (MTBE)
- Naphthalene

EISB-a, with focused ISCO at CAA 4C only, was selected for CAA 4C and CAA 7 on the basis of the site-specific geochemical conditions in groundwater and the types of petroleum compounds present. Sustained oxygen-releasing compounds will be delivered to the TTZs to provide extended aerobic biodegradation of petroleum hydrocarbon compounds. At CAA 4C only, a focused ISCO application will be used to target two small areas of elevated hydrocarbon concentrations. In addition to treating the saturated zone at CAA 4C, both ISCO and EISB-a will target the capillary fringe and "smear zone" resulting from seasonal fluctuation of the water table by extending the vertical TTZ to 2 feet above the average groundwater elevation, approximately 4 feet below ground surface (bgs).

Prior to delivery of the EISB-a reagents, select wells at each site will be sampled to establish baseline groundwater conditions. Groundwater samples will be analyzed at a fixed laboratory using the following methods:

- TPH fractions using United States Environmental Protection Agency (U.S. EPA) Modified Method 8015B with silica gel cleanup
- BTEX (and MTBE at CAA 7 only) using U.S. EPA Method 8260B
- Polycyclic aromatic hydrocarbons (PAHs) using U.S. EPA Method 8270C Selected Ion Monitoring (SIM)
- Total dissolved solids using U.S. EPA Method 160.1/SM2540C
- Arsenic and lead at select wells using U.S. EPA Method 6010B
- Inorganic anions using U.S. EPA Method 300.1

After groundwater treatment has been performed, three rounds of quarterly groundwater sampling will be performed to assess EISB-a (and ISCO at CAA 4C) treatment performance. Groundwater samples will be analyzed using the same methods listed above.

SAP WORKSHEETS

Page

SAP WORKSHEETS (CONTINUED)

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF ATTACHMENTS

ABBREVIATIONS AND ACRONYMS

%R	percent recovery
°C	degrees Celsius
μg/L	micrograms per liter
A	analysis
AMEC	AMEC Environment & Infrastructure, Inc.
amsl	above mean sea level
APP	Accident Prevention Plan
AS	air sparge
BEC	BRAC Environmental Coordinator
bgs	below ground surface
BRAC	Base Realignment and Closure
BSU	Bay Sediment Unit
BTEX	benzene, toluene, ethylbenzene, xylene
CA	corrective action
CAA	corrective action area
CAS	Chemical Abstracts Service
CCB	continuing calibration blank
CCC	criteria continuing concentration
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHMM	Certified Hazardous Materials Manager
COC	chain of custody
COD	coefficient of determination
CPR	cardiopulmonary pulmonary resuscitation
CSM	conceptual site model
CSO	Caretaker Site Office
DCC	daily calibration check
DCN	document control number
DL	detection limit
DO	dissolved oxygen
DoD	U.S. Department of Defense
DON	U.S. Department of the Navy
DOT	Department of Transportation
DPT	direct push technology
DQO	data quality objective
DTSC	Department of Toxic Substances Control

ABBREVIATIONS AND ACRONYMS (CONTINUED)

DTW	depth to water
DVE	dual vacuum extraction
EB	equipment blank
EISB-a	enhanced aerobic in-situ bioremediation
ELAP	Environmental Laboratory Accreditation Program
EWI	Environmental Work Instruction
ft	foot or feet
FWBZ	First Water Bearing Zone
GC	gas chromatograph
GC/MS	gas chromatograph/mass spectrometer
GIS	geographic information system
H&S	health and safety
HAZWOPER	hazardous waste operations and emergency response
HDPE	high density polyethylene
IC	ion chromatography
ICAL	initial calibration
ICB	initial calibration blank
ICS	interference check solution
ICV	initial calibration verification
ID	identification
IDW	investigation-derived waste
IS	internal standard
ISCO	In-situ chemical oxidation
L/min	liters per minute
LCS	laboratory control sample
LDC	Laboratory Data Consultants, Inc.
LIF	laser-induced fluorescence
LOD	limit of detection
LOQ	limit of quantitation
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
μg/L	micrograms per liter
mg/L	milligrams per liter
mL	milliliter
mL/min	milliliters per minute
MM/DD/YYYY	month/day/year

ABBREVIATIONS AND ACRONYMS (CONTINUED)

MMEC Group	Multimedia Environmental Compliance Group
MS	mass spectrometer
MS	matrix spike
MSD	matrix spike duplicate
MTBE	methyl tert-butyl ether
mV	millivolts
NA	not available/not applicable
NAVFAC SW	Naval Facilities Engineering Command Southwest
NEDD	Navy Electronic Data Deliverable
NFESC	Naval Facilities Engineering Service Center
NIRIS	Naval Installation Restoration Information Solution
NTU	Nephelometric turbidity unit
ORP	oxidation reduction potential
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbon
PAL	Project Action Level
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity
P.E.	Professional Engineer
P.G.	Professional Geologist
PID	photoionization detector
PM	Project Manager
PMO	Program Management Office
PMP	Petroleum Management Plan
POC	point of contact
PPE	personal protective equipment
PQL	practical quantification limit
PRC	preliminary remediation criteria
psi	pounds per square inch
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QCM	Quality Control Manager
QL	Quantitation Limit
QSM	quality systems manual
RF	response factor

ABBREVIATIONS AND ACRONYMS (CONTINUED)

RG	remediation goal
RL	reporting limit
ROICC	Resident Officer in Charge of Construction
RPD	relative percent difference
RPM	Remedial Project Manager
rps	revolutions per second
RSD	relative standard deviation
RWQCB	Regional Water Quality Control Board
S	sampling
S&A	sampling and analysis
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
SPCC	system performance-check compound
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SVE	soil vapor extraction
SWBZ	Second Water Bearing Zone
SWRCB	State Water Resources Control Board
TB	trip blank
TDS	total dissolved solids
TOC	total organic carbon
TPH	total petroleum hydrocarbon
TPH-E	extractable total petroleum hydrocarbons (diesel, motor oil, jet fuel)
TPH-P	purgeable total petroleum hydrocarbons (gasoline)
U.S. EPA	United States Environmental Protection Agency
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
UST	underground storage tank
VOA	volatile organic analyte
VOC	volatile organic compound
Water Board	Regional Water Quality Control Board – San Francisco Region
WDR	waste discharge requirement
WS	Worksheet

SAP WORKSHEET #2 SAP IDENTIFYING INFORMATION

Site Name/Number:	CAA 4C and CAA 7 Alameda Point, Alameda, California
Operable Unit:	Not Applicable
Contractor Name:	Multimedia Environmental Compliance Group (MMEC Group)
Contract Number:	N62473-12-D-2012
Contract Title:	Multimedia Environmental Compliance Engineering Support Services Contract
Work Assignment Number (optional):	Not Applicable
DCN:	MMEC-2012-0069-0004

1. This SAP was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (U.S. Environmental Protection Agency [U.S. EPA], 2005) and *EPA Guidance for Quality Assurance Project Plans,* EPA QA/G-5, QAMS (U.S. EPA, 2002)*.*

This SAP is also prepared on the basis of the requirements provided in the following documents:

- Department of Defense (DoD). *Quality Systems Manual for Environmental Laboratories*, Version 5.0, July 2013.
- Department of the Navy (DON). *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*, October 2009.
- NAVFAC Southwest (NAVFAC SW). Environmental Work Instruction (EWI) #1, Chemical Data Validation, November 2001; Environmental Work Instruction #6, Environmental Data Management and Required Electronic Delivery Standards, April 2005; Department of the Navy Environmental Restoration Program Manual, August 2006; Environmental Work Instruction #3, Selecting an Environmental Laboratory that Meets Environmental Restoration Program Requirements, August 2010; and Environmental Work Instruction #2, Review, Approval, Revision, and Amendment of Sampling Analysis Plans (SAPs), January 2011.
- Naval Facilities Engineering Service Center (NFESC). *Installation Restoration Chemical Data Quality Manual*, 1999.

SAP WORKSHEET #2 CONTINUED

- U.S. EPA. *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Compliance with Other Laws Manual*, Draft Guidance, EPA/540/G-89/006. Office of Emergency and Remedial Response, Washington, DC, August 1988; *Guidance for the Data Quality Objectives (DQO) Process,* EPA QA/G-4, Final, September 1994; *Test Methods for Evaluation of Solid Wastes,* SW-846, Update III, 1997; *Guidance for the DQOs Process.* Office of Environmental Information, EPA/600/R-96/055. EPA QC/G-4. August 2000; *Guidance on Systematic Planning Using the DQO Process,* EPA QA/G-4. Office of Environmental Information EPA/240/B-06/001, February 2006. *National Functional Guidelines for Inorganic Superfund Data Review,* January 2010. *National Functional Guidelines for Organic Superfund Data Review,* October 2013.

2. Identify regulatory program: Petroleum program
3. This SAP is a site-specific SAP.
4. List dates of scoping sessions that were held:

Scoping Session	Date
N/A	N/A

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

Title	Date
N/A	*N/A*

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

   Regional Water Quality Control Board – San Francisco Region (Water Board) is the lead regulatory stakeholder for this project. California Department of Toxic Substances Control (DTSC) provides regulatory support.

   These regulatory agencies are not connected to the Navy or to NAVFAC SW.

7. Lead organization (see Worksheet [WS] #7 for detailed list of data users):

   NAVFAC SW

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:

   - No required information omitted.

SAP WORKSHEET #2 CONTINUED

UFP-QAPP Worksheet #	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	
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 Sample Summary Table	
21	Project Sampling SOP References Table Sampling SOPs	
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	
Analytical Tasks		
23	Analytical SOPs Analytical SOP References Table	
24	Analytical Instrument Calibration Table	
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	

SAP WORKSHEET #2 CONTINUED

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
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 and Seal	
Quality Control Samples		
28	Quality Control (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 (Optional)	E-mail Address or Mailing Address
Dave Darrow	Navy Remedial Project Manager (RPM)	NAVFAC SW Base Realignment and Closure (BRAC) Program Management Office (PMO) West	(619) 532-0903	david.c.darrow.ctr@navy.mil 1455 Frazee Road Suite 900 San Diego, CA 92108
Bill McGinnis, Professional Engineer (P.E.)	Lead RPM	NAVFAC SW BRAC PMO West	(619) 532-0907	william.mcginnis1@navy.mil 1455 Frazee Road Suite 900 San Diego, CA 92108
Derek Robinson, P.E.	Navy BRAC Environmental Coordinator (BEC), Alameda	NAVFAC SW BRAC PMO West	(619) 532-0951	derek.j.robinson1@navy.mil 1455 Frazee Road Suite 900 San Diego, CA 92108
Doug DeLong	BRAC Caretaker Site Officer or Activity Point of Contact (POC)	NAVFAC SW BRAC PMO West	(415) 743-4713	douglas.delong.ctr@navy.mil 1 Ave of the Palms, Suite 161 San Francisco, CA 94130
Joseph Michalowski, Ph.D.	Quality Assurance Officer (QAO)	NAVFAC SW	(619) 532-4125	joseph.michalowski@navy.mil 1220 Pacific Highway Building 128, Mail Room San Diego, CA 92132 Attn: Code EVR JM
Gregory Grace	Resident Officer in Charge of Construction (ROICC)	Alameda Point	(510) 749-5940	gregory.grace@navy.mil Alameda Point 950 West Mall Square Suite-160 MS-2 Alameda, CA 94501
Dianne Silva	Records Manager	NAVFAC SW	(619) 556-1280	diane.silva@navy.mil Command Records Manager ATTN: Code EV33 1220 Pacific Highway (NBSD Bldg. 3519) San Diego, CA 92132
Jim Hogan, P.E.	Program Manager	MMEC Group	(858) 514-6460	jim.hogan@amecfw.com 9177 Sky Park Court San Diego, CA 92123

SAP WORKSHEET #3 CONTINUED

Name of SAP Recipients	Title/Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address
Curtis Moss, Professional Geologist (P.G.)	Project Manager (PM)	MMEC Group	(858) 869-7548	curtis.moss@amecfw.com 9177 Sky Park Court San Diego, CA 92123
Ulf Richter	Site Health and Safety Officer (SSHO), Site Supervisor	MMEC Group	(619) 451-6200	urichter@kmea.net 9177 Sky Park Court San Diego, CA 92123
Lansana Coulibaly, P.E., Ph.D.	Senior Technical Lead	MMEC Group	(858) 514-6433	lansana.coulibaly@amecfw.com 9177 Sky park Court San Diego, CA 92123
Matt Brookshire, Certified Manager of Quality (CMQ)	Quality Control Manager (QCM)	MMEC Group	(858) 514-6454	matthew.brookshire@amecfw.com 9177 Sky park Court San Diego, CA 92123
Molly Nguyen	Laboratory PM	EMAX Labs, Inc.	(310) 618-8889 ext. 119	Mnguyen@emaxlabs.com 1835 W. 205th St. Torrance, CA 90501
Ms. Linda Rauto	Operations Manger	Laboratory Data Consultants, Inc. (LDC)	(760) 634-0437	lrauto@lab-data.com 7750 El Camino Real, Ste. 2L Carlsbad, CA 92009
TBD	DPT Operations Manager	TBD	TBD	TBD

TBD: Project subcontractors are still in the process of being procured and have not been determined yet.

SAP WORKSHEET #4 PROJECT PERSONNEL SIGN-OFF SHEET

Name[1]	Organization/ Title/Role	Telephone Number (Optional)	Signature/E-mail Receipt[2]	SAP Section Reviewed	Date SAP Read
Curtis Moss, P.G.	MMEC Group PM	(858) 869-7548		All Worksheets	
Lansana Coulibaly, P.E., Ph.D.	MMEC, Senior Technical Lead	(858) 514-6433		All Worksheets	
Ulf Richter	SSHO, Site Supervisor	(619) 451-6200		All Worksheets	
TBD	DPT Subcontractor	TBD		Worksheets #1, 3, 12, 15, 19, 20, 22, 23, 24, 25, 26, 27, 28, 30, 34, 35	
Molly Nguyen	EMAX Laboratory	(310) 618-8889		Worksheets #15, 19, 23, 24, 25, 26, 28, 30, 34, 35, 36	
Linda Rauto	LDC Operations Manger	(760) 634-0437		Worksheets #1, 3, 12, 15, 19, 20, 22, 23, 24, 25, 28, 30, 34, 35, 36	

Notes:

1 Matthew Brookshire, MMEC Group QCM, and Joseph Michalowski, NAVFAC SW QAO, have reviewed and approved this SAP; therefore, their names are not listed above in the project personnel sign-off worksheet.

2 A copy of the complete sign-off sheet will be maintained in the project file.

TBD: Project subcontractors are still in the process of being procured and have not yet been determined.

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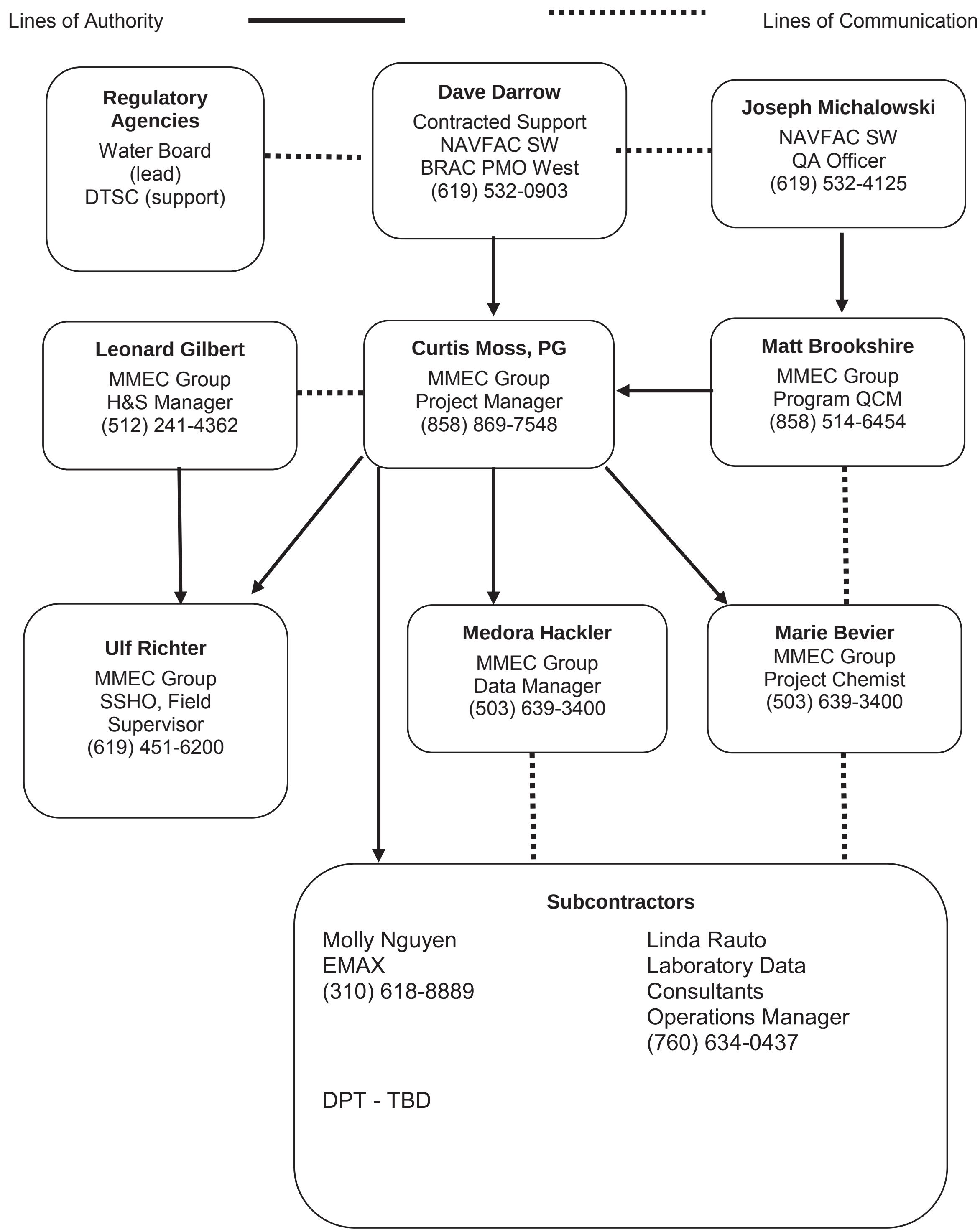
SAP WORKSHEET #5 PROJECT ORGANIZATIONAL CHART



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SAP WORKSHEET #6 COMMUNICATION PATHWAYS

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure (Timing, Pathway to and from, etc.)
SAP Amendment	MMEC Group	QCM: Matt Brookshire	(858) 514-6454 matthew.brookshire@amecfw.com	The MMEC Group QCM will submit all SAP amendments electronically to the NAVFAC SW QAO for review and approval prior to regulatory review and/or field implementation (see NAVFAC SW EWI #2). Major or significant changes will be documented in SAP amendments.
Field Change Request	MMEC Group	PM: Curtis Moss	(858) 869-7548 curtis.moss@amecfw.com	The MMEC Group PM will document any deviation from the SAP, including minor changes, by notifying the MMEC Group QCM by telephone and e-mail within 24 hours (see NAVFAC SW EWI #2). The NAVFAC SW RPM and QAO will be notified of field changes and of changes relating to site characterization that may entail a change in sampling location or analyses. All completed field changes will be documented in the final report.
Field Audit	MMEC Group	QCM: Matt Brookshire	(858) 514-6454 matthew.brookshire@amecfw.com	The MMEC Group QCM may conduct a field audit during project field work. The audit report will be maintained in project and QA files. Any issues requiring corrective action will be documented and assigned an appropriate response period. Problems with data quality will be reported to the MMEC Group PM by telephone and e-mail within 24 hours.

SAP WORKSHEET #6 CONTINUED

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure (Timing, Pathway to and from, etc.)
Stop Work	MMEC Group	PM: Curtis Moss SSHO: Ulf Richter	(858) 869-7548 curtis.moss@amec.com (619) 451-6200 urichter@kmea.net	The MMEC Group PM, QCM, Site Safety and Health Officer or NAVFAC SW RPM, QAO, CSO and ROICC may stop work in response to any serious quality- or safety-related issue, if warranted. The PM will communicate work stoppages to the project organization and NAVFAC SW RPM by telephone and e-mail within 24 hours.
	NAVFAC SW	NAVFAC SW RPM: Dave Darrow Bill McGinnis NAVFAC SW QAO: Joseph Michalowski	(619) 532-0903, (619) 532-0907 david.c.darrow.ctr@navy.mil william.mcginnis1@navy.mil (619) 532-4125 joseph.michalowski@navy.mil	
		CSO NAVFAC SW Doug Delong ROICC NAVFAC SW Robert Perricone	(415) 743-4713 douglas.delong.ctr@navy.mil robert.perricone@navy.mil	

SAP WORKSHEET #6 CONTINUED

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure (Timing, Pathway to and from, etc.)
Reporting of Health and Safety (H&S) Issues	MMEC Group	PM: Curtis Moss	(858) 869-7548 curtis.moss@amecfw.com	All H&S issues involving an injury, a "near miss," or a condition that may result in an incident must be reported to the MMEC Group H&S Manager and the MMEC Group PM immediately. The PM will notify the NAVFAC SW RPM of serious H&S incidents/issues within 24 hours of occurrence. Non-serious incidents/issues may be forwarded to the NAVFAC SW RPM through the PM on a monthly basis via the monthly progress reports.
Notification of Non-Usable Analytical Data	MMEC Group	QCM: Matt Brookshire	(858) 514-6454 matthew.brookshire@amecfw.com	If significant problems are identified by the laboratory or the project team that impact the usability of the data (i.e., the data are rejected or the data quality objectives [DQOs] are not met), the MMEC Group QCM and the PM will notify the NAVFAC SW RPM by telephone and e-mail within 24 hours or the next business day.

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SAP WORKSHEET #7 PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE

Name	Title/Role	Organizational Affiliation	Responsibilities
Dave Darrow	RPM	NAVFAC SW	• Serves as project management representative for NAVFAC SW. • Verifies that work is accomplished as required by project scope of work. • Oversees project cost and schedule. • Provides formal technical instructions to MMEC Group staff. • Serves as the lead interface between agencies involved.
Joseph Michalowski	QAO	NAVFAC SW	• Reviews and approves SAP for compliance with NAVFAC SW and UFP-QAPP requirements. • Provides Navy oversight of MMEC Group's QA Program. • Provides technical and administrative oversight of MMEC Group's surveillance audit activities. • Serves as point of contact for QA and DON's Laboratory QA Program issues. • Coordinates training for improving the generation and maintenance of quality data. • Holds the authority to suspend project activities if QA requirements are not met.
Curtis Moss	PM	MMEC Group	• Coordinates work activities for the MMEC Group and subcontractor personnel and ensures that field activities are being performed in accordance with the Work Plan, SAP, Accident Prevention Plan (APP), and Site Safety and Health Plan (SSHP). • Promotes a safe work environment for all project personnel by applying work guidelines as specified in the SSHP and all applicable Occupational and Safety Health Administration (OSHA) regulations. • Oversees project, financial, schedule, and technical day-to-day management of the project. • Assists appropriate NAVFAC SW technical personnel in decision making when necessary.

SAP WORKSHEET #7 CONTINUED

Name	Title/Role	Organizational Affiliation	Responsibilities
Matt Brookshire	QCM	MMEC Group	• Ensures that project-specific SAP conforms to current NAVFAC SW and UFP-QAPP requirements. • Reviews and approves SAPs and work plans. • Communicates with PM and notifies PM of deviations from the SAP and nonconformance issues. • Coordinates field and laboratory QA and oversees field QA and project QA compliance. • Holds the authority to suspend project activities if QA requirements are not met.
Ulf Richter	SSHO, Site Supervisor	MMEC Group	• Ensures that all field activities are done per the SAP, APP, and SSHP. • Provides direction to field staff and subcontractors.
Marie Bevier	Project Chemist	MMEC Group	• Coordinates with the selected contracted laboratory. • Verifies appropriateness of sampling procedures, analytical methods, and laboratory quality systems. • Coordinates with the laboratory for field supplies, schedule, sample shipping, and deliverables. • Oversees data quality review and QA data validation deliverables.
TBD	DPT Operations Manager	TBS	• Responsible for communication between the DPT subcontractor and MMEC Group. • Performs DPT injections per the project-specific SAP. • Ensures that the analysis is performed in accordance with specifications and meets the requirements of this SAP. • Reviews the onsite laboratory data package before it is delivered to the MMEC Group.
Molly Nguyen	Laboratory Project Manager	EMAX	• Responsible for communication between the laboratory and MMEC Group. • Performs the analytical services per the project-specific SAP. • Ensures that the analysis is performed in accordance with specifications and meets the requirements of this SAP. • Reviews the laboratory data package before it is delivered to the MMEC Group.

SAP WORKSHEET #7 CONTINUED

Name	Title/Role	Organizational Affiliation	Responsibilities
Linda Rauto	Operations Manager	LDC	• Conducts independent, third-party validation of analytical data received from the laboratory per the project-specific SAP. • Assures the data end users of known and documented data quality.

TBD: Project subcontractors are still in the process of being procured and have not yet been determined.

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SAP WORKSHEET #8 SPECIAL PERSONNEL TRAINING REQUIREMENTS TABLE

All field personnel will be required to (1) have completed the OSHA 40-hour Hazardous Waste Emergency Response Operations (HAZWOPER) Standard Protection training as described in Title 29 Code of Federal Regulations (CFR) Section 1910.120, (2) have completed the continued 8-hour HAZWOPER refresher, and (3) submit to annual medical surveillance, as required by OSHA. Field personnel who directly supervise employees engaged in hazardous waste operations will also receive at least 8 hours of specialized supervisor training. The supervisor training covers H&S program requirements, training requirements, personal protective equipment (PPE) requirements, the spill containment program, and health-hazard monitoring procedures and techniques. At least one of the two field personnel will maintain cardiopulmonary pulmonary resuscitation (CPR) and standard first aid training certificates.

Safety requirements are addressed in detail in the SSHP, prepared separately. Copies of certifications and training records for team members and supervisors will be kept in the MMEC Group project file.

The subcontractor laboratory to be selected for this project will have successfully completed the laboratory evaluation process as described in the DoD Quality Systems Manual (QSM). Copies of their current laboratory certifications will be included in Attachment 2.

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SAP WORKSHEET #9 PROJECT SCOPING SESSION PARTICIPANTS

Project Name: Treatability Study at CAA 4C and CAA 7 **Projected Date(s) of Sampling: N/A**	**Site Name: CAA 4C and CAA 7** **Site Location: Alameda Point, Alameda, California**
BRAC, NAVFAC SW RPM: **Dave Darrow**	
Date of Session: Tuesday, August 12, 2015 at 1430 **Scoping Session Purpose: Kickoff Meeting**	

Name	Title/Role	Affiliation	Phone #	E-mail Address
David Darrow	RPM	NAVFAC SW	(619) 532-0903	david.c.darrow.ctr@navy.mil
Robert Perricone	ROICC	NAVFAC SW		robert.perricone@navy.mil
Doug Delong	CSO	NAVFAC SW	(415) 743-4713	douglas.delong.ctr@navy.mil
Marshall Theyel	Intern	NAVFAC SW	NA	NA
Jim Hogan	Program Manager	MMEC Group	(858) 514-6460	jim.hogan@amecfw.com
Curtis Moss	Project Manager	MMEC Group	(858) 869-7548	curtis.moss@amecfw.com
Lansana Coulibaly	Technical Lead	MMEC Group	(858) 514-6433	lansana.coulibaly@amecfw.com

Mr. Moss began by identifying the contract and task order number, and then introduced the project team. Mr. Moss said that he will serve as the MMEC Group Project Manager, Jim Hogan is the MMEC Group Program Manager, Lansana Coulibaly is the Technical Lead, and Matt Brookshire is the QC Manager for the MMEC Group. Mr. Moss stated that he will communicate directly with Mr. Darrow for all project updates and discussion. Mr. Darrow concurred and said that Mr. Coulibaly can contact Mr. Darrow directly with specific questions as well. Mr. Moss said that the Site Superintendent/SSHO has not yet been identified for the field work, which is anticipated for late Spring 2015, but this individual will be named in the Work Plan for Navy review.

Mr. Moss discussed each site's history and briefly described the in-situ oxygen-releasing treatment planned for both sites CAA 4C and CAA 7. He explained that the MMEC Group approach is direct push injections of an oxygen releasing compound at both sites and self-activated persulfate in two small areas within CAA 4C. No equipment will have to be left overnight as the direct push drill rig is self-contained.

Bob Perricone described the Navy's preferred format for receiving daily reports during field work. He said to send separate files for pictures and the daily production and quality control reports, make sure to pdf the daily reports, and put the contract number in the subject line of the email. The MMEC Group concurred. He added to identify a realistic work schedule and put it in the Work Plan and APP/SSHP. Mr. Moss said that a 0700 to 1700 daily schedule is anticipated. Mr. Delong said to not make excessive construction-related noise prior to 0800 because of close proximity to a residential area. The MMEC Group concurred. Mr. Moss said the first hour of the work day is the safety meeting and equipment calibration, which will not be loud.

SAP WORKSHEET #9 CONTINUED

Mr. Delong added that when we notify USA Dig Alert for subsurface utilities clearance, to remind them to add Alameda Municipal Power to USA's work order.

The meeting adjourned in the office and the team proceeded to walk each CAA site.

CAA 7 Site Walk:

- No access issues were identified. No work is required inside any buildings.
- A perimeter fence and a gate with a lock is present at the site and will serve the purpose of site security and work exclusion zone. Mr. Delong will provide the combination to the lock; if a new lock is used on the fence, his contact information should be attached.
- Some direct push work is required outside of the fenced area northeast of Building 459. Some traffic control was noted to be required but this effort is likely a half day at most due to the small direct push treatment footprint.
- No safety issues were noted.
- Overhead power lines were noted as present but will not be an issue with the direct push drill rig mast height.
- All site wells (i.e., monitoring, DVE, SVE, and air sparge wells) were identified in the field and the general treatment footprint was paced off. Access is unobstructed.

CAA 4C Site Walk:

- No access issues were identified. No work is required inside any buildings.
- A perimeter fence with a gate is present and will serve the purpose of site security and work exclusion zone. Mr. Delong will provide the combination to the lock; if a new lock is used on the fence, his contact information should be attached.
- No safety issues were noted.
- Overhead power lines were noted as present but will not be an issue with the direct push drill rig mast height.
- All site wells (i.e., monitoring, DVE, SVE, air sparge wells) were identified in the field and the general treatment footprint was paced off. Access is unobstructed.
- Nearly two-thirds of the treatment footprint must first core through 6- to 7-inch-thick concrete in order to perform the direct push injections. Numerous concrete cores from previous site work were present at the former fuel pump islands.

SAP WORKSHEET #10 PROBLEM DEFINITION

This project-specific SAP is prepared following the UFP-QAPP requirements (U.S. EPA, 2005), and is intended for a treatability study and groundwater monitoring to evaluate the efficacy of enhanced aerobic in-situ bioremediation (EISB-a) to treat fuel-related petroleum hydrocarbon compounds in groundwater at Corrective Action Area (CAA) 4C and CAA 7 at Alameda Point (Figure A-2). CAA 4C will also evaluate the efficacy of ISCO at two locations.

This worksheet provides the first of seven steps of the data quality objective (DQO) process as detailed by the U.S. EPA (U.S. EPA, 2006). The DQO process is designed to define the project objectives and to ensure that the quality of data collected supports the objectives. This worksheet summarizes the environmental problem to be addressed by the project, the site background, and current conditions to define the key components of the conceptual site model (CSM) for the site.

Topography

Site-wide topographic data are not available for CAA 4C and CAA 7; however, based on well elevation surveys, the surface elevation at CAA 4C is approximately 13 to 16 feet above mean sea level (amsl). The site is relatively flat; the surface is undeveloped, partially paved, and partially covered with vegetation. Based on well surveys, the surface elevation at CAA 7 is approximately 8 to 11 feet amsl. The site is relatively flat and the surface is undeveloped and paved.

Geology

Alameda Point occupies a depression between two uplifted areas: the Berkeley Hills to the east and the Santa Cruz Mountains on the San Francisco Peninsula to the west. The depression and uplifted areas are formed by two subparallel, active faults: the San Andreas and the Hayward Faults. Alameda Point and the surrounding San Francisco Bay are underlain by 400 to 500 feet of unconsolidated sediments that overlay the metamorphosed sandstone, siltstone, shale, greywacke, and igneous bedrock, which form the Franciscan Formation (Bechtel, 2003).

Surface and near-surface soil at Alameda Point consists of artificial fill emplaced during historical filling of the tidal marshlands and the subtidal area of San Francisco Bay during site development. The fill material consists of sediments that were dredged from the tidal flats of San Francisco Bay and Oakland Inner Harbor and is characterized by sands, clays, and silts (Bechtel, 2003). The unconsolidated sediments that lie beneath the artificial fill consist of the following five units, from top to bottom: (1) the Bay Sediment Unit (BSU), (2) the Merritt Sand Formation, (3) the upper unit of the San Antonio Formation, (4) the lower unit of the San Antonio Formation (Yerba Buena Mud), and (5) the Alameda Formation.

Hydrogeology

Groundwater across Alameda Point is usually encountered at depths of 3 to 8 feet below ground surface (bgs) in the artificial fill. Three hydrogeologic units are present in the unconsolidated sediment at Alameda Point. These units have been designated the unconfined first water-bearing zone (FWBZ), the semi-confined second water-bearing zone (SWBZ), and the deep, confined aquifer, known as the Alameda Aquifer.

The following shallow hydrogeologic units are present (Tetra Tech, 2004):

- FWBZ

SAP WORKSHEET #10 CONTINUED

- BSU Aquitard
- SWBZ
- Yerba Buena Mud Aquitard, a regional aquitard

The first of these units is the unconfined FWBZ, which is the target treatment zone of the EISB-a groundwater treatment. The FWBZ occurs within the artificial fill material, beginning at approximately 5 feet bgs and extending to a depth of approximately 9 feet bgs. The upper portion of the BSU acts as an aquitard between the FWBZ and the SWBZ. The semi-confined SWBZ occupies the lower portion of the BSU (the Merritt Sand) and the upper unit of the San Antonio Formation. The lower unit of the San Antonio Formation (the Yerba Buena Mud) acts as a regional aquitard, separating the SWBZ from the Alameda Aquifer.

Groundwater flow at Alameda Point is highly variable with seasonal variations resulting from precipitation levels. Recent groundwater measurements at CAA 4C indicated water table depths of approximately 4 feet bgs to 5.6 feet bgs and flow direction to the southwest. Groundwater in CAA 7 was recently measured at approximately 1.25 feet bgs to 3.8 feet bgs, and generally flows to the west-northwest (Tetra Tech, 2014).

Site History

The following presents a history of CAA 4C.

CAA 4C consists of the former Annex Service Station (Building 567), located northeast of the intersection of Skylark Street and West Pacific Street (Figure A-2). The site operated as a service station from 1971 until 1980 and included three underground storage tanks (USTs) (547-1 through 547-3), fuel distribution islands, and a car wash. CAA 4C is approximately 3,360 square feet in size. Investigations conducted at CAA 4C have identified petroleum-impacted soil and groundwater.

Corrective actions conducted at the site include soil excavation, dual vacuum extraction (DVE), in-situ chemical oxidation (ISCO), and air sparge/soil vapor extraction (AS/SVE).

From 2004 to 2006, DVE/SVE treatment produced the following contaminant concentration reductions:

- 11,200 milligrams per kilogram (mg/kg) to 5,746 mg/kg total petroleum hydrocarbon (TPH)
- 1,750 mg/kg to 41.8 mg/kg benzene, toluene, ethylbenzene, xylene (BTEX)

The 2006 ISCO pilot study produced the following reduction:

- 1,871 mg/kg to 96.8 mg/kg TPH

Petroleum constituents in groundwater remain above their respective preliminary remediation criteria (PRC) following the implementation of the 2013 corrective action (AS/DVE). Groundwater monitoring (spring and fall 2013 and spring 2014) data indicate that petroleum constituent concentrations exceeding the PRCs remain at CAA 4C, with benzene concentrations in groundwater as high as 1,000 micrograms per liter (μg/L) and TPH concentrations in groundwater of 31,000 μg/L; both exceed their site-specific PRC of 36 μg/L and 20,000 μg/L, respectively.

SAP WORKSHEET #10 CONTINUED

The following presents a history of CAA 7.

CAA 7 operated as a Naval Exchange Service Station from at least 1951 to 1997. The site included a vehicle repair shop, a small convenience store, and nine USTs storing automotive fuels, fuel oil, solvents, and lubricating oils. The USTs and their associated fuel distribution lines and fueling islands were removed in 1997. Investigations conducted at CAA 7 identified free-phase and dissolved-phase fuel hydrocarbons in soil and groundwater. Remediation took place between 1998 and 2006 and consisted of soil excavation and DVE. Pre- and post-excavation confirmation samples indicated significant reductions in TPH, BTEX, and methyl tert-butyl ether (MTBE) concentrations. Monitoring conducted since 2012 has identified petroleum constituents in groundwater at concentrations exceeding PRCs. In 2013 and 2014, AS/SVE corrective action was conducted at CAA 7.

Recent groundwater monitoring (spring and fall 2013 and spring 2014) data indicate that petroleum constituent concentrations exceeding the PRC still exist at CAA 7, with MTBE and TPH as the primary contaminants. The MTBE data are atypical of gasoline releases from former service stations. A review of recent monitoring data indicated that groundwater is very shallow seasonally, with measured depth to water at 0.8 to 2.6 feet bgs in the fall (AMEC, 2013). These pronounced seasonal fluctuations in shallow groundwater are likely playing an important role in distributing compounds between the saturated and unsaturated zones (Shaw, 2008). This finding is supported by the persistence of elevated contaminant concentrations following implementation of AS/SVE corrective action measures. In spite of this relatively shallow depth of groundwater occurrence, both oxidation-reduction potential (ORP) and dissolved oxygen (DO) are indicative of anaerobic conditions, with recorded values of -291 millivolts (mV) and 0.15 mg/L, respectively (Tetra Tech, 2014).

Problem Definition

Fuel-related petroleum hydrocarbon compounds exceeding site-specific cleanup criteria (i.e., PRC) remain in groundwater at CAA 4C and CAA 7 following previous corrective actions conducted at both sites.

Problem Statement

Petroleum hydrocarbons have been released to the soil subsurface and continue to impact groundwater in CAA 4C and CAA 7. Previous corrective actions have reduced the concentrations of petroleum hydrocarbons in soil and groundwater, but groundwater concentrations remain above the PRC. Additionally, residual petroleum hydrocarbons exist at two relatively small locations at CAA 4C where concentrations of fuel components have remained above the PRC following successive corrective actions at the site, including soil excavation, DVE, and AS/SVE conducted between 2004 and 2013. Therefore, this treatability study will evaluate the efficacy of using EISB-a (and focused ISCO at CAA 4C) to reduce fuel-related hydrocarbon compounds in groundwater at CAA 4C and CAA 7. The effectiveness of the EISB-a treatment will be measured on the basis of meeting applicable PRCs, or meeting the requirements of the SWRCB *Low-Threat Underground Storage Tank Case Closure Policy*.

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SAP WORKSHEET #11 PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS

This worksheet provides Steps 1 through 7 of the DQO process as detailed by the U.S. EPA (U.S. EPA, 2006). This process is used to determine the type, quantity, and quality of data necessary to support decision making regarding current site conditions and future site management decisions.

The following subsections provide the objectives of this treatability study for groundwater contamination at CAA 4C and CAA 7, the information inputs and analytical approach that will be used to achieve the objectives, and the performance criteria that will be used to ensure that the data used to make project decisions are of sufficient quality.

SAP WORKSHEET #11 CONTINUED

<table>
<tr><th colspan="2">Treatability Study and Groundwater Monitoring</th></tr>
<tr><td>STEP 1</td><td>State the Problem</td></tr>
<tr><td></td><td>Petroleum hydrocarbons have been released to the subsurface and continue to impact groundwater in CAA 4C and CAA 7. Previous corrective actions have reduced the concentrations of petroleum hydrocarbons in soil and groundwater, but groundwater concentrations remain above cleanup criteria (i.e., PRC). Additionally, relatively elevated concentrations of petroleum hydrocarbons exist at two relatively small locations at CAA 4C where concentrations of fuel components have remained above the PRC following successive corrective actions at the site, including soil excavation, DVE, and AS/SVE conducted between 2004 and 2013. Therefore, this treatability study will evaluate the efficacy of using EISB-a (and focused ISCO at CAA 4C) to reduce fuel-related hydrocarbon compounds in groundwater to below the PRC or to meet the SWRCB's Low Threat UST Closure Case Policy.</td></tr>
<tr><td>STEP 2</td><td>Identify the Goals of the Study</td></tr>
<tr><td></td><td>The goals of this treatability study are to:

1. Evaluate the effectiveness of EISB-a to treat fuel components with concentrations that exceed site-specific PRC at both CAA 4C and CAA 7 using an extended release oxygen substrate to stimulate and sustain aerobic biodegradation of the fuel components; and

2. Evaluate the effectiveness of focused ISCO at two locations in CAA 4C with elevated petroleum hydrocarbon concentrations.

A groundwater monitoring program is proposed to analyze hydrocarbon compounds and geochemical parameters, and to evaluate the effectiveness of the ISCO and EISB-a to potentially reduce fuel component concentrations to below their PRC at CAA 4C and CAA 7.

These goals will be achieved by answering the following specific decision questions:

a) Do the fuel hydrocarbon groundwater analytical results indicate degradation of the fuel components in the two areas treated using ISCO within CAA 4C?

b) Do the fuel hydrocarbon groundwater analytical results indicate degradation of the fuel components in the areas treated using EISB-a at CAA 4C and CAA 7?

c) Do the selected geochemical monitoring parameters in groundwater indicate that the distributions of the ISCO and EISB-a substrates in groundwater are sufficient for sustained biodegradation of petroleum hydrocarbons?

d) Do the fuel component concentration trends and other applicable criteria indicate that the site is a candidate for closure under the SWRCB's Low-Threat Underground Storage Tank Closure Policy?</td></tr>
</table>

SAP WORKSHEET #11 CONTINUED

Treatability Study and Groundwater Monitoring	
STEP 3	**Identify Information Inputs**
	1. Previously collected site data used to estimate substrate that include recent groundwater concentrations of fuel components (TPH, BTEX, MTBE and PAHs), and hydrogeologic and geochemical data. 2. Initial pre-treatment groundwater monitoring results of fuel components and geochemical parameters to establish baseline groundwater conditions for the treatability study. 3. Post-treatment groundwater monitoring results of fuel components and geochemical parameters. 4. Groundwater levels collected from wells to evaluate potential upwelling during treatment injections and to evaluate groundwater flow direction. 5. PRCs established in the 2012 Alameda Point Petroleum Management Plan (PMP). 6. Previously collected lithologic and hydrogeologic data, and monitoring well construction details, as a basis to develop the EISB-a and ISCO injection methods and to evaluate the results. 7. Performance parameters (such as pressure and injection volumes) collected during injection of the substrates.
STEP 4	**Define the Boundaries of the Study**
	The physical study boundaries of this project are defined by the site features shown on Figures A-4 and A-5, and Worksheet #18 of this SAP. ***CAA 4C*** *Horizontal*: The boundaries of the treatment area extend the width of the former fuel lines and from the southern edge of the former fuel pump island to approximately 40 feet north of the pump island as shown on Figure A-4 – approximately 3,360 square feet. The boundaries of the groundwater monitoring extend to locations of monitoring wells in the petroleum program. *Vertical:* The vertical boundary is defined by the project's target treatment zone, which is from the top of the water table to approximately 16 feet bgs. *Temporal*: The temporal boundary is defined by the time to complete the investigation and assumes adherence by all stakeholders to the schedule presented in this SAP (Figure A-6). The proposed work schedule is in Worksheet #6 and the work is planned to start in March 2015. The EISB-a and ISCO injections activities are estimated to last one week. One baseline and three post-injection quarterly sampling events will be conducted. ***CAA 7*** *Horizontal*: The boundaries of the study extend laterally approximately 40 feet north-east of Building 459 to Hancock Street in the east-west direction and to 80 feet north of Glenview Serenade Place in the north-south direction as shown on Figure A-5 – approximately 5,040 square feet. The boundaries of the groundwater monitoring extend to locations of monitoring wells in the petroleum program. *Vertical:* The vertical boundary is defined by the project's target treatment zone, which is from the top of the water table to approximately 16 feet bgs. *Temporal*: The temporal boundary is defined by the time to complete the investigation and assumes adherence by all stakeholders to the schedule presented in this SAP (Figure A-6). The proposed work schedule is in Worksheet #6 and the work is planned to start in March 2015. The EISB-a injection activities are estimated to last one week. One baseline and three post-injection quarterly sampling events will be conducted.

SAP WORKSHEET #11 CONTINUED

<table>
<tr><th colspan="2">Treatability Study and Groundwater Monitoring</th></tr>
<tr><td>STEP 5</td><td>Develop the Analytical Approach</td></tr>
<tr><td></td><td>Groundwater samples collected for chemical analysis will provide the basis for evaluating the effectiveness of ISCO at two locations in CAA 4C and EISB-a at all locations in CAA 4C and CAA 7 in reducing petroleum hydrocarbon concentrations. These analytes include:

• TPH fractions (by U.S. EPA modified Method 8015B with silica gel)
• BTEX (and MTBE at CAA 7 only) (by U.S. EPA Method 8260B)
• PAHs (by U.S. EPA Method 8270C Selected Ion Monitoring [SIM])
• Total dissolved solids (TDS) (by U.S. EPA Method 160.1/SM2540C)
• Selected dissolved metals (arsenic and lead) (by U.S. EPA Method 6010B)
• EISB-a parameters:
    o ORP (by field meter)
    o pH (by field meter)
    o Dissolved oxygen (by field meter and Hach Test Kit)
    o Nitrate and sulfate (by U.S. EPA Method 300)
    o Total organic carbon (by U.S. EPA Method 415.1/SM5310B)

Based on the analytical approach and the analyses listed above, the following decision rules that address each decision question in Step 2 are proposed:

a. If concentrations of fuel components in groundwater at the two ISCO treatment areas within CAA 4C indicate decreasing trends or are reported below PRC after three rounds of post-treatment quarterly monitoring, then the ISCO treatment will be considered effective in these two areas. If not, then potential approaches for a treatment optimization may be recommended.

b. If concentrations of fuel components in the EISB-a treatment footprint within CAA 4C and CAA 7 indicate decreasing trends, or are reported below PRC after three rounds of post-treatment quarterly monitoring, then the EISB-a treatment will be considered a potentially viable treatment technology for the site. If not, then potential approaches for a treatment optimization may be recommended.

c. If geochemical conditions indicate effective distribution of substrate and remaining levels indicate ongoing aerobic conditions through three quarters of performance monitoring, then it will be concluded that geochemical conditions are conducive to ongoing treatment. If not, then alternative treatment of residual fuel components in groundwater may be recommended.

d. If fuel component concentrations show a decreasing trend, and geochemical conditions indicate aerobic conditions and sustained fuel component degradation after three rounds of performance monitoring, then the site will be evaluated for closure under SWRCB’s Low-Threat Underground Storage Tank Case Closure Policy. If not, then the site will be evaluated for further treatment and/or monitoring.</td></tr>
</table>

SAP WORKSHEET #11 CONTINUED

Treatability Study and Groundwater Monitoring	
STEP 6	**Specify Performance or Acceptance Criteria**
	The performance criteria for this study are hydrocarbon concentrations and geochemical parameters reported during the pre-treatment baseline sampling event and three quarterly groundwater monitoring events following EISB-a treatment. The limited dataset collected as part of this study (i.e., four monitoring rounds) limits the use of statistical methods to evaluate a decreasing trend. To address this limitation, the past four years of reported hydrocarbon concentrations will be evaluated for each site when assessing overall decreasing trends of hydrocarbon concentrations. Substrate injection boring locations have been proposed and will be selected judgmentally on the basis of a sampling grid to obtain adequate coverage of the target treatment zone using the estimated radius of influence for the treatment injections (i.e., 5 feet). To limit uncertainty in the obtained environmental data, criteria have been developed for the precision, accuracy, representativeness, completeness, and comparability parameters and limit of detection (LOD) for the chemicals of concern as presented in Worksheet #37. Measurement errors will be controlled by using appropriate sampling and analytical methods; laboratory errors will be controlled by adhering to established standard operating procedures (SOPs) and having 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 subcontracted analytical laboratory will have a copy of the SAP and will adhere to DoD QSM guidance to limit measurement errors.

SAP WORKSHEET #11 CONTINUED

Treatability Study and Groundwater Monitoring	
STEP 7	**Develop the Plan for Obtaining Data**
	Treatability Study: The treatability study will utilize a single injection round at each CAA, using different substrate customized to the nature of the contaminants present in each plume. CAA 4C will have approximately 43 direct push technology (DPT) injection locations to cover a target treatment zone of approximately 3,360 square feet. ISCO treatment will be applied to two areas of approximately 800 square feet each within CAA 4C – around well OB-04 and DVE-07 where elevated concentration of fuel components have persisted. Approximately 10 DPT injections are proposed for these two areas. EISB-a treatment will be applied to the remaining 2,560 square feet using approximately 33 DPT injections. The DPT injection depth interval will be from approximately 4 feet bgs to 16 feet bgs at CAA 4C. CAA 7 will have approximately 64 DPT injection locations to cover an EISB-a target treatment zone of approximately 5,040 square feet. The DPT injection depth interval will be from approximately 2 to 16 feet bgs at CAA 7. Groundwater Monitoring: Groundwater samples will be collected from 15 existing permanent monitoring wells (9 wells in CAA 4C and 6 in CAA 7) using low-flow sampling techniques and analyzed for TPH, BTEX (and MTBE at CAA 7), PAHs, TDS, selected anions (nitrate and sulfate), selected dissolved metals (arsenic and lead), and total organic compounds (TOCs), by laboratory analysis and ORP, pH, DO with a field instrument. Data collection and analysis are described in Worksheets #14 and #17 and will satisfy the data quality objectives (DQOs) specified in the preceding six steps. Analytical data will be validated by a third-party data validator. Monitoring well locations were selected from the existing monitoring well network. An initial monitoring round will be performed prior to the initiation of ISCO and EISB-a injections for the treatability study and three quarterly monitoring rounds will be conducted upon completion of the injections.

SAP WORKSHEET #12 MEASUREMENT PERFORMANCE CRITERIA TABLE

Measurement Performance Criteria Table Field Quality Control (QC) Samples					
QC Sample	**Analytical Group**	**Frequency**	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample Assessment Error[6]**
Equipment Blank[1]	VOCs (BTEX and MTBE), TPH, PAHs, dissolved arsenic, dissolved lead, anions (nitrate and sulfate), TDS, and TOC	One per day if sampling is conducted with non-dedicated equipment	Sensitivity	The equipment blank should not contain concentrations of analytes above the laboratory practical quantification limit (PQL) or below the PQL at a level that impacts the associated sample results.	S&A
Field Duplicate[2]	VOCs (BTEX and MTBE), TPH, PAHs, dissolved arsenic, dissolved lead, anions (nitrate and sulfate), TDS, and TOC	1 per 10 samples collected	Precision	Less than or equal to 30% relative percent difference	S&A
Source Water Blank[3]	VOCs (BTEX and MTBE), TPH, PAHs, dissolved metals (arsenic and lead)	One per source	Sensitivity/ Contamination (Accuracy/Bias)	No analyte > limits of quantitation (LOQs)	S&A
Temperature Blank[4]	Temperature	One per cooler	Representativeness (Accuracy/Bias)	2°C to 6°C	S
Trip Blank[5]	VOCs (BTEX and MTBE)	One per cooler containing water samples for VOC analysis	Sensitivity/ Contamination (Accuracy/Bias)	No analyte > LOQs	S&A

Notes:

1 Equipment Blank: An equipment blank (rinsate blank) is used to assess the effectiveness of decontamination procedures. Equipment blanks are obtained under representative field conditions by running analyte-free, deionized/distilled water (provided by the laboratory) through sample collection equipment after decontamination and prior to use, and placing the water in the appropriate sample containers for analysis.

2 Field Duplicate: A field duplicate is used to assess the overall precision of the sampling effort contaminant variability in the sample matrix. Field duplicates are samples collected at the same time and from the same source as their corresponding primary samples. Field duplicates will represent at least 10 percent of all field aqueous samples.

SAP WORKSHEET #12 CONTINUED

3 Source Blank: A source water blank is used to determine the quality of the source water used for decontamination. Source water blanks will be collected from each new lot of water used for decontamination procedures, or, if water is being stored in large quantities in carboys, from each carboy of water prior to use.

4 Temperature Blank: A temperature blank is used to verify the sample temperature upon laboratory receipt. The analytical laboratory will prepare the temperature blank by filling volatile organic analyte (VOA) vials with contaminant-free, deionized water and placing a vial in each sample cooler.

5 Trip Blank: A trip blank is used to determine whether samples have been cross-contaminated with VOCs during sample collection and transportation. Trip blanks will consist of the contaminant-free, deionized water preserved with hydrochloric acid and prepared by the fixed-base laboratory in 40-milliliter (mL) VOA vials. Trip blanks will be carried into the field, stored with the samples, and returned to the laboratory for VOC analysis. Trip blanks will be provided in each cooler containing a water sample for VOCs analysis.

6 For sampling (S), analysis (A), or both (S&A).

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
Draft Groundwater Monitoring Technical Memorandum	Tetra Tech EC, Inc. (Tetra Tech). 2014. *Draft Spring 2014 Petroleum Program Groundwater Monitoring Technical Memorandum.* Alameda Point, Alameda, California. May.	Tetra Tech	Data will be used to evaluate assumptions regarding site conditions and the nature and extent of contamination	No limitations on data
Petroleum Corrective Action Summary Report	Shaw Environmental, Inc. (Shaw). 2008. *Final Petroleum Corrective Action Summary Report. Dual Vacuum Extraction, Biosparge, and Pilot-Scale Chemical Oxidation Injection, Corrective Action Area 4C. Alameda Point, Alameda, California*. November.	Shaw	Data will be used to evaluate assumptions regarding site conditions and the nature and extent of contamination	No limitations on data
Petroleum Management Plan	Battelle. 2012. *2012 Update. Petroleum Management Plan, Alameda Point, Alameda, California.* February.	Battelle	Data will be used to evaluate assumptions regarding site conditions and the nature and extent of contamination	No limitations on data

SAP WORKSHEET #13 CONTINUED

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
Corrective Action Plan	Tetra Tech Environmental Management, Inc. 2004. *Corrective Action Plan for Corrective Action Area 4C*, Alameda Point, Alameda, California. January.	Tetra Tech	Data will be used to evaluate assumptions regarding site conditions and the nature and extent of contamination	No limitations on data
Fuel Hydrocarbon Transport Modeling Report	Parsons Engineering Science, Inc. 2000. *Fuel Hydrocarbon Transport Modeling Report, Site 7 and Area 37, Alameda Point, Alameda, California*. August.	Parsons Engineering Science, Inc.	Data will be used to evaluate assumptions regarding site conditions and the nature and extent of contamination	No limitations on data
Final Investigation Report, Petroleum Program Groundwater Monitoring	AMEC Environment & Infrastructure, Inc. (AMEC). 2013. *Final Investigation Report, Petroleum Program Groundwater Monitoring, Corrective Action Areas 4C, 7, and 11; Area of Concern 23G; and Building 410, Alameda Point, Alameda, California*. February.	AMEC Environment & Infrastructure, Inc	Data will be used to evaluate assumptions regarding site conditions and the nature and extent of contamination	No limitations on data

SAP WORKSHEET #14 SUMMARY OF PROJECT TASKS

The MMEC Group has been contracted by the Navy to perform a treatability study to evaluate potential remedial alternatives for treating persistent petroleum-impacted subsurface soil and water. The treatability study will consist of a single round of injections of oxygen-producing compounds customized to the contaminants present in each plume. Approximately 43 DPT injection locations will cover a lateral target treatment zone of approximately 3,360 square feet in CAA 4C (Figure A-4), while 64 DPT locations will cover a target treatment zone of approximately 5,040 square feet in CAA 7 (Figure A-5). The DPT injection interval will range from 4 feet bgs to 16 feet bgs in CAA 4C, and from 2 feet bgs to 16 feet bgs in CAA 7.

In addition, the MMEC Group will perform groundwater monitoring at CAA 4C and CAA 7 at nine and six existing groundwater monitoring wells, respectively. One round of sampling will be performed prior to injections of the EISB-a and ISCO amendments to establish baseline groundwater conditions. Three additional rounds of quarterly groundwater monitoring will be performed in conjunction with the treatability study to assess the effectiveness of the injections.

Permitting and Notification

Necessary permitting and notifications will be completed prior to the commencement of field activities.

Before beginning field work, the MMEC Group will coordinate with the Navy to hold a Field Readiness Meeting prior to beginning field work. The MMEC Group will coordinate site access with the BRAC Caretaker Site Office (CSO) and will notify the ROICC of the upcoming schedule for field work, in addition to subsequent field mobilizations to monitor and sample groundwater. The Navy is conducting this project pursuant to the 2009 Alameda Point Petroleum Strategy and the 2012 PMP.

Mobilization

Mobilization for the field work will include designating a decontamination area and conducting a preparatory inspection. The preparatory phase inspection may be held prior to mobilization to discuss project scope, health and safety requirements, drilling procedures, sampling procedures, status of submittals and procurements, and quality control protocols. A perimeter will be installed around the investigation area using cones and caution tape as needed. This area will include the exclusion, contamination reduction, and support zones. The investigation-derived waste (IDW) storage area will also be located within the support zone.

Utility Clearance

Prior to intrusive sampling activities, each subsurface sampling location will be cleared for underground utilities using handheld equipment to ensure that no subsurface utilities are present. The MMEC Group will notify Underground Service Alert at least 48 hours prior to initiation of any subsurface drilling activities. All boring locations will be marked and cleared for proposed drilling. A minimum clearance of 2 feet from the closest observed underground utility will be maintained at all drilling locations. Additionally, a minimum distance of 20 feet will be maintained from all overhead power lines. Prior to drilling activities using the DPT rig, each boring location will be cleared to 5 feet bgs using a hand-auger to ensure clearance from subsurface utilities.

SAP WORKSHEET #14 CONTINUED

Bioremediation Amendment Injections

The MMEC Group subcontractor, [to be determined], will perform the EISB-a and ISCO amendment injections using DPT. The oxygen-releasing substrate will be mixed with water per the manufacturer's instructions prior to subsurface injections. The groundwater will come from existing groundwater monitoring wells within the proposed treatment areas. The measured amount of compound slurry will then be injected into the subsurface under pressure using DPT at the targeted depths. The targeted depths for CAA 4C range from 4 feet bgs to 16 feet bgs, and the targeted depths for injections in CAA 7 range from 2 feet bgs to 16 feet bgs. The solution of groundwater and substrate will be injected at a pressure low enough to avoid fracturing the subsurface. It is anticipated that the injection pressure will not exceed 25 pounds per square inch (psi). The injections are based on achieving a radius of influence of 5 feet. Volumes of substrate at each injection location will be documented on the injection field form, provided in Attachment 1. Once the desired volume of substrate has been injected at each injection location, the injection will be terminated, the drilling equipment removed from the borehole, and the borehole backfilled with hydrated bentonite chips and patched at the surface with concrete or asphalt to match the surrounding surface material.

Groundwater Monitoring

Fifteen existing monitoring wells at CAA 4C and CAA 7 (see Worksheet #18) will be purged prior to groundwater sampling. The purging and groundwater sampling will be conducted in general accordance with the U.S. EPA low-flow purging and sampling methodology (U.S. EPA, 2010b). All sampling equipment will be thoroughly decontaminated prior to initiating any site work. All reusable sampling equipment will be decontaminated prior to use at each boring location to minimize the potential for contaminant migration or cross-contamination. Table 14-1 presents details on the existing monitoring well network that will be used to monitor the progress of the EISB-a at CAA 4C and CAA 7. Figures A-4 and A-5 show the locations of the wells.

Each well will be micro-purged (100 to 500 milliliters per minute [mL/min]) using a bladder pump or equivalent. The pump should provide consistent results and minimal disturbance of the sample across low-flow rates.

The following procedures will be followed when sampling a well:

1. Confirm the well identification at each monitoring well. Preferentially collect samples from wells with the lowest expected contaminant concentrations to the highest expected concentrations to minimize the potential for cross-contamination.

2. Put on a new, clean, and chemical-resistant pair of disposable gloves. Calibrate field instruments in accordance with the manufacturer's directions. Record all calibration documentation in the field logbook or on the "Groundwater Monitoring Form."

3. Measure the depth to water at each monitoring well using an electronic water level indicator probe. Record the water level measurement to the nearest 0.01 foot on the "Groundwater Monitoring Form." Decontaminate the water level indicator before each measurement according to the decontamination procedure.

4. Carefully lower the tubing or the pump into the well with as little disturbance to the groundwater as possible. If the water level is above the top of the screen, place the intake to the pump at the middle of the screen interval. Install the pump slowly to the

SAP WORKSHEET #14 CONTINUED

middle or slightly above the middle of the screened interval, thus minimizing mixing of stagnant casing water with formation water within the screened interval, and re-suspension of settled solids from the bottom of the well. If the water level is below the top of the screen, the pump intake will be placed in the middle of the water column.

5. Purge the well at a flow rate of 100 to 500 milliliters per minute (mL/min). Monitor water quality parameters (turbidity, pH, temperature, conductivity, ORP, and DO) every 3 to 5 minutes during purging, using in-line monitoring equipment to increase the reading stability. Record the water quality parameters on the groundwater sampling log form. Stabilization is achieved if three consecutive readings are within ± 0.1 pH units, ± 3 percent of the reading for temperature, ± 3 percent of the reading for conductivity, ±10 millivolts (mV) for ORP, ± 10 percent for DO (if DO reading is > 0.5 mg/L), and ±10 percent for turbidity (if turbidity reading is > 5 Nephelometric turbidity units [NTU]).
6. When the water quality parameters are stable for three consecutive readings, collect samples for chemical analysis. If the water quality parameters have not stabilized, continue purging until stabilization occurs or until three calculated well volumes have been purged.
7. Samples will be collected at the same pump flow rate used during purging. Collect samples for BTEX and MTBE analysis first. Fill the containers so that no headspace exists. Collection of TPH sample will be next, followed by the remaining analyses. Collect field QC samples (e.g., field duplicates) as required.
8. Label samples properly and place the sample container into a ziplock bag. Transfer the samples to cold storage immediately after collection. Handle and transport the samples to the laboratory according to the procedure described in Worksheet #27.

Analytical Tasks

The analytical parameters and methods for CAA 4C and CAA 7 were selected on the basis of available historical information regarding fuel material contained in the USTs and previous site investigations.

Groundwater samples collected from groundwater monitoring wells located in CAA 4C and CAA 7 will be analyzed in a fixed laboratory or in the field using a field meter or test kit for the following to evaluate the performance of the EISB-a:

- Volatile organic compounds (VOCs) (by U.S. EPA Method 8260B)
- TPH (by U.S. EPA modified Method 8015B with silica gel)
- BTEX (and MTBE at CAA 7 only, by U.S. EPA Method 8260B)
- PAHs (by U.S. EPA Method 8270C SIM)
- TDS (by U.S. EPA Method 160.1/SM2540C)
- Selected dissolved metals (arsenic and lead, by U.S. EPA Method 6010B)
- EISB-a parameters:
    - ORP (by field meter)

SAP WORKSHEET #14 CONTINUED

- pH (by field meter)
- Dissolved oxygen (by field meter and Hach Test Kit)
- Nitrate and sulfate (by U.S. EPA Method 300.0)
- Total organic carbon (by U.S. EPA Method 415.1/SM5310B)

Refer to Worksheet #18 for the analyses to be conducted at each well, as not all analyses will be performed in every well.

Water Level Measurements

Groundwater levels will be measured only at the monitoring wells to be sampled located at CAA 4A (BW-06, DVE-03, DVE-05, DVE-07, DVE-16, DVE-22, DVE-30, OB-04, and OB-06) and at CAA 7 (DVE-3, DVE-5, DVE-8, DVE-9, IT013-CA07-0014, and M07A-05). Water levels will be measured immediately prior to each sampling event.

At each well, the well cap will be removed and the wellhead will be checked for organic vapors using a photoionization detector (PID). A permanent reference mark has been located or scribed onto the top of the casing to provide a consistent reference point from which all levels are measured. Depth to water (DTW) measurements will be taken to an accuracy of 0.01 foot (ft) using a water-level indicator. The water-level indicator will be decontaminated as described below. The measurements will be checked by slowly raising and lowering the tape and watching the instrument response. The measurement will be recorded in the field logbook.

Decontamination

All sampling equipment will be thoroughly decontaminated prior to initiating any site work. All reusable sampling equipment will be decontaminated prior to use at each sampling location to minimize the potential for contaminant migration or cross-contamination. Equipment decontamination areas will be located within or adjacent to the field work area, as designated by supervising field personnel. Equipment decontamination will be conducted in accordance with the following procedure:

1. Potable water and nonphosphate detergent (i.e., Liquinox™) wash (using brushes or a steam cleaner, as appropriate
2. Potable water rinse
3. Distilled or deionized water rinse
4. Equipment air dried and stored until used

The effectiveness of the decontamination procedures will be tested by collecting one equipment rinsate per day of use following the end-of-the-day equipment decontamination. The laboratory-supplied, analyte-free water will be poured over and around the decontaminated sampler and collected for analysis at the laboratory. Decontamination liquids will be managed along with other IDW as described below.

Investigation-derived Waste Management

IDW generated during the field activities will include purged groundwater, soil from hand-augering, decontamination fluids, personal protective equipment (PPE), and other disposable sampling materials. All IDW will be managed and disposed of in accordance with U.S. EPA and California Department of Transportation (DOT) guidelines in accordance with the Waste Management Plan provided as Attachment B to the Work Plan, and as summarized below.

Pending characterization, IDW will be stored onsite in a secure and controlled area. IDW will include the wastewater from decontamination procedures, which will be containerized in DOT-approved 55-gallon steel drums and appropriately labeled until waste characterization is complete.

A small amount of nonhazardous PPE and sampling equipment IDW will be generated during the field work. Used PPE may consist of protective coveralls, nitrile gloves, and other disposable gear associated with field activities. Sampling equipment may include such items as sampling tools, cleaning/decontamination equipment, and used paper towels. Used PPE will be stored onsite, double-bagged, and disposed of along with other nonhazardous solid waste pending the analytical results of the field samples. Disposal of IDW will be performed within 90 days of waste generation. The removal of IDW to an offsite disposal facility will be coordinated with the NAVFAC SW RPM and the Alameda Point ROICC.

Field Documentation

Field measurements will be made by qualified Field Team Leaders, Field Geologists, Engineers, Environmental Scientists, and/or Technicians. All field data will be recorded in ink on the forms listed below. Review of field data and records will be performed by the Field Team Leader or designee. Instrument selections and use, including calibration and standardization, field deviations, and sampling limitations, will be recorded on the daily field log. Field records will be initialed by the reviewer prior to their incorporation into reports or use in making program decisions. Changes or corrections to field form entries will be completed by striking out the incorrect entry with a single line and initialing (by the person making the correction) and dating the correction. The original item, although erroneous, must remain legible beneath the crossed-out line. The new information should be written clearly above the crossed-out item.

Examples of the field forms listed below are found in Attachment 1:

- Daily report/field log
- Chain of custody form
- Field boring log
- Groundwater sampling form

Sampling Quality Control

Quality control (QC) samples will be collected at a frequency designated in Worksheets #12, #20, and #28 of this SAP. QC samples will include matrix spikes (MS), matrix spike duplicates (MSD), equipment blanks, source water blanks, and temperature blanks. If re-usable sampling equipment is used, an equipment blank will be collected from decontaminated sampling equipment. Analytical methods will include initial calibrations, continuing calibrations, tuning, reagent blanks, instrument blanks, surrogates, replicates, laboratory control spikes, and other applicable QC as defined by the methods.

Groundwater samples will be collected, handled, and shipped to the selected laboratory in accordance with the guidelines presented in Worksheet #26 and Worksheet #27, Sample

SAP WORKSHEET #14 CONTINUED

Custody Requirements. Field QC samples and MS/MSD samples will be submitted and analyzed as directed in Worksheet #28. Additional details of QC sample requirements are provided in Worksheet #28.

Data Management Review

Data from this sampling effort will be generated from three primary pathways: field activities, laboratory analytical data, and validated data. Data from all three pathways will be submitted to the Navy Electronic Data Deliverable/Naval Installation Restoration Information Solution (NEDD/NIRIS) website in accordance with the data format described in EWI #6, "Environmental Data Management and Required Electronic Delivery Standards" (NAVFAC SW, 2005).

Data generated during field activities will be recorded using a field logbook and field forms. The field team lead will review these forms for compliance with QC criteria established in the SAP for completeness and accuracy.

Upon sample arrival, the analytical laboratory will verify each sample's physical condition and ensure that all pertinent documentation associated with each sample is complete. Data generated from the laboratory analysis will be recorded in hardcopy and in electronic data deliverables for submission to the Navy NEDD/NIRIS database. Analytical laboratory staff will verify the data according to the process described in Worksheet #34. The laboratory QA director will review the data before they are submitted for third-party data validation. Details on data validation are provided in the next section and in Worksheets #35–37.

Pertinent data (i.e., geological, spatial, and temporal descriptions) from the field records and third-party-validated electronic data deliverables will then be entered into the Navy's NEDD/NIRIS web-based database. Through the web-based system, the data can be compiled rapidly, plotted in the geographic information system (GIS), and reviewed for changes in target analyte concentrations at each sampling point. Hardcopy field records will be stored in a secure project file.

Third-Party Data Validation

Data generated for this project will be reviewed and verified by the MMEC Group QCM and validated by Laboratory Data Consultants (LDC), an independent, third-party data validation laboratory located in Carlsbad, California. The data validation process and criteria are described in Worksheets #35–37. These requirements are established in accordance with EWI #1, "Chemical Data Validation" (NAVFAC SW, 2001)., "Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review" (U.S. EPA, 2010a), and the "Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review" (U.S. EPA, 2013).

All data within the data set will be independently validated using the DQOs established for the project. Twenty percent of the data are subjected to a Level IV validation. The remaining 80 percent of the data are validated per Level III procedures. The validator will perform calculation checks for these data and the data for the associated laboratory QC samples. The data validator will also facilitate uploading the validated data into the Navy's NEDD/NIRIS database in accordance with EWI #6 (NAVFAC SW, 2005). The guideline elements for Level III and Level IV data validation are summarized below.

Level III Data Validation 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

SAP WORKSHEET #14 CONTINUED

assessed by comparing the parameters listed below to the appropriate criteria (or limits) as specified in the project SAP, by Contract Laboratory Program (CLP) requirements, or by method-specific requirements (e.g., CLP, SW-846). If calculations for quantitation are verified, they are done on a limited basis and may require raw data in addition to the standard data forms normally present in a data package, including the following QC parameters summarized on CLP or CLP-like data forms:

- Holding times (exceedance)
- Gas chromatograph/mass spectrometer (GC/MS) tune
- Initial and continuing calibrations
- Blanks (use of “5X/10X rule” for assessment of contamination)
- Blank spikes/laboratory control samples (LCS)
- Surrogates
- MS/MSD
- Internal standards (IS) area performance

Level IV Data Validation Level IV data validation will require analytical data packages that include the raw data (e.g., spectra and chromatograms) and backup documentation for calibration standards, analysis run logs, LCS, dilution factors, and other types of information. This additional information is utilized in the Level IV data validation process for checking calculations of quantified analytical data. Calculations are checked for QC samples (e.g., MS/MSD and LCS data) and routine field samples (including duplicates, and field and equipment rinsate blanks). To ensure that detection limit and data values are appropriate, an evaluation is made of the instrument performance, method of calibration, and original data for calibration standards.

Analytical data may be qualified on the basis of data validation reviews. Qualifiers will be consistent with the applicable U.S. EPA functional guidelines and will be used to provide data users with an estimate of the level of uncertainty associated with the qualified results. The project team will determine the data usability based on data validation results with respect to the following qualifiers:

U – Not detected at or above the stated limit

J – Estimated concentration

R – Non-usable data

UJ – Not detected at or above an estimated sample detection limit

N – Tentative identification

For any instances where the validation qualifiers impact the overall data interpretation and project recommendations, the data usability assessment will discuss the issue and the necessary corrective action.

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SAP WORKSHEET #14 CONTINUED

Table 14-1
Existing Monitoring Well Network CAA 4C and CAA 7,
Alameda Point, Alameda, California

Well ID	Well Type	Location	Evaluation	Purpose
CAA 4C				
BW-06	Monitoring	In-plume, downgradient southern edge	EISB-a parameters	Monitor in-plume conditions in source area and along southern plume edge.
DVE-03	Monitoring	In-plume, cross gradient western edge	EISB-a parameters	Monitor in-plume conditions in source area and along western plume edge
DVE-05	Monitoring	In-plume, downgradient southern target zone	EISB-a parameters	Monitor in-plume conditions and southern portion of plume
DVE-07	Monitoring	In-plume, downgradient southern edge	ISCO/EISB-a parameters	Monitor in-plume conditions and southern edge of plume
DVE-16	Monitoring	Out of plume, downgradient southwest	EISB-a parameters	Monitor downgradient/southwestern edge for plume mobilization from injections
DVE-22	Monitoring	Out of plume, downgradient southwest	EISB-a parameters	Monitor downgradient/southwestern edge for plume mobilization from injections
DVE-30	Monitoring	In-plume, upgradient northern edge	EISB-a parameters	Monitor in-plume conditions at upgradient, northern edge of plume
OB-04	Monitoring	In-plume, upgradient northeastern edge	ISCO/EISB-a parameters	Monitor in-plume conditions at upgradient, northeastern edge of plume
OB-06	Monitoring	Out of plume, downgradient east	EISB-a parameters	Monitor eastern edge of plume mobilization from injections
CAA 7				
DVE-3	Monitoring	In-plume, central target area	EISB-a parameters	Monitor in-plume conditions in central source area
DVE-5	Monitoring	In-plume, northern target area	EISB-a parameters	Monitor in-plume conditions in northern source area
DVE-8	Monitoring	In-plume, southwestern target area	EISB-a parameters	Monitor in-plume conditions in southwestern source area
DVE-9	Monitoring	In-plume, southeastern target area	EISB-a parameters	Monitor in-plume conditions in southeastern source area

SAP WORKSHEET #14 CONTINUED

Table 14-1 (continued)
Existing Monitoring Well Network CAA 4C and CAA 7,
Alameda Point, Alameda, California

Well ID	Well Type	Location	Evaluation	Purpose
IT013-CA07-0014	Monitoring	In-plume, southwestern target area	EISB-a parameters	Monitor in-plume conditions in southwestern source area
M07A-05	Monitoring	Out of plume, downgradient west	EISB-a parameters	Monitor downgradient/northwestern edge for plume mobilization from injections

Notes:
ID: identification; EISB-a parameters: enhanced aerobic in-situ bioremediation parameters (ORP, pH, DO, nitrate and sulfate concentrations, TOC)

SAP WORKSHEET #15 REFERENCE LIMITS AND EVALUATION TABLE

Laboratory: EMAX
Matrix: Groundwater
Analytical Group: TPH (Purgeable by U.S. EPA Method 8015B, extractable by U.S. EPA modified Method 8015B with silica gel)
Concentration Level: µg/L

Analyte	CAS Number	PAL[1] (µg/L)	PAL Reference	Project Quantitation Limit Goal (µg/L)	Laboratory-Specific		
					LOQs (µg/L)	LODs (µg/L)	DLs (µg/L)
TPH gasoline (C6-C12)	8006-61-9	NA	NA	100	100	20	10
TPH jet fuel (C8-C12) (JP5)	HZ0600-26-T	NA	NA	500	500	100	50
TPH diesel (C12-C24)	68834-30-5	NA	NA	500	500	100	50
TPH motor oil (C20-C36)	68476-77-7	NA	NA	500	500	100	50

Notes:

1. PRC are not available for TPH fractions (i.e., gasoline, jet fuel, motor oil) in the 2012 Update Petroleum Management Plan.

DL: detection limit
LOD: limit of detection
CAS: chemical abstracts service
NA: not applicable to this project
µg/L: micrograms per liter
LOQ: limit of quantitation
PAL: Project Action Level

SAP WORKSHEET #15 CONTINUED

Laboratory: EMAX
Matrix: Groundwater
Analytical Group: BTEX and MTBE (U.S. EPA Method 8260B)
Concentration Level: µg/L

Analyte	CAS Number	PAL[1] (µg/L)	PAL Reference	Project Quantitation Limit Goal (µg/L)	Laboratory-Specific		
					LOQs (µg/L)	LODs (µg/L)	DLs (µg/L)
Benzene	71-43-2	1	PRC	1	1	0.2	0.1
Toluene	108-88-3	150	PRC	1	1	0.2	0.1
Ethylbenzene	100-41-4	25	PRC	1	1	0.2	0.1
o, m, p-Xylene	136777-61-2	100	PRC	2	2	0.4	0.1
MTBE	1634-04-4	13	PRC	1	1	0.2	0.132

Notes:

1 PAL is the more conservative value between residential and marine ecological PRC presented in the 2012 Update Petroleum Management Plan

PRC: Preliminary Remediation Criteria
DL: detection limit
LOD: limit of detection
PAL: Project Action Level
CAS: chemical abstracts service
µg/L: micrograms per liter
LOQ: limit of quantitation

SAP WORKSHEET #15 CONTINUED

Laboratory: EMAX
Matrix: Groundwater
Analytical Group: PAHs (U.S. EPA Method 8270C SIM)
Concentration Level: µg/L

Analyte	CAS Number	PAL[1] (µg/L)	PAL Reference	Project Quantitation Limit Goal (µg/L)	Laboratory-Specific LOQs (µg/L)	Laboratory-Specific LODs (µg/L)	Laboratory-Specific DLs (µg/L)
1-Methylnaphthalene	90-12-0	1.4	PRC	0.02	0.02	0.01	0.005
2-Methylnaphthalene	91-57-6	150	PRC	0.02	0.02	0.01	0.005
Acenaphthalene	83-32-9	40	PRC	0.02	0.02	0.01	0.005
Acenaphthylene	208-96-8	300	PRC	0.02	0.02	0.01	0.005
Anthracene	120-12-7	300	PRC	0.02	0.02	0.01	0.005
Benzo(a)anthracene	56-55-3	0.029	PRC	0.02	0.02	0.01	0.005
Benzo(a)pyrene	50-32-8	0.2	PRC	0.02	0.02	0.01	0.005
Benzo(b)fluoranthene	205-99-2	0.029	PRC	0.02	0.02	0.01	0.005
Benzo(g,h,i)perylene	191-24-2	300	PRC	0.02	0.02	0.01	0.005
Benzo(k) Fluoranthene	207-08-9	0.056	PRC	0.02	0.02	0.01	0.005
Chrysene	218-01-9	0.56	PRC	0.02	0.02	0.01	0.005
Dibenzo(a,h)anthracene	53-70-3	0.0029	PRC	0.02	0.02	0.01	0.005
Fluoranthene	206-44-0	11	PRC	0.02	0.02	0.01	0.005
Fluorene	86-73-7	240	PRC	0.02	0.02	0.01	0.005
Indeno(1,2,3-cd)pyrene	193-39-5	0.029	PRC	0.02	0.02	0.01	0.005
Naphthalene	91-20-3	0.14	PRC	0.02	0.02	0.01	0.005
Pyrene	129-00-0	180	PRC	0.02	0.02	0.01	0.005

Notes:

1 PAL is the more conservative value between residential and marine ecological PRC presented in the 2012 Update Petroleum Management Plan

CAS: chemical abstracts service
DL: detection limit
LOD: limit of detection
LOQ: limit of quantitation
µg/L: micrograms per liter
PRC: Preliminary Remediation Criteria
PAL: Project Action Level

SAP WORKSHEET #15 CONTINUED

Laboratory: EMAX
Matrix: Groundwater
Analytical Group: Dissolved Metals (U.S. EPA Method 6010B)
Concentration Level: µg/L

Analyte	CAS Number	PAL[1] (µg/L)	PAL Reference	Project Quantitation Limit Goal (µg/L)	Laboratory-Specific LOQs (µg/L)	Laboratory-Specific LODs (µg/L)	Laboratory-Specific DLs (µg/L)
Arsenic	7440-38-2	NA	NA	10	10	5.0	3.0
Lead	7439-92-1	8.1	PRC	10	10	3.0	1.7

Notes:

1 PAL is the more conservative value between residential and marine ecological PRC presented in the 2012 Update Petroleum Management Plan

CAS: chemical abstracts service
PRC: Preliminary Remediation Criteria
LOD: limit of detection
DL: detection limit
NA: not applicable to this project
PAL: Project Action Level
µg/L: micrograms per liter
LOQ: limit of quantitation

SAP WORKSHEET #15 CONTINUED

Laboratory: EMAX
Matrix: Groundwater
Analytical Group: Total Dissolved Solids (U.S. EPA Method 160.1/SM2540C)
Concentration Level: mg/L

Analyte	**CAS Number**	**PAL[1]** (mg/L)	**PAL Reference**	**Project Quantitation Limit Goal** (mg/L)	**Laboratory-Specific**		
					LOQs (mg/L)	**LODs** (mg/L)	**DLs** (mg/L)
Total Dissolved Solids	Not applicable	NA	NA	10	10	10	10

Notes:

1 No Action Limits for Anions. Data are collected as a general chemistry parameter and do not have an established project action limits. The data will be used to assess natural attenuation.

CAS: chemical abstracts service
mg/L: milligrams per liter
LOQ: limit of quantitation
PAL: Project Action Level
DL: detection limit
LOD: limit of detection
NA: not applicable to this project

SAP WORKSHEET #15 CONTINUED

Laboratory: EMAX
Matrix: Groundwater
Analytical Group: Anions (U.S. EPA Method 300.0)
Concentration Level: mg/L

Analyte	CAS Number	PAL[1] (mg/L)	PAL Reference	Project Quantitation Limit Goal (mg/L)	Laboratory-Specific LOQs (mg/L)	Laboratory-Specific LODs (mg/L)	Laboratory-Specific DLs (mg/L)
Sulfate	14808-79-8	NA	NA	0.5	0.5	0.25	0.13
Nitrate	14797-55-8	NA	NA	0.1	0.1	0.05	0.025

Notes:

1 No Action Limits for Anions. Data are collected as a general chemistry parameter and do not have an established project action limits. The data will be used to assess natural attenuation.

CAS: chemical abstracts service
mg/L: milligrams per liter
LOQ: limit of quantitation
PAL: Project Action Level
DL: detection limit
LOD: limit of detection
NA: not applicable to this project

SAP WORKSHEET #15 CONTINUED

Laboratory: EMAX
Matrix: Groundwater
Analytical Group: Total Organic Carbon (U.S. EPA Method 415.1/SM5310B)
Concentration Level: mg/L

Analyte	CAS Number	PAL[1] (mg/L)	PAL Reference	Project Quantitation Limit Goal (mg/L)	Laboratory-Specific LOQs (mg/L)	Laboratory-Specific LODs (mg/L)	Laboratory-Specific DLs (mg/L)
Total Organic Carbon (TOC)	Not applicable	NA	NA	1.0	1.0	0.5	0.25

Notes:

1 No Action Limits for Anions. Data are collected as a general chemistry parameter and do not have an established project action limits. The data will be used to assess natural attenuation.

CAS: chemical abstracts service
mg/L: milligrams per liter
LOQ: limit of quantitation
PAL: Project Action Level
DL: detection limit
LOD: limit of detection
NA: not applicable to this project

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SAP WORKSHEET #16 PROJECT SCHEDULE/TIMELINE TABLE (OPTIONAL FORMAT)

The project schedule is presented in a Gantt chart in Figure A-6. The schedule is contingent on the approval of the Sampling and Analysis Plan.

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SAP WORKSHEET #17 SAMPLING DESIGN AND RATIONALE

The treatability study and groundwater monitoring will be conducted to assess the effectiveness of the oxygen-producing compounds to degrade remaining petroleum hydrocarbons in the subsurface soils and groundwater at CAA 4C and CAA 7. The sampling design and rationale for this project are described below.

Treatment Study

A total of approximately 107 DPT injections of bioremediation amendment will be installed (ca. 43 injections in CAA 4C and ca. 64 in CAA 7) in a single injection event, to perform the treatment study of the petroleum contamination in groundwater. Approximately 3,360 square feet in CAA 4C and approximately 5,040 square feet in CAA 7 will be treated using the oxygen-releasing compounds. The treatment footprint within CAA 4C includes ISCO treatment of two areas of approximately 800 square feet within CAA 4C (around well OB-04 and DVE-07 where elevated concentrations of fuel components have persisted). A total of 10 DPT injections are proposed for these two areas. EISB-a treatment will be applied to the remaining 2,560 square feet using 33 DPT injections. The DPT injection depth interval will be from approximately 4 feet bgs to 16 feet bgs at CAA 4C and approximately 2 feet bgs to 16 feet bgs at CAA 7. This proposed treatment area is made on the basis of achieving a radius of influence of 5 feet for each injection. A sampling grid was prepared for both CAA 4C and CAA 7 (Figures A-4 and A-5) that has grids sized 10 feet by 10 feet to allow site coverage.

The in-situ treatment consists of the following tasks:

- Groundwater extraction
- Groundwater amendment (i.e., mix reagent/oxidant with extracted groundwater)
- Amended groundwater injection
- Performance monitoring

Groundwater will be extracted from the existing monitoring wells to provide the mixing water for the oxygen amendment. The advantages of using site groundwater to the extent practicable for the treatment are that (1) plume displacement is minimized by removing site groundwater and thus avoiding increases to the overall volume of water in the treatment area, and (2) favorable geochemistry is maintained by avoiding use municipal water that has been treated with sanitation chemicals (such as chlorine or chloramines) intended to kill microorganisms.

As a contingency, water from a nearby fire hydrant may be used as an alternate water supply if the extraction of aquifer water fails to achieve targeted flow/volume requirements to support the planned injection. Water obtained from the fire hydrant for amendment and injection will be filtered using an in-line carbon filter to remove chloramines and chlorine sanitation products that may be detrimental to native bacteria.

Groundwater will be extracted from the existing monitoring wells using down-well electric submersible pumps and/or tubing connected to an above-grade water pump. The extraction will occur continuously during working hours (i.e., Monday through Friday, 0700 to 1730) to obtain enough water to mix the slurry to 10 percent to 30 percent by volume. An anticipated volume of 2,500 gallons is required to complete the reagent injection at CAA 4C and 2,900 gallons are required for the injection at CAA 7. These volumes require a daily extraction of 300 gallons at CAA 4C and 270 gallons at CAA 7.

SAP WORKSHEET #17 CONTINUED

A portable mixing and injection system will be used for the reagent delivery; the system consists of trailer-mounted equipment and a water storage tank. The portable system allows effective and efficient reagent delivery to up to three injection points simultaneously. A total of 700 gallons of reagent can be stored on the trailer in two tanks. Dosing of reagent and water is automatically controlled by a metering pump. The reagent and groundwater mix are emulsified by an in-line static mixer. Options exist for storing reagent and groundwater mix either prior to or after mixing, depending on injection requirements.

At each injection location, the drive rods will be pushed to the desired depth and the slurry will be applied under pressure while the drive rods are slowly pulled up using a specialized fluid injection tooling. First, steel rods led by a “drivepoint” will be advanced to the target depths; amended groundwater will then be injected at a rate no higher than 8 gallons per minute, as the rods and drivepoint are slowly retracted from the boring (a bottom-up injection). Using DPT injection provides control on vertical placement of the reagent, and allows for field flexibility and adjustment to unanticipated field conditions. Amended groundwater will be injected at a sufficient pressure to distribute the reagent horizontally within a depth horizon. The injection tooling is attached to the drivepoint and will be equipped with a check valve assembly to prevent backflow that could occur as the drive rods are retracted form the borehole. Once the drivepoint and rods are removed, the injection borehole will be sealed with a bentonite grout slurry, and tremied to the surface. The surface will be completed to match the existing grade.

Groundwater monitoring at CAA 4C and CAA 7 will be performed to evaluate effectiveness of proposed ISCO (at selected locations of CAA 4C) and EISB-a in reducing fuel contamination of groundwater and achieving the PRCs. Summaries of the proposed monitoring program for the two sites, and well as groundwater monitoring wells included in the performance monitoring program, are presented in Table 14-1. Groundwater monitoring wells included in the proposed groundwater monitoring program are listed below:

Treatability Area	**Treatment Zone**	**Downgradient**	**Upgradient**
CAA 4C	DVE-03, -05, -07, 30, BW-06, and OB-04	DVE-16, -22, -25, -27, MW547-4	DVE-20, OB-02, -06, -07 and -09
CAA 7	DVE-3, -5, -8, -9, M07A-05, and IT013-CA07-0014	DVE-28, -29	

Locations of the monitoring wells at CAA 4C are presented on Figure A-4 of this SAP and monitoring wells selected for CAA 7 are shown on Figure A-5. Sample IDs, estimated sample depth, and sampling SOP references are listed in Worksheet #18. The collected groundwater samples will be delivered to analytical laboratory for the analyses listed in Worksheet #18. Analytical results generated during the treatability testing will be compared with baseline results to evaluate effectiveness of ISCO and EISB-a processes in reducing fuel component contamination in the groundwater below their site-specific PRC. Groundwater results for TPH, VOCs, and PAHs, will be used to estimate removal efficiency and mass removal. ISCO and EISB-a processes will be evaluated using groundwater results for selected anions (nitrate, sulfate, TOC), and field measured geochemical parameters.

SAP WORKSHEET #17 CONTINUED

Field QC samples will be collected for groundwater analysis for VOCs, PAHs, and dissolved metals, including field duplicates (10 percent of field samples) and trip blanks (1 trip blank per cooler with water samples for VOC analysis). Field duplicates are not proposed for other groundwater analyses because of the screening nature of the data. Collection and analysis of matrix spike (MS) and MS duplicates (MSD) for all applicable water analysis will provide sufficient precision information to meet DQOs.

Groundwater samples will be collected using well-dedicated or disposable sampling equipment and, therefore, no equipment blanks are anticipated.

The proposed field QC samples are summarized in Worksheet # 20.

Groundwater Sampling Methodology

Groundwater monitoring at CAA 4C and CAA 7 will be performed in accordance with this SAP, which will be onsite at all times during the sampling. Proposed groundwater monitoring wells and analyses are listed in Worksheet #18. Measurements of groundwater levels will be conducted for all monitoring wells as listed in Worksheet #18. The measurements will be collected prior to each sampling event. Water level measurements will be performed immediately prior to the sampling event. At each well, the well cap will be removed and wellhead will be checked for organic vapors using a PID. The groundwater will be allowed to equilibrate with atmospheric conditions for approximately 5 minutes before water level measurements are taken. A permanent reference mark will be scribed onto the top of the casing to provide a consistent reference point. Depth to water (DTW) measurements will be taken to an accuracy of 0.01 foot using a water level indicator. The water level indicator will be decontaminated as described in Worksheet #14. The measurement will be recorded in the field logbook.

Groundwater from monitoring wells will be sampled for offsite laboratory analyses, as summarized in Worksheet #18. Monitoring wells will be purged using the low-flow purging (micropurge) method. The objective of micropurging is to minimize stress to the groundwater system by decreasing drawdown caused by pumping. Pumping at a low flow rate effectively isolates the screened interval from the overlying (stagnant) casing water, thereby sampling water from the screened interval only. The flow rate will be adjusted to approximately 0.5 liters per minute (L/min) or less. A submersible pump (Sample Pro® bladder pump or similar) with a flow controller and disposable tubing and bladders will be used for well purging and sample collection.

The water level in each well will be measured during drawdown to determine the most appropriate flow rate for the well. During purging, in-line water quality parameters will be monitored continuously in a flow-through cell with Horiba U-22TM (or similar) instrument. Water level monitoring and water quality parameter measurements will be taken every 3 to 5 minutes.

Stabilization is achieved after three consecutive readings are within:

- ± 10% for pH
- ± 20 millivolts for ORP
- ± 0.2 mg/L for DO
- ± 10 NTU for turbidity

SAP WORKSHEET #17 CONTINUED

- ± 10% (± 2°C) for temperature
- ± 10% for conductivity

After parameter stabilization, groundwater samples will be collected using the submersible pump (e.g., Sample Pro®) with a flow controller and disposable or well-dedicated tubing. To collect a representative groundwater sample, the in-line water quality parameter monitoring device for sample collection will be disconnected or bypassed. The sample flow rate will be adjusted to minimize aeration, bubble formation, turbulent filling of the sample bottles, or loss of volatiles due to extended residence time in tubing. Samples will be collected in approved sample containers for the appropriate type of analysis to be performed (for details refer to Worksheet #19).

The groundwater monitoring will include laboratory analyses to allow evaluation of contaminant concentration trends. Groundwater samples will be analyzed using the following methods:

- Purgeable TPH (TPH-P, by modified U.S. EPA Method 8015B)
- BTEX (and MTBE at CAA 7 only, by U.S. EPA Method 8260B)
- PAHs (by U.S. EPA Method 8270C SIM)
- Extractable TPH (TPH-E, by modified U.S. EPA Method 8015B, including silica gel cleanup to remove polar compounds)
- TDS (by U.S. EPA Method 160.1/SM2540C)
- Selected dissolved metals (arsenic and lead, by U.S. EPA Method 6010B)
- Anions (Nitrate and sulfate, by U.S. EPA Method 300.0)
- EISB-a parameters:
    - ORP (by field meter)
    - pH (by field meter)
    - Dissolved oxygen (by field meter and Hach Test Kit)
    - Nitrate and sulfate (by U.S. EPA Method 300)
    - Total organic carbon (by U.S. EPA Method 415.1/SM5310B)

Glass vials with a Teflon®−lined septum will be used when sampling groundwater for TPH-P and BTEX analyses. The sample vials will be filled completely so the water forms a convex meniscus at the top and then a Teflon®−lined cap will be screwed on tightly so that no air space (i.e., bubbles) is present in the vial and to prevent the container from leaking. If the sample is spilled during this procedure, the vial will be discarded and another sample vial will be collected.

All sample vials and containers will be labeled according to Worksheet #27 and appropriate sample information will be recorded on a chain of custody form and in the field logbook as described in Worksheet #27. After the samples have been collected, they will be immediately placed in an ice-filled cooler. The sampling team will keep the coolers in their possession until shipped to an offsite laboratory.

SAP WORKSHEET #18 SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE

Sample Location/ID Number	Matrix	Depth	Analytical Group	Number of Samples	Sampling SOP Reference[1]
BW-06/CAA4C-BW06-XXXXXXX (Date provided in month, date, year)	Water	10.20 feet bgs	TPH-P, TPH-E, BTEX, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
DVE-03/CAA4C-DVE03-XXXXXXX (Date provided in month, date, year)	Water	10.63 feet bgs	TPH-P, TPH-E, BTEX, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
DVE-05/CAA4C-DVE05-XXXXXXX (Date provided in month, date, year)	Water	10.90 feet bgs	TPH-P, TPH-E, BTEX, PAHs, Lead, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
DVE-07/CAA4C-DVE07-XXXXXXX (Date provided in month, date, year)	Water	11.09 feet bgs	TPH-P, TPH-E, BTEX, PAHs, Lead, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
DVE-16/CAA4C-DVE16-XXXXXXX (Date provided in month, date, year)	Water	11.47 feet bgs	TPH-P, TPH-E, BTEX, PAHs, Lead, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
DVE-22/CAA4C-DVE22-XXXXXXX (Date provided in month, date, year)	Water	10.02 feet bgs	TPH-P, TPH-E, BTEX, PAHs, Lead, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
DVE-30/CAA4C-DVE30-XXXXXXX (Date provided in month, date, year)	Water	10.77 feet bgs	TPH-P, TPH-E, BTEX, PAHs, Lead, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
OB-04/CAA4C-OB04-XXXXXXX (Date provided in month, date, year)	Water	10.70 feet bgs	TPH-P, TPH-E, BTEX, PAHs, Lead, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
OB-06/CAA4C-OB06-XXXXXXX (Date provided in month, date, year)	Water	10.71 feet bgs	TPH-P, TPH-E, BTEX, PAHs, Lead, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
DVE-3/CAA7-DVE3-XXXXXXX (Date provided in month, date, year)	Water	8.09 feet bgs	TPH-P, TPH-E, BTEX+MTBE, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14

SAP WORKSHEET #18 CONTINUED

Sample Location/ID Number	Matrix	Depth	Analytical Group	Number of Samples	Sampling SOP Reference[1]
DVE-5/CAA7-DVE5-XXXXXXX (Date provided in month, date, year)	Water	8.08 feet bgs	TPH-P, TPH-E, BTEX+MTBE, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
DVE-8/CAA7-DVE8-XXXXXXX (Date provided in month, date, year)	Water	7.96 feet bgs	TPH-P, TPH-E, BTEX, PAHs, Lead, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
DVE-9/CAA7-DVE9-XXXXXXX (Date provided in month, date, year)	Water	8.73 feet bgs	TPH-P, TPH-E, BTEX, PAHs, Lead, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
DVE-28/CAA7-DVE28-XXXXXX (Date provided in month, date, year)	Water	13.70 feet bgs	TPH-P, TPH-E, BTEX, PAHs, Arsenic, Lead, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
DVE-29/CAA7-DVE29-XXXXXX (Date provided in month, date, year)	Water	13.52 feet bgs	TPH-P, TPH-E, BTEX, PAHs, Arsenic, Lead, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
IT013-CA07-0014/CAA7-IT013CA070014-XXXXXXX (Date provided in month, date, year)	Water	4.45 feet bgs	TPH-P, TPH-E, BTEX, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14
M07A-05/CAA7-M07A05-XXXXXXX (Date provided in month, date, year)	Water	8.69 feet bgs	TPH-P, TPH-E, BTEX, Sulfate, Nitrate, TDS, TOC	4	Worksheet #14

Notes:

1 Standard operating procedure (SOP) or worksheet that describes the sample collection procedures.

SAP WORKSHEET #19 ANALYTICAL SOP REQUIREMENTS TABLE

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Containers (number, size, and type)	Sample Volume[1] (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time[2] (preparation/analysis)
Groundwater	TPH-Extractable	U.S. EPA Method modified 8015B	1 liter amber glass bottle	500 ml	< 6°C	7 days Extraction / 40 Days Analysis
Groundwater	TPH-Purgeable (Gas)	U.S. EPA Method modified 8015B	2 x 40-ml VOA vials	40 ml	HCl to pH< 2, no head space, < 6°C	14 days
Groundwater	Anions (nitrate and sulfate)	U.S. EPA Method 300.0/ Ion Chromatography Analysis	250-ml HDPE bottle	100 ml	< 6°C	48 hours for nitrate; 28 days for sulfate
Groundwater	PAHs	U.S. EPA Method 8270C SIM	1 liter amber glass bottle	500 ml	< 6°C	7 days Extraction / 40 Days Analysis
Groundwater	Dissolved metals (field filtered 0.45 micron)	U.S. EPA Method 6010B	250-ml HDPE bottle	50 ml	HNO_3; < 6°C	6 months
Groundwater	TDS	U.S. EPA Method 160.1/SM2540C	1 liter HDPE bottle	1000 ml	< 6°C	7 days
Groundwater	TOC	U.S. EPA 415.1/SM5310B	250-ml glass bottle	150 ml	HCl ; < 6°C	28 days
Groundwater	VOCs (BTEX and MTBE)	U.S. EPA Method 8260B/Volatile Organics by GC/MS	3 x 40-ml VOA vials	40 ml	HCl to pH< 2, no head space, < 6°C	14 days

Notes:

1 The minimum volume requirement is provided when it differs from the container volume.
2 Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.
3 IDW samples not presented in this table.
ml = milliliters
°C = degrees Celsius

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SAP WORKSHEET #20 FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE

Matrix	Analytical Group	No. of Samples[1]	No. of Field Duplicates[2]	No. of MS/MSD[3]	No. of Source Water Blanks[4]	No. of Equip. Blanks[5]	No. of Trip Blanks	Total No. of Samples to Lab
Groundwater	TPH-P	60	0	3	1	0	0	64
Groundwater	TPH-E	60	0	3	0	0	0	68
Groundwater	PAHs	36	4	2	0	0	0	42
Groundwater	TDS	60	0	0	0	0	0	60
Groundwater	Dissolved metals (arsenic and/or lead)	36	4	2	0	0	0	42
Groundwater	Nitrate and sulfate	60	0	3	0	0	0	63
Groundwater	TOC	60	0	3	0	0	0	63
Groundwater	VOCs (BTEX and MTBE only)	60	6	3	1	0	8	78

Notes:

1 Samples will be collected in accordance with Worksheet #18. This includes four groundwater sampling events: the baseline groundwater sampling event and three quarterly performance monitoring sampling events.
2 Field duplicates will be collected at a rate of 1 per 10 field samples.
3 Although the MS/MSD is not typically considered a field QC, it is included here because location determination is often established in the field. An MS/MSD will be collected at a rate of 1 per 20 field samples.
4 Source Water Blank: A source water blank is used to determine the quality of the source water used for decontamination and will only be analyzed for BTEX, MTBE and TPH-P.
5 Equipment Blank: An equipment blank (rinsate blank) is used to assess the effectiveness of decontamination procedures. Equipment blanks are obtained under representative field conditions by running analyte-free, deionized/distilled water (provided by the laboratory) through sample collection equipment after decontamination and prior to use, and placing the water in the appropriate sample containers for analysis. Equipment blanks are not required because either well-dedicated equipment or disposable sampling equipment will be used for each well.

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SAP WORKSHEET #21 PROJECT SAMPLING SOP REFERENCES TABLE

All project-specific tasks and procedures are detailed within SAP Worksheets #14 and #17.

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SAP WORKSHEET #22 FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION TABLE

Field Equipment [1]	Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference	Comments
PID	Visual Inspection	Daily, prior to sampling activity	Within manufacturer's recommended values	Operator correction or return to manufacturer for repair.	Ulf Richter	Manufacturer's operating instructions	–
	Maintenance and Charging	Daily, prior to sampling activity. Maintenance check at end of day	Within manufacturer's recommended values	Operator correction or return to manufacturer for repair.	Ulf Richter	Manufacturer's operating instructions	–
	Calibration	Daily, prior to sampling activity and as needed	Within manufacturer's recommended values	Recalibrate until acceptable range or return to manufacturer for repair.	Ulf Richter	Manufacturer's operating instructions	–
	Testing	Daily, during sampling activity	Within manufacturer's recommended values	Operator correction or return to manufacturer for repair.	Ulf Richter	Manufacturer's operating instructions	–
Water Quality Meter	Visual Inspection	Daily, prior to sampling activity	Within manufacturer's recommended values	Operator correction or return to manufacturer for repair.	Ulf Richter	Manufacturer's operating instructions	–
	Maintenance and Charging	Daily, prior to sampling activity. Maintenance check at end of day	Within manufacturer's recommended values	Operator correction or return to manufacturer for repair.	Ulf Richter	Manufacturer's operating instructions	–
	Calibration	Daily, prior to sampling activity and as needed	Within manufacturer's recommended values	Recalibrate until acceptable range or return to manufacturer for repair.	Ulf Richter	Manufacturer's operating instructions	–
	Testing	Daily, during sampling activity	Within manufacturer's recommended values	Operator correction or return to manufacturer for repair.	Ulf Richter	Manufacturer's operating instructions	–

Notes:

1 Rental equipment and instruments are frequently used in the field by the MMEC Group. The rental firms will be responsible for the proper care, maintenance, and repair of these items, and for tracking and documenting equipment and instrument maintenance and repairs.

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SAP WORKSHEET #23 ANALYTICAL SOP REFERENCES TABLE

Lab SOP Number	Title, Revision Date, and/or Number [1]	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
EMAX-8015G	Gasoline Range Organics (GRO), Rev. 5, 1/24/2014	Definitive	Water/TPH-P	Gas Chromatograph (GC)	EMAX	No
EMAX-8015D	Diesel Range Organics (DRO), Rev. 6, 09/24/2014	Definitive	Water/TPH-E	Gas Chromatograph (GC)	EMAX	No
EMAX-8260	Volatile Organics by GC/MS, Rev. 10, 06/4/2014	Definitive	Water-BTEX and MTBE	GC/MS	EMAX	No
EMAX-8270SIM	Semi Volatile Organics by GC/MS SIM, Rev. 2, 05/7/2014	Definitive	Water-PAHs	GC/MS	EMAX	No
EMAX-6010	Trace Metals By ICP, Rev. 7, 9/9/2014	Definitive	Water-Metals	ICP	EMAX	No
EMAX-300.0	Anions by Ion Chromatography Analysis, Rev. 10, 09/24/2014	Screening	Water/Nitrate and Sulfate	Ion Chromatography (IC)/Conductivity	EMAX	No
EMAX-415.1/SM5310B	Total Organic Carbon, Rev. 4, 5/5/2014/ Rev. 3, 5/5/2014	Screening	Water/Total Organic Carbon	TOC Analyzer	EMAX	No
EMAX-160.1/SM2540C	Total Dissolved Solids, Rev. 8, 4/15/2014/ Rev. 7, 4/15/14	Screening	Water/TDS	Filtration	EMAX	No

Notes:

1 The laboratory SOPs are included in Attachment 3.

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SAP WORKSHEET #24 ANALYTICAL INSTRUMENT CALIBRATION TABLE

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for CA	SOP Reference[1]
GC/MS	ICAL	Initially; as needed	SPCCs: RF >= 0.1 for Bromoform, Chloromethane, 1,1-Dichloroethane. RF >= 0.3 for Chlorobenzene, 1,1,2,2 Tetrachloroethane CCCs: Chloroform; 1,1-DCE; 1,2-DCP; Ethylbenzene; Toluene; Vinyl Chloride. CCCs < 30% and one option below: 1). linear- mean RSD for all analytes =/<15% 2). linear least squares regression r =/> 0.995, when RSD >15% 3). non-linear COD > 0.990 (6 points shall be used for second order, 7 points shall be used for third order	Locate the source of the problem. If expected RFs are not met, check for standard degradation or perform instrument adjustment and/or maintenance to correct the problem, then ICAL.	Chemist	EMAX-8260

SAP WORKSHEET #24 CONTINUED

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for CA	SOP Reference[1]
GC/MS	ICV	Every after ICAL	All analytes within ±25% of expected value except for the following compounds due to erratic chromatographic behavior: Bromomethane, Chloroethane, Chloromethane, and Dichlorodifluoromethane within 35% of expected values.	Prepare fresh standard and re-analyze ICV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL and ICV.	Chemist	EMAX-8260
GC/MS	DCC	Every 12 hrs.	SPCCs: Min RF same as ICAL. CCC: < 20% difference (when using RFs) or drift (when using least squares regression or non-linear calibration)	Prepare fresh standard and re-analyze CCV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	Chemist	EMAX-8260
GC/HPLC/IC	ICAL	Initially; as needed	1) RSD for all analytes ≤20% 2) linear least squares regression r > = 0.995 3) non-linear COD > 0.990 (6 points shall be used for second order, 7 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.	Chemist	EMAX-300.0 EMAX-8015G EMAX-8015D

SAP WORKSHEET #24 CONTINUED

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for CA	SOP Reference[1]
GC/HPLC/IC	ICV	Every after ICAL	All project analytes within established retention time windows. All analytes within ±20% of expected value from ICAL for GC methods. All analytes within ±15% of expected value from ICAL for HPLC/IC methods.	Prepare fresh standard and re-analyze ICV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	Chemist	EMAX-300.0 EMAX-8015G EMAX-8015D
GC	DCC	Every 12 hrs.	All analytes within ±20% of expected value for 8015G, 8015D	Prepare fresh standard and re-analyze CCV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	Chemist	EMAX-8015G EMAX-8015D
IC	ICAL	Initial calibration prior to sample analysis and as needed.	r > =0.995	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.	Chemist	EMAX-300.0

SAP WORKSHEET #24 CONTINUED

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for CA	SOP Reference[1]
IC	ICV	Once after each initial calibration.	All project analytes within established retention time windows. IC Methods: All project analytes within ±10% of expected value from ICAL.	Prepare fresh standard and re-analyze ICV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	Chemist	EMAX-300.0
IC	CCV	Daily, before sample analysis, after every 10 field samples, and at the end of analysis sequence.	All project analytes within established retention time windows. IC Methods: All project analytes within ±10% of expected value from ICAL.	Diagnose problem. Prepare fresh standard and re-analyze CCV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem. Reanalyze all samples since last successful CCV. If problem persists, repeat ICAL.	Chemist	EMAX-300.0
TOC Analyzer	ICAL	Initially, as needed thereafter	Correlation coefficient (r) ≥0.995	Locate the source of the problem. If outliers exist, prepare fresh calibration standards and repeat ICAL. If problem persists, perform photometric linearity check. If maximum absorbance is non-compliant, replace the spectrometer lamp and repeat ICAL.	chemist	EMAX-415.1/SM5310B

SAP WORKSHEET #24 CONTINUED

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for CA	SOP Reference[1]
TOC Analyzer	ICV	After ICAL	All analytes within ± 10% of expected value	Prepare fresh standard and re-analyze ICV to rule out standard degradation or inaccurate injection. If problem persists perform instrument maintenance to correct the problem and repeat ICAL.	Chemist	EMAX-415.1/SM5310B
TOC Analyzer	CCV	Daily before sample analysis, at the end of the analysis sequence	All analytes within ±10% of expected value	Repeat calibration and reanalyze all samples since last successful calibration.	Chemist	EMAX-415.1/SM5310B
TOC Analyzer	Initial Calibration Blank (ICB) Continuing Calibration Blank (CCB)	Following ICV, prior to sample analysis Following CCV, prior to sample analysis, after every 10 samples, and at end of analysis sequence	No detects ≥ ½ LOQ	Determine source of blank contamination and correct problem. Reanalyze with all associated samples	Chemist	EMAX-415.1/SM5310B

SAP WORKSHEET #24 CONTINUED

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for CA	SOP Reference[1]
ICP	Initial Calibration (ICAL) –	Daily	If more than one calibration standard is used, r>= 0.995	Locate the source of the problem. Check for standard degradation or perform instrument adjustment and/or maintenance to correct the problem and then repeat initial Calibration	Chemist	EMAX-6010
ICP	Low Level Calibration Check Standard	Once after each initial calibration	Value of all project analytes within 20% of true value.	Diagnose the problem. Prepare fresh standard and re-analyze to rule out standard degradation or inaccurate injection. If problem persist perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	Chemist	EMAX-6010
ICP	ICV	Once after each initial calibration	Value of all project analytes within 10% of true value.	Prepare fresh standard and re-analyze 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.	Chemist	EMAX-6010

SAP WORKSHEET #24 CONTINUED

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for CA	SOP Reference[1]
ICP	Continuing Calibration Verification	After every 10 field samples, and at the end of analysis sequence.	Value of all project analytes within 10% of true value.	Diagnose problem. Prepare fresh standard and re-analyze CCV to rule out standard degradation or inaccurate injection. If problem persist perform instrument adjustment and/or maintenance to correct the problem. Reanalyse all samples since last successful CCV. If problem persists, repeat ICAL.	Chemist	EMAX-6010
GRAVIMETRIC	Analytical Balance Calibration Check	Daily before sample analysis	+ 0.1% of certified weight value.	Clean the balance, center the level indicator and repeat calibration check.	Chemist	EMAX-160.1 /SM2540C

SAP WORKSHEET #24 CONTINUED

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for CA	SOP Reference[1]
GC/MS	Initial Calibration (ICAL) –	Initial calibration prior to sample analysis	SPCCs average RF ± 0.050 and %RSD for RFs for CCCs < 30% and one option below (1). linear – mean RSD for all analytes ≤15% (2). linear – least squares regression r ≥ 0.995, when RSD >15% (3). non-linear – COD r^2 > 0.990 (6 points shall be used for second order, 7 points shall be used for third	Locate the source of the problem. If expected RFs are not met, check for standard degradation or perform instrument adjustment and/or maintenance to correct the problem then repeat initial calibration If SPCC is non-compliant, it could be a result of standard degradation or active presence to active sites in the system. Correct the problem and repeat calibration. If CCC is non-compliant, it could be a result of system leaks, or reactive column sites or standard degradation. Correct the problem and recalibrate. If RSD is non-compliant, check for outlier and repeat that ICAL point; otherwise perform instrument troubleshooting and repeat calibration	Analyst	EMAX-8270SIM

SAP WORKSHEET #24 CONTINUED

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for CA	SOP Reference[1]
GC/MS	Second source calibration verification	Once after each initial calibration	Value of second source for all analytes within ±20% of expected value (initial source) except for the following compounds due to erratic chromatographic behavior: benzidine, 4,6-dinitro-2-methylphenol, 4-chloroaniline, benzylalcohol, n-Nitrosodimethylamine, 4-nitrophenol, 2-nitroaniline, pyridine, benzoic acid and 3-nitroaniline within +/- 35% of expected value.	Prepare fresh standard and reanalyze second source to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance, and rerun initial calibration and second source verification standard. If problem continues, new standards may need to be purchased, prepared, and analyzed.	Analyst	EMAX-8270SIM
GC/MS	Calibration Verification (CV)	Daily, before sample analysis, and every 12 hours of analysis time	SPCCs average RF ≥ 0.050; and CCCs and target analytes £ 20% difference (when using RFs) or drift (when using least squares regression or non-linear calibration) except for the following compounds due to erratic chromatographic behavior: benzidine, 4,6-dinitro-2-methylphenol, 4-chloroaniline, benzylalcohol, n-Nitrosodimethylamine, 4-nitrophenol, 2-nitroaniline, pyridine, benzoic acid and 3-nitroaniline within +/- 30% of expected value.	If SPCC is non-compliant, it could be a result of standard degradation or active presence to active sites in the system. Correct the problem and repeat calibration. If CCC is non-compliant, it could be a result of system leaks, or reactive column sites or standard degradation. Correct the problem and recalibrate	Analyst	EMAX-8270SIM

SAP WORKSHEET #24 CONTINUED

Notes:

1 The laboratory SOP is included in Attachment 3.

CCC	criteria continuing concentration
CCV	continuing calibration verification
COD	coefficient of determination
DCC	daily calibration check
GC	gas chromatograph
IC	ion chromatography
ICAL	initial calibration
ICV	initial calibration verification
MS	mass spectrometer
RF	response factor
RSD	relative standard deviation
SPCC	system performance check compound

All analytical instruments will be calibrated and the calibration acceptance criteria met before samples are analyzed. The analytical laboratories will follow calibration procedures that are compliant with the DoD QSM (DoD, 2013) and the published U.S. EPA methods. Calibration standards will be prepared with National Institute for Standards and Testing traceable standards and analyzed per methods requirements.

Worksheet #24 will be used to identify all project-specific analytical instrumentation that requires maintenance, testing, or inspection and provide the SOP reference number for each.

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 GC ICP IC	Parameter setup	Physical check	Check that autosampler is functioning as expected Check that temperature program is set at the most recently determined optimum condition Check pressure, effluent, detector, flowrate is set per SOP	Initially; prior to each use	Autosampler must move to the expected position when activated. Refer to instrument optimize-temperature-program setup.	Reset autosampler; if problem persists, perform autosampler 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	Chemist	EMAX-8260 EMAX-8015 EMAX-6010 EMAX-8270SIM

SAP WORKSHEET #25 CONTINUED

Instrument/Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
						on that condition when checked.)		
GC/MS	Tune check	Instrument performance check	Conformance to instrument tuning	Initially; then prior to DCC	Compliance to ion abundance criteria as specified by the method	Repeat tune check to rule out standard degradation or inaccurate injection. If problem persists, perform retune the instrument and repeat tune check.	Chemist	EMAX-8260 EMAX-8270SIM
GC-MS	Traps	Instrument performance – failing CCV	Change trap	When responses start to drop; failing CCV	Lack of moisture; CCV pass	Replace and rebake traps; reanalyze CCV or recalibrate instrument	Chemist	EMAX-8260 EMAX-8270SIM
GC-MS	Detector maintenance	Column change, failing tune	Change detector and/or pump oil	Oil level/quality visually examined monthly; oil physically changed every 6 months	Tune passes; scan does not indicate presence of air/water	Refill or exchange the oil; clean parts; reanalyze tune	Chemist	EMAX-8260 EMAX-8270SIM

SAP WORKSHEET #25 CONTINUED

Instrument/Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
IC	Daily Check	Physical check	Examples: Check pump for leaks and spills. Check all air lines for crimping or discoloration. Empty waste container if needed. Detector maintenance inspect flow cell for leaks.	Daily, prior to use	No physical defects and performance checks within limits.	Examples: Isolate and repair leaks. Relocate pinched lines and replace damaged lines.	Chemist	EMAX-300.0
IC TOC,	ICB/CCB	Instrument Performance	Instrument contamination check	After every ICV/CCV	No analytes detected > 1/2 RL or above LOD as applicable to project	Determine possible source of contamination, correct the problem, and reanalyze calibration blank and all associated samples.	Chemist	EMAX-300.0 EMAX-415.1/SM5310B

SAP WORKSHEET #25 CONTINUED

Instrument/Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
ICP	ICS/ICSA	Instrument Performance	Conformance to interference check	Prior to sample analysis	**ICS-A:** Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified impurity from a spiked analyte. **ICS-AB** ± 20% of expected value	Terminate analysis, and reanalyze ICS to rule out standard degration or inaccurate injection. If the problem persists, perform instrument maintenance, repeat calibrations, and reanalyze all associated samples.	Chemist	EMAX-6010

SAP WORKSHEET #25 CONTINUED

Instrument/Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
ICP	ICB/CCB	Instrument Performance	Instrument contamination check	After every calibration Verification – Before samples, after every 10, and at the end of sequence.	No analytes detected $\geq$ LOD	Determine possible source of contamination and apply appropriate measure to correct the problem. Reanalyze calibration blank and all associated samples.	Chemist	EMAX-6010

Notes:

CCB = continuing calibration blank
DCC = daily calibration check
GC = gas chromatograph
IC = ion chromatography
ICB = initial calibration blank
ICS = interference check solution
L/min = liters per minute
MS = mass spectrometer
RL = reporting limit
rps = revolutions per second

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SAP WORKSHEET #26 SAMPLE HANDLING SYSTEM

Sample Handling System
Sample Collection, Packaging, and Shipment
Sample Collection (Personnel/Organization): Field Sampling Team/MMEC Group
Sample Packaging (Personnel/Organization): Field Sampling Team/MMEC Group
Coordination of Shipment (Personnel/Organization): Field Sampling Team/MMEC Group
Type of Shipment/Carrier: Courier and Overnight Shipping
Sample Receipt and Analysis
Sample Receipt (Personnel/Organization): Molly Nguyen/ EMAX
Sample Custody and Storage (Personnel/Organization): Molly Nguyen/ EMAX
Sample Preparation (Personnel/Organization): Molly Nguyen/EMAX
Sample Determinative Analysis (Personnel/Organization): Molly Nguyen/EMAX
Sample Archiving
Field Sample Storage (Number of days from sample collection): 60 days, or as required on a project specific basis
Sample Extract/Digestate Storage (Number of days from extraction/digestion): 60 days, or as required on a project specific basis
Biological Sample Storage (Number of days from sample collection): Not Applicable
Sample Disposal
Personnel/Organization: Sample Receiving, EMAX
Number of Days from Analysis: 30 days, or as required on a project specific basis

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SAP WORKSHEET #27 SAMPLE CUSTODY REQUIREMENTS TABLE

Sample Identification Number

Each sample collected from boreholes and for IDW characterization will be assigned a unique sample identification (ID) code used to record and report the results. The sample ID code consists of two sections divided by a hyphen as follows: ***CAA4C- or CAA7--WELLID-DATE***

- CAA4C designates the site as CAA 4C and CAA7 designates the site as CAA 7.
- The WELLID is the ID for existing monitoring wells at either CAA 4C (BW-06, DVE-03, DVE-05, DVE-07, DVE-16, DVE-22, DVE-30, OB-04, OB-06) or CAA 7 (DVE-3, DVE-5, DVE-8, DVE-9, IT013-CA07-0014, M07A-05)
- The DATE is eight digits identifying the date that the sample was collected.

For example, a groundwater sample collected at monitoring well DVE-03 on November 15, 2014, would have an ID of CAA4C-DVE03-11152014.

QC samples collected during the sampling will use the same coding system as the environmental samples. Field QC designations will conform to the following formats:

Source Blanks: Source blank sample identifiers will consist of a “SB” label and the sequential number. Example: SB01

Equipment Blanks: Equipment blank (EB) sample identifiers will consist of an “EB” label, and the sequential number. Example: EB01

Trip Blanks: Trip blank sample identifiers will consist of a “TB” label, and the sequential number. Example: TB01

Temperature Blanks will be labeled as temperature blanks. Temperature blanks are not subject to chemical analysis and the results will not be entered into the database.

Field Documentation

Complete and accurate documentation is essential to ensure proper sample identification and to demonstrate that sampling procedures are carried out as described in the SAP. Field activities and original data generated in the field will be recorded using permanently bound, hardcover, uniquely labeled field logbooks with sequentially numbered pages. The following general guidelines for maintaining field documentation will be followed by project personnel:

- Documentation will be completed in permanent black ink.
- All entries will be legible.
- Errors will be corrected by drawing a single line through the error and writing the correct information; the correction will be initialed and dated.
- Unused pages will be crossed out, and each page will be signed and dated.

In addition, a field logbook will be maintained by the field sampler to summarize chronologically all field activities performed during the course of a given workday. Details on the logbook procedures are discussed in this Worksheet under Field Logbook.

SAP WORKSHEET #27 CONTINUED

All information pertinent to field sampling will be recorded in a field logbook to maintain the integrity and traceability of samples. All samples will be properly labeled and custody sealed before they are transported to the laboratory and will be accompanied by completed chain of custody (COC) documentation. All documentation will be recorded in a field logbook in indelible ink.

No information will be obliterated from a sample label, logbook, instrument calibration form, or COC record. Corrections made to any field forms or logbooks will be made by drawing a line through the error, entering the correct information, and entering initials by the individual making the correction and the date on which the correction was made. If the error is noted after the sample label has been taped for protection or after a custody seal has been affixed to the sample container before being shipped, the field sampler will discard the erroneous label or seal and make a new one. Error corrections made to a sample label or COC form will be noted in the logbook.

Sample Labels

Sample labels serve to prevent misidentification of samples by openly displaying unique identification. Sample containers can be prepared before field work or onsite. Sample labels will be made of weatherproof paper or plastic with a gummed back and will be completed with indelible ink. When necessary, the labels will be covered with clear tape to minimize damage to the label. This information will be entered into the database during sample check in. A description of the sample (including the sample identification number and sample date and time) will be recorded in the field logbook. Any other pertinent information regarding sample identification will be recorded on the sample log sheets or in the field logbooks. The following information will be on each sample label:

- Sample ID code
- Identification of the project site of sample collection
- Name or initials of field sampler
- Analysis required and sample preservation (if applicable)
- Date of sampling (MM/DD/YYYY)
- Local standard time of sample collection, using 24-hour clock notation

Chain of Custody

The field sampler is responsible for creating a COC record where information for each sample collected in the field will be entered. The COC record is necessary to physically trace sample possession from the time of collection to ultimate disposition. Each COC record will be signed as relinquished or received with each change of possession. The following information must be contained in the COC:

- Project name and number
- Names of field samplers
- Sample identification number

SAP WORKSHEET #27 CONTINUED

- Date of sampling
- Local standard time of sample collection, using 24-hour clock notation
- Sample matrix
- Number and type of containers for each sample aliquot
- Type of analysis requested
- Preservation of sample containers (if applicable)
- Means of transmittal to the analytical laboratory or unusual circumstances
- Special handling instructions
- Destination of samples
- Name, date, time, and signature of each individual releasing the shipping container
- Name, address, and individual to receive results

The "COMMENTS/INSTRUCTIONS" line in the COC record will be used to communicate any specific instructions to the analytical laboratory. Additional information relating to a sample may also be noted in the "REMARKS" line. In the event that more than one analytical laboratory will be used, different COC forms will be made for each lab. The number of containers (i.e., coolers) intended to go to a specific analytical laboratory will be made clear on the COC form under the block, "NO. OF COOLERS SHIPPED." See Attachment 1 for a sample of the COC form.

Field Logbook

A logbook will be maintained by the field sampler to summarize chronologically all field activities performed during the course of a given workday. The logbook is intended to provide interested parties, who are not present in the field at the time of data entry, with all the necessary information about field conditions in order to recreate the event that occurred during field work. Logbooks are to be pre-bound with numbered pages and all entries must be made in indelible ink. To avoid tampering, the user will draw a line across any unused space and initial to signify that no entries were made in those blank pages or spaces by the authorized user. Logbooks will contain, at a minimum, the following information:

- Date of entry and recorder's name
- Site location
- Sample location, including distances to nearest fixed point (s) of reference
- Sample depth (bgs, if applicable)
- Sample matrix
- Sample appearance
- Volume of sample collected

SAP WORKSHEET #27 CONTINUED

- Field measurements (if applicable)
- Type of sampling equipment used
- Names of all individuals present during sampling
- Sample collection date and times, using 24-hour clock notation
- Sample identification numbers
- Type and number of sample containers used per sampling site
- Designation of QC samples (e.g., blanks, splits, or duplicates)

A logbook is considered a legal document and is admissible as evidence in legal proceedings; therefore, entries made should be factual, detailed, and objective.

Sample Packing and Shipment

Because degradation of samples can occur rapidly following collection due to physical, chemical, and biological factors, it is important to exercise precaution when handling, transporting, or storing samples prior to laboratory analyses. Immediately following collection, the samples will be appropriately labeled, packaged, and placed in a cooler with ice (double bagged in re-sealable bags), to maintain a temperature of between 2 and 6°C. The samples will be delivered to the laboratory at the earliest possible time (but no later than two days following collection) and accompanied by a proper COC record and shipping documentation to track any change in sample possession. Details of the sample packing and shipment procedures are as follows.

Sample packaging and shipment procedures for this project will conform to Department of Transportation/International Air Transport Association procedures as applicable for packaging. All sample containers will be double-bagged using resealable plastic bags to protect the sample from moisture and to minimize the potential for breakage or cross-contamination during transportation to the laboratory. If transported by a commercial carrier, all glass sample containers will be protected with bubble wrap before they are placed in coolers.

Each cooler will be shipped with a temperature blank. The temperature of the cooler will be recorded by the laboratory on the COC record immediately upon receipt of the samples. Sample cooler drain spouts will be taped from the inside and outside of the cooler to prevent leakage.

The samples will be packed in a sample cooler with ice (double bagged in resealable bags) below and above sample containers. Two custody seals will be taped across the cooler lid: one seal in the front and one seal in the back. The COC record will be completed and signed by the courier. The cooler and the top two copies (white and pink) of the COC record will then be released to the courier for transportation to the laboratory.

Saturday deliveries will be coordinated with the laboratory in advance, and field sampling personnel or their designee must confirm that Saturday delivery stickers are placed on each cooler.

SAP WORKSHEET #27 CONTINUED

Laboratory Custody Procedures

Laboratory sample receipt, handling, and custody procedures are provided in more detail in the lab quality systems manual. The lab SOP includes laboratory sample management and COC procedures. At a minimum, the following procedures will be included. The laboratory sample custodian will inspect the integrity of the cooler custody seals and measure the temperature of the samples received using the “Temperature Blank” container included in each cooler. The samples will be checked according to the laboratory “Sample Receiving Checklist” (see laboratory custody SOPs included in Attachment 3) against the COC form for holding times, sample identification, and integrity. The samples will be logged into the laboratory management system. Immediately after receipt, the samples will be stored in an appropriate, secure storage area. Custody of the samples will be maintained and recorded in the laboratory from receipt to analysis and this record will be included with the data package deliverables. If the laboratory sample custodian judges sample custody to be invalid (e.g., samples arrive damaged or custody seals have been broken), the MMEC Group PM will be advised immediately, and the samples will not be analyzed unless the MMEC Group PM so authorizes. The MMEC Group PM, laboratory PMs, and QCM will be notified. The MMEC Group PM will make a decision as to the fate of the sample(s) in question on a case-by-case basis.

The sample(s) will be either processed “as is” with custody failure noted along with the analytical data, or rejected with sampling rescheduled if necessary. Any problem with a sample will be noted in the appropriate data report.

In addition, the lab will follow the laboratory SOPs for proper disposal of the environmental samples in accordance with federal, state, and local ordinances.

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SAP WORKSHEET #28 LABORATORY QC SAMPLES TABLE

Matrix:	**Water**
Analytical Group:	**TPH by Gas Chromatograph**
Analytical Method/SOP Reference:	**U.S. EPA Modified 8015B (GRO)**

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Blank	1 per 20 samples	No analyte detected equal to or above the reporting limit	1) Reanalyze blank 2) Qualify data, as appropriate	Analyst	Accuracy/Bias-Contamination	No analytes detected equal to or above RL
MS/MSD Set	Project designated sample matrix QC	% Recovery-50-130%, RPD <30%	1) Reanalyze 2) Qualify data, as appropriate	Analyst	Accuracy/Bias-Contamination	% Recovery 50-130%, RPD <30%
LCS/LCSD Set (as necessary)	1 set per 20 samples	% Recovery-60-130%, RPD <30%	1) Reanalyze 2) Qualify data, as appropriate	Analyst	Accuracy/Bias-Contamination	% Recovery 60-130%, RPD <30%

RL = reporting limit
RPD = relative percent difference

SAP WORKSHEET #28 CONTINUED

Matrix:	**Water**
Analytical Group:	**TPH by Gas Chromatograph (DRO)**
Analytical Method/SOP Reference:	**U.S. EPA Modified 8015B**

QC Sample	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Blank	1 per 20 samples	No analyte detected equal to or above the reporting limit	1) Reanalyze blank 2) Qualify data, as appropriate	Analyst	Accuracy/Bias-Contamination	No analytes detected equal to or above RL
MS/MSD Set	Project designated sample matrix QC	% Recovery-50-130%, RPD <30%	1) Reanalyze 2) Qualify data, as appropriate	Analyst	Accuracy/Bias-Contamination	% Recovery 50-130%, RPD <30%
LCS/LCSD Set (as necessary)	1 set per 20 samples	% Recovery-50-130%, RPD <30%	1) Reanalyze 2) Qualify data, as appropriate	Analyst	Accuracy/Bias-Contamination	% Recovery 50-130%, RPD <30%

RL = reporting limit
RPD = relative percent difference

SAP WORKSHEET #28 CONTINUED

Matrix	Water
Analytical Group	VOCs
Method/SOP Reference	U.S. EPA 8260B

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1/batch	No detects ≥ ½ LOQ	If sufficient sample volume is available, reanalyze blank, QC and affected samples. If volume is not sufficient, qualify data as needed.	Analyst	Accuracy, Bias, Contamination	No detects ≥ ½ LOQ
LCS/LCSD	1/batch	Refer to QC Limits provided below	If sufficient sample volume is available, reanalyze QC and affected samples. If volume is not sufficient, qualify data as needed. Discuss in narrative	Analyst	Accuracy, Precision	Refer to QC Limits provided
MS/MSD	Project designated sample matrix QC	Refer to QC Limits provided below	None refer to LCS/LCSD-Flag/discuss in narrative	Analyst	Accuracy, Precision	
Surrogate	All environmental and laboratory samples	Refer to QC Limits provided below	If sufficient sample volume is available, reanalyze affected samples. If volume is not sufficient, qualify data as needed.	Analyst	Accuracy/Bias	
Internal Standard	All environmental and laboratory samples	Areas within -50% to +100% of ICAL midpoint standard	If sufficient sample volume is available, reanalyze affected samples. If volume is not sufficient, qualify data as needed.	Analyst	Accuracy, Representativeness	Areas within -50% to +100% of ICAL midpoint standard

SAP WORKSHEET #28 CONTINUED

Analytes	**LCS/MS (%)**
Benzene	80-120
Toluene	75-120
Ethylbenzene	75-125
m/p xylene	75-130
O-xylene	80-120
MTBE	65-125
Surrogates	
1,2-Dichloroethane-d4	70-120
4-Bromofluorobenzene	75-120
Dibromofluoromethane	85-115
Toluene-d8	85-120

SAP WORKSHEET #28 CONTINUED

Matrix	Aqueous
Analytical Group	SVOCs
Analytical Method / SOP Reference	Method 8270 SIM EMAX-8270

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	No analytes detected > ½LOQ. For common laboratory contaminants, no analytes detected > LOQ. Blank result must not otherwise affect sample results.	Determine cause of contamination and re-prep and reanalyze method blank and all samples processed with the non-conforming method blank.	EMAX Chemist	Accuracy/Bias - Contamination	No analytes detected > ½LOQ. For common laboratory contaminants, no analytes detected > LOQ. Blank result must not otherwise affect sample results.
Surrogate	Every analytical sample	Refer to QC Limit Table below	Correct problem and then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	EMAX Chemist	Accuracy/Bias	Refer to QC Limit Table below

SAP WORKSHEET #28 CONTINUED

Matrix	Aqueous					
LCS	One per sample preparation batch	Refer to QC Limit Table below with DOD ME Guidance	Re-prep and reanalyze LCS and all samples processed with the non-conforming LCS.	EMAX Chemist	Accuracy/Bias	Refer to QC Limit Table below
MS/MSD	Project designated sample matrix QC	Refer to QC Limit Table below	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 - Precision	Refer to QC Limit Table below

SAP WORKSHEET #28 CONTINUED

Analyte	CL_LL	CL_UL	RPD
1-Methylnaphthalene	25	135	30
2-Methylnaphthalene	25	135	30
Acenaphthene	20	130	30
Acenaphthylene	30	140	30
Anthracene	40	130	30
Benzo(a)anthracene	40	130	30
Benzo(a)pyrene	40	130	30
Benzo(b)fluoranthene	40	130	30
Benzo(k)fluoranthene	40	130	30
Benzo(g,h,i)perylene	30	150	30
Chrysene	40	130	30
Dibenzo(a,h)anthracene	40	140	30
Fluoranthene	40	130	30
Fluorene	10	150	30
Indeno(1,2,3-cd)pyrene	40	130	30
Naphthalene	20	130	30
Phenanthrene	40	130	30
Pyrene	40	130	30
Surrogates			
Terphenyl-d14	30	145	

SAP WORKSHEET #28 CONTINUED

Matrix	Water
Analytical Group	**METALS**
Analytical Method / SOP Reference	**6010B / EMAX-6010**

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	No analytes detected > ½LOQ. For common laboratory contaminants, no analytes detected > LOQ. Blank result must not otherwise affect sample results.	Re-prep and reanalyze blank and all samples processed with the non-conforming blank.	EMAX Analyst	Accuracy/Bias - Contamination	No analytes detected > ½LOQ. For common laboratory contaminants, no analytes detected > LOQ. Blank result must not otherwise affect sample results.
LCS	One per preparation batch	% Rec. : 80-120	Re-prep and reanalyze LCS and all samples processed with the non-conforming LCS.	EMAX Analyst	Accuracy/Bias	% Rec. : 80-120
MS/MSD	Project designated sample matrix QC.	%Rec.: 75-125 RPD +-20%	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract / reanalyze the sample.	EMAX Analyst	Interferences - Accuracy/Bias - Precision	%Rec.: 75-125 RPD +-20%
Dilution Test	Per sample preparation batch.	1:5 dilution must agree within +- 10% of the original determination	Perform post digestion spike addition	EMAX Analyst	Accuracy/Bias)	1:5 dilution must agree within +- 10% of the original determination

SAP WORKSHEET #28 CONTINUED

Matrix	Water					
Analytical Spike	When Dilution Test fails or analyte concentration in all samples < 50x LOD	Recovery within 75-125% of expected value	Run all samples by method of standard addition (MSA)	EMAX Analyst	Interferences - Accuracy/Bias - Precision	Recovery within 75-125% of expected value
PT	Bi-annual	Within Study Limits	Review source of error, perform corrective action and rerun PT sample.	EMAX Analyst	Accuracy/Bias	

SAP WORKSHEET #28 CONTINUED

Matrix	Water
Analytical Group	Anions
Method/SOP Reference	U.S. EPA 300.0

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1/batch	No detects ≥ ½ LOQ	Reanalyze with all associated samples	Analyst	Accuracy, Contamination	No detects ≥ ½ LOQ
LCS/LCSD	1/batch	% REC: 90 110%	If sufficient sample volume is available, reanalyze affected samples. If volume is not sufficient, qualify data as needed. Discuss in narrative	Analyst	Accuracy/ Precision	% REC: 90 110%
		% RPD: 15%				% RPD: 15%
MS/MSD	Project designated sample matrix QC	% REC: 80 120%	Evaluate LCS/LCSD for acceptable accuracy and precision demonstration for the batch. Reanalyze if necessary and qualify data as needed.	Analyst	Accuracy/ Precision	% REC: 80 120%

SAP WORKSHEET #28 CONTINUED

Matrix	Water
Analytical Group	TOC
Method/SOP Reference	U.S. EPA 415.1/SM5310B

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1/batch	No detects ≥ ½ LOQ	If sufficient sample volume is available, reanalyze affected samples. If volume is not sufficient, qualify data as needed.	Analyst	Accuracy	No detects ≥ ½ LOQ
LCS/LCSD	1/batch	80% 120% Recovery 20% RPD	If sufficient sample volume is available, reanalyze affected samples. If volume is not sufficient, qualify data as needed. If outside CL but within ME, no action discuss in narrative.	Analyst	Accuracy/Precision	80% 120% Recovery 20% RPD
MS/MSD	Project designated sample matrix QC	70% 130% Recovery	Analyze post-digestion spikes and qualify data as needed.	Analyst	Accuracy/Precision	70% 130% Recovery 25% RPD

SAP WORKSHEET #28 CONTINUED

Matrix	Water
Analytical Group	TDS
Method/SOP Reference	U.S. EPA 160.1/SM2540C

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1/batch	No detects ≥ LOQ	If sufficient sample volume is available, reanalyze affected samples. If volume is not sufficient, qualify data as needed.	Analyst	Accuracy	No detects ≥ LOQ
LCS	1/batch	80% 120% Recovery 20% RPD	If sufficient sample volume is available, reanalyze affected samples. If volume is not sufficient, qualify data as needed. If outside CL but within ME, no action discuss in narrative.	Analyst	Accuracy	80% 120% Recovery
Duplicate	Project designated sample matrix QC.	RPD: ± 20%	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract / reanalyze the sample.	Analyst	Precision	RPD: + 20%

SAP WORKSHEET #29 PROJECT DOCUMENTS AND RECORDS TABLE

Document	Where Maintained
Work Plan	MMEC Group Project File and NAVFAC SW Administrative Record
Sampling and Analysis Plan	MMEC Group Project File and NAVFAC SW Administrative Record
Accident Prevention Plan and Site Safety and Health Plan	MMEC Group Project File and NAVFAC SW Administrative Record
Field notes/logbook	MMEC Group Project File
Chain of custody forms	MMEC Group Project File and NAVFAC SW Administrative Record
Audit checklists/reports	MMEC Group Project File
Field photographs	MMEC Group Project File
Laboratory analytical reports including the data packages (Level III and Level IV) as follows: • Table of contents • Signed cover letter • Chain of custody • Sample receipt form 1 • Communication logs (e-mails, phone logs etc.) • Data qualifier table • Case narrative • Results summary forms • QC summary forms • Calibration summary forms • Extraction/analysis logs • Nonconformance report (if applicable) • Raw data for samples, associated laboratory QC samples and calibrations	MMEC Group, Laboratory Project File, and NAVFAC SW Administrative Record
Third-party Level III and Level IV data validation reports	MMEC Group Project File and NAVFAC SW Administrative Record
Validated Laboratory Electronic Data Package	MMEC Group Project File and NAVFAC NEDD NIRIS Website

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SAP WORKSHEET #30 ANALYTICAL SERVICES TABLE

For this project, analytical services will be provided by EMAX. Turnaround times for the laboratory data package will be based on the date on which the laboratory receives the samples. Preliminary results from EMAX will be sent electronically via e-mail or web portal within 7 working days, and the final data package will be sent in electronic and hardcopy formats to the MMEC Group office within 10 working days. The backup laboratory for this project has yet to be determined. Both labs will be currently certified by the California Department of Health Services Environmental Laboratory Accreditation Program (ELAP), and will have received accreditation from a Department of Defense ELAP-accrediting body for analysis of hazardous materials for the methods specified in this SAP. Copies of the laboratory certifications are presented in Attachment 2. Status of laboratory certifications will be verified during project preparation and before samples are sent to the laboratory. If the laboratory's certification expires during the project execution, a copy of the renewed certification will be obtained to ensure that the laboratory is qualified to perform the analysis.

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/ Organization	Backup Laboratory/ Organization
Water	TPH	See Worksheet #20	U.S. EPA modified 8015B	Standard	EMAX	Eurofins
Water	BTEX, MTBE	See Worksheet #20	U.S. EPA 8260B	Standard	EMAX	Eurofins
Water	PAHs	See Worksheet #20	U.S. EPA 8270C SIM	Standard	EMAX	Eurofins
Water	Dissolved Metals	See Worksheet #20	U.S. EPA 160.1/SM2540C	Standard	EMAX	Eurofins
Water	Anions	See Worksheet #20	U.S. EPA 300	Standard	EMAX	Eurofins
Water	TDS	See Worksheet #20	U.S. EPA 160.1/SM2540C	Standard	EMAX	Eurofins
Water	TOC	See Worksheet #20	U.S. EPA 415.1/SM5310B	Standard	EMAX	Eurofins

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SAP WORKSHEET #31 PLANNED PROJECT ASSESSMENTS TABLE

Assessment Type[1]	Frequency	Internal or External	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	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
Operational Readiness Review	Prior to sampling activity	Internal	MMEC Group	PM, MMEC Group	PM, MMEC Group	PM, MMEC Group	PM, MMEC Group
Field Sampling Surveillance	During sampling activity	Internal	MMEC Group	QCM, MMEC Group	PM, MMEC Group	QCM, MMEC Group	QCM, MMEC Group MMEC Group PM, MMEC Group
Field Documentation Review	Daily	Internal	MMEC Group	QCM, MMEC Group PM, MMEC Group	PM, MMEC Group	QCM, MMEC Group	QCM, MMEC Group PM, MMEC Group
Data Review Surveillance	Once	Internal	MMEC Group	QCM, MMEC Group	PM, MMEC Group	QCM, MMEC Group	QCM, MMEC Group PM, MMEC Group

Notes:

1 Attachment 1 includes a copy of the sample field audit and review forms.

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SAP WORKSHEET #32 ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES

Assessment Type[1]	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
Operational Readiness Review	Audit Report	Matt Brookshire MMEC Group	1 day after completion of the inspection	Corrective Action Report	Matt Brookshire, QCM, MMEC Group	5 days
Field Sampling Surveillance	Audit Report	Matt Brookshire MMEC Group	1 day after completion of the inspection	Corrective Action Report	Matt Brookshire, QCM, MMEC Group	5 days
Field Documentation Review	Audit Report	Matt Brookshire MMEC Group	1 day after completion of the inspection	Corrective Action Report	Matt Brookshire, QCM, MMEC Group	5 days
Data Review Surveillance	Audit Report	Matt Brookshire MMEC Group	2 days after completion of the inspection	Corrective Action Report	Matt Brookshire, QCM, MMEC Group	5 days

Notes:

1 Attachment 1 includes a copy of the sample field audit and review forms

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SAP WORKSHEET #33 QA MANAGEMENT REPORTS TABLE

Type of Report[1]	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Operational Readiness Review	Prior to initiating field work and periodically throughout the duration of the project.	5 days after completion	Matt Brookshire, QCM, MMEC Group	MMEC Group PM
Field Sampling Surveillance	After all data have been generated and reviewed.	5 days after completion	Matt Brookshire, QCM, MMEC Group	MMEC Group PM
Field Documentation Review	After all data have been generated and reviewed.	5 days after completion	Matt Brookshire, QCM, MMEC Group	MMEC Group PM
Data Review Surveillance	After all data have been generated and reviewed.	5 days after completion	Matt Brookshire, QCM, MMEC Group	MMEC Group PM
Corrective Action Plan	After all data have been generated and reviewed.	Preliminary Draft of report approximately 60 days after validated data received. Final report delivery to be determined after internal and regulatory review cycles have been established.	Matt Brookshire, PM, MMEC Group	NAVFAC SW RPMs, Water Board

Notes:

1 Attachment 1 includes a copy of the sample field audit and review forms.

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SAP WORKSHEET #34 VERIFICATION (STEP I) PROCESS TABLE

Verification Input	Description	Internal/External	Responsible for Verification
Chain of Custody Forms	Content of the COC form will be reviewed daily and verified for completeness against the samples within the associated cooler. A copy of the COC form will be filed with other project documents in the assigned project file. The original COC form will be taped on the inside of the cooler for sample shipment.	Internal	Ulf Richter, MMEC Group
Field Notes/ Logbook	Field sampling data, i.e., field logbooks and field forms, will be reviewed and verified for completeness. Field notes/logbook will be forwarded to the PM and placed in the project file.	Internal	Ulf Richter, MMEC Group
Audit Reports	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.	Internal	Matt Brookshire, MMEC Group
Analytical Data Package	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 externally and internally according to the data validation process specified in Worksheet #36 of this SAP.	Internal/ External	Molly Nguyen, EMAX Linda Rauto, LDC
Electronic Data Deliverables	All electronic data deliverables will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal. All received electronic data deliverables will be verified externally and internally against the hard copy laboratory data packages	Internal/ External	Molly Nguyen, EMAX Linda Rauto, LDC

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SAP WORKSHEET #35 VALIDATION (STEPS IIA AND IIB) PROCESS TABLE

Step IIa/IIb[1]	Validation Input	Description	Responsible for Validation
IIa	Communication	Establish that the required communication procedures were followed by field or laboratory personnel.	Matt Brookshire, MMEC Group
IIa	Methods (sampling and analysis)	Establish that required sampling and analytical methods were implemented and that any deviations were noted. Evaluate whether proper procedures met performance criteria.	Molly Nguyen, EMAX
IIa	Location, maps, and sample ID numbers	Verify the accuracy and precision of the information under scrutiny.	Matt Brookshire, MMEC Group
IIa	Holding times	Ensure that samples were analyzed within holding times specified in method, procedure, or contract requirements. If holding times were not met, confirm that deviations were documented and appropriate notifications were made.	Molly Nguyen, EMAX
IIa	List of project-specific analytes	Establish that the project-specific analytes were reported as specified in governing documents (i.e., analytical method, contract, etc.).	Molly Nguyen. EMAX
IIa	Field logbook	On a weekly basis, the QCM or assignee will review and verify completeness of the information in the field logbooks as described in Worksheet #27 of this SAP.	Matt Brookshire, MMEC Group
IIa & IIb	Sampling instrument decontamination records	Establish that proper decontamination procedures were implemented by field sampling personnel.	Matt Brookshire, MMEC Group
IIa	Sampling instrument calibration logs	Establish that field instrumentation requiring calibration was implemented in accordance with the method, manufacturer’s manual, or procedure.	Matt Brookshire, MMEC Group
IIa	Chain of custody forms	Review COC records for completeness and accuracy on a daily basis. The QCM or assignee will look primarily for project information, sample analyses requested, number of field QC samples collected, and Level III and IV validation to be performed by the data validator.	Matt Brookshire, MMEC Group

SAP WORKSHEET #35 CONTINUED

Step IIa/IIb[1]	Validation Input	Description	Responsible for Validation
IIa	Sample receipts	Check the sample cooler for compliance with temperature and packaging requirements in Worksheet #19 of this SAP.	Molly Nguyen, EMAX
IIa	Sample logins	Review sample login for accuracy against the COC form.	Matt Brookshire, MMEC Group Marie Bevier, MMEC Group
IIb	Sampling plan and procedures	Evaluate whether sampling plan was executed as specified (i.e., the number, location, and type of field samples that were collected and analyzed as specified in the SAP). Evaluate whether sampling procedures were followed with respect to equipment and proper sampling support (i.e., techniques, equipment, decontamination, volume, preservation, temperature, etc.).	Matt Brookshire, MMEC Group
IIb	Project quantitation limits	Determine that quantitation limits were achieved as outlined in the SAP and that the laboratory successfully analyzed a standard at the quantitation limit.	Linda Rauto, LDC
IIb	Performance criteria	Evaluate QC data against project-specific performance criteria in the SAP (i.e., evaluate quality parameters beyond those outlined in the methods).	Matt Brookshire, MMEC Group Linda Rauto, LDC
IIa	Laboratory data packages	The analytical laboratory will validate laboratory data packages for technical accuracy. Review data packages for accuracy against the laboratory data that was faxed/e-mailed.	Linda Rauto, LDC
IIb	Data validation reports	Review data validation reports in conjunction with the project DQOs and DQIs per the SAP.	Matt Brookshire, MMEC Group

Notes:

1 IIa=compliance with methods, procedures, and contracts (see Table 10, page 117, UFP-QAPP manual, V.1, March 2005)
IIb=comparison with measurement performance criteria in the SAP (see Table 11, page 118, UFP-QAPP manual, V.1, March 2005)

SAP WORKSHEET #36 ANALYTICAL DATA VALIDATION (STEPS IIA AND IIB) SUMMARY TABLE

Step IIa/IIb[1]	Matrix	Analytical Group	Validation Criteria	Data Validator
IIa	Groundwater		In accordance with: • U.S. EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (2013) • U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review (2010a) • DoD Quality Systems Manual Version 5.0 (2013) • NAVFAC SW EWI #1 Data Validation Guidelines for Chemical Analysis of Environmental Samples (2001) • U.S. EPA SW-846 Methods	Linda Rauto, LDC
IIb	Groundwater		In accordance with: • U.S. EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (2013) • U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review (2010) • DoD Quality Systems Manual Version 5.0 (2013) • NAVFAC SW EWI #1 Data Validation Guidelines for Chemical Analysis of Environmental Samples (2001) • U.S. EPA SW-846 Methods	Marie Bevier, MMEC Group

Notes:

1 IIa=compliance with methods, procedures, and contracts (see Table 10, page 117, UFP-QAPP manual, V.1, March 2005)
IIb=comparison with measurement performance criteria in the SAP (see Table 11, page 118, UFP-QAPP manual, V.1, March 2005)

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SAP WORKSHEET #37 USABILITY ASSESSMENT

The usability assessment process is used to evaluate and document the usability (i.e., Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity [PARCCS]) of the data by considering the project DQOs and whether the data are suitable during the decision-making process. The analytical laboratory will be responsible for reviewing all analytical data generated under this contract to ensure that they meet the requirements of this UFP-QAPP. Each analyst reviews the quality of his/her work based on established protocols specified in laboratory SOPs, analytical method protocol, project-specific requirements, and DQOs.

The intent of the data quality assessment process is to establish the levels of PARCCS and the usability of the final results with respect to the project DQOs. Upon completion of data validation, each data point will be assessed as nonqualified, qualified, or rejected on the basis of the acceptance criteria, and data validation flags will be added to the project database. These parameters will be based upon the analytical data quality and will encompass the QC criteria established in this UFP–QAPP. Qualification will be given according to each sample’s sample delivery group, and will be based on the guidelines as presented in the National Functional Guidelines for Data Review (U.S. EPA, 2013; 2010a). Both analytical completeness and contract compliance completeness levels will then be determined for each analytical parameter. Finally, the overall usefulness of the data will be established as related to the project DQOs.

The usability assessment process will consist of reviewing the analytical data validation reports for both usable analytical data (i.e., no validation qualifications or estimated “J”/”UJ” qualifications) and rejected (“R” qualified) analytical data, as well as evaluating the field and analytical data for discrepancies or deviations. This assessment will evaluate the impact of the discrepancies or deviations on the usability of the data and assess whether all the necessary information has been provided for use in the decision-making process. The assessment will assess whether there were deviations in sampling activities (e.g., incorrect sample location or analysis performed), COC documentation, or holding times; compromised samples (i.e., damaged samples) and the need to resample; or changes to SOPs or methods that could potentially impact data quality. An evaluation of QC sample results will be performed to assess whether unacceptable QC results (e.g., blank contamination) impact data usability. Data use limitations will be discussed in the quality control reports for data that do not meet the DQOs or DQIs. Other parameters to be evaluated during the usability assessment may include, but are not limited to, the following:

- Matrix effects: Matrix conditions (e.g., salt water) that may impact the performance of the extraction or analytical method
- Site conditions: Unusual weather conditions or site conditions that may affect the sampling plan
- Identification of critical and noncritical samples or target analytes
- Background or historical data
- Data restrictions: Data that do not meet the project DQOs or were “R” qualified might be restricted but usable as qualitative values for limited decision-making purposes

SAP WORKSHEET #37 CONTINUED

Precision

Precision is the measure of variability between individual sample measurements under prescribed conditions. Analytical precision is the measurement of the variability associated with duplicate or replicate analyses. Laboratory duplicate, MSD, and LCS duplicate (if analyzed) samples will be used to assess field and analytical precision. The precision measurement will be determined using the relative percent difference (RPD) between the duplicate sample results as follows:

$$RPD = \frac{|A-B|}{(A+B)/2} \ x \ 100$$

where:

A = First duplicate concentration

B = Second duplicate concentration

The RPD limits for precision are presented in Worksheet #28. Associated samples that do not meet the criteria will be evaluated by the MMEC Group Project Chemist as described in Worksheet #35.

Accuracy

Accuracy is defined as the nearness of a result, or the mean of a set of results, to the true or accepted value. Analytical accuracy is measured by comparing the percent recovery (%R) of analytes spiked into a sample against a control limit. Accuracy will be measured using spiked samples, such as MS, MSD, LCS, and surrogates, if applicable. Surrogates, MS, MSD, and LCS analyzed for contaminants will also be used to assess matrix interferences. Calculation of %R is as follows:

$$Percent \ Recovery = \frac{S-C}{T} \ x \ 100$$

where:

S = Measured spike sample concentration

C = Sample concentration

T = True or actual concentration of the spike

The laboratory will review the QC samples and surrogate recoveries for each analysis to ensure that the %R lies within the control limits listed in the SAP. Otherwise, data will be flagged by the laboratory.

Representativeness

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.

SAP WORKSHEET #37 CONTINUED

The representativeness of data will be maintained by the use of established field and laboratory procedures and their consistent application.

Field personnel will be responsible for collecting and handling samples according to the procedures in this SAP so that samples are representative of field conditions. Errors in sample collection, packaging, preservation, or COC procedures may result in samples being judged as non-representative and may form a basis for rejecting the data.

Completeness

Completeness is the percentage of measurements made that are judged to be valid compared to the amount that was expected to be obtained under correct, normal conditions. The completeness goal is to generate a sufficient amount of valid data to meet project needs. To be considered complete, the data set must contain all analytical results and data specified for the project. In addition, all data are compared to project requirements to determine whether specifications were met. Completeness is evaluated by comparing the project objectives to the quality and quantity of the data collected to determine if any deficiencies exist. Data validation and data quality assessment will determine which data are valid and which data are rejected or missing.

Completeness is calculated and reported for each method, matrix, and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not qualified with a rejected (R) flag. The requirement of completeness is 90 percent for samples and is determined using the following equation:

$$Completeness = \frac{Number\ of\ Valid\ Measurements}{Total\ Number\ of\ Measurements}\ x\ 100$$

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 U.S. EPA-approved protocols. Laboratory procedures will follow standard analytical protocols, use standard units and standardized report formats, follow the calculations as referenced in approved analytical methods, and use a standard statistical approach for QC measurements.

Sensitivity

Sensitivity is the ability of the analytical test method and/or instrumentation to differentiate between detector responses to varying concentrations of the target constituent. Methodology to establish sensitivity for a given analytical method or instrument includes examination of standardized blanks, instrument detection limit studies, and calibration of the quantitation limit (QL). The findings of the usability of the data relative to sensitivity will be included in the report, including any limitations on the data set and/or individual analytical results.

SAP WORKSHEET #37 CONTINUED

The PARCCS measured performance criteria are described in Worksheets #12, 15, and 28. The following steps will be performed:

- Evaluate whether the project-required quantitation limits listed in Worksheet #15 were achieved for non-detected site contaminants. If no detectable results were reported and data are acceptable for the verification and validation steps, then the data are usable.
- If detectable concentrations are reported and the verification and validation steps are acceptable, the data are usable.
- If verification and validation are not acceptable, the data are qualified. Qualifiers (J, UJ) will be added for minor QC deviations that do not affect the data usability, or rejection (R) will be added for major QC deviations affecting data usability. The impact of rejected data will be evaluated and resampling may be necessary. The use of estimated data will be discussed in the project report.
- For statistical comparisons and mathematical manipulations, non-detect values will be represented by a concentration equal to one-half the sample-specific reporting limit. Duplicate results (original and duplicate) will not be averaged for the purpose of representing the range of concentrations. However, the average of the original and duplicate will be used to represent the concentration at that sample location.
- Statistical tests will be conducted to identify potential outliers. Potential outliers will be removed if a review of the field and laboratory documentation indicates that the results are true outliers.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

After completion of the data validation and review of the data quality indicator, the data will be reconciled with the measured performance criteria to determine whether sufficient data of acceptable quality are available for decision making. A series of inspections and statistical analyses will be performed to estimate the set characteristics. The statistical evaluations will include simple summary statistics for target analytes, such as maximum concentration, minimum concentration, number of samples exhibiting non-detected results, number of samples exhibiting positive results, and proportion of samples with raised results. The data will be presented in a tabular format. These inspections and statistical analyses will be designed to:

- Identify deviations from the field sampling SOPs, from laboratory analytical methods, from this SAP, and from the validation process.
- Evaluate effects of the above-listed deviations from planned procedures on the quality of the data to meet project objectives.
- Identify elevated sample quantitation limits and explain the impact of these results on project objectives.
- Identify unusable, rejected data.

SAP WORKSHEET #37 CONTINUED

- Evaluate project assumptions.
- Identify unanticipated data set characteristics such as laboratory variance greater than the sampling variance (i.e., ANOVA, t-test), if enough data are available.
- Identify and evaluate potential data outliers (95 percent confidence goodness-of-fit test on probability plot data); the plotted data will be transformed, if necessary, depending on the observed distribution.
- Evaluate adherence to investigation objectives and decision rules.
- Ensure completion of any corrective actions (CAs).
- Identify any data gaps.

Identify the personnel responsible for performing the usability assessment:

MMEC Group Project Chemist or designee.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

The data will be presented in tabular format; data qualifiers such as estimation (J, UJ) or rejection (R) will be applied. Written documentation will support the non-compliance estimated or rejected data results. The project report will identify and describe the data usability limitations and suggest resampling if necessary to fill out the data gaps.

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REFERENCES

Alameda Reuse and Redevelopment Authority (ARRA). 2006 Preliminary Development Concept for Alameda Point, Alameda, California. February.

AMEC Environment & Infrastructure, Inc. (AMEC). 2013. *Final Investigation Report Petroleum Program Groundwater Monitoring, Corrective Action Areas 4C, 7, and 11; Area of Concern 23G; and Building 410, Alameda Point, Alameda, California.* February.

Bechtel. 2003. *Draft Work Plan for Assessment of PAH Contamination at Selected CERCLA Sites and EBS Parcels, Alameda Point, Alameda, California*. May.

Battelle, 2009. Final Technical Memorandum, Update to Preliminary Remediation Criteria and Closure Strategy for Petroleum-Contaminated Sites, Petroleum Program at Alameda Point, Alameda, California. September.

_____. 2012. *2012 Update Petroleum Management Plan, Alameda Point, Alameda, California.* February.

Department of Defense (DoD). 2013. *Quality Systems Manual for Environmental Laboratories*, Version 5.0. July.

DON (Department of the Navy). 2009. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. October.

Naval Facilities Engineering Command Southwest (NAVFAC SW). 2001. *Environmental Work Instruction #1, Chemical Data Validation*, November.

_____. 2005. *Environmental Work Instruction #6, Environmental Data Management and Required Electronic Delivery Standards*, April.

_____. 2006. *Department of the Navy Environmental Restoration Program Manual*, August.

_____. 2010. *Environmental Work Instruction #3, Selecting an Environmental Laboratory That Meets Environmental Restoration Program Requirements*. August.

_____. 2011. *Environmental Work Instruction #2, Review, Approval, Revision, and Amendment of Sampling Analysis Plans (SAPs).* January.

NFESC (Naval Facilities Engineering Service Center). 1999. *Installation Restoration Chemical Data Quality Manual*.

Shaw Environmental, Inc. 2008. *Final Petroleum Corrective Action Summary Report, Former Naval Exchange Service Station, Corrective Action Area 7*, Alameda Point, Alameda, California. August.

Tetra Tech EC, Inc. (Tetra Tech). 2014. *Spring 2014 Petroleum Program Groundwater Monitoring Technical Memorandum, Corrective Action Areas C, 4C, 5B West, 6, 7, and Building 410, Alameda Point, Alameda, California.* May.

———. 2004. Final Remedial Investigation Report, Sites 6, 7, 8, and 16, Alameda Point, Alameda, California. November.

U.S. Environmental Protection Agency (U.S. EPA). 1988. *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Compliance with other Laws Manual,* Draft Guidance, EPA/540/G-89/006. Office of Emergency and Remedial Response, Washington DC. August.

______. 1994. *Guidance for the Data Quality Objectives (DQO) Process*, EPA QA/G-4, Final, September.

______. 1997. *Test Methods for Evaluation of Solid Wastes*, SW-846, Update III.

______. 2000. *Guidance for the DQOs Process*. Office of Environmental Information, EPA/600/R-96/055. EPA QC/G-4. August.

______. 2002. *Guidance for Quality Assurance Project Plans*. EPA QA/G-5, QAMS

______. 2005. *Uniform Federal Policy for Implementing Environmental Quality Systems: valuating, Assessing, and Documenting Environmental Data Collection/Use and Technology Programs*. March.

______. 2006. *Guidance on Systematic Planning Using the DQO Process*. EPA QA/G-4. Office of Environmental Information EPA/240/B-06/001. February.

______. 2010a. *Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review.* January.

______. 2010b. *Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.* January 19.

______. 2013. *Contract Laboratory Program National Functional Guidelines for Organic Superfund Data Review*. October.

Figures

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PROJECT NO.: 5023-14-6069
DATE: September 2014
DRAWN BY: RMH
CHECKED BY: CM

MMEC GROUP

Alameda Point, Alameda, California

ALAMEDA POINT LOCATION MAP

BIOREMEDIATION TREATABILITY STUDY AT PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7

FIGURE A-1

PROJECT NO.:	5023-14-6069
DATE:	September 2014
DRAWN BY:	RMH
CHECKED BY:	CM

MMEC GROUP

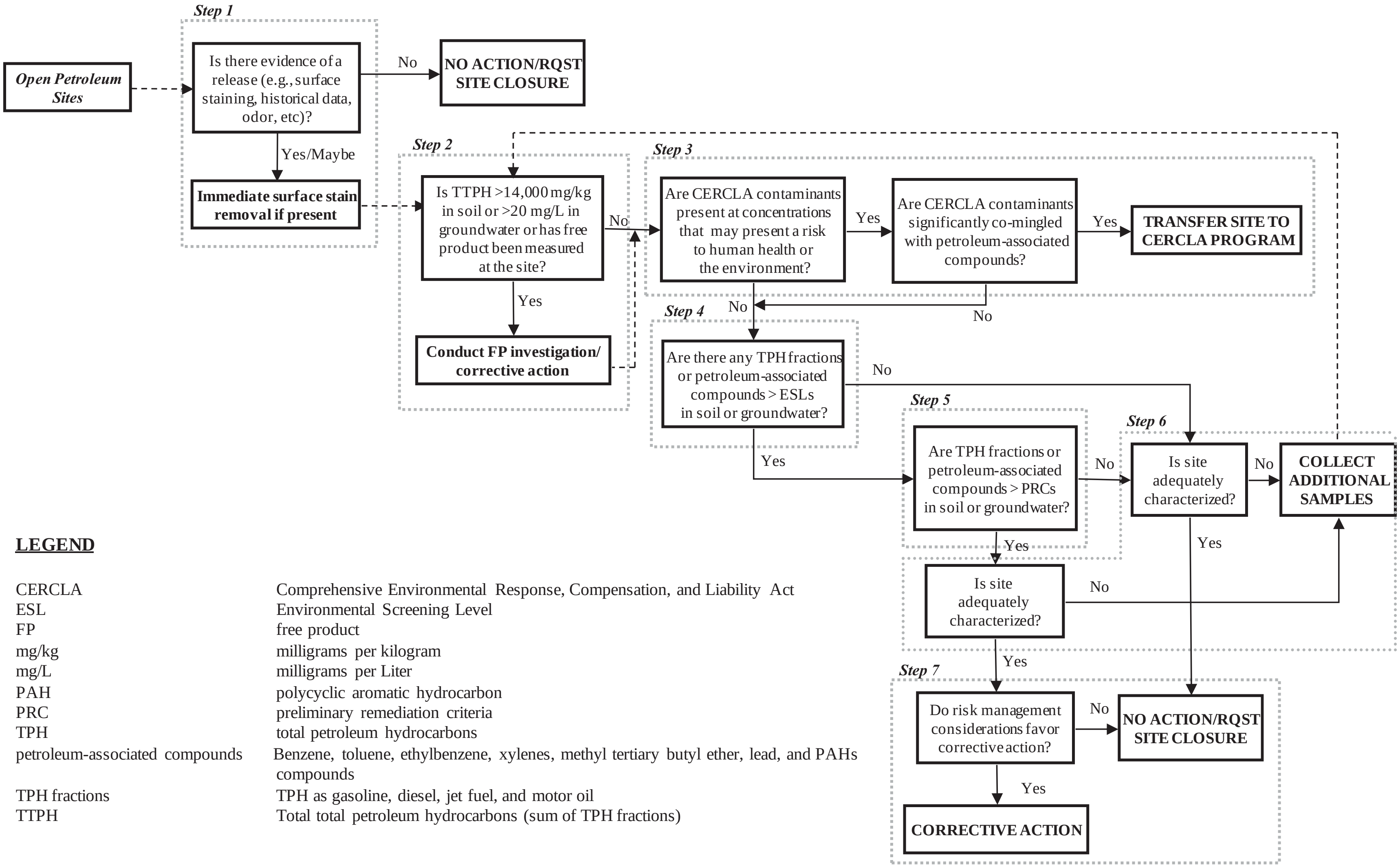
Alameda Point, Alameda, California

CORRECTIVE ACTION AREAS (CAA) 4C AND 7 LOCATION MAP

BIOREMEDIATION TREATABILITY STUDY AT PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7

FIGURE

A-2



LEGEND

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
ESL	Environmental Screening Level
FP	free product
mg/kg	milligrams per kilogram
mg/L	milligrams per Liter
PAH	polycyclic aromatic hydrocarbon
PRC	preliminary remediation criteria
TPH	total petroleum hydrocarbons
petroleum-associated compounds	Benzene, toluene, ethylbenzene, xylenes, methyl tertiary butyl ether, lead, and PAHs compounds
TPH fractions	TPH as gasoline, diesel, jet fuel, and motor oil
TTPH	Total total petroleum hydrocarbons (sum of TPH fractions)

Figure A-3. Petroleum Closure Decision Tree (Navy, 2009)

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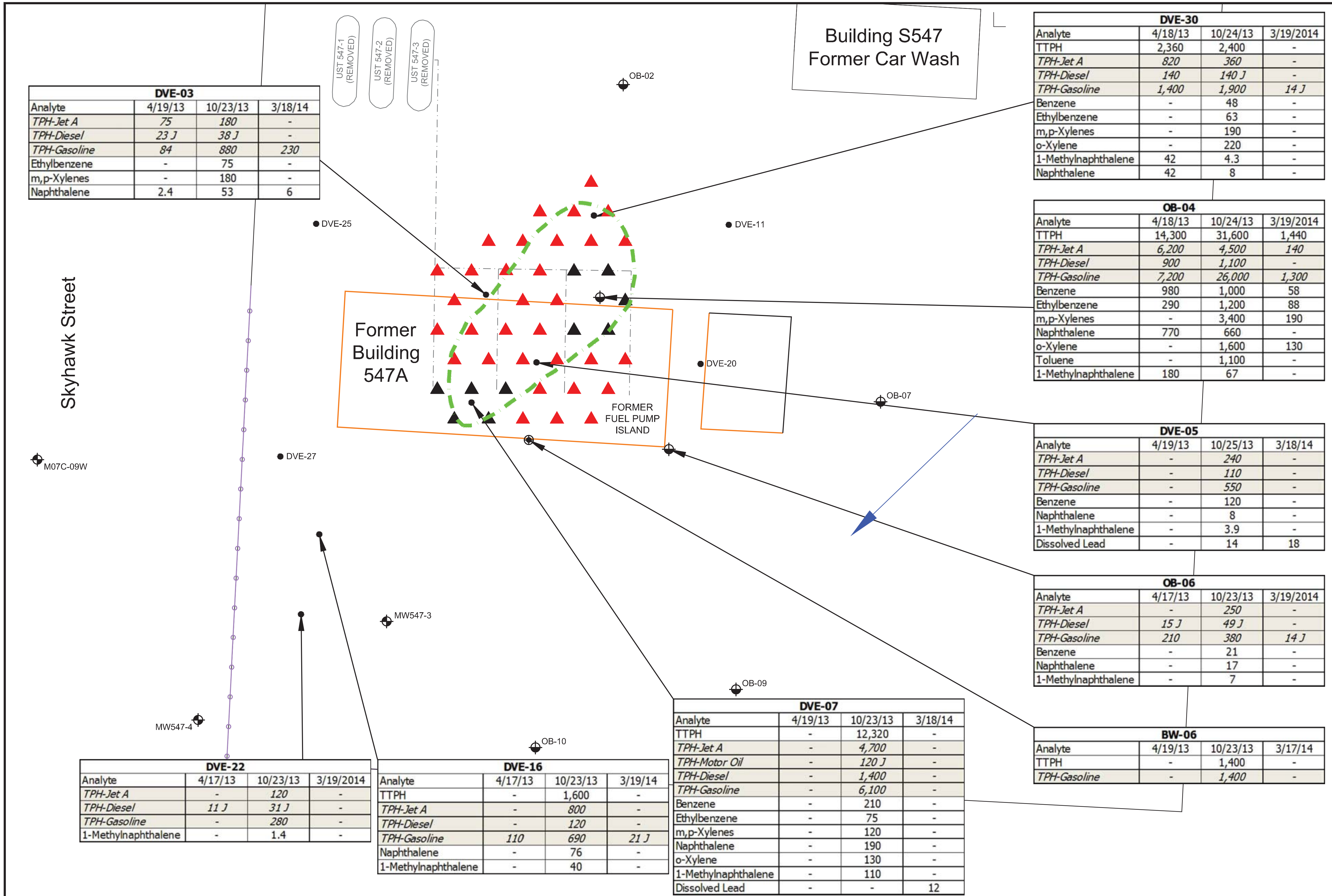

DVE-03			
Analyte	4/19/13	10/23/13	3/18/14
TPH-Jet A	75	180	-
TPH-Diesel	23 J	38 J	-
TPH-Gasoline	84	880	230
Ethylbenzene	-	75	-
m,p-Xylenes	-	180	-
Naphthalene	2.4	53	6

DVE-30			
Analyte	4/18/13	10/24/13	3/19/2014
TTPH	2,360	2,400	-
TPH-Jet A	820	360	-
TPH-Diesel	140	140 J	-
TPH-Gasoline	1,400	1,900	14 J
Benzene	-	48	-
Ethylbenzene	-	63	-
m,p-Xylenes	-	190	-
o-Xylene	-	220	-
1-Methylnaphthalene	42	4.3	-
Naphthalene	42	8	-

OB-04			
Analyte	4/18/13	10/24/13	3/19/2014
TTPH	14,300	31,600	1,440
TPH-Jet A	6,200	4,500	140
TPH-Diesel	900	1,100	-
TPH-Gasoline	7,200	26,000	1,300
Benzene	980	1,000	58
Ethylbenzene	290	1,200	88
m,p-Xylenes	-	3,400	190
Naphthalene	770	660	-
o-Xylene	-	1,600	130
Toluene	-	1,100	-
1-Methylnaphthalene	180	67	-

DVE-05			
Analyte	4/19/13	10/25/13	3/18/14
TPH-Jet A	-	240	-
TPH-Diesel	-	110	-
TPH-Gasoline	-	550	-
Benzene	-	120	-
Naphthalene	-	8	-
1-Methylnaphthalene	-	3.9	-
Dissolved Lead	-	14	18

OB-06			
Analyte	4/17/13	10/23/13	3/19/2014
TPH-Jet A	-	250	-
TPH-Diesel	15 J	49 J	-
TPH-Gasoline	210	380	14 J
Benzene	-	21	-
Naphthalene	-	17	-
1-Methylnaphthalene	-	7	-

BW-06			
Analyte	4/19/13	10/23/13	3/17/14
TTPH	-	1,400	-
TPH-Gasoline	-	1,400	-

DVE-07			
Analyte	4/19/13	10/23/13	3/18/14
TTPH	-	12,320	-
TPH-Jet A	-	4,700	-
TPH-Motor Oil	-	120 J	-
TPH-Diesel	-	1,400	-
TPH-Gasoline	-	6,100	-
Benzene	-	210	-
Ethylbenzene	-	75	-
m,p-Xylenes	-	120	-
Naphthalene	-	190	-
o-Xylene	-	130	-
1-Methylnaphthalene	-	110	-
Dissolved Lead	-	-	12

DVE-22			
Analyte	4/17/13	10/23/13	3/19/2014
TPH-Jet A	-	120	-
TPH-Diesel	11 J	31 J	-
TPH-Gasoline	-	280	-
1-Methylnaphthalene	-	1.4	-

DVE-16			
Analyte	4/17/13	10/23/13	3/19/14
TTPH	-	1,600	-
TPH-Jet A	-	800	-
TPH-Diesel	-	120	-
TPH-Gasoline	110	690	21 J
Naphthalene	-	76	-
1-Methylnaphthalene	-	40	-

LEGEND

MW547-4 Monitoring Well

DVE-03 DVE Well

OB-06 Observation Well

BW-06 Biosparging Well

Former Fuel Line

Proposed Direct Push Technology (DPT) Injection Points Using PermeOx Ultra™

Proposed Direct Push Technology (DPT) Injection Points Using Klozur® CR

Approximate groundwater flow direction (FWBZ)

µg/L micrograms/liter

- Concentration below PRC or non-detect

PRC Preliminary Remediation Criteria

Plume Boundary

NOTES:

All results presented in micrograms/liter (µg/L).

Analytes shown on the Figure exceeded the PRC presented in the 2012 updated Petroleum Management Plan unless "-" shown.

CAA 4C is in a Non-Drinking Water and Commercial Use Area.

Proposed direct push technology (DPT) injection points are approximate with an estimated 5' radius of influence.

Compounds in italics do not have a PRC.

Only wells associated with data tables will be included in the treatability study.

J indicates an estimated value in the data tables.

0 15 30 feet

APPROXIMATE SCALE: 1"= 30'

NOTE:
Site feature locations are taken from Figure 18, Proposed Quarterly Groundwater Monitoring Locations *in* Final Petroleum Corrective Action Summary Report, Dual Vacuum Extraction, Biosparge, and Pilot-Scale Chemical Oxidation Injection, Corrective Action Area 4C, Alameda Point, Alameda California, (Shaw Environmental 2008).

Individual constituent levels provided on the figure were provided from, Draft Spring 2014 Petroleum Program Groundwater Monitoring Technical Memorandum, Corrective Action Areas C, 4C, 5B West, 6, 7 AND Building 410, (TtEC Tetra Tech EC, Unc. 2014).

U.S. Department of the Navy
Base Realignment and Closure
Program Management Office West

MMEC Group
9177 Sky Park Court
San Diego, California 92123

DWN BY:	RMH
CHK'D BY:	RB
DATUM:	NAD27
PROJECTION:	CA SP Zone III
SCALE:	1" = 30'

Alameda Point, Alameda, California

BIOREMEDIATION TREATMENT LAYOUT CAA 4C

BIOREMEDIATION TREATABILITY STUDY AT PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7

DATE: NOVEMBER 2014

CONTRACT NO:

REV. NO.:

FIGURE NO. A-4

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M07A-05			
Analyte	4/17/13	10/24/13	3/19/14
MTBE	-	-	18
TPH-Diesel	19 J	-	-
TPH-Gasoline	-	62	-

IT013-CA07-0014			
Analyte	4/18/13	10/24/13	3/18/14
Benzene	-	1 J	4.2
TPH-Jet A	56	62	-
TPH-Gasoline	420	280	250
Naphthalene	0.2 J	0.7 J	1.5 J

DVE-5			
Analyte	4/17/13	10/24/13	3/18/14
MTBE	58	46 J	75 J
TPH-Gasoline	260	270	180

DVE-3			
Analyte	4/17/13	10/24/13	3/18/14
MTBE	72	43	-
TPH-Gasoline	-	150	-

DVE-8			
Analyte	4/16/13	10/24/13	3/18/14
MTBE	1,800	4,500	1,500
TTPH	-	2,200	-
TPH-Gasoline	78	2,200	73
Naphthalene	0.5	0.4	1.2
1-Methylnaphthalene	-	-	2.7

DVE-9			
Analyte	4/16/13	10/24/13	3/19/14
MTBE	3,700	2,700	1,500
TPH-Gasoline	-	1,300	-

LEGEND

M07A-08	Monitoring Well
DVE-03	Dual Vacuum Extraction (DVE) Well
6H-11A	Piezometer
	Former Excavation
	Former Fuel Line
	Proposed Direct Push Technology (DPT) Injection Points
	Approximate groundwater flow direction (FWBZ)
µg/L	micrograms/liter
-	Concentration below PRC or non-detect
PRC	Preliminary Remediation Criteria
	Plume Boundary

NOTES:

All results presented in micrograms/liter (µg/L) .

Analytes shown on the Figure exceeded the most conservative PRC presented in the Spring 2014 Petroleum Program Groundwater Monitoring Technical Memorandum. The PRC on this figure are not site-specific (i.e., not based on land or groundwater reuse).

CAA 7 is a Drinking Water and Residential Use Area.

Proposed direct push technology (DPT) injection points are approximate with an estimated 5' radius of influence.

Compounds in italics do not have a PRC.

Only wells associated with data tables will be included in the treatability study.

J indicates an estimated value in the data tables.

0 25 50 feet
APPROXIMATE SCALE: 1"= 50'

NOTE:
Site features taken from Figure 12, Dissolved TTPH/MtBE/Benzene Concentrations in Groundwater, 2004-2006 in Final Petroleum Corrective Action Summary Report, Former Naval Exchange Service Station, Corrective Action Area 7, Alameda Point, Alameda, California (Shaw Environmental 2008a).

Individual constituent levels provided on the figure were provided from, Draft Spring 2014 Petroleum Program Groundwater Monitoring Technical Memorandum, Corrective Action Areas C, 4C, 5B West, 6, 7 AND Building 410, (TtEC Tetra Tech EC, Unc. 2014).

U.S. Department of the Navy
Base Realignment and Closure
Program Management Office West

MMEC Group
9177 Sky Park Court
San Diego, California 92123

DWN BY: RMH
CHK'D BY: RB
DATUM: NAD27
PROJECTION: CA SP Zone III
SCALE: 1" = 50'

Alameda Point, Alameda, California

BIOREMEDIATION TREATMENT LAYOUT CAA 7

BIOREMEDIATION TREATABILITY STUDY AT PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7

DATE: NOVEMBER 2014
CONTRACT NO.:
REV. NO.:
FIGURE NO. A-5

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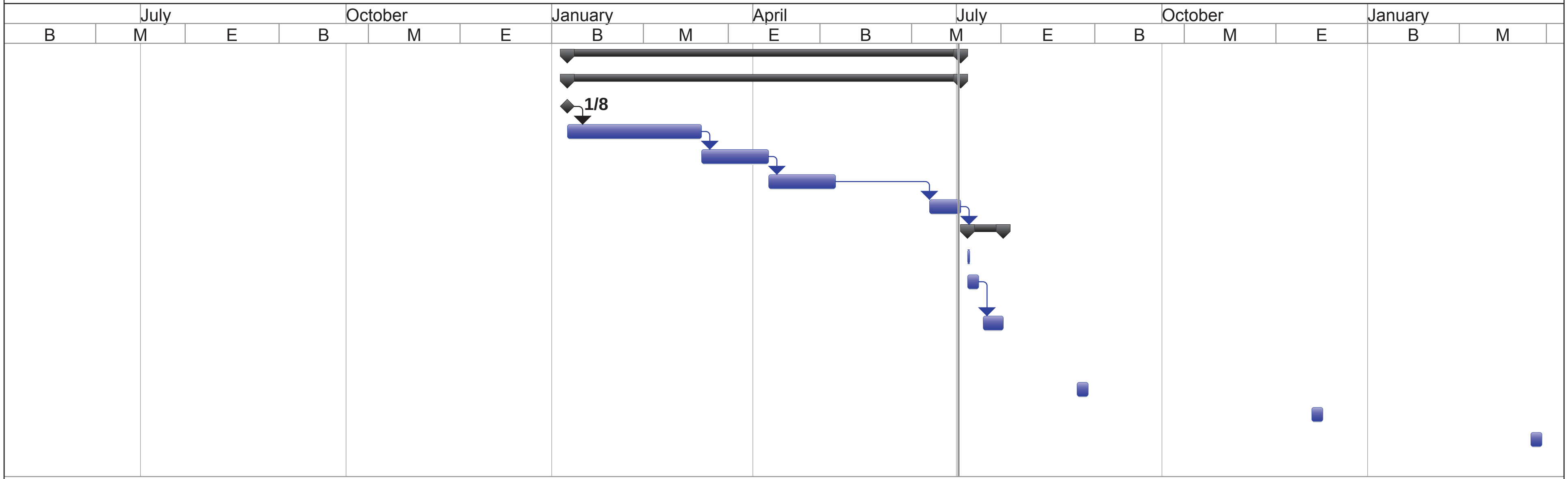
Figure A6. CAA 4C and CAA 7 Project Schedule

ID	Task Name	Duration	Start	Finish
1	**Work Plan Preparation**	**126 days**	**Thu 1/8/15**	**Thu 7/2/15**
2	**CAA 4C and 7 Work Plan**	**126 days**	**Thu 1/8/15**	**Thu 7/2/15**
3	Draft	0 days	Thu 1/8/15	Thu 1/8/15
4	Agency Review	60 edays	Thu 1/8/15	Mon 3/9/15
5	Draft Final	30 edays	Mon 3/9/15	Wed 4/8/15
6	Agency Review	30 edays	Wed 4/8/15	Fri 5/8/15
7	Final	14 edays	Thu 6/18/15	Thu 7/2/15
8	**CAA 4C & 7 ISB Field Work**	**12 days**	**Mon 7/6/15**	**Tue 7/21/15**
9	Field Readiness Meeting w/ROICC	1 day	Mon 7/6/15	Mon 7/6/15
10	Groundwater sampling, Geophysical Survey, Field Preparation	5 days	Mon 7/6/15	Fri 7/10/15
11	ISB DPT Injections both sites sequentially	7 days	Mon 7/13/15	Tue 7/21/15
12	**Quarterly performance monitoring**	**9 mons**	**Mon 8/10/15**	**Fri 4/15/16**
13	Q1	1 wk	Mon 8/24/15	Fri 8/28/15
14	Q2	1 wk	Mon 12/7/15	Fri 12/11/15
15	Q3	1 wk	Mon 3/14/16	Fri 3/18/16
16				

July / October / January / April
M E B M E B M E

Date: Thu 7/2/15 | Task | Split | Milestone | Summary

Figure A6. CAA 4C and CAA 7 Project Schedule



Date: Thu 7/2/15	Task	Split	Milestone	Summary

Attachment 1: Field Forms

DAILY INJECTION FIELD FORM

Job Number: ______________________________ Date: ______________________________

Project: ______________________________ Personnel: ______________________________

	Reading #				Reading #				Reading #			
Well ID	Time (hr:min)	Flow Meter (gal.)	Pressure Reading (psi)	Field Observations	Time (hr:min)	Flow Meter (gal.)	Pressure Reading (psi)	Field Observations	Time (hr:min)	Flow Meter (gal.)	Pressure Reading (psi)	Field Observations

Reviewed by ______________

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MMEC Group GROUNDWATER SAMPLING FIELD FORM	Job #: Date: Page of

Field Personnel: **Monitoring Well ID:**

Start Time: **Weather Conditions:** **Approx. Air Temp (F):**

INITIAL WELL DATA & WELL PURGING INFORMATION

Water Temperature (degree C)	Water pH (S.U.)	Specific Conductivity (µS/cm)	Turbidity (NTUs)	Dissolved Oxygen (mg/L)	ORP (mV)	Water Level (feet bgs)	Time (0:00 - 23:59)	Volume Purged (milliliters)
Stabilization:	3 consecutive readings within:							
±1°C	±0.1 S.U.	±0.1 uS	<5NTU	±0.2 mg/L	±10 mV	-	-	-
Results of Field Ferrous Iron Kit (mg/L):						**Total Purged:**		

Measurements: 0.5 inch tubing: 0.020 gallons/linear foot 2" well casing: 0.17 gal/linear foot 4" well casing: 0.65 gal/linear foot

Purge Pumping Rate (approx. mL/min): ______

Approx. Pump/Intake Depth: ______ screen

Well Yield: High / Moderate / Low Decontamination Method:

WELL CONDITION

Casing Size and Type:			
Casing Condition:	OK / NA / Needs Repairs/Repaired	Lock Condition:	OK / NA / Needs Repairs/Repaired
Cap Condition:	OK / NA / Needs Repairs/Repaired	Monument Condition:	OK / NA / Needs Repairs/Repaired
NOTES:			

SAMPLING INFORMATION / DATA

QA/QC Sample (circle one): Duplicate Lab QA/QC NONE

Sampling Method (circle one): dedicated Dual Valve Pump peristaltic pump

Analytical Parameters	Minimum Sample Vol.	Preservative	Bottle size	Number of bottles	Sample ID	Time Sampled
CSIA	40 mL		40 mL			
VOA	40 mL		40 mL			
qPCR	Sterivex *or* 2 L					

Method of Transportation of samples:

All samples were immediately placed into a cooler and packed with ice or "Blue Ice" YES / NO

Field Observations/Notes of Sampling Event:

Signature of Field Personnel:

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DAILY INJECTION FIELD FORM

Job Number: ______________________________ Date: ______________________________

Project: ______________________________ Personnel: ______________________________

	Reading #				Reading #				Reading #			
Well ID	Time (hr:min)	Flow Meter (gal.)	Pressure Reading (psi)	Field Observations	Time (hr:min)	Flow Meter (gal.)	Pressure Reading (psi)	Field Observations	Time (hr:min)	Flow Meter (gal.)	Pressure Reading (psi)	Field Observations

Reviewed by ________________

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DAILY EXTRACTION FIELD FORM

Job Number: ______________________________ Date: ______________________________

Project: ______________________________ Personnel: ______________________________

	Reading #				Reading #				Reading #			
Well ID	Time (hr:min)	Flow Meter (gal.)	Depth to Water (ft.)	Field Observations	Time (hr:min)	Flow Meter (gal.)	Depth to Water (ft.)	Field Observations	Time (hr:min)	Flow Meter (gal.)	Depth to Water (ft.)	Field Observations

Reviewed by ________________

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Attachment 2: Laboratory Certifications

To be included with the Final SAP on CD

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Attachment 3: Laboratory Standard Operating Procedures

To be included with the Final SAP on CD

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Appendix B
WASTE MANAGEMENT PLAN

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FINAL

WASTE MANAGEMENT PLAN

BIOREMEDIATION TREATABILITY STUDY AT PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7

For

ALAMEDA POINT, ALAMEDA, CALIFORNIA

July 2015

Prepared for

Naval Facilities Engineering Command Southwest
San Diego, California

Prepared Under

Contract N62473-12-D-2012
Task Order 0069

DCN: MMEC-2012-0069-0004

Prepared by

Multimedia Environmental Compliance Group
9177 Sky Park Court
San Diego CA 92123-4341
(858) 278-3600

MMEC Group Project 5023-14-6069

CONTENTS

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ACRONYMS AND ABBREVIATIONS

AST	above ground storage tank
CFR	Code of Federal Regulations
DON	Department of the Navy
DOT	Department of Transportation
EBMUD	East Bay Municipal Utility District
ft	foot/feet
ft^2	square feet
HDPE	high density polyethelene
IDW	investigation-derived waste
ISB	In-situ bioremediation
MMEC Group	Multimedia Environmental Compliance Group
MSW	municipal solid waste
POTW	publicly owned treatment works
PPE	personal protective equipment
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
ROICC	Resident Officer in Charge of Construction
RPM	Remedial Project Manager
SVOC	semi-volatile organic compound
TCLP	toxicity characteristic leaching procedure
TPH	total petroleum hydrocarbons
TSCA	Toxic Substances Control Act
TSDF	treatment, storage, and disposal facility
U.S. EPA	United States Environmental Protection Agency
VOC	volatile organic compound
WMP	Waste Management Plan
yd^3	cubic yards

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1 WASTE MANAGEMENT SUMMARY

The Multimedia Environmental Compliance Group (MMEC Group), a joint venture between AMEC Environment & Infrastructure, Inc. (AMEC) and KMEA, is supporting the Naval Facilities Engineering Command Southwest (NAVFAC SW) by conducting a Treatability Study (TS) at Corrective Action Area (CAA) 4C and CAA 7 at former Naval Air Station Alameda (Alameda Point), Alameda, California. This work is being performed under NAVFAC SW Contract Number N62473-12-D-2012, Task Order Number 0069.

This Waste Management Plan (WMP) describes the manner in which investigation-derived waste (IDW) will be handled. The United States Environmental Protection (U.S. EPA) Agency *Management of Investigation-Derived Wastes During Site Inspections* developed in 1991 will be used as guidance for waste management methods during this project. All subsurface soil and groundwater removed as part of this enhanced aerobic in-situ bioremediation (EISB-a) TS will be containerized and stored at the lay-down area until it is properly classified for disposal. Care shall be taken to confirm that IDW storage containers are compatible with the IDW to be generated and stored, and that all personnel wear the appropriate level of personal protective equipment (PPE) while handling wastes. Also, IDW will be stored in an area where damage to the containers is unlikely (such as away from vehicle and equipment high-traffic areas).

IDW includes soil cuttings, groundwater, decontamination fluids, PPE, and decontamination equipment, which will be managed as follows:

Soil cuttings:

- Soil generated during drilling will be stored in Department of Transportation (DOT)-approved 55-gallon drums. A forklift may be used to transport 55-gallon drums filled at the drilling location to the designated IDW storage area. Following completion of the investigation activities, the soil will be characterized and shipped offsite to an appropriate disposal facility.

Groundwater:

- Purged groundwater and decontamination fluids will be stored temporarily in 5-gallon buckets during sampling. The water will then be transferred to 55-gallon drums or an aboveground storage tank (AST) at the designated IDW storage area, and drums (or an AST) will be stored within a secondary containment berm. Groundwater staged in the 55-gallon drums or ASTs will primarily be re-used as substrate mixing water for the ISB injection. Is it assumed all groundwater extracted as part of this project will be re-injected back into the subsurface as part of the ISB treatment. The decontamination fluids will be containerized in 55-gallon drums.

PPE, decontamination equipment, and miscellaneous non-hazardous solid waste (refuse):

- PPE and sampling equipment IDW will be generated during the field work. Used PPE may consist of protective coveralls, nitrile gloves, and other disposable gear associated with field activities. Sampling equipment may include such items as sampling tools, cleaning/decontamination equipment, and used paper towels. Used PPE will be stored onsite, double-bagged, and disposed of along with other non-hazardous solid waste pending the analytical results of samples.

A solid waste is a Resource Conservation and Recovery Act (RCRA) characteristic hazardous waste if it exhibits the characteristics of ignitability, corrosivity, reactivity, or toxicity, as defined in Title 40 of the Code of Federal Regulations (CFR), Section 261, Subpart C. Toxicity will be determined in accordance with the toxicity characteristic leaching procedure (TCLP). IDW will also be evaluated as a State of California hazardous waste per Title 22.

Soil cuttings and fluids pending characterization will be placed 55-gallon DOT–approved drums. Each drum or rolloff container stored at the site will have a self-adhesive label affixed to the outside of the container. At a minimum, the label will document the following:

- Waste type (e.g., soil, purge water, decontamination fluids)
- Site name—CAA 4C or CAA 7
- Treatment well from which the IDW was generated
- Date of accumulation
- Estimated quantity in container (e.g., 50 gallons)
- MMEC Group field personnel name and telephone number as an emergency contact (MMEC Group will contact the CSO POC and/or ROICC)

Drums containing IDW are to be stored in rows with labels facing outward for easy identification.

The disposal of IDW will be in compliance with the Offsite Rule (40 CFR 300.440) and other pertinent codes and regulations. Hazardous substances will be characterized in accordance with applicable U.S. EPA and state regulations. The MMEC Group will sample and profile containerized IDW for transportation and disposal offsite in accordance with the requirements of the disposal facility, and will provide the Navy complete waste manifests and similar documentation.

Disposal of IDW will be performed within 90 days of waste generation. The removal of IDW to an offsite disposal facility will be coordinated with the Navy Remedial Project Manager (RPM) and the CSO.

2 WASTE MANAGEMENT AND DECONTAMINATION AREAS

A temporary waste staging area will be established along an existing paved area inside the construction fence perimeter area at both CAA 4C and CAA 7, to temporarily store project waste streams. Several areas will be bermed with sandbags or planks/timbers (or equivalent) and lined with a minimum 20-mil high-density polyethylene (HDPE) or polyvinyl chloride (PVC) (or equivalent) liner to facilitate collection of water from incident precipitation (if any). The areas will be the primary areas for receiving and temporarily holding project wastes prior to characterization and offsite disposal, including debris and soil. Further segregation within these areas will be conducted on the basis of anticipated waste characterization results (i.e., RCRA hazardous versus non-RCRA hazardous versus non-hazardous designation). It should be noted that onsite storage of RCRA and non-RCRA hazardous waste will be limited to fewer than 90 days without a permit.

The waste storage area will also have two smaller bermed pads (i.e., 25 foot [ft] by 25 foot, or 625 square feet [ft^{2}], each), each of which will hold a HDPE (or equivalent) aboveground storage tank (AST) for the temporary storage of aqueous project wastes, and a 1,600-ft^2 (i.e., 40 ft by 40 ft) bermed pad for the temporary storage of drummed waste materials. These pads will be bermed in a manner identical to that described above for the primary waste storage pads. Water that accumulates in the staging area and/or AST pads will be collected and stored in one of the ASTs. Groundwater staged in the ASTs will primarily be re-used as substrate mixing water for the ISB injection. Is it assumed all groundwater extracted as part of this project will be re-injected back into the subsurface as part of the ISB treatment.

2.1 WASTEWATER STAGING

Waste groundwater development, purge, and sampling water will be collected, properly containerized, and transported to and staged at the main central storage yard. Waste liquids may be consolidated with other waste liquids in the AST tanks at the central storage yard until used for the EISB-a treatment. When discussing wastewater in this WMP it refers to water primarily from decontamination procedures and not groundwater extracted for the purposes of mixing substrate for the EISB-a treatment.

2.2 DECONTAMINATION

The TS at CAA 4C and CAA 7 will require the use of various types of heavy equipment, including drill rigs and forklift transporting contaminated soils to the staging area, and support vehicles and trucks transporting contaminated soils and other waste streams for offsite disposal. Heavy equipment and vehicles that come into contact with suspected contaminated soil, liquids, and/or infrastructure will be decontaminated prior to demobilization from any individual work site to prevent contaminants from being transferred out of active work zones. Decontamination will be conducted at the decontamination pad constructed at the site.

Dry brushing or wiping will be the primary decontamination methods used for equipment and vehicles to minimize the volume of decontamination rinsate water requiring treatment and/or disposal. If necessary, due to heavy contamination or wet conditions, equipment and vehicles (especially tires) will be washed with a pressure washer. Decontamination will proceed until the soil and residues are removed.

Reusable, non-dedicated equipment used for development or sampling (e.g., water-level meter, submersible pump or surge block, and hand-sampling tools) will be decontaminated prior to initial use and after each use by washing with a non-phosphate detergent (e.g., Liquinox™ or equivalent) and rinsed with fresh potable water, followed by rinsing with deionized water. The rinsed equipment will be placed on clean plastic sheeting and allowed to air dry. If equipment will not be reused immediately, it will be placed in plastic bags or covered in clean plastic sheeting until used. Tools and items for which decontamination is difficult or impossible to verify will remain onsite until completion of the work for subsequent packing and offsite disposal at an approved disposal facility.

Decontamination of temporary facilities located within the project support zone will be limited to exterior cleaning, as necessary.

Residual solids or liquids will be collected, properly containerized (i.e., in DOT-approved 55-gallon drums) and transported to and staged at the staging area pending characterization and disposal. Waste liquids may be consolidated with other project waste liquids in the aboveground wastewater storage tanks at the central storage area, and residual decontamination solids may be consolidated with other soil.

3 WASTE CHARACTERIZATION

Project waste materials will consist of solid and liquid waste and will be stored in appropriate staging piles and/or containers (e.g., DOT-approved 55-gallon drums) pending waste characterization and disposal. Wastes that are temporarily stored at any individual work site or at the central storage yard will be labeled as "Classification Pending Analysis."

Characterization of project wastes will be necessary for proper waste profiling and waste acceptance by receiving facilities. To properly characterize wastes, the following sampling conventions will be followed:

- For drummed solid waste (e.g., soil), a well-mixed, composite sample will be collected from several areas within the drum (one composite sample per drum) using a stainless steel sampling trowel, a stainless steel hand auger or coring device, or equivalent.
- For containerized wastewater, a representative sample will be collected from the container (one per drum or AST) using a clean disposable bailer or a reusable sampling device (e.g., drum thief or equivalent).

Waste characterization samples will be collected and placed in laboratory-provided glassware and shipped to the designated California-certified and Department of Navy (DON)-approved offsite laboratory. Analytical criteria for waste characterization samples will depend on the requirements of the receiving facility. For example, the analytical criteria considered likely for proper profiling of soil waste will include:

- Metals (toxicity characteristic leaching procedure [TCLP])
- Volatile organic compounds (VOCs)

Several options for discharge of wastewater include discharge to the publicly owned treatment works (POTW) via sanitary sewer or discharges to the storm sewer or offsite treatment and discharge facility. In the case of using the sanitary sewer, the discharge must meet the wastewater discharge standards established by East Bay Municipal Utility District (EBMUD) Ordinance No. 311A-03. An appropriate suite of analytes will likely be analyzed for wastewater samples to meet storm water discharge or offsite treatment, storage, and disposal facility (TSDF) requirements. Additional tests may also be required based on the results of the tests above and discussions with the receiving facilities. It should be noted that prior Alameda remediation projects used either the local POTW or offsite TSDFs for the disposal of wastewater from remedial activities.

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4 WASTE PROFILING AND DISPOSAL

Based on the results of the waste characterization analyses, project wastes will be properly profiled for disposal at an appropriate California-licensed disposal facility.

General waste, including used PPE, disposable sampling tools, paper towels, and other incidentals, that is not visibly contaminated or grossly soiled will be disposed of as municipal solid waste (MSW) in an appropriate MSW receptacle at each project work site. These receptacles will be emptied and contents disposed of through existing MSW pick-ups for the particular work site. Alternatively, these general wastes will be consolidated in an appropriate MSW receptacle at an individual project work site with an active contract for MSW hauling.

For project wastewater, if the results of the waste characterization analyses meet surface-water discharge standards, the water may be discharged to the site storm drain system, provided that the proper EBMUD permits have been acquired. Project wastewater that does not meet surface-water discharge standards but does meet POTW acceptance criteria may be discharged to the POTW through the sanitary sewer system, provided that the proper EBMUD permits have been acquired. Project wastewater that does not meet surface-water or POTW discharge standards will be transported to an offsite treatment and disposal facility based on characterization data and the associated waste profile. It is assumed that non-hazardous project wastewater requiring offsite disposal will be transported to and disposed of at the Oakland EBMUD treatment facility under the Alameda Point Basewide Program's Trucked Non-Hazardous Waste Permit # INTE3000-001.

Solid wastes (soil, debris, and grossly soiled or visibly contaminated used PPE or sampling tools) generated during the remedial action project will be transported to and disposed of at an appropriate offsite landfill facility based on characterization data and the associated waste profile.

The waste hauling subcontractor will supply the labor, equipment, and materials necessary to transport the wastes. Individual drivers must be employees of the selected subcontractor.

The MMEC Group will verify or alter the identified waste disposal facilities, after approval and with the oversight of the CSO. The ultimate receiving facility will issue a letter of waste acceptance for each waste stream, as indicated by waste characterization information and the associated profile.

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Appendix C
ENVIRONMENTAL PROTECTION PLAN

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FINAL

ENVIRONMENTAL PROTECTION PLAN

BIOREMEDIATION TREATABILITY STUDY AT PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7

For

ALAMEDA POINT, ALAMEDA, CALIFORNIA

July 2015

Prepared for

NAVFAC SOUTHWEST

Naval Facilities Engineering Command Southwest
San Diego, California

Prepared Under

Contract N62473-12-D-2012
Task Order 0069

DCN: MMEC-2012-0069-0004

Prepared by

Multimedia Environmental Compliance Group
9177 Sky Park Court
San Diego CA 92123-4341
(858) 278-3600

MMEC Group Project 5023-14-6069

CONTENTS

FIGURES

TABLES

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ACRONYMS AND ABBREVIATIONS

AMEC	AMEC Environment & Infrastructure, Inc.
AST	above ground storage tank
AS	air sparge
BMP	best management practice
BTEX	benzene, toluene, ethylbenzene, xylene
CAA	Corrective Action Area
CCR	California Code of Regulations
CFR	Code of Federal Regulations
DON	Department of the Navy
DVE	duel vacuum extraction
EISB-a	enhanced in-situ bioremediation (aerobic)
EPP	Environmental Protection Plan
ESL	Environmental Screening Level
FAR	Federal Acquisitions Regulation
HDPE	high density polyethelene
IDW	investigation-derived waste
ISCO	in-situ chemical oxidation
MMEC	Group Multimedia Environmental Compliance Group
MTBE	methyl tertiary butyl ether
mg/L	milligrams per liter
PRC	Preliminary Remediation Criteria
RCRA	Resource Conservation and Recovery Act
ROICC	Resident Officer in Charge of Construction
RWQCB	(San Francisco Bay) Regional Water Quality Control Board
RPM	Remedial Project Manager
SWRCB	California State Water Resources Control Board
SVE	soil vapor extraction
TPH	total petroleum hydrocarbons
TS	Treatability Study
TTZ	target treatment zone
USEPA	United States Environmental Protection Agency
UST	underground storage tank
WP	Work Plan
WMP	Waste Management Plan

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1 INTRODUCTION

1.1 GENERAL OVERVIEW AND PURPOSE

This Environmental Protection Plan (EPP) has been prepared for conducting a treatability study (TS) at Corrective Action Area (CAA) 4C and CAA 7 at former Naval Air Station Alameda (Alameda Point), Alameda, California (Figure 1). This EPP has been prepared by The Multimedia Environmental Compliance Group (MMEC Group), a joint venture between AMEC Environment & Infrastructure, Inc. (AMEC) and KMEA, and is being performed under NAVFAC SW Contract Number N62473-12-D-2012, Task Order Number 0069.

This EPP identifies known or potential environmental issues that may be encountered while conducting the TS activities and presents mitigation measures and best management practices (BMPs) that will be implemented.

1.2 GENERAL SITE INFORMATION ALAMEDA POINT, CAA 4C & CAA 7

Alameda Point

Alameda Point is on the western tip of Alameda Island, which is on the eastern side of San Francisco Bay (Figure 1). Most of the northern portion of what is now Alameda Point was covered by the waters and tidal lands of San Francisco Bay. To create Alameda Point, fill material was dredged from San Francisco Bay. In 1930, the U.S. Army acquired Alameda Point from the City of Alameda. In 1936, the Navy acquired the land from the U.S. Army and built the former NAS Alameda, which was operated as an active facility from 1940 to 1997. During the history of the former NAS Alameda, it housed approximately 60 military tenant commands for a combined military and civilian work force of over 18,000 personnel.

CAA 4C

CAA 4C consists of the former Annex Service Station (Building 567), located northeast of the intersection of Skylark Street and West Pacific Street (Figure 2). The site operated as a service station from 1971 until 1980 and included 3 underground storage tanks (USTs; 547-1 through 547-3), fuel distribution islands, and a car wash. CAA 4C is approximately 3,360 square feet in size.

Investigations conducted at CAA 4C have identified petroleum impacted soil and groundwater. Corrective actions conducted at the site include: soil excavation, dual vacuum extraction (DVE), ISCO, and air sparge/soil vapor extraction (AS/SVE). Corrective actions were implemented from 2004 to 2006 using DVE along with a pilot-scale ISCO to treat residual contamination in soil. More recent corrective actions were performed in 2013 and 2014 using AS/SVE technology. Groundwater monitoring (spring and fall 2013 and spring 2014) data indicate that petroleum constituent concentrations exceed the preliminary remediation criteria (PRCs) and environmental screening levels (ESLs) at CAA 4C. Benzene concentrations in groundwater as high as 1 milligram per liter (mg/L) and TPH concentrations of 31 mg/L in groundwater, exceeded their respective PRCs of 0.021 mg/L and 1.4 mg/L, respectively (TtEC, 2014).

CAA 7

CAA 7 operated as a Navy Exchange Service Station from at least 1951 to 1997 and is located near the corner of Main Street and West Tower Avenue (Figure 2). The site included a vehicle repair shop (Building 459), a small convenience store (Former Building 284), and nine USTs storing automotive fuels, fuel oil, solvents, and lubricating oils. The USTs and their associated fuel distribution lines and fueling islands were removed in 1997. CAA 4C is approximately 5,040 square feet in size.

Investigations conducted at CAA 7 identified free-phase and dissolved-phase fuel hydrocarbons in soil and groundwater. Remediation took place between 1998 and 2006 and consisted of soil excavation and DVE. Pre- and post-excavation confirmation samples indicated significant reduction in TPH, BTEX and MTBE concentrations. Monitoring conducted since 2012 has identified petroleum constituents in groundwater at concentrations exceeding PRCs. In 2013 and 2014, AS/SVE corrective action was conducted at CAA 7. Recent groundwater monitoring events (Spring and Fall 2013 and Spring 2014) indicate that petroleum constituent concentrations exceeding the PRCs still exist at CAA 7, with MTBE and total petroleum hydrocarbons as gasoline (TPH-g) the primary fuel-related constituents remaining above PRCs.

2 STORMWATER MANAGEMENT AND EROSION CONTROL

Construction projects with a disturbed area of less than 1 acre are not covered under the State Water Resources Control Board's ("General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities" (SWRCB Order No. 2009-0009-DWQ). Therefore, a Stormwater Pollution Prevention Plan, or SWPPP, is not required by the California Regional Water Quality Control Board, San Francisco Bay Region for the project.

Although a Stormwater Pollution Prevention Plan will not be submitted with the Work Plan for the TS activities, BMP methods for stormwater runoff control will be included in this EPP. A copy of this EPP will be kept at the on-site office and updated, as required, to reflect current site conditions.

BMPs using a combination of erosion and sediment controls that significantly reduce or prevent potential pollutants from CAA 4C and CAA 7 from runoff will be used during all phases of the project. These may include structural and non-structural BMPs required to be left in place as post-project pollution prevention controls. These controls may include erosion control measures, sand bags, vegetation preservation, street sweeping, and material management (CASQA, 2009).

The following BMP methods may be used to prevent erosion and control sedimentation during the TS activities:

Table 2-1
BMP Implementation Schedule

Method	BMP	Implementation	Duration
Erosion Control	EC-1, Scheduling	During Work Plan Preparation	Entirety of Project
	EC-2, Preservation of Existing Vegetation	Start of TS	Entirety of Project
Sediment Control	SE-6, Gravel Bag Berm	Start of TS	Entirety of Project
	SE-8, Sandbag Barrier	Start of TS	Entirety of Project
	WE-1, Wind Erosion Control	Start of TS	Entirety of Project
Wind Erosion	WM-4, Spill Prevention and Control	Start of TS	Entirety of Project
Temporary Materials Management	WM-5, Solid Waste Management	Start of TS	Entirety of Project
	WM-6, Hazardous Waste Management	Start of TS	Entirety of Project
	WM-7, Contaminated Soil Management	Start of TS	Entirety of Project
	WM-9, Sanitary-Septic Waste Management	Start of TS	Entirety of Project
	NS-9, Vehicle and Equipment Fueling	Start of TS	Entirety of Project

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3 PREVENTION OF RELEASES TO THE ENVIRONMENT

This section provides a summary of procedures to be followed in order to prevent the release of contaminants to the environment during work activities.

Fueling and the lubrication of equipment and motor vehicles will be conducted in a manner that protects against spills and evaporation. BMP NS-9, Vehicle and Equipment Fueling, will be followed for these practices (CASQA, 2009). Fuels, lubricants, and chemical wastes to be discarded will be managed in accordance with federal, state, and local regulations, including Title 40 of the *Code of Federal Regulations* (CFR), parts 263, 264, 265, 268, and 279. MMEC Group will determine if any used oil generated while on site exhibits characteristics of hazardous waste. MMEC Group will dispose of used oil containing 1,000 parts per million of solvents, which will be considered hazardous waste. Used oil mixed with a hazardous waste will also be considered a hazardous waste. All hazardous waste will be managed in accordance with Section 4.3 of this EPP, Management Procedures for All Hazardous Waste Generated.

Site work will proceed with specified precautions to prevent releases/spills of oil and hazardous substances. WM-4, Spill Prevention and Control BMP, will be followed as required (CASQA, 2009).

Oil or hazardous substances will be prevented from entering the ground, drainage areas, or navigable waters. In accordance with 40 CFR 112, all temporary fuel oil or petroleum storage tanks will be surrounded with a temporary berm or containment of sufficient size and strength to contain the contents of the tanks, plus 10% freeboard for precipitation. The berm will be impervious to oil for 72 hours and be constructed so that any discharge will not permeate, drain, infiltrate, or otherwise escape before cleanup occurs.

Fueling and maintenance of equipment will take place within existing paved areas or the identified laydown areas, but not closer than 100 feet to drainage areas. Contractor equipment will be checked for leaks prior to operation and repaired as necessary. Fueling and maintenance of vehicles and equipment will be performed in accordance with BMPs NS-9, Vehicle and Equipment Fueling, and NS-10, Vehicle and Equipment Maintenance (CASQA, 2009).

Field equipment staging, access, and disposal or temporary placement of excess fill, brush, or debris will be prohibited within drainage or other wetland areas. Emergency provisions will be in place at all crossings prior to the onset of fieldwork to prevent accidental spills from contaminating downstream habitats.

3.1 NOTIFICATIONS IN THE EVENT OF A RELEASE TO THE ENVIRONMENT

In the event of a release of oil, hazardous substance, chemical, or gas, the Site Project Manager will immediately notify the CSO, the NAVFAC SW Contracting Officer's Representative, and the NAVFAC SW RPM. Spill response will be in accordance with 40 CFR 300 and applicable state and local regulations. MMEC Group will be responsible for verbal and written notifications as required by 40 CFR 355, state and local regulations, and NAVFAC SW instructions. Copies of the written notification and documentation that a verbal notification was made will be provided to the NAVFAC SW within 20 days.

3.2 PROTOCOL FOR UNFORESEEN HAZARDOUS MATERIAL

If materials containing PCBs, lead paint, friable or non-friable asbestos (not previously identified), or any other hazardous material or waste are encountered during fieldwork, then that portion of the work will be stopped and the NAVFAC SW Contracting Officer's Representative will be notified immediately.

The NAVFAC SW RPM will determine if the material is hazardous after review of contractor provided analytical data. If the material is determined to be non-hazardous or poses no danger, then the NAVFAC SW Contract Officer's Representative will provide the notice to the NAVFAC SW contractor to proceed as planned. If material is determined to be hazardous and handling of such material is necessary to accomplish the work, NAVFAC SW may choose to issue a modification pursuant to Federal Acquisition Regulation (FAR) 52.243-4, “Changes” and FAR 52.236-2, “Differing Site Conditions,” or leave the material in place.

3.3 HAZARDOUS WASTE SITES

If contamination is encountered, any workers in contact with contamination must have Occupational Safety and Health Administration Hazardous Waste Operations and Emergency Response Regulation 40-hour training and must wear the appropriate personal protective equipment. All investigation-derived waste (IDW) will be properly disposed of and handled in accordance with the federal, state, and local regulations.

4 PROTECTION OF THE ENVIRONMENT FROM CONTRACTOR-DERIVED WASTE

4.1 CONTROL AND DISPOSAL OF SOLID WASTE

Solid wastes, decontamination liquids, and used personal protective equipment will be stored in appropriately covered containers located in the laydown area. Containers will be clearly identified with the NAVFAC SW contractor’s name, project identification, and a notification label restricting the container for sole use. Contamination of the site or other areas will be prevented when handling and disposing of wastes. At project completion, the areas will be left clean. All solid waste (including non-hazardous debris) will be removed from Navy property and disposed of at an approved landfill. Rubbish and debris will be disposed of in the same manner and removed from the site. Solid waste disposal off site will comply with local, state, and federal requirements including 40 CFR 241, 40 CFR 243, 40 CFR 258, and BMP WM-5, Solid Waste Management (CASQA, 2009). Waste generated during the TS will be stored and disposed of in accordance with the procedures described in the Work Plan.

4.2 CONTROL AND DISPOSAL OF HAZARDOUS WASTE

Waste soil and water may be generated by field tasks associated with TS activities. IDW includes soil cuttings, groundwater and decontamination fluids:

Soil cuttings:

- Soil generated during drilling will be stored in Department of Transportation (DOT)-approved 55-gallon drums. A forklift may be used to transport 55-gallon drums filled at the drilling location to the designated IDW storage area. Following completion of the investigation activities, the soil will be characterized and shipped offsite to an appropriate disposal facility.

Groundwater and decontamination fluids:

- Purged groundwater and decontamination fluids will be stored temporarily in 5-gallon buckets during sampling. The water will then be transferred to 55-gallon drums or an aboveground storage tank (AST) at the designated IDW storage area, and drums (or an AST) will be stored within a secondary containment berm. Groundwater staged in the 55-gallon drums or ASTs will primarily be re-used as substrate mixing water for the EISB-a injection. Is it assumed all groundwater extracted as part of this project will be re-injected back into the subsurface as part of the EISB-a treatment. The decontamination fluids will be containerized in 55-gallon drums.

Characterization of project wastes will be necessary for proper waste profiling and waste acceptance by receiving facilities. To properly characterize wastes, the following sampling conventions will be followed:

- For drummed solid waste (e.g., soil), a well-mixed, composite sample will be collected from several areas within the drum (one composite sample per drum) using a stainless steel sampling trowel, a stainless steel hand auger or coring device, or equivalent.

- For containerized wastewater, a representative sample will be collected from the container (one per drum or AST) using a clean disposable bailer or a reusable sampling device (e.g., drum thief or equivalent).

Waste characterization samples will be collected and placed in laboratory-provided glassware and shipped to the designated California-certified and Department of Navy (DON)-approved offsite laboratory. Analytical criteria for waste characterization samples will depend on the requirements of the receiving facility. For example, the analytical criteria considered likely for proper profiling of soil waste will include:

- Metals (toxicity characteristic leaching procedure [TCLP])
- Volatile organic compounds (VOCs)

Several options for discharge of wastewater include discharge to the publicly owned treatment works (POTW) via sanitary sewer or discharges to the storm sewer or offsite treatment and discharge facility. In the case of using the sanitary sewer, the discharge must meet the wastewater discharge standards established by East Bay Municipal Utility District (EBMUD) Ordinance No. 311A-03. An appropriate suite of analytes will likely be analyzed for wastewater samples to meet storm water discharge or offsite treatment, storage, and disposal facility (TSDF) requirements. Additional tests may also be required based on the results of the tests above and discussions with the receiving facilities. It should be noted that prior Alameda remediation projects used either the local POTW or offsite TSDFs for the disposal of wastewater from remedial activities.

4.3 MANAGEMENT PROCEDURES FOR ALL HAZARDOUS WASTE GENERATED

MMEC Group will identify all field activities that will generate hazardous waste/debris. MMEC Group will provide a documented waste determination for waste streams. Hazardous waste/debris will be identified, labeled, handled, stored, and disposed of in accordance with federal, state, and local regulations including 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, 40 CFR 266, and 40 CFR 268. Hazardous wastes will be stored in approved containers in accordance with 49 CFR 173 and 49 CFR 178. Hazardous waste generated within the confines of BRAC PMO-W facilities will be identified as being generated by BRAC PMO-W.

4.3.1 Waste Determination

Prior to the removal of any hazardous waste from Navy property, all hazardous waste characterization information in regard to waste origin, volume, and intended destination will be compiled and attached to a Waste Determination Form. Upon signature approval by the BRAC PMO-W Hazardous Waste/Facility Manager and issuance of a USEPA generator identification number for the waste, a soil profile will be generated and submitted to the receiving agency. The receiving agency will supply the waste manifests for each load of waste soil transported off BRAC PMO-W property.

No hazardous waste will be brought onto BRAC PMO-W property. The NAVFAC SW Contracting Officer's Representative, NAVFAC SW RPM, and CSO hazardous waste POC will be provided a copy of waste determination documentation for any solid waste streams that have the potential to be hazardous waste or contain any chemical constituents listed in 40 CFR 372, Subpart D. BMP WM-6, Hazardous Waste Management, will be followed as required (CASQA, 2009).

4.3.2 Hazardous Waste Accumulation/Storage

If generated during field activity, all hazardous wastes will be stored in approved containers in accordance with 49 CFR 173 and 49 CFR 178. Generated hazardous waste will be properly identified, packaged, and labeled in accordance with 49 CFR 178. If the work requires temporary storage/collection of regulated or hazardous wastes, the NAVFAC SW Contracting Officer's Representative and NAVFAC SW RPM will request the establishment of a regulated waste storage area or a 90-day storage area at the point of generation.

4.3.3 Storage, Labeling, Transportation, and Disposal of Waste

MMEC Group will be responsible for collecting, labeling, containerizing, and having waste properly tested by the designated certified laboratory. No hazardous waste will be stored on site for more than 90 days. Management of hazardous wastes must meet the specifications as cited in the contract and all applicable federal, state, and local laws and regulations. Prior to removal of any hazardous waste from Navy property, all hazardous waste manifests must be signed by authorized Navy personnel.

4.3.4 Land Disposal of Hazardous Waste

Land disposal of hazardous waste will comply with Land Disposal Restrictions (40 CFR 268). MMEC Group will submit a copy of the applicable USEPA permit(s), manifest(s), or license(s) for the transportation, treatment, storage, and disposal of hazardous and regulated waste by permitted facilities to the Contracting Officer.

4.3.5 Recycling of Waste Materials

MMEC Group will provide clearly marked containers and bins to facilitate recycling of waste materials. Contamination of recyclable materials from incompatible products and materials will be prevented. Separation of IDW at the project site will be accomplished by one of the following methods:

- Source Separated Method: Waste products and materials that are recyclable will be separated from trash and sorted into appropriately marked, separate containers and then transported to appropriate recycling facilities for further processing. Trash will be transported to a landfill or incinerator.
- Co-mingled Method: All IDW waste will be placed into a single container and then transported to a recycling facility where the recyclable materials will be sorted and processed and the remaining trash transported to a landfill or incinerator.
- Other methods as proposed by MMEC Group and approved by the Contracting Officer.

4.3.5.1 Used Oil

Fueling and lubrication of equipment will be done in a manner that affords maximum protection against spills and evaporation. Fuels, lubricants, and chemical wastes to be discarded (hazardous waste) will be disposed of in accordance with the approved procedures meeting federal, state, and local regulations, especially 40 CFR 263, 40 CFR 264, 40 CFR 265, 40 CFR 268, and 40 CFR 279.

4.3.6 Pollution Prevention/Hazardous Waste Minimization Procedures

MMEC Group will make every effort to eliminate or reduce acquisition of products containing hazardous substances or toxic chemicals. By efficiently preventing pollution at its sources, MMEC Group will achieve cost savings, increase operations efficiencies, improve the quality of services, maintain a safe and healthy work place for employees, and improve the environment. MMEC Group will comply with the Emergency Planning and Community Right-to-Know Act of 1986 emergency planning and response requirements.

MMEC Group will follow these hazardous-waste-minimization practices to reduce wastes:

- Control hazardous materials;
- Substitute materials/products;
- Process modification/change;
- Properly identify hazardous waste;
- Delist previously listed hazardous waste;
- Segregate waste; and
- Recycle and reuse.

4.3.7 Disposal of Hazardous Waste by Permitted Facilities

MMEC Group will submit a copy of the applicable USEPA permit(s), manifest(s), or license(s) for the transportation, treatment, storage, and disposal of hazardous and regulated waste by a permitted facility to BRAC PMO-W. The permits for disposal and transportation of hazardous waste will be submitted to the BRAC PMO-W manager responsible for managing all waste disposal activities for BRAC PMO-W.

4.3.8 Employee Training Records

All site contractors and subcontractors will prepare and maintain employee-training records throughout the term of the contract to meet 40 CFR 265 requirements. MMEC Group will require every employee at CAA 4C and CAA 7 to complete a training program that teaches them to perform their duties in a way that ensures compliance with federal, state, and local regulatory requirements. These training records will be submitted prior to startup and at applicable intervals during the contract period of performance (i.e., weekly health and safety/training meetings). Training procedures are outlined in the Work Plan in accordance with 40 CFR 265 and applicable state and local regulations.

5 POLLUTION CONTROL PLAN

Signs will be placed at the TS area perimeter to delineate the work limits. The signs will inform visitors of safety hazards requiring unauthorized personnel to keep out. Signs will be placed on all sides of the project. Other control measures that will be implemented at CAA 4C and CAA 7 during the TS activities are discussed in the following sections.

5.1 DUST CONTROL

Dust control at CAA 4C and CAA 7 will be achieved by keeping dust down at all times, including during non-working periods. All field activities that involve intrusive investigations will be minimized during the rainy season and other periods of heavy precipitation.

Although less than 1 acre will be disturbed during the TS activities, BMP methods for stormwater runoff will meet the requirements of SWRCB Order No. 2009-0009-DWQ.

5.2 NOISE CONTROL

Field equipment approved for this project will make use of low-noise emission products and equipment, as certified by the USEPA.

5.3 MUD AND SEDIMENT CONTROL

Mud or sediment control is not applicable at CAA 4C or CAA7. Both sites are in developed areas consisting of paved parking lots. If soils are tracked or inadvertently deposited onto the surrounding roadways by field activities conducted by MMEC Group or its subcontractors, MMEC Group will arrange for street sweepers to mobilize and clean the affected road. This will limit the amount of sediment that may be transported to storm drains or watercourses (BMP SE-7, Street Sweeping and Vacuuming; CASQA, 2009).

5.4 SEVERE WEATHER

The NAVFAC SW RPM will have the authority to stop all fieldwork due to inclement weather and/or natural disasters.

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6 REFERENCES

Battelle. *2012 Update Petroleum Management Plan*, Alameda Point, Alameda, California. February 2012.

CASQA (California Stormwater Quality Association). 2009. *Stormwater Best Management Practice Handbook, Construction*. September.

TtEC (Tetra Tech EC, Inc.) 2014. *Draft Spring 2014 Petroleum Program Groundwater Monitoring Technical Memorandum, Corrective Action Areas C, 4C, 5B West, 6, 7, AND Building 410,* Alameda Point, Alameda, California. May.

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FIGURES

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Legend
Facility Boundary
CAA 4C
CAA 7
CAA 7
CAA 4C
San Francisco Bay
Treasure Island
Yerba Buena Island
Bay Brg
I-80
Oakland
San Francisco
Alameda Point
Oakland Inner Harbor
The Embarcadero
0 1 2 3 4
Miles
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community
0 1,000 2,000 3,000
Feet
N
PROJECT NO.: 5023-14-6069
DATE: September 2014
DRAWN BY: RMH
CHECKED BY: CM
MMEC GROUP
Alameda Point, Alameda, California
ALAMEDA POINT LOCATION MAP
BIOREMEDIATION TREATABILITY STUDY AT PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7
FIGURE
C-1

PROJECT NO.: 5023-14-6069		Alameda Point, Alameda, California	FIGURE
DATE: September 2014	MMEC GROUP	CORRECTIVE ACTION AREAS (CAA) 4C AND 7 LOCATION MAP	C-2
DRAWN BY: RMH		BIOREMEDIATION TREATABILITY STUDY AT	
CHECKED BY: CM		PETROLEUM CORRECTIVE ACTION AREAS 4C AND 7	

Appendix D
AMENDMENT DOSAGE CALCULATIONS

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Klozur® CR
Demand Calculations

PeroxyChem

12-Sep-2014

Customer:	**AMEC**		**Prepared by:**
Contact:	**Lansana Coulibaly**		**Stacey Telesz**
Site Location:	**CAA 4C ISCO, Alameda, CA**		**1-949-280-5765**
Proposal Number:	**PeroxyChem-02097-26572**		**Stacey.Telesz@peroxychem.com**

PRODUCT OVERVIEW

Klozur® CR is a single, formulated product consisting of high pH - activated Klozur® Persulfate and PermeOx® engineered calcium peroxide, uniting the strengths of both products to treat contaminant source zones and down-gradient plumes. The Klozur® CR is formulated to provide a self-activated persulfate oxidation system which couples chemical oxidation with aerobic and anaerobic bioremediation processes that can last up to one year after applied.

Klozur® CR can be utilized as a combined remedy for the treatment of BTEX, MTBE, PAHs and petroleum hydrocarbons, or as a high-pH activated persulfate system for the destruction of chlorinated solvents and pesticides. As a result, the product can be readily applied to either source areas or plumes with mixed petroleum and chlorinated solvents contamination.

The product is supplied as a dry powder in 45-lb (20.4 kg) pails or 1,800-lb (816.5 kg) super sacs.

SITE INFORMATION / ASSUMPTIONS

	Value	Unit	Comment
Area of Treatment	800	ft x ft	customer supplied
Treatment Zone Thickness	12	ft	customer supplied
Treatment Volume	9,600	ft3	calculated value
Porosity	27	%	default value
Ground Water Volume	2,592	ft3	calculated value
Soil Density	90	lbs/ft3	default value
Soil Mass	432	ton	calculated value
Soil Oxidant Demand	1	g Klozur CR / kg soil	estimated value, it is recommend that this be analytically determined

CONTAMINANTS OF CONCERN (COCs)

Constituent	GW (mg/L)	Soil (mg/kg)	Total COI Mass (lb)
GRO	31	30	30.9
BTEX	8.3	0	1.3

*Unless provided, sorbed concentrations were roughly estimated based on expected groundwater concentrations, foc and Koc values. For a more refined estimate, it is recommended that actual values be verified via direct sampling of the targeted treatment interval.

KLOZUR® CR DEMAND CALCULATIONS

Demand from COCs	1,052	lb
Demand from SOD	864	lb
Total Klozur® CR Demand	1,916	lb

KLOZUR® CR PACKAGING OPTIONS AND ~~PR~~ICING

Available Packaging Types	# of packages per pallet	Mass Klozur CR per pallet (lbs)	# of packages needed [1]
45 # pails	32	1,440	43

Available Packaging Types	Unit Rate [2] ($ / lb)	Total Mass (lbs)	Cost in USD [3, 4] (FOB Tonawanda, NY)
45 # pails	4.25	1,935	$8,223.75

1) Number of packages needed is rounded up to nearest whole unit.

2) Price valid for 90 days from date at top of document. Terms: net 30 days.

3) Any applicable taxes not included. Please provide a copy of your tax exempt certificate or resale tax number when placing your order. In accordance with the law, applicable state and local taxes will be applied at the time of invoicing if PeroxyChem has not been presented with your fully executed tax exemption documentation.

4) Shipping not included. Freight rates from Tonawanda, NY available upon request. Standard delivery time can vary from 1-3 weeks from time of order, depending upon volume. Expedited transport can be arranged at extra cost.

5) All sales are per PeroxyChem's Terms and Conditions.

Disclaimer:

The estimated dosage and recommended application methodology described in this document are based on the site information provided to us, but are not meant to constitute a guaranty of performance or a predictor of the speed at which a given site is remediated. Klozur® CR demand calculations are based on stoichiometry, and do not take into account the kinetics, or speed of the reaction, and represent the minimum anticipated amount needed to mineralize the contaminants. As a result, these calculations should be used as a general approximation for initial economic assessment. PeroxyChem recommends that oxidant demand and treatability testing be performed to verify the quantities of oxidant needed.

INSTALLATION

The product is supplied as a dry powder which can be mixed with soil or slurried in water. Installation techniques vary widely depending on the application. For example, the powder can be directly mixed into the soil using deep soil mixing equipment or placed into an open excavation where prior soil removal had been conducted. A slurry can be made and the mixture can be injected into the subsurface using techniques such as direct injection through Geoprobe rods or hydraulic fracturing. Injection through fixed wells is not recommended given that the product does not fully dissolve in water.

Klozur CR Slurry Preparation (assuming 45 lb pails packaging)

The Klozur CR slurry can been prepared in a variety of ways, including using paddle mixers, recirculation and manual mixing using a hand-held drill with a mixing attachment. However, particularly for larger projects, we recommend having a mechanical mixing system available on site. In general we recommend continuous mixing in smaller batches (<100 USG / 400 L) to avoid settling of solids at the bottom.

The amount of water to prepare the Klozur CR slurry could be varied depending on the desired injection volume and slurry properties. When applied via direct injection, normally a concentration of between 10 and 30% is typically targeted. The below table shows the amount of water needed per 45-lb pail depepending on the targeted concentration and the resulting total injection volumes and percent pore fill (injection volume to total pore volume).

Target concentration (% solids):	**10%**	**20%**	**30%**
Mass Klozur CR per pail (lbs)	45	45	45
Volume water per pail (USG)	49	22	13
Volume slurry per pail (lbs)	54	27	18
Total mass Klozur CR (lbs)	1,935	1,935	1,935
Total volume water (USG)	2,087	928	541
Total injection volume (USG)	2,319	1,159	773
Resulting injection volume to total pore volume	11.9%	6.0%	4.0%

Preparation of Klozur CR Slurry

Concentration of Klozur CR slurry to inject	20%	by weight
Total volume of water required	928	U.S. gallons
Approximate volume of slurry to inject	1,159	U.S. gallons

Injection Details

Injection spacing	9	ft
Number of points required	10	locations
Mass Klozur CR per location	194	lbs
Volume slurry per location	115.9	U.S. gallons
Slurry volume to total pore space volume	6.0%	

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PermeOx Ultra®
Demand Calculations

PeroxyChem

15-Sep-2014

Customer:	**AMEC**	**Prepared by:**	
Contact:	**Lansana Coulibaly**	**Stacey Telesz**	
Site Location:	**CAA 7 ISB, Alameda, CA**	**1-949-280-5765**	
Proposal Number:	**PeroxyChem-02095-44893**	**Stacey.Telesz@peroxychem.com**	

PRODUCT OVERVIEW

PermeOx Ultra® is an engineered calcium peroxide for the slow release of oxygen and nutrients to stimulate aerobic bioremediation of soils, sediment or groundwater environments. For organic constituents amenable to aerobic biodegradation processes (e.g., petroleum hydrocarbons, certain pesticides/herbicides), PermeOx Ultra significantly stimulates the catabolic activity of the indigenous microflora, thereby accelerating the rate of contaminant removal.

The product is supplied as a dry powder in five-gallon pails with 25 lbs/11.3 kg per pail or in drums with 50 lbs/22.7 kg per drum. The product will release approximately 18% oxygen by weight over an estimated 12-month period.

SITE INFORMATION / ASSUMPTIONS

	Value	Unit	Comment
Treatment Area Dimensions:			
Width of targeted zone (perpendicular to gw flow)	126	ft	customer supplied
Length of targeted zone (parallel to gw flow)	40	ft	customer supplied
Depth to top of treatment zone	5	ft bgs	customer supplied
Treatment zone thickness	14	ft	customer supplied
Treatment volume	70,560	ft3	calculated value
Porosity	27	%	default value
Groundwater volume	19,051	ft3	calculated value
Soil bulk density	90	lbs/ft3	default value
Soil mass	3,175	ton	calculated value
Transport characteristics:			
Treatment time / design life for one application	1	years	default value
Linear groundwater flow velocity	2	ft/year	calculated value
Distance of inflowing gw over design life	2	ft	calculated value
Effective porosity for groundwater flow	15	%	default value
Volume of water passing region over design life	529	ft3	calculated value
Soil type	low permeability		customer supplied
Fraction organic carbon in soil, foc	0.010		estimated value

CONTAMINANTS OF CONCERN (COCs)

Constituent	GW (mg/L)	Soil* (mg/kg)	Total COI Mass** (lb)
GRO	2.2	0	2.69
MTBE	4.5	0	5.5

*Unless provided, sorbed concentrations were roughly estimated based on expected groundwater concentrations, foc and Koc values. For a more refined estimate, it is recommended that actual values be verified via direct sampling of the targeted treatment interval.

**The total COI mass was estimated based on concentrations in soil and groundwater within the targeted area plus expected contributions from inflowing groundwater over the projected design life.

GEOCHEMICAL DATA

	GW (mg/L)	Soil (mg/kg)
Reduced Metals (dissolved Fe, Mn)	13	NA
Biological Oxygen Demand, BOD	NA	NA
Chemical Oxygen Demand, COD	350	NA

STOICHIOMETRIC OXYGEN DEMAND CALCULATIONS

The oxygen demand was calculated based on available data and assumptions presented above. The oxygen demand from COCs were estimated using EPA oxygen demand rates and represent the minimum anticipated amount needed to mineralize the COCs. The calculations based on BOD and COD provides a more conservative estimate as it includes the oxygen demand from COCs, reduced metals and natural organics. Therefore, if available, we recommend using these parameters as a bases for estimating the total PermeOx Plus requirements below (selecting the higher number).

	Dissolved Phase Demand (lbs)	Sorbed Phase Demand (lbs)	Demand from Flux (lbs)	Total Oxygen Demand (lbs)
Calculation 1 - COCs + Metals	29.4	0.0	2.3	31.8
Calculation 2 - BOD	NA	NA	NA	0.0
Calculation 3 - COD	416.3	NA	11.6	427.9

Note, for a more refined estimate of the total oxygen demand we recommend sampling both soil and groundwater for BOD or COD.

PERMEOX ULTRA DEMAND CALCULATIONS

Bases for recommendation: Calculation 3 - COD

	Value	Unit
Oxygen Demand from COD	427.9	lbs
Oxygen Release from PermeOx	18%	by weight
Mass PermeOx needed to meet O2 Demand	2377.2	lbs
Recommended min. conc. PermeOx in pore water*	4,000	mg/L
Mass of PermeOx recommended	4,758	lbs

*Note, our general recommendation of targeting at least 4,000 mg/L PermeOx Ultra in groundwater exceeds the mass required based on oxygen demand calculations and was therefore used for the purpose of this dosing calculation.

PERMEOX ULTRA PACKAGING OPTIONS AND PRICING

Available Packaging Types	# of packages per pallet	Mass PermeOx per pallet (lbs)	# of packages needed*
25 # pails	36	900	191
50 # drum	14	700	96

Available Packaging Types	Unit Rate [2] ($ / lb)	Total Mass (lbs)	Cost in USD [3, 4] (FOB Burlington NJ)
25 # pails	6.60	4,775	$31,515.00
50 # drum	6.50	4,800	$31,200.00

1) Number of packages needed is rounded up to nearest whole unit.

2) Price valid for 90 days from date at top of document. Terms: net 30 days.

3) Any applicable taxes not included. Please provide a copy of your tax exempt certificate or resale tax number when placing your order. In accordance with the law, applicable state and local taxes will be applied at the time of invoicing if PeroxyChem has not been presented with your fully executed tax exemption documentation.

4) Shipping not included. Freight rates from Burlington NJ available upon request. Standard delivery time can vary from 1-3 weeks from time of order, depending upon volume. Expedited transport can be arranged at extra cost.

5) All sales are per PeroxyChem's Terms and Conditions.

Disclaimer:

The estimated dosage and recommended application methodology described in this document are based on the site information provided to us, but are not meant to constitute a guaranty of performance or a predictor of the speed at which a given site is remediated. The calculations in the Cost Estimate regarding the amount of product to be used in your project are based on stoichiometry or default minimum guideline values, and do not take into account the kinetics, or speed of the reaction. Note that the Stoichiometric mass represent the minimum anticipated amount needed to address the contaminants of concern (COCs). As a result, these calculations should be used as a general approximation for purposes of an initial economic assessment. PeroxyChem recommends that you or your consultants complete a comprehensive remedial design that takes into consideration the precise nature of the COC impact and actual site conditions.

INSTALLATION

The product is supplied as a dry powder which can be mixed with soil or slurried in water. Installation techniques vary widely depending on the application. For example, the powder can be directly mixed into the soil using deep soil mixing equipment or placed into an open excavation where prior soil removal had been conducted. A slurry can be made and the mixture can be injected into the subsurface using techniques such as direct injection through Geoprobe rods or hydraulic fracturing. Injection through fixed wells is not recommended given that the product does not dissolve in water.

PermeOx Slurry Preparation (assuming 25 lb pails packaging)

The PermeOx slurry can been prepared in a variety of ways, including using paddle mixers, recirculation and manual mixing using a hand-held drill with a mixing attachment. However, particularly for larger projects, we recommend having a mechanical mixing system available on site. In general we recommend continuous mixing in smaller batches (<100 USG / 400 L) to avoid settling of solids at the bottom.

The amount of water to prepare the PermeOx slurry could be varied depending on the desired injection volume and slurry properties. When applied via direct injection, normally a concentration of between 10 and 30% is targeted. The below table shows the amount of water needed per 25-lb pail depending on the targeted concentration and the resulting total injection volumes and percent pore fill (injection volume to total pore volume).

Target concentration (% solids):	**10%**	**20%**	**30%**
Mass PermeOx per pail (lbs)	25	25	25
Volume water per pail (USG)	27	12	7
Volume slurry per pail (lbs)	30	15	10
Total mass PermeOx (lbs)	4,775	4,775	4,775
Total volume water (USG)	5,150	2,289	1,335
Total injection volume (USG)	5,722	2,861	1,907
Resulting injection volume to total pore volume	4.0%	2.0%	1.3%

Preparation of PermeOx Slurry

Concentration of PermeOx slurry to inject	20%	by weight
Total volume of water required	2,289	U.S. gallons
Approximate volume of slurry to inject	2,861	U.S. gallons

Injection Details

Injection spacing	10	ft
Number of points required	50	locations
Mass PermeOx per location	96	lbs
Volume slurry per location	57.2	U.S. gallons
Slurry volume to total pore space volume	2.0%	

PermeOx Ultra®
Demand Calculations

PeroxyChem

15-Sep-2014

Customer:	**AMEC**	**Prepared by:**	
Contact:	**Lansana Coulibaly**		**Stacey Telesz**
Site Location:	**CAA 4C In-Situ Aerobic**		**1-949-280-5765**
Proposal Number:	**PeroxyChem-02097-26572**		**Stacey.Telesz@peroxychem.com**

PRODUCT OVERVIEW

PermeOx Ultra® is an engineered calcium peroxide for the slow release of oxygen and nutrients to stimulate aerobic bioremediation of soils, sediment or groundwater environments. For organic constituents amenable to aerobic biodegradation processes (e.g., petroleum hydrocarbons, certain pesticides/herbicides), PermeOx Ultra significantly stimulates the catabolic activity of the indigenous microflora, thereby accelerating the rate of contaminant removal.

The product is supplied as a dry powder in five-gallon pails with 25 lbs/11.3 kg per pail or in drums with 50 lbs/22.7 kg per drum. The product will release approximately 18% oxygen by weight over an estimated 12-month period.

SITE INFORMATION / ASSUMPTIONS

	Value	Unit	Comment
Treatment Area Dimensions:			
Width of targeted zone (perpendicular to gw flow)	45	ft	customer supplied
Length of targeted zone (parallel to gw flow)	57	ft	customer supplied
Depth to top of treatment zone	4	ft bgs	customer supplied
Treatment zone thickness	12	ft	customer supplied
Treatment volume	30,780	ft3	calculated value
Porosity	27	%	default value
Groundwater volume	8,311	ft3	calculated value
Soil bulk density	90	lbs/ft3	default value
Soil mass	1,385	ton	calculated value
Transport characteristics:			
Treatment time / design life for one application	1	years	default value
Linear groundwater flow velocity	2	ft/year	calculated value
Distance of inflowing gw over design life	2	ft	calculated value
Effective porosity for groundwater flow	15	%	default value
Volume of water passing region over design life	162	ft3	calculated value
Soil type	low permeability		customer supplied
Fraction organic carbon in soil, foc	0.010		estimated value

CONTAMINANTS OF CONCERN (COCs)

Constituent	GW (mg/L)	Soil* (mg/kg)	Total COI Mass** (lb)
GRO	4.8	30	85.65
BTEX	0.88	0	0.5

*Unless provided, sorbed concentrations were roughly estimated based on expected groundwater concentrations, foc and Koc values. For a more refined estimate, it is recommended that actual values be verified via direct sampling of the targeted treatment interval.

**The total COI mass was estimated based on concentrations in soil and groundwater within the targeted area plus expected contributions from inflowing groundwater over the projected design life.

GEOCHEMICAL DATA

	GW (mg/L)	Soil (mg/kg)
Reduced Metals (dissolved Fe, Mn)	13	NA
Biological Oxygen Demand, BOD	NA	NA
Chemical Oxygen Demand, COD	350	NA

STOICHIOMETRIC OXYGEN DEMAND CALCULATIONS

The oxygen demand was calculated based on available data and assumptions presented above. The oxygen demand from COCs were estimated using EPA oxygen demand rates and represent the minimum anticipated amount needed to mineralize the COCs. The calculations based on BOD and COD provides a more conservative estimate as it includes the oxygen demand from COCs, reduced metals and natural organics. Therefore, if available, we recommend using these parameters as a bases for estimating the total PermeOx Plus requirements below (selecting the higher number).

	Dissolved Phase Demand (lbs)	Sorbed Phase Demand (lbs)	Demand from Flux (lbs)	Total Oxygen Demand (lbs)
Calculation 1 - COCs + Metals	11.0	290.9	0.9	302.7
Calculation 2 - BOD	NA	NA	NA	0.0
Calculation 3 - COD	181.6	NA	3.5	185.2

PERMEOX ULTRA DEMAND CALCULATIONS

Bases for recommendation: Calculation 3 - COD

	Value	Unit
Oxygen Demand from COD	185.2	lbs
Oxygen Release from PermeOx	18%	by weight
Mass PermeOx needed to meet O2 Demand	1028.6	lbs
Recommended min. conc. PermeOx in pore water*	4,000	mg/L
Mass of PermeOx recommended	2,076	lbs

*Note, our general recommendation of targeting at least 4,000 mg/L PermeOx Ultra in groundwater exceeds the mass required based on oxygen demand calculations and was therefore used for the purpose of this dosing calculation.

PERMEOX ULTRA PACKAGING OPTIONS AND PRICING

Available Packaging Types	# of packages per pallet	Mass PermeOx per pallet (lbs)	# of packages needed*
25 # pails	36	900	84
50 # drum	14	700	42

Available Packaging Types	Unit Rate [2] ($ / lb)	Total Mass (lbs)	Cost in USD [3, 4] (FOB Burlington NJ)
25 # pails	6.60	2,100	$13,860.00
50 # drum	6.50	2,100	$13,650.00

1) Number of packages needed is rounded up to nearest whole unit.

2) Price valid for 90 days from date at top of document. Terms: net 30 days.

3) Any applicable taxes not included. Please provide a copy of your tax exempt certificate or resale tax number when placing your order. In accordance with the law, applicable state and local taxes will be applied at the time of invoicing if PeroxyChem has not been presented with your fully executed tax exemption documentation.

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INSTALLATION

The product is supplied as a dry powder which can be mixed with soil or slurried in water. Installation techniques vary widely depending on the application. For example, the powder can be directly mixed into the soil using deep soil mixing equipment or placed into an open excavation where prior soil removal had been conducted. A slurry can be made and the mixture can be injected into the subsurface using techniques such as direct injection through Geoprobe rods or hydraulic fracturing. Injection through fixed wells is not recommended given that the product does not dissolve in water.

PermeOx Slurry Preparation (assuming 25 lb pails packaging)

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The amount of water to prepare the PermeOx slurry could be varied depending on the desired injection volume and slurry properties. When applied via direct injection, normally a concentration of between 10 and 30% is targeted. The below table shows the amount of water needed per 25-lb pail depending on the targeted concentration and the resulting total injection volumes and percent pore fill (injection volume to total pore volume).

Target concentration (% solids):	**10%**	**20%**	**30%**
Mass PermeOx per pail (lbs)	25	25	25
Volume water per pail (USG)	27	12	7
Volume slurry per pail (lbs)	30	15	10
Total mass PermeOx (lbs)	2,100	2,100	2,100
Total volume water (USG)	2,265	1,007	587
Total injection volume (USG)	2,517	1,258	839
Resulting injection volume to total pore volume	4.0%	2.0%	1.3%

Preparation of PermeOx Slurry

Concentration of PermeOx slurry to inject	20%	by weight
Total volume of water required	1,007	U.S. gallons
Approximate volume of slurry to inject	1,258	U.S. gallons

Injection Details

Injection spacing	9	ft
Number of points required	32	locations
Mass PermeOx per location	66	lbs
Volume slurry per location	39.3	U.S. gallons
Slurry volume to total pore space volume	2.0%	

Appendix E
RESPONSES TO COMMENTS

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Comment	Section	Comment	Response
Comments from Yemia Hashimoto, San Francisco Bay Regional Water Quality Control Board (SF RWQCB), received February 13, 2015			
1	Executive Summary	The text in the fourth paragraph of the Executive Summary and XXXX refers to the "Navy's Exception to Drinking Water Policy for shallow groundwater". This wording needs to be revised. **Action Requested:** Please revise the text the "Navy's Exception to Drinking Water Policy for shallow groundwater." Replace it with "finding that the shallow groundwater meets the exception criteria in Resolution 88-63, Sources of Drinking Water." So, for example, the first line of the fifth paragraph of the Executive Summary would be revised to: CAA 4C is located in Southeast Alameda Point and shallow groundwater meets the exception criteria in Resolution 88-63, Sources of Drinking Water.	The text has been revised to "CAA 4C is located in Southeast Alameda Point where shallow groundwater meets the exception criteria in Resolution 88-63, Sources of Drinking Water.
2	Figure 4	Suggest making edits to the title and legend notes.	Specific edits are captured in the RTCs below.
2a	Figure 4	Suggest adding the italicized text for the note "Analytes shown on the Figure exceeded the PRC presented in the 2012 updated Petroleum Management Plan unless *"-" shown".*	The note has been revised per the comment.
2b	Figure 4	To the legend and title, suggested stating that the direct push technology injection points are *proposed* points.	The symbol is currently defined in the Figure legend as *Proposed Direct Push Technology (DPT)™ Injection Points*.The legend note also states: *DPT locations are approximate based on an ROI of 5 feet.*
2c	Figure 4	The legend note "text in italics are compounds without established screening criteria" refers to the TPHs. The ESLs for TPHs are available and do serve as established screening criteria, per Step 4 of Figure 3, Petroleum Closure Decision Tree (Navy, 2009). This note should be removed.	This project's remediation performance criteria are based only on the preliminary remediation criteria (PRC) in accordance with the Petroleum Decision Tree - Figure 3 Step 5. ESLs are screening levels; screening levels are not remediation criteria. The note in the legend for Figures 4 and 5 has been revised to read: *"Compounds in italics do not have a PRC."*
2d	Figure 4	Please show in the figure the current extent of the groundwater plume. This Figure 4, text in Section 2.2.2 and text in Step 4 of the SAP Worksheet #11 describes the site boundaries of the study, but the extent of the groundwater plume is not shown. Based on the data in the tables and the figure, the extent of the plume is beyond the study area, yet wells are referred to as "outside the plume" in SAP Worksheet #14.	The intent of Figures 4 and 5 are to show the target treatment area at each site based on PRC exceedances, not TPH exceeding the ESL. In accordance with the decision framework presented in Figure 3 Step 5; after ESLs are considered, if remediation is warranted, remediation is measured against the PRC.
3	Figure 5	Suggest making edits to the title and legend notes.	Specific edits are captured in the RTCs below.

Comment	Section	Comment	Response
3a	Figure 5	Suggest adding the italicized text for the note "Analytes shown on the Figure exceeded the PRC presented in the 2012 updated Petroleum Management Plan unless *"-" shown*	The note has been revised per the comment.
3b	Figure 5	To the legend and title, suggested stating that the direct push technology injection points are *proposed* points.	The note has been revised per the comment.
3c	Figure 5	This figure refers to the proposed bioremediation layout for CAA7, so please change the legend note referring to CAA 4C to "CAA7 is a Drinking Water and Residential Area."	The legend note has been changed to read "CAA 7 is a Drinking Water and Residential Use Area."
3d	Figure 5	The legend note "text in italics are compounds without established screening criteria" refers to the TPHs. The ESLs for TPHs are available and do serve as established screening criteria, per Step 4 of Figure 3, Petroleum Closure Decision Tree (Navy, 2009). This note should be removed.	This project's remediation performance criteria are based only on the preliminary remediation criteria (PRC) in accordance with the Petroleum Decision Tree - Figure 3 Step 5. ESLs are screening levels, not remediation criteria. The note in the legend for Figures 4 and 5 has been revised to read: *"Compounds in italics do not have a PRC."*
3e	Figure 5	Please show in the figure the current extent of the groundwater plume. This Figure 5, text in Section 2.3.2 and text in Step 4 of the SAP Worksheet #11 describes the site boundaries of the *study*, but the extent of the groundwater plume is not shown. Based on the data in the tables and the figure, the extent of the plume is beyond the study area, yet wells are referred to as "outside the plume" in SAP Worksheet #14.	The intent of Figures 4 and 5 are to show the target treatment area at each site based on PRC exceedances, not TPH exceeding the ESL. In accordance with the decision framework presented in Figure 3 Step 5; after ESLs are considered, if remediation is warranted, remediation is measured against the PRC.
4	Table 1	Table 1 tabulates analytical data for select wells from 2011 to 2014 and compares the analytical data to PRC screening level criteria. While the note regarding "Values in grey italics are compounds without established screening criteria" is accurate for PRCs, it is inaccurate that there is no screening criteria for these constitutents in groundwater. According to Figure 3, step 4, first a comparison is made to ESL screening levels, then PRCs in Step 5. Hence, in the absence of, and prior to, comparison to PRCs, the compounds shown in grey italics can be compared to ESLs. **Action Requested:** Please revise the text in Table 1 to clarify that while there is no established screening PRCs for the italicized constituents, there are ESL screening levels and those values are..."	The bioremediation treatment effectiveness will be measured against the PRCs, not the ESLs. ESLs are *screening criteria*, PRCs are *remediation criteria*. The note on Tables 1 and 2 has been changed to read "Values in grey italics are compounds without established PRC."

Comment	Section	Comment	Response
5	Table 3	According to Table 3, all the shaded wells are within the treatability footprint, but according to the Table in SAP Worksheet #14, 3 wells are located outside of the plume and monitored with the specific purpose of monitoring the downgradient edge of the plume for mobilization from injections. **Action Requested:** Please clarify this discrepancy in the text and tables.	The footnote for Table 3 will be revised to state "Wells shaded in grey will be used to evaluate the effectiveness of the treatability study, however, all wells in this table will be sampled."
6	SAP Worksheet #11	Suggest referencing SAP Worksheet #11 in the work plan for further clarification of the treatability steps and decision process.	The SAP is referenced in Section 5.3, performance monitoring, of the Work Plan to clarify the rationale for selected treatment locations and analytical data collection.
Comments from Peter Russell, PhD, PE Russell Resources, received February 5, 2015.			
1	Executive Summary, Section 1.1, Section 2.4	The fifth paragraph of the Executive Summary (p. iii) says "CAA 4C is planned for commercial/industrial reuse." Please change the planned future use to "commercial-mixed use" (see for example Final OU-2A iROD, Section 2.4, P. 22). Please correct this statement wherever it occurs in the work plan, for example, Section 1.1 (p. 1-1).	The Work Plan has been revised to identify "commercial-mixed" as the planned future use for CAA 4C.
2	Section 5	The second paragraph of Section 5 (p. 5-1) says treatment effectiveness wells are indicated on Table 3: 9 wells in CAA 4C and 6 wells in CAA 7. These numbers of wells are shaded on Table 3, but the table's note says "wells shaded in grey are located in the treatability footprint." Please clarify this apparent discrepancy.	The footnote for Table 3 will be revised to state "Wells shaded in grey will be used to evaluate the effectiveness of the treatability study. Please note that all wells in this table will be sampled to support the Navy's on-going basewide petroleum monitoring program."
3	Section 5.3	Section 5.3 discusses performance monitoring. Its orientation is evaluation of whether PRCs have been met and/or whether Low-Threat UST closure is appropriate. However, this work plan is for a treatability study, not an RA work plan. Please discuss recommendations for next steps if the treatment is effective but fails to achieve closure criteria, for next steps if the treatment is ineffective, etc.	If the treatment does not meet either closure criteria, treatment optimizations and/or alternatives will be recommended based on an evaluation of treatability study results (e.g., site specific geochemistry and residual petroleum compounds present). This has been added to Section 5.3 to clarity any next steps, if warranted.
Comments received from Doug DeLong, BRAC PMO West, received January 15, 2015			
1	Work Plan (p. 1-1)	Throughout the document, NAVFAC SW is stated as the owner. References should be changed to reflect BRAC PMO-W ownership	On page 1-1, NAVFAC SW has been correctly identified as the entity administrating Contract Number N62473-12-D-2012.

Comment	Section	Comment	Response
2	SAP - Worksheet #3 (p. 5)	Contact info (e-mail) for Doug DeLong will change.	Doug Delong's email has been updated to: douglas.delong.ctr@navy.mil
3	SAP - Worksheet #6 (p. 11)	Is this a NAVFAC SW RPM or a BRAC PMO-W. If BRAC, references throughout the document should reflect this.	The RPM has been correctly identified as a NAVFAC SW RPM. Please note that BRAC RPMs are NAVFAC SW employees forward deployed to BRAC.
4	SAP - Worksheet #6 (p. 12)	I don't see any references to the ROICC or CSO included in the Stop Work procedure	ROICC and CSO notification and authority to stop work has been included in the Stop Work Procedure and their names have been added to WS#6.
5	SAP - Worksheet #7 (p. 15)	Shouldn't the Organizational Affiliation be changed from NAVFAC SW to BRAC PMO-W?	NAVFAC SW has been correctly identified as the correct Organizational Affiliation.
6	SAP - Worksheet #9 (p. 21)	E-mail address for DeLong will change. Check the Affiliations.	Doug Delong's email has been updated to: douglas.delong.ctr@navy.mil NAVFAC SW has been correctly identified as the correct affiliation.
7	WMP - Summary (p. 1-2)	Label should include AMEC field personnel contact info while still an IDW. AMEC will in turn contact CSO POC and ROICC.	The IDW labeling procedure has been updated to reflect that the label will include MMEC Group field personnel contact info, and that MMEC Group will contact the CSO POC and/or ROICC
8	WMP - Summary (p. 1-2)	Disposal of IDW should be coordinated through CSO POC, not the ROICC.	Document updated to reflect that the disposal of IDW will be coordinated through the CSO POC, and not the ROICC
9	WMP - Waste Profiling and Disposal (p. 4-1)	Wastewater will be discharged to the POTW through the sanitary sewer system, provided the proper EBMUD permits have been acquired.	Document has been updated to reflect that wastewater will be discharged to the local POTW through the sanitary system only after the proper EBMUD permits have been acquired.
10	WMP - Waste Profiling and Disposal (p. 4-1)	The MMEC Group will verify or alter the identified waste disposal facilities - after approval and oversight by CSO.	The document has been updated to reflect that the MMEC Group will verify or alter the identified waste disposal facilities only after approval and with the oversight of the CSO.
11	EPP - Prevention of Releases to the	Notify the local BRAC PMO-W CSO. The local fire department isn't the CUPA for the Navy.	The document has been updated to reflect that in the event of an accidental release, the local BRAC PMO-W CSO will be notified.

Comment	Section	Comment	Response
	Environment (p. 3-1)		
12	EPP - Management Procedures for All Hazardous Waste Generated (p.4-2)	…the confines of BRAC PMO-W…generated by BRAC PMO-W	The EPP has been revised to show BRAC PMO-W.
13	EPP - Management Procedures for All Hazardous Waste Generated (p. 4-2)	by the BRAC PMO-W HW/Facility Manager…	The EPP has been revised to show BRAC PMO West HW/Facility Manager
14	EPP - Management Procedures for All Hazardous Waste Generated (p. 4-2)	BRAC PMO-W property	The EPP has been revised to show BRAC PMO-W as the property owner.
15	EPP - Management Procedures for All Hazardous Waste Generated (p. 4-2)	BRAC PMO-W property	The EPP has been revised to show BRAC PMO-W as the property owner.
16	EPP - Management Procedures for All Hazardous Waste	and BRAC PMO-W RPM and local CSO HW POC	The document has been updated to reflect that the CSO will be provided copies of waste determination documentation for any solid waste streams that have the potential to be hazardous waste or contain any chemical constituents listed in 40 CFR 372, Subpart D. NAVFAC SW has been correctly identified as the

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	Generated (p. 4-2)		affiliation for the RPM. Please note that BRAC RPMs are forward-deployed NAVFAC SW employees.
17	EPP - Disposal of Hazardous Waste by Permitted Facilities (p. 4-4)	BRAC PMO-W	BRAC PMO-W has been identifed in the EPP.
Comments from Yemia Hashimoto, San Francisco Bay Regional Water Quality Control Board (SF RWQCB) received via email April 24, 2015			
		In Section 1.1 Objective, there is mention that the effectiveness of the EISB-a-treatment will be measured on the basis of meeting applicable PRCs. In Figures 4 and 5, however, there is a statement that refers to the TPH values, implying that TPH does not have a screening value. TPH DOES have a PRC, per Table 3 and Table 4 of the Technical Memorandum. Please make the edit regarding this.	Total TPH does have a PRC, however, the Total TPH PRC is for Marine Ecological Receptors for sites 0-250 feet from the bay. Both sites are much farther than 250 feet from the bay, therefore the PRC for Total TPH does not apply to CAA 4C and 7.
		Also, in the RTC there is a statement regarding ESLs and PRCs. ESLs and PRCs are both SCREENING criteria. It is incorrect to state that one is screening and one is remediation criteria. In paragraph 2 of the Technical Memorandum, last sentences: The ESLs serve as a primary screen and the PRCs are a secondary screen. Remediation goals will be determined on a site-specific basis.	PRCs will serve as the target concentration goals for this Treatability Study. ESLs are meant to be used as a primary screen at sites to determine ifa site can be closed or if further action is warranted. Because action is warranted and being taken at CAA 4C and 7, the PRCs will be used to assess the effectiveness of this Treatability Study.

Comment	Section	Comment	Response
		Also, the RTC response to the Water Board request (Items 2d and 3e) for a plume boundary to be shown on Figures 4 and 5 does not address the request to show the extent of the groundwater plume. This RTC reiterates a response regarding TPH, ESLs and PRCs. Showing the ground plume extent would aid in understanding which wells are within or outside of the plume as stated in Worksheet #14.	The plume boundaries at CAA 4C and 7 have been added to Figures 4 and 5 of the Work Plan.
Comments from Yemia Hashimoto, San Francisco Bay Regional Water Quality Control Board (SF RWQCB) received via email May 20, 2015			
		Water Board staff response: Water Board staff do not concur that TPH does not apply to CAA 4C and 7. The text in the Draft WP (specifically in the Executive Summary, Tables 1 and 2, and in Sections 2.2.2, 2.3.2, 2.4.4, 2.4.5, 3.1.3.1, and 3.1.3.2) references TPH as having a PRC of 1,400 ug/L and that the work plan is focused in areas with residual total petroleum hydrocarbon exceeding the PRC of 1,400 ug/L. The Draft WP is in conflict with the statement provided by the contractor in these May 18, 2015, RTCs. Understand that Table 3 of the Technical Memorandum does not stipulate distance from the shoreline as a possible waiver to evaluate risk from Total TPH or any other chemical listed in this table. Table 4 of the Technical Memorandum does provide for PRCs of different values for benzene, MTBE, lead, and Total TPH discharging to surface water based on distance to shoreline ranging from 0 to 250 feet, in 25 foot increments. The intent of this distinction in Table 4 is not to exclude total TPH as a possible risk at the site if the site is located over 250 feet from the shoreline, but to define when the ecological receptor pathway is open and must be evaluated. Regardless of whether an ecological receptor pathway is considered open within a set distance of 250 feet, other pathways are valid and the PRC does apply. Other alternatives to the use of the PRC include determining site-specific clean up values based on a site specific risk assessment. In lieu of that, Water Board staff are willing to concur with the use of the PRC for TPH, 1,400 ug/L, for this remediation clean up value. Also acceptable are the appropriate ESL values.	The text in the Work Plan and Figure 4 will be rephrased to indicate that the PRC value of 1.4 mg/L for Total TPH shown on Table 5-2 of the February 2012 Update Petroleum Management Plan (PMP) [Battelle, 2012] is not applicable at CAA 4C and CAA 7 because both sites are greater than 250 feet from the shoreline. In accordance with Table 5-3 of the 2012 Update Petroleum Management Plan, the PRC value of 20 mg/L will be used for Total TPH. Tables 1 and 2 only show historical site data (2011-2014) presented in previous reports that are used to design the target treatment zone for this treatability study. Instead, footnote 1 will be revised to: *The PRC presented in this table are generic PRC for a site located on the shoreline (i..e, 0 feet from the bay) as shown in the 2012 Update Petroleum Management Plan for Alameda Point (Battelle, 2012). However, both CAA 4C and CAA 7 are greater than 250 feet from the shoreline, and thus Table 5-3 of the Update Petroleum Management Plan applies when deriving CAA 4C and CAA 7 specific PRC values for benzene, MTBE, lead, and total TPH.*

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		Action requested: Please review the text in the Draft WP that already states that the PRC of 1,400 ug/L will be used for TPH, and include this on Tables 1 and 2, and Figures 4 and 5	
		Water Board staff response: PRCs may serve as the agreed-upon target concentration goals for this site and study and this can be stated. Note, however, that it is not accurate to state that PRCs are remediation criteria and ESLs are screening criteria when both are technically screening criteria.	It is noted that both ESL and PRC are technically screening level. No revision is required.
		Water Board staff response: Please use consistent values to delineate the plumes and identify areas for treatment based on the PRCs. We understand "residential" PRCs will serve as the "target concentration goals" for this Treatability Study. **Action requested:** Be consistent about which residential PRCs are being used as target concentration goals in this study or state why different PRC values are referenced.	Please note CAA 7 is planned for residential reuse and CAA 4C is commercial reuse. The Work Plan *screened* both sites to residential PRCs, however, when defining *target concentration goals* for the study, the Navy selects the appropriate PRC for the planned reuse in accordance with the 2012 Update PMP Table 5-3 and 5-4. Consequently, CAA 7 applies residential PRCs for a drinking water site, and CAA 4C applies commercial/industrial PRCs for a non-drinking water site when setting target concentration goals. Both sites are greater than 250 feet from the bay when considering marine ecological receptor concentration goals. To clarify goals for CAA 4C, the note on Figure 4 has been revised to: *The PRC selected is the lower of either* ***non-residential vapor intrusion*** *or marine ecological risk for a site greater than 250 feet from the bay*. The value used for each chemical and the rationale for its use is as follows: **1. PRC for benzene is 0.036 mg/L** and is based on non-residential vapor intrusion (Table 5-2 of Update PMP). **2. PRC for ethylbenzene is 0.094 mg/L** and is based on non-residential vapor intrusion (Table 5-2 of the Update PMP). Note that the lower PRC for marine ecological receptor of 0.025 mg/L is for sites 0-feet from the shoreline and thus not appropriate for CAA 4C. **3. PRC for naphthalene is 0.089 mg/L and** is based on non-residential vapor intrusion (Table 5-2 of the Update PMP), the lowest non-ingestion value. Note that the

Comment	Section	Comment	Response
			lower PRC for marine ecological receptor of 0.0014 mg/L is for sites 0-feet from the shoreline location and thus not appropriate for CAA 4C. **4. PRC for total TPH is 20 mg/L** and is based on protection of marine ecological receptors for a site 250-feet away from the shoreline (Table 5-3 of the Update PMP). Note that the lower PRC for marine ecological receptor of 1.4 mg/L is for 0-feet from the shoreline and thus not appropriate for CAA 4C, or CAA 7.
Comments from Yemia Hashimoto, San Francisco Bay Regional Water Quality Control Board (SF RWQCB) received via email June 9, 2015			
1		The contractor states that, "*The text in the Work Plan and Figure 4 will be rephrased to indicate that the PRC value of 1.4 mg/L for Total TPH shown on Table 5-2 of the February 2012 Update Petroleum Management Plan (PMP) [Battelle, 2012] is not applicable at CAA 4C and CAA 7 because both sites are greater than 250 feet from the shoreline. In accordance with Table 5-3 of the 2012 Update Petroleum Management Plan, the PRC value of 20 mg/L will be used for Total TPH.* *Tables 1 and 2 only show historical site data (2011-2014) presented in previous reports that are used to design the target treatment zone for this treatability study. Instead, footnote 1 will be revised to: The PRC presented in this table are generic PRC for a site located on the shoreline (i.e., 0 feet from the bay) as shown in the 2012 Update Petroleum Management Plan for Alameda Point (Battelle, 2012). However, both CAA 4C and CAA 7 are greater than 250 feet from the shoreline, and thus Table 5-3 of the Update Petroleum Management Plan applies when deriving CAA 4C and CAA 7 specific PRC values for benzene, MTBE, lead, and total TPH.*" **Water Board staff response:** Water Board staff do not concur with the above statement. As stated in the May 20, 2015, response by Water Board staff and repeated here for emphasis: "*Understand that Table 3 of the Technical Memorandum does not stipulate distance from the shoreline as a possible waiver to evaluate risk from Total TPH or any other chemical listed in this table. Table 4 of the Technical Memorandum does provide for PRCs of different*	"PRC does not apply" was meant to indicate that both CAA 4C and CAA 7 are greater than 250 feet from surface water and thus the marine ecological PRC for a site on the shoreline (i.e., 0 feet from shore) is not appropriate for use at either site per Table 5-4 (2012 PMP). Rather, the PRC for a site 250 feet from the surface water body is appropriate. Please note that neither the Navy, nor its contractor is implying that risk from total TPH and other chemicals should be waived, it clearly wasn't given that TPH-related chemicals, such as benzene and MTBE for which toxicity values are available were screened using applicable PRC values. There is no risk-based human health screening criteria for total TPH or TPH fractions (i..e, gasoline, jet fuel, motor oil) in the PMP or the ESL tables. The values suggested by the reviewers are based on toxicity values using surrogates to represent different TPH fractions (e.g., n-hexane for aliphatics C5 through C8). The Navy believes that site decisions should be based on risk-based, peer-reviewed and accepted toxicity values with broad consensus such as benzene and MTBE risk-based criteria. This point is well noted on the disclaimer page of the referenced ESL user's guide that "it is not intended to establish policy or regulations, and especially not intended to serve as a stand-alone decision making tool."

Comment	Section	Comment	Response
		values for benzene, MTBE, lead, and Total TPH discharging to surface water based on distance to shoreline ranging from 0 to 250 feet, in 25 foot increments. The intent of this distinction in Table 4 is not to exclude total TPH as a possible risk at the site if the site is located over 250 feet from the shoreline, but to define when the ecological receptor pathway is [potentially complete] and must be evaluated. Regardless of whether an ecological receptor pathway is considered [potentially complete] within a set distance of 250 feet, other pathways are valid and the PRC does apply." Water Board staff understand that the clean-up, or target concentration, goals of this study are residential and the planned reuse is residential and commercial. Therefore, the human health risk pathway for groundwater needs to be evaluated. Because the beneficial use includes drinking water for one of the two sites, this evaluation should include ingestion, inhalation, and dermal contact for residents and workers, unless adequate justification for exclusion is provided. Because groundwater is shallow, direct contact (incidental ingestion, inhalation, and dermal contact) with groundwater by a utility or construction worker should be evaluated. Lastly vapor intrusion should also be evaluated. Water Board staff will not concur with a site closure request for residential or commercial use based on a clean-up value for TPH that does not consider the human receptor pathway. Currently the selected TPH clean-up value of 20,000 ug/L for an ecological pathway over 250 feet from the shore is inappropriate and does not meet the work plan's objective. Water Board staff concur with the MMEC statement in section 1.1, that "the effectiveness of the EISB-a treatment will be measured on the basis of meeting applicable PRCs or ESLs, and/or meeting the criteria set forth in the State of California Water Resources Control Board's (SWRCB's) Low Threat Underground Storage Tank Closure Policy (Policy)." The release scenario appears to meet the Policy requirements. MMEC states in the RTCs, that, "*when defining target concentration goals for the study, the Navy selects the appropriate PRC for the planned reuse in accordance with the 2012 Update PMP Table 5-3 and 5-4*". Water Board staff concur that the consultant shall use	It is also important to make a distinction between CAA 4C and CAA 7 in that CAA 4C is planned commercial use and groundwater is not potential drinking water (2012, RWQCB EDWP). CAA 7 is planned for residential use and groundwater is considered potential drinking water. Proposed Action: For the purpose of this Treatability Study, the Navy will use the PRC values presented in the Final 2012 Update to Petroleum Management Plan (Battelle, 2012) as performance treatment goals. The Navy understands that site closure decisions will be determined in conjunction with the RWQCB, following treatment.

Comment	Section	Comment	Response
		appropriate screening values, and in this situation, clean-up goals. Because there is not a residential groundwater PRC for petroleum hydrocarbons, the ESL risk-based goals for drinking water (Table F-3) shall be used as clean-up goals for TPH in this study. The appropriate groundwater ESLs to use as clean-up goals for TPHg, TPHd, and TPHm are 400 ug/L, 150 ug/L, and 2,700 ug/L, respectively. Understand that the use of a higher clean-up value, such as the presumed groundwater solubility limit pf 20,000 ug/L for TPH, will not be sufficient for the Water Board to determine closure eligibility. The sites will not be considered for closure with a clean-up value exceeding the appropriate ESLs or without a site specific risk assessment. **Action requested:** Please review the text in the Draft WP that states that the PRC of 1,400 ug/L will be used for TPH, and change this to the Table F-3 ESLs for petroleum hydrocarbons.	
2		The contractor stated, "*Please note CAA 7 is planned for residential reuse and CAA 4C is commercial reuse". The Work Plan screened both sites to residential PRCs, however, when defining target concentration goals for the study, the Navy selects the appropriate PRC for the planned reuse in accordance with the 2012 Update PMP Table 5-3 and 5-4. Consequently, CAA 7 applies residential PRCs for a drinking water site, and CAA 4C applies commercial/industrial PRCs for a non-drinking water site when setting target concentration goals. Both sites are greater than 250 feet from the bay when considering marine ecological receptor concentration goals.To clarify goals for CAA 4C, the note on Figure 4 has been revised to: The PRC selected is the lower of either non-residential vapor intrusion or marine ecological risk for a site greater than 250 feet from the bay.The value used for each chemical and the rationale for its use is as follows: 1. PRC for benzene is 0.036 mg/L and is based on non-residential vapor intrusion (Table 5-2 of Update PMP). 2. PRC for ethylbenzene is 0.094 mg/L and is based on non-residential vapor intrusion (Table 5-2 of the Update PMP). Note that the lower PRC for marine ecological receptor of 0.025 mg/L is for sites 0-feet from the shoreline and thus not appropriate for CAA 4C. 3. PRC for naphthalene is 0.089 mg/L and is based on non-residential vapor intrusion (Table 5-2 of the Update PMP), the*	The Navy agrees that ESLs could serve as a screening criteria when PRC values are not available. However, for total TPH, the Navy will use the PRC value of 20 mg/L (table 5-3) as the performace treatment goal for this treatability study. As noted by the reviewer, the Navy appropriately select the most conservative values for TPH constituents with available toxicity values such as benzene and MTBE, as stated previously for commercial reuse site CAA 4C: The PRC selected is the lower of either non-residential vapor intrusion or marine ecological risk for a site greater than 250 feet from the bay (Table 5-2 2012 Update PMP).

Comment	Section	Comment	Response
		lowest non-ingestion value. Note that the lower PRC for marine ecological receptor of 0.0014 mg/L is for sites 0-feet from the shoreline location and thus not appropriate for CAA 4C. 4. PRC for total TPH is 20 mg/L and is based on protection of marine ecological receptors for a site 250-feet away from the shoreline (Table 5-3 of the Update PMP). Note that the lower PRC for marine ecological receptor of 1.4 mg/L is for 0-feet from the shoreline and thus not appropriate for CAA 4C, or CAA 7." **Water Board staff response:** Water Board staff concur that the appropriate PRC be selected in accordance with the planned reuse and with the updated PMP. In instances where a PRC value is unavailable for the planned reuse (i.e. TPH), ESLs may be used. It is inappropriate to select the most conservative values for some constituents and then the least conservative for another (TPH).**Action requested:** Per item 1. above, re-evaluate the use of 20 mg/L for use as a screening or clean-up value for TPH.	