

**FINAL
WORK PLAN
CHEMICAL OXIDATION TREATABILITY STUDY
INSTALLATION RESTORATION SITE 25
ALAMEDA POINT
ALAMEDA, CALIFORNIA**

**Environmental Remedial Action
Contract Number N62474-98-D-2076
Contract Task Order 0076**

**Document Control Number 1859
Revision 0**

August 3, 2001

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Naval Facilities Engineering Command
Environmental Division
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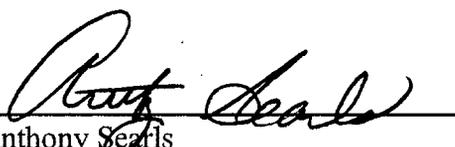
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Anthony Searls
IT Project Manager

Date: August 7, 2001



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Table of Contents

List of Figures.....	iii
List of Tables.....	iii
List of Appendices.....	iii
Acronyms and Abbreviations.....	iv
1.0 Introduction.....	1-1
1.1 Project Objective.....	1-1
1.2 Site Conditions.....	1-1
1.2.1 Site History	1-2
1.2.2 Site Geology	1-6
1.2.3 Site Hydrogeology.....	1-9
1.2.4 Extent of PAH Contamination	1-10
1.3 Report Organization.....	1-14
1.4 Statutory Authority and Other Requirements	1-14
2.0 Treatability Study Rationale.....	2-1
2.1 Baseline Remediation Options.....	2-1
2.2 Alternative Remediation Technology Summary	2-1
2.3 Treatability Study Goals.....	2-6
2.3.1 Evaluate Treatment Effectiveness	2-6
2.3.2 Evaluate Permanganate Delivery Methods.....	2-6
2.3.3 Evaluate Permanganate Dose Requirements	2-6
2.4 Community Health and Safety	2-6
3.0 Treatability Study Design.....	3-1
3.1 Permanganate Delivery Methods.....	3-1
3.1.1 Shallow Subsurface Injection.....	3-1
3.1.2 Surface Tilling	3-1
3.1.3 Surface Irrigation.....	3-2
3.2 Treatability Study Preparation.....	3-2
3.2.1 Mobilization of Equipment and Personnel.....	3-2
3.2.2 Utility Clearance.....	3-2
3.2.3 Support Facilities and Temporary Utilities.....	3-3
3.2.4 Construction of Test Area	3-3
3.2.5 Instrument Installation	3-4
3.2.5.1 Lysimeters	3-4
3.2.5.2 Piezometer	3-7
3.2.5.3 Neutron Depth Probe.....	3-8
3.3 Sampling and Analysis Rationale.....	3-8
3.4 Sampling and Analysis Approach	3-9
3.5 Sampling Frequency	3-10
3.5.1 Baseline Sampling	3-11
3.5.2 Operational Monitoring.....	3-11
3.5.3 Performance Monitoring.....	3-12
3.6 Permanganate Mixing and Delivery	3-16
3.6.1 Shallow Subsurface Injection.....	3-17
3.6.1.1 Safety Considerations	3-17

Table of Contents (continued)

	3.6.1.2	Required Equipment.....	3-17
	3.6.1.3	Potassium Permanganate Solution Mixing	3-17
	3.6.1.4	Potassium Permanganate Solution Injection	3-18
3.6.2		Surface Tilling	3-18
	3.6.2.1	Safety Considerations	3-18
	3.6.2.2	Required Equipment.....	3-18
	3.6.2.3	Potassium Permanganate Solids Delivery	3-19
	3.6.2.4	Mixing Water Application	3-19
3.6.3		Surface Irrigation.....	3-19
	3.6.3.1	Safety Considerations	3-19
	3.6.3.2	Required Equipment.....	3-20
	3.6.3.3	Potassium Permanganate Solution Mixing	3-20
	3.6.3.4	Potassium Permanganate Surface Irrigation	3-20
4.0		Demobilization and Site Restoration	4-1
	4.1	Demobilization	4-1
	4.2	Site Restoration	4-1
	4.3	Wastes.....	4-2
5.0		Waste Management	5-1
	5.1	Types of Wastes	5-1
	5.2	Accumulation of Wastes	5-1
	5.3	Waste Disposal Methods	5-1
6.0		Treatability Study Reporting	6-1
7.0		References	7-1

List of Figures

Figure 1-1	Site Location Map.....	1-3
Figure 1-2	Installation Restoration Site 25 Treatability Study Location Map.....	1-4
Figure 1-3	Chemical Oxidation Treatability Study Test Cell Layout.....	1-7
Figure 1-4	PAH in Soil as B(a)P Equivalents, Depths Less Than 2 ft bgs	1-12
Figure 1-5	PAH in Soil as B(a)P Equivalents, Depths 2 to 4 ft bgs	1-13
Figure 3-1	Lysimeter, Piezometer, and Neutron Probe Casings Schematic.....	3-6

List of Tables

Table 1-1	Multipliers for PAH Concentrations to B(a)P-Equivalent Concentrations.....	1-11
Table 2-1	Summary Matrix of Potential In Situ Polycyclic Aromatic Hydrocarbon Treatment Technologies.....	2-4
Table 3-1	Sampling Parameters, Rationale, and Collection Frequency	3-5
Table 3-2	Soil SOD Samples at 1 Month of Treatment.....	3-13
Table 3-3	Soil SOD Samples at 3 Months of Treatment.....	3-13
Table 3-4	Soil SOD Samples at 6 Months of Treatment.....	3-14
Table 3-5	Soil PAH Samples at 1 Month of Treatment.....	3-14
Table 3-6	Soil PAH Samples at 3 Months of Treatment	3-14
Table 3-7	Soil PAH Samples at 6 Months of Treatment	3-15
Table 3-8	Soil Mn Samples at 6 Months of Treatment.....	3-15
Table 3-9	Groundwater Cr(VI) and As Samples at 6 Months of Treatment	3-16
Table 3-10	Pore Water KMnO ₄ Samples During 6 Months of Treatment.....	3-16

List of Appendices

Appendix A	Field Sampling Plan
Appendix B	Quality Assurance Project Plan
Appendix C	Site Health and Safety Plan
Appendix D	Project Quality Control Plan
Appendix E	Environmental Protection Plan

Acronyms and Abbreviations

°F	degrees Fahrenheit
Alameda Annex	Fleet and Industrial Supply Center Oakland Alameda Annex Facility
As	arsenic
B(a)P	benzo(a)pyrene
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Cr(VI)	hexavalent chromium
DDT	dichlorodiphenyltrichloroethane
DQO	data quality objectives
DTSC	Department of Toxic Substances Control
EBS	Environmental Baseline Survey
Environ	Environ International Corporation
EPA	U.S. Environmental Protection Agency
Fe ²⁺	ferrous iron
FSP	Field Sampling Plan
ft	foot/feet
g/L	gram(s) per liter
gpm	gallon(s) per minute
H ₂ O ₂	hydrogen peroxide
IDLH	immediately dangerous to life or health
in.	inch(es)
IR	Installation Restoration
IT	IT Corporation
kg	kilogram
KMnO ₄	potassium permanganate
MCL	maximum contaminant level
Mg	milligram
Mn	manganese
MnO ₄	permanganate ion
MtBE	methyl tertiary butyl ether
NAS	Naval Air Station
Neptune	Neptune and Company, Inc.
O ₃	ozone
OH*	hydroxyl radical
ORP	Oxidation-Reduction Potential
PAH	polycyclic aromatic hydrocarbon
PPE	personal protective equipment
ppm	parts(s) per million
QAPP	Quality Assurance Project Plan
SHSP	Site Health and Safety Plan
SOD	Soil Oxidant Demand
SOP	Standard Operating Procedure
TSTR	Treatability Study Technical Report
TtEMI	Tetra Tech EM, Inc.

1.0 Introduction

This in situ chemical oxidation field treatability study is intended to assess treatment of polycyclic aromatic hydrocarbon (PAH) contamination in shallow soil at Installation Restoration (IR) Site 25 at Alameda Point, Alameda, California. The shallow soil, which consists of fill material used to create Alameda Island (where there were historically marshes or shallow bay), have been identified as contaminated with PAHs. The PAHs are believed to have originated from historical industrial activities in adjacent areas and are ubiquitous in the fill material. The need to assess PAH treatment is driven by the fact that elevated PAH concentrations have been detected at shallow depths within a residential area. Furthermore, options evaluated to date for mitigating the potential human health hazard associated with the PAHs involve either capping or excavating the PAH-contaminated soil. Implementing these options in a residential area may pose significant logistical and technical challenges and limitations. Therefore, the U.S. Navy is researching alternative methods to clean up the PAH-contaminated soil to levels protective of human health and the environment from the soil. One such alternative is in situ chemical oxidation with potassium permanganate (KMnO₄).

1.1 Project Objective

The field treatability study will involve the use of KMnO₄ to treat PAH-contaminated soil to a depth of 4 feet (ft) below ground surface (bgs) within a controlled area at IR Site 25. KMnO₄ is a chemical oxidant that is capable of destroying PAH contaminants and that may be effective for field-scale in situ treatment under the site-specific conditions at IR Site 25. The field treatability study is designed primarily to assess the following key technical issues:

- The level of PAH treatment that can be obtained under conditions that mimic a potential full-scale application scenario
- The appropriate approach for subsurface delivery of KMnO₄ to the shallow soil
- The application dose of KMnO₄ that is required for treatment

Further statement of the project goals can be found in the project Quality Assurance Project Plan (QAPP) (Appendix B), which includes a complete statement of the project Data Quality Objectives.

1.2 Site Conditions

The 42-acre installation known as Operable Unit 5 (OU-5) and IR Site 25 is located in the San Francisco Bay Area and lies in the northeastern corner of Alameda Point (formerly Naval

Air Station [NAS] Alameda) as shown in Figure 1-1, "Site Location Map," and Figure 1-2, "Installation Restoration Site 25 Treatability Study Location Map." Approximately 40 percent of the site area is covered with structures and cement or asphalt paving; the remainder of the site is open space covered with vegetation and soil. The site is bordered by the Fleet and Industrial Supply Center Oakland Alameda Annex Facility (Alameda Annex) to the north and east, Alameda Point Environmental Baseline Survey (EBS) Parcels 178 through 180 to the south, and privately held property to the west. A set of railroad tracks is immediately north of the site. Todd Shipyard borders the site to the northwest.

During the course of environmental investigations in the vicinity of NAS Alameda and at IR Site 25, organic chemical analyses have revealed the presence of PAHs in the soil and groundwater. Currently, investigations are being conducted at IR Site 25 to collect data and fill data gaps to assist with risk assessment activities and to further characterize the concentrations of inorganic chemicals in the fill.

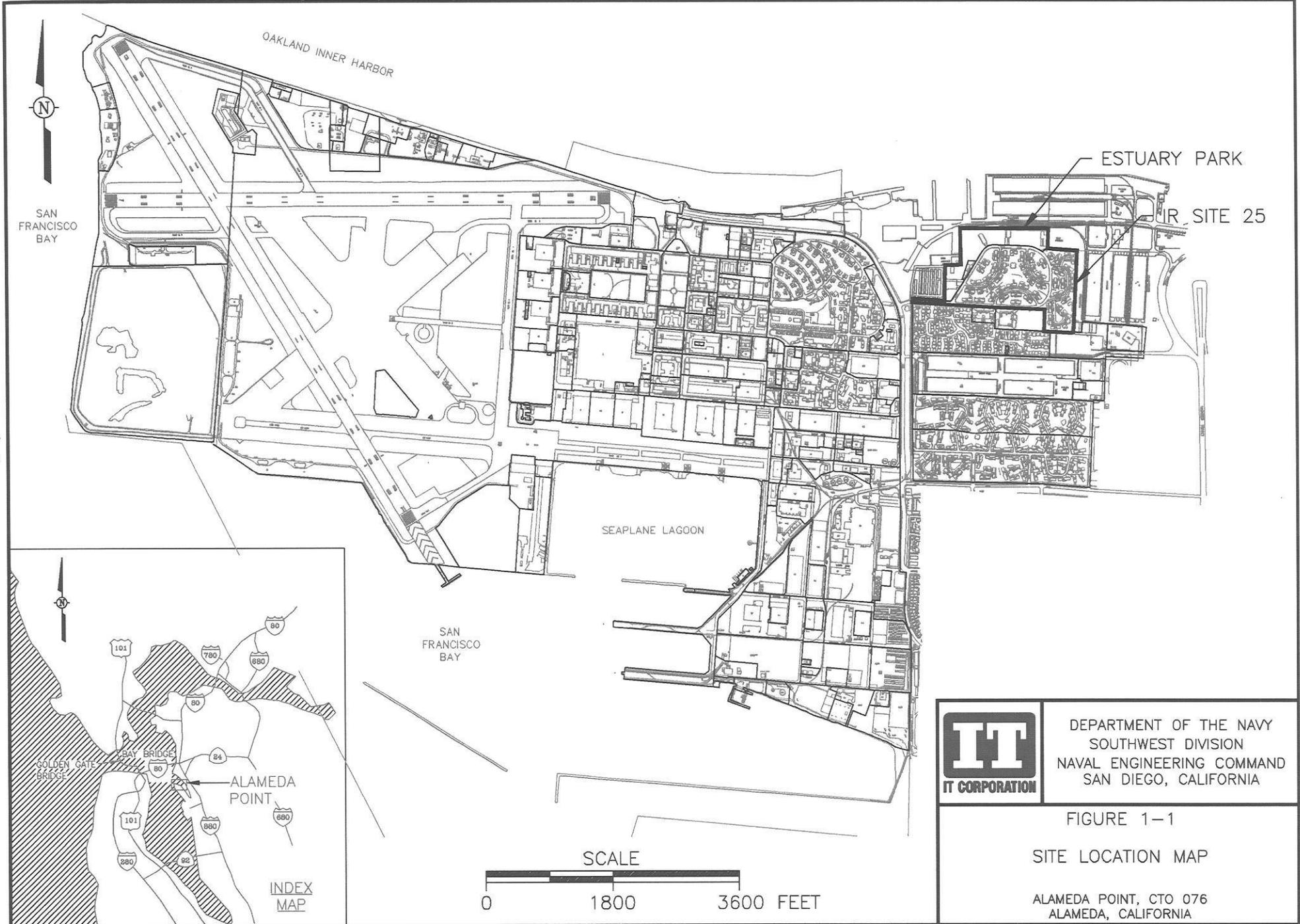
The City of Alameda precipitation records indicate that the mean annual precipitation is 18.69 inches. Most rainfall occurs between the months of November and April. Mean yearly low and high temperatures are 50.7 degrees Fahrenheit (°F) and 64°F, respectively. The wind direction is predominantly from the southeast and southwest.

1.2.1 Site History

IR Site 25 is comprised of approximately 42 acres, divided into three parcels (Parcels 181, 182, and 183). U.S. Coast Guard employees and their families are currently occupying a portion of the multi-unit housing structures within Parcel 181, under lease from the Navy. Parcel 182 is the Estuary Park and Parcel 183 is the location of the Coast Guard Housing Management Office. Parcels within IR Site 25 will be transferred to the City of Alameda and will be leased to the U.S. Coast Guard for continued use as Coast Guard housing.

The area encompassing IR Site 25 existed as marshland and tidal flat prior to development in the early 1900s, at which time these areas were filled with dredged material of uncertain origin to create usable land for development. The site was filled in two separate fill events (Tetra Tech EM, Inc. [TtEMI], 2000a). The first fill event (1887 to 1915) occurred along the northern border of the site. A later fill event (1930 to 1939) encompassed the entire site.

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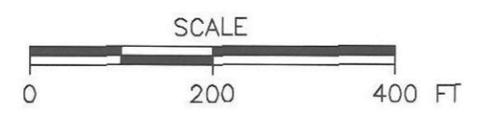
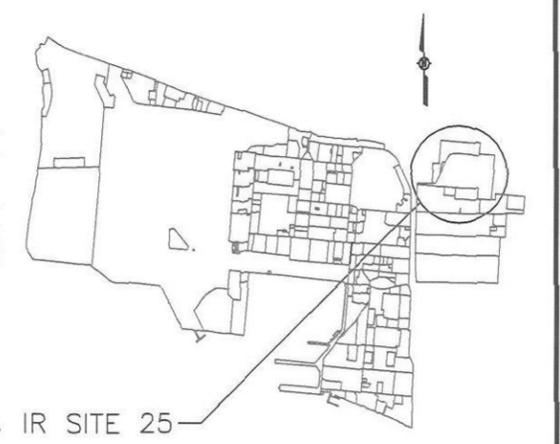
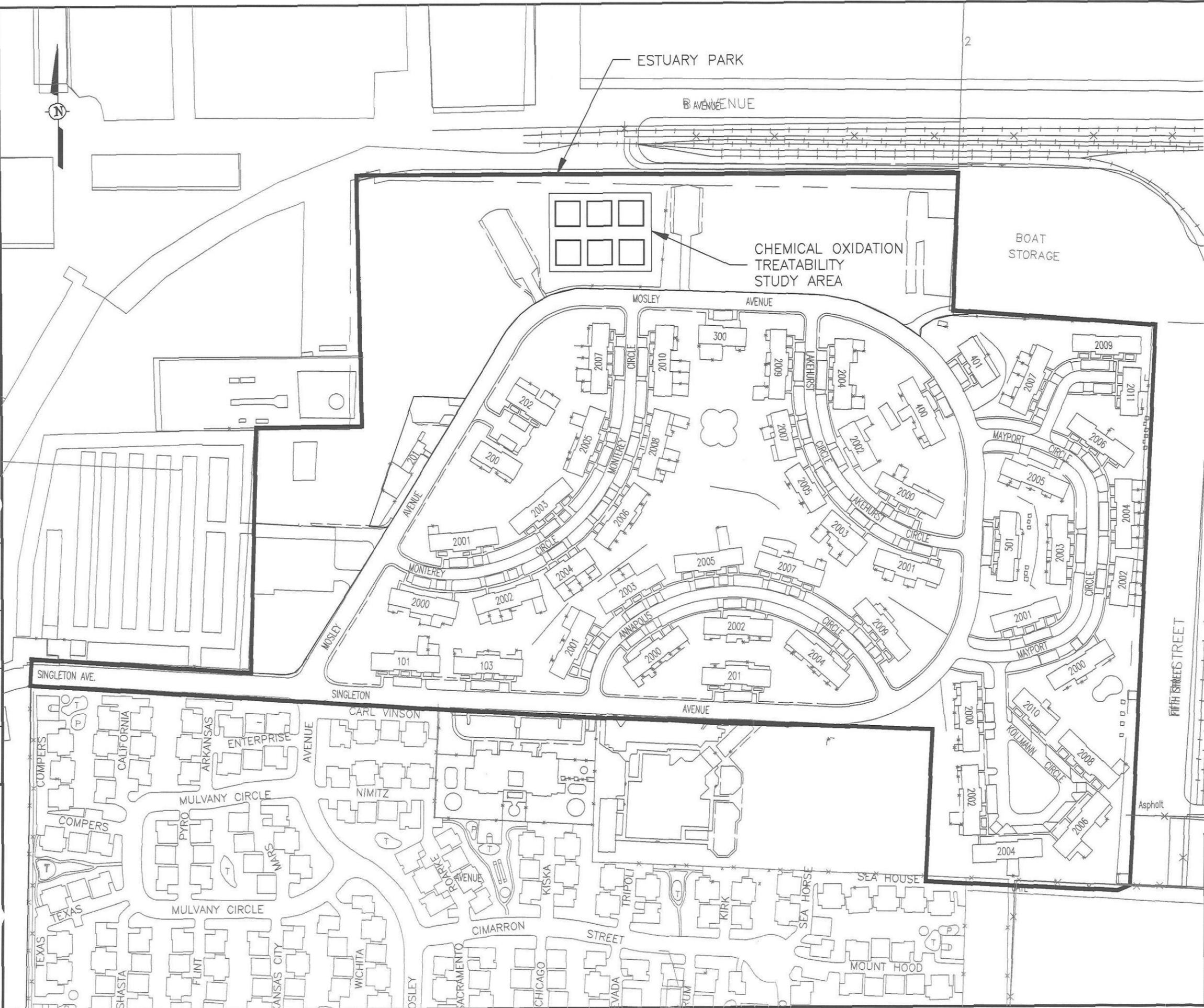


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 SAN DIEGO, CALIFORNIA

FIGURE 1-1
 SITE LOCATION MAP

ALAMEDA POINT, CTO 076
 ALAMEDA, CALIFORNIA

IMAGE X-REF ALA/BASE CONCORD
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FIGURE 1-2
 INSTALLATION RESTORATION SITE 25
 TREATABILITY STUDY LOCATION MAP
 ALAMEDA POINT, CTO 076
 ALAMEDA, CALIFORNIA

Parcel 181 is presently occupied by nine open-space areas and 51 residential buildings, which were constructed in 1969. Aerial photographs from 1947 and 1958 show different housing units that were reportedly used by the City of Alameda as housing projects (ERM-West, 1995). Some large structures of unknown use are also present on the eastern half of Parcel 181 in these photographs. No chemicals were known to have been used or stored at Parcel 181. A 1968 aerial photograph indicates that a stained area was present in an open area in the eastern portion of the parcel (Neptune and Company, Inc. [Neptune] and IT Corporation [IT], 2000). This staining was addressed during activities associated with the Parcel Evaluation Plan (ERM-West, 1995). A rectangular area approximately 240 ft by 300 ft centered near the intersection of Mayport and Kollmann Circles was identified by ERM-West (1995) as a former wetland within Parcel 181, as well as the location of the observed staining. There is an extensive system of sanitary sewers and storm drains underlying portions of IR Site 25 (Figure 1-3, "Chemical Oxidation Treatability Study Test Cell Layout"). The storm sewers discharge to the Oakland Inner Harbor. An inactive sanitary sewage pump station (Facility 591) is also located in Parcel 181 near the southeast corner of Estuary Park (Parcel 182).

Parcel 182 comprises the area currently defined as Estuary Park. This is where the treatability study will be performed. Between 1947 and 1966 the area was used for residential purposes and contained barracks-type housing. These buildings were reportedly demolished sometime between 1966 and 1970 (ERM-West, 1995). AN office building currently used (Building 534) was constructed sometime between 1990 and 1992 in the southernmost portion of Parcel 182. No chemical spills or releases have been documented within Parcel 182 (ERM-West, 1995).

Parcel 183 is less than 1 acre in size and contains Building 545. Building 545 is presently used as the Coast Guard Housing Management Office and was constructed between 1970 and 1975 (ERM-West, 1995). Parcel 183 was historically used to house barracks and shares a similar history in this regard as Parcel 182. No chemical spills or releases have been documented within Parcel 183 (ERM-West, 1995).

Several historical industrial operations that are likely to have released petroleum hydrocarbons to the environment were located in the vicinity of present-day Alameda Point. In particular, an oil refinery (Pacific Coast Oil Works) operated from about 1864 to 1899 at the western tip of pre-fill Alameda, and a manufactured gas plant that used oil (most active from 1903 through 1930) existed on the waterfront in Oakland. Releases of oil and by-products associated with manufacturing operations from these large industries are believed to have resulted in widespread contamination of the former Oakland Inner Harbor shoreline and tidal channels. Subsequent fill

events are believed to have trapped this contamination in place, resulting in a zone of elevated PAH and petroleum hydrocarbons described as the “marsh crust.”

The presence of PAH in the “marsh crust” and fill reflects their environmental persistence. Other organic chemicals present in petroleum products, such as single-ring aromatic compounds and light aliphatics, are largely lost over time due to volatilization, dissolution, and breakdown by a variety of microbial processes.

An interpretation of a 1937 aerial photo revealed several features that indicate the origin of contamination in IR Site 25, and why contaminant concentrations may differ from those in surrounding areas (Neptune, Environ International Corporation [Environ], and IT, 2001). It is clear that the area north of the railroad right-of-way was filled prior to the area of IR Site 25. There are already roads and structures north of the railroad in the 1937 photograph, while to the south there are indications of recent filling in the area of present-day IR Site 25. Alluvial-type patterns are indications of dredge-fill operations moving from the northern portion of the present-day site proceeding in a southeasterly direction.

A road, which today runs along the southern border of IR Site 25, is evident in the 1937 photograph. The railroad tracks that run along the northern border of IR Site 25 turned south beyond the present-day western boundary of Parcel 181. A large facility can be seen in the northwest portion of this historical photograph and may be a former electric car manufacturing plant. In summary, the area of present-day IR Site 25 was already a distinct region in the past that might have received sediments from different sources, and at different times, as compared to surrounding areas.

Fill associated with the excavation of Todd Shipyard may have been placed on IR Site 25. Todd Shipyard was not constructed as of 1937. Therefore, it appears that the berths of the shipyard were excavated from fill that was in place in the 1937 photo. The fate of the excavated fill is unknown, but it is possible that the excavated material was used to create the current grade of the site, which is 4 to 5 ft higher than the railroad tracks and the Oakland/Alameda Annex property north and east of IR Site 25. However, the EBS Report for Parcel 182 (ERM-West, 1995) states that the grade of Parcel 182 has not significantly changed since 1939.

1.2.2 Site Geology

The San Francisco Bay structural basin divides the north-south ridges of the California Coast Ranges, forming a natural basin several hundred miles long. The San Francisco Bay, combined with the San Pablo and Suisun Bays, constitutes one of the few estuarial waterways on the West

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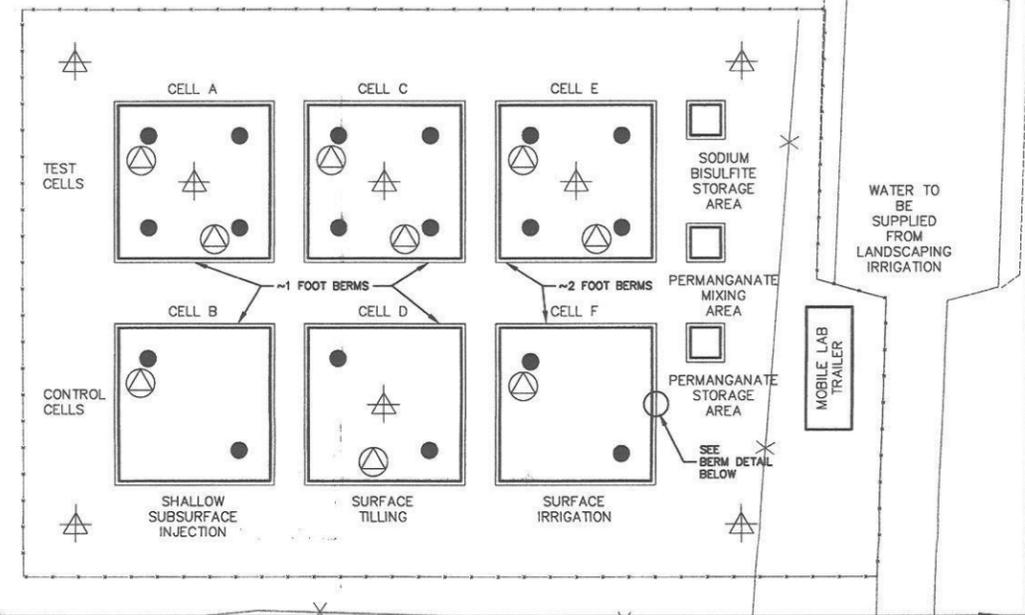
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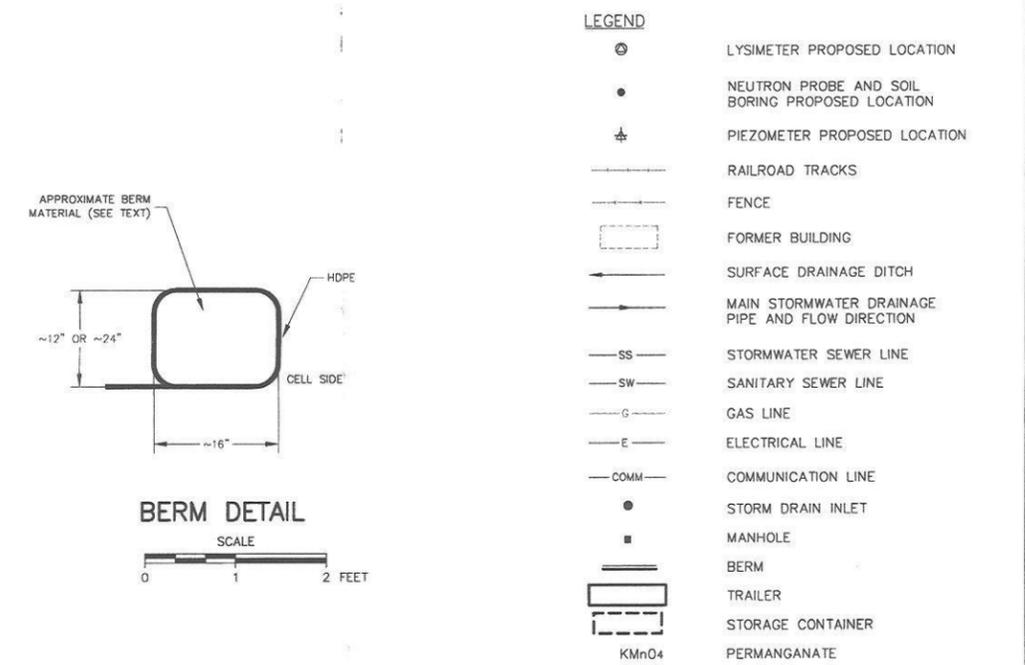
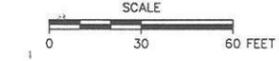
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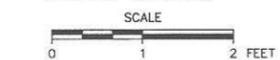
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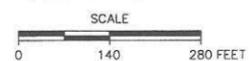
CELL LAYOUT DETAIL



BERM DETAIL



PLAN VIEW



- LEGEND**
- LYSIMETER PROPOSED LOCATION
 - NEUTRON PROBE AND SOIL BORING PROPOSED LOCATION
 - PIEZOMETER PROPOSED LOCATION
 - RAILROAD TRACKS
 - FENCE
 - FORMER BUILDING
 - SURFACE DRAINAGE DITCH
 - MAIN STORMWATER DRAINAGE PIPE AND FLOW DIRECTION
 - STORMWATER SEWER LINE
 - SANITARY SEWER LINE
 - GAS LINE
 - ELECTRICAL LINE
 - COMMUNICATION LINE
 - STORM DRAIN INLET
 - MANHOLE
 - BERM
 - TRAILER
 - STORAGE CONTAINER
 - PERMANGANATE

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FIGURE 1-3

**CHEMICAL OXIDATION TREATABILITY STUDY
CELL LAYOUT**

ALAMEDA POINT, CTO 076
ALAMEDA, CALIFORNIA

Coast of North America. The San Francisco Bay is open to the Pacific Ocean to the west through the Golden Gate. The waters from the Bay Region, from portions of the Central Valley and from the western slopes of the Sierra Nevada, discharge through the Golden Gate.

The IR Site 25 Study Area is adjacent to the Oakland Inner Harbor (Estuary), which opens to the San Francisco Bay, 1½ miles to the west of Alameda Point. Alameda Point is located along the eastern San Francisco Bay (East Bay Margin). San Francisco Bay occupies a depression between two uplifted areas, the Berkeley Hills to the east and the Montara and other mountains to the west. The depression and the uplifted areas were formed by two subparallel, active faults, the San Andreas Fault west of San Francisco Bay and the Hayward fault east of San Francisco Bay. The San Andreas and Hayward faults are located approximately 12 miles west and 5 miles east of the Annex, respectively.

The geologic section present in the East San Francisco Bay was described by Hickenbottom and Muir (1988), and the specific lithology present at Alameda Point was outlined by Tetra Tech EM, Inc., (TtEMI, 1999). The sedimentary deposits represented along the East San Francisco Bay include (from youngest to oldest) the Bay Mud, the Temescal Formation, the Merritt Sand, the Posey Formation, the San Antonio Formation, and the Alameda Formation. Dredge and fill operations created the shallow soil horizon, which is the target zone for this treatability study.

The fill is a heterogeneous, laterally discontinuous mixture of sand, silt, and clay (including dredged Bay Mud) with some construction debris and organic material. The thickness of the fill varies from approximately 10 to 20 ft across the facility. The thickness of the fill is probably most influenced by the presence of historical tidal channels that once transected the tidal flats.

The fill material was dredged from the Oakland Inner Harbor and San Francisco Bay, mixed with material from the Merritt Sand Formation (PRC, 1996). The marshland underneath the fill material is an organic-rich peat and grass layer about 2- to 6-in. thick at depths ranging from 15 to 20 ft bgs. This layer was first recognized during geotechnical investigation and the term “marsh crust” was used to signify this unit. Investigations conducted at the Alameda Annex indicate that the marsh crust contains contaminants that resulted from the waste disposal practices of pre-1937 industrial activities.

Borings located near the center of the facility indicate native sediment beneath the fill is Bay Mud, which consists primarily of gray to black, medium to high plasticity silty clay with occasional thin lenses of fine sand. No extensive sand layers were observed within the Bay Mud. The Bay Mud ranges from 25 to 80 ft. in thickness. The Merritt Sand Formation is found below the Bay Mud, although the thickness of the Merritt Formation is unknown at the Alameda

Annex. The Merritt Sand is found at depths as great as 135 ft bgs, but maximum depths are unknown.

The geology, as described in the Basewide Groundwater Beneficial Use Report, indicates the shallow water-bearing zone (TtEMI, 2000b) includes two groups: the shallow fill that is found in the uppermost 10 to 20 ft, and the underlying native sediment material, which includes the Bay Mud and the Merritt Sand.

1.2.3 Site Hydrogeology

Two primary aquifers have been identified at Alameda Point: the Merritt Sand aquifer (which includes the Merritt and Posey Sands) and the deeper Alameda aquifer. The Oakland Upland and Alluvial Plain Management Subarea groundwater management subarea contains the Merritt Sand and the Alameda aquifers. The shallow water-bearing zone in the fill at the facility is not considered an aquifer.

The Alameda aquifer is the principal aquifer within the Oakland Upland and Alluvial Plain Management Subarea. Depth to the top of the formation ranges from 100-ft bgs at Alameda Point to 200-ft bgs beneath the Oakland Inner Harbor. The formation thickness ranges between 200 and 800 ft (Hickenbottom and Muir, 1998). The San Antonio aquitard, which includes the Yerba Buena Mud and a thin upper, clay rich portion of the Alameda Formation, separates the Alameda aquifer from the shallower Merritt Sand aquifer.

The Merritt Sand aquifer is a poorer grade aquifer within the Oakland Upland and Alluvial Plain Management Subarea. The depth to the top of the formation is at approximately 23 ft bgs. The formation thickness can be greater than 110 ft. The Merritt Sand tends to thin close to the San Francisco Bay margin and grade into thick sequences of Bay Mud.

The shallow water-bearing zone within the fill forms the upper unconfined aquifer at the site. Groundwater elevation data indicate that the shallow groundwater generally flows to the northwest. There appears to be tidal influence in the shallow water-bearing zone near the Oakland Inner Harbor.

The horizontal gradient in the shallow water-bearing zone ranges from 0.002 ft/ft to 0.02 ft/ft. Localized groundwater mounds and depressions occur at isolated locations. Variations in the permeability of the soil are largely the result of grain size difference within the shallow saturated soil, and groundwater flow patterns are probably greatly influenced by this permeability. The depth to the top of the shallow water-bearing zone (i.e., water table) is at approximately 7 ft bgs, dependent on location and season.

The unsaturated zone is the zone between the ground surface and the water table, where the subsurface water only fills a portion of the soil pore space. Water movement in the unsaturated zone is controlled by gravity (downward infiltration) and by capillary pressure (wicking action due to surface tension of the water). The two key parameters that characterize the hydrologic conditions in the unsaturated zone are the water saturation (S_w) (percent of pore space that is water filled) and the capillary pressure head (H_c) (the negative pressure or suction associated with the wicking action of water). The capillary pressure and saturation are related by functions referred to as pressure-saturation curves. Each soil type has a unique pressure-saturation curve associated with it, which represents the soil properties (such as pore size distribution) that ultimately control water movement in the unsaturated zone. The unsaturated zone is between 0 and 3.6 ft thick in the treatability study area in Estuary Park.

1.2.4 Extent of PAH Contamination

PAH data were collected in 1994, 1995, 1998, 1999, and 2001 in the area of IR Site 25. The majority of the 1998 data were collected on a 150-ft regular grid within Parcel 182, although there are also some additional discretionary samples at a location near the northern boundary of the parcel where 1994 and 1995 data showed relatively high PAH concentrations. The 1999 PAH data were collected exclusively within Parcel 181, with the exception of a single sample from Parcel 183. The 2001 sampling event was conducted throughout IR Site 25.

For purposes of data analysis and presentation, concentrations of the seven carcinogenic PAHs (benzo[a]pyrene [B(a)P], benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene) were normalized according to their toxicity relative to B(a)P to create a single B(a)P-equivalent concentration. Table 1-1, "Multipliers for PAH Concentrations to B(a)P-Equivalent Concentrations," presents the multipliers used to convert the seven PAHs to B(a)P-equivalent concentrations. B(a)P is the only carcinogenic PAH for which the U.S. Environmental Protection Agency (EPA) publishes risk evaluation factors.

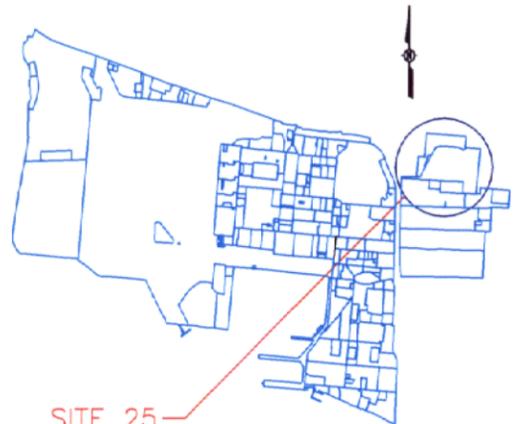
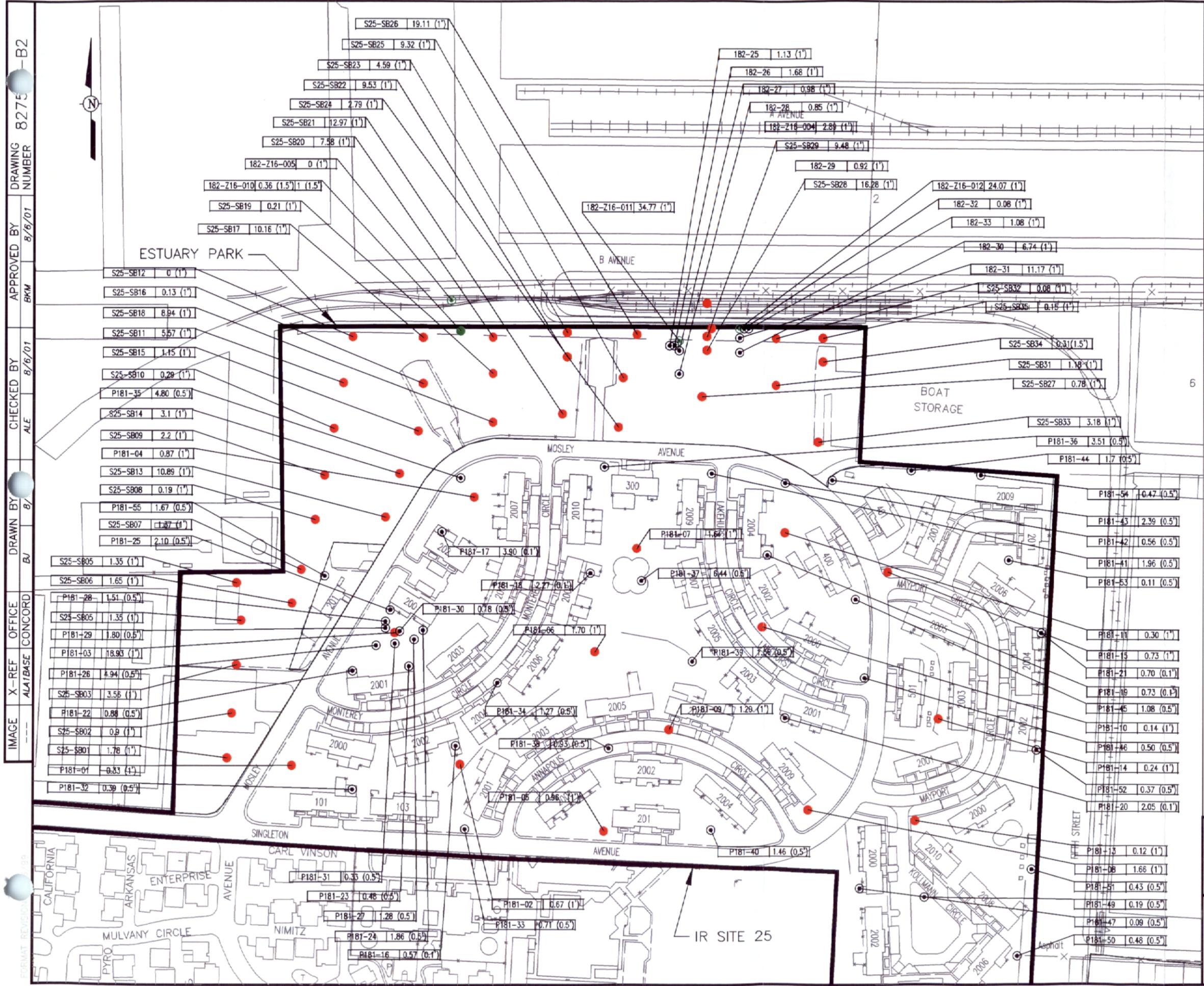
**Table 1-1
Multipliers for PAH Concentrations to B(a)P-Equivalent Concentrations**

	EPA Multiplier	DTSC Multiplier
Benzo[a]pyrene	1	1
Benzo[a]anthracene	0.1	0.1
Benzo[b]fluoranthene	0.1	0.1
Benzo[k]fluoranthene	0.01	0.1
Chrysene	0.001	0.01
Dibenzo[a,h]anthracene	1	0.342
Indeno[1,2,3-cd]pyrene	0.1	0.1

Multipliers provided by the EPA and the California Department of Toxic Substances Control (DTSC) are shown in Table 1-1. Each specific PAH is multiplied by the larger of the two values for that compound and then the converted values are summed by location. The multiplier value that is higher was used to be conservative (i.e., the greatest potential risk). Figure 1-4, "PAH in Soil as B(a)P Equivalents, Depths Less Than 2 ft bgs," and Figure 1-5, "PAH in Soil as B(a)P Equivalents, Depths 2 to 4 ft bgs," present B(a)P-equivalent concentrations in soil at less than 2 ft and 2 to 4 ft bgs, respectively.

Two trends in B(a)P-equivalent data were identified in the Final IR Site 25 Work Plan (Neptune, Environ, and IT, 2001). Benzo(a)pyrene-equivalent concentrations were noted to be elevated in the northwest region of IR Site 25 in the area of Estuary Park and then to decrease in a southeasterly direction toward Alameda Annex IR Site 02. At Alameda Annex IR Site 02, B(a)P-equivalent concentrations increase again, but are still generally lower than in the northwest region of IR Site 25. Benzo(a)pyrene-equivalent concentrations were not found to vary significantly as a function of location relative to the railroad tracks that divide the site on an east-west axis. The second trend identified was that B(a)P-equivalent concentrations are significantly higher, between 2 and 8 ft bgs than at 0 to 2 ft bgs in the area of Estuary Park. Benzo(a)pyrene-equivalent concentrations are lowest in the 8 to 10 ft bgs interval in this area.

Overall, the B(a)P-equivalent concentrations in Estuary Park soils are heterogeneously distributed. Figures 1-4 and 1-5 clearly demonstrate that PAH concentrations are not normally distributed or geostatistically correlated.



- LEGEND**
- IRP SOIL BORING
 - ⊙ IRP SURFACE SOIL SAMPLE
 - EBS SOIL BORING
 - ⊙ EBS SURFACE SOIL LOCATION

- ACRONYMS:**
- BGS - BELOW GROUND SURFACE
 - B(a)P - BENZO(a)PYRENE
 - EBS - ENVIRONMENTAL BASELINE SURVEY
 - IRP - INSTALLATION RESTORATION PROGRAM
 - PAH - POLYCYCLIC AROMATIC HYDROCARBON
 - mg/kg - MILLIGRAMS PER KILOGRAM
 - ft bgs - FEET BELOW GROUND SURFACE
 - - IR SITE BOUNDARY
- P181-53 0.11 (0.5') - DEPTH OF SAMPLE (ft bgs)
 B(a)P EQUIVALENT
 SAMPLE ID

NOTES:

B(a)P EQUIVALENT CONCENTRATION FOR EACH SAMPLE LOCATION CALCULATED USING CONCENTRATIONS OF THE FOLLOWING PAHS AT THE LOCATION AND RESPECTIVE PRGs FOR THE VARIOUS PAH COMPOUNDS:

BENZO(A)ANTHRACENE	CHRYSENE
BENZO(A)PYRENE	DIBENZO(A,H)ANTHRACENE
BENZO(B)FLUORANTHENE	INDENO(1,2,3-CD)PYRENE
BENZO(K)FLUORANTHENE	

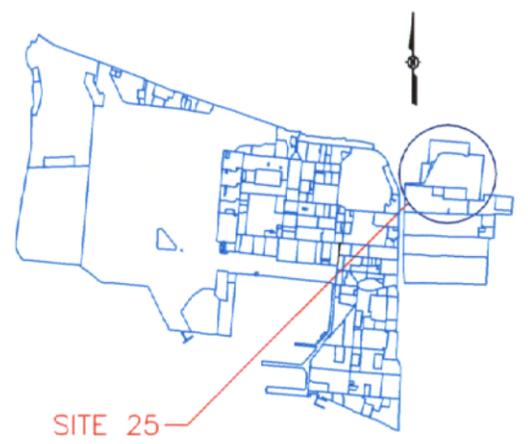
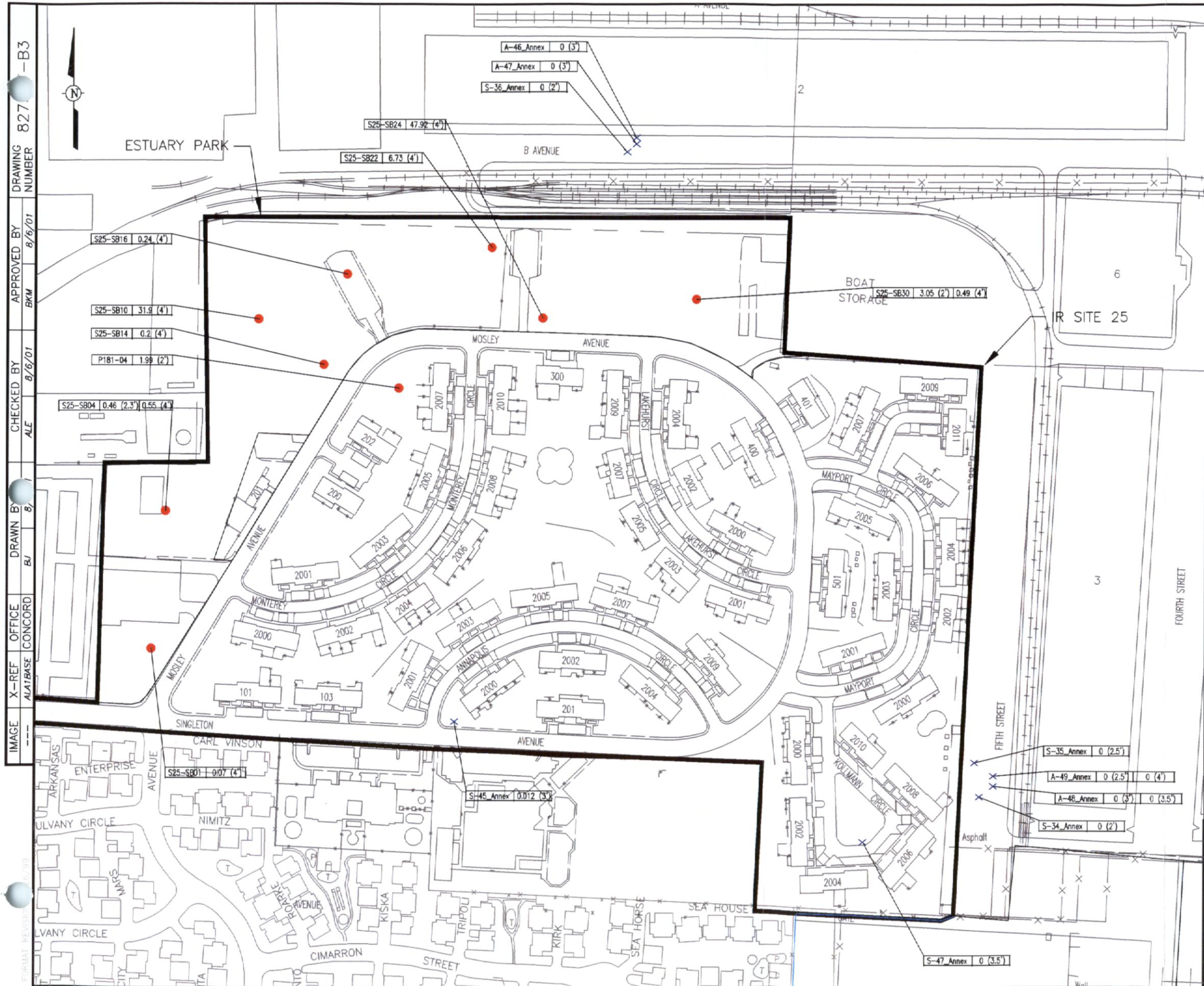
SCALE

0 200 400 FT

DEPARTMENT OF THE NAVY
SOUTHWEST DIVISION
NAVAL ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE 1-4
PAH IN SOIL AS B(a)P EQUIVALENTS
DEPTHS LESS THAN 2 FT BGS
ALAMEDA POINT, CTO 076
ALAMEDA, CALIFORNIA

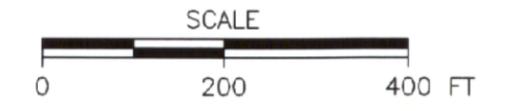
DRAWING NUMBER 8275-B2
 APPROVED BY BKM 8/6/01
 CHECKED BY ALE 8/6/01
 DRAWN BY BU 8/6/01
 IMAGE X-REF OFFICE ALABASE CONCORD
 FORMAT: REVISED 10/01



- LEGEND**
- IRP SOIL BORING
 - × HISTORICAL SAMPLING LOCATION

- ACRONYMS:**
- BGS - BELOW GROUND SURFACE
 - B(a)P - BENZO(a)PYRENE
 - IRP - INSTALLATION RESTORATION PROGRAM
 - PAH - POLYCYCLIC AROMATIC HYDROCARBON
 - mg/kg - MILLIGRAMS PER KILOGRAM
 - ft bgs - FEET BELOW GROUND SURFACE
 - ▭ - IR SITE BOUNDARY
- S-35 Annex 0 (2.5') — DEPTH OF SAMPLE (ft bgs)
 — B(a)P EQUIVALENT
 — SAMPLE ID

- NOTES:**
- B(a)P EQUIVALENT CONCENTRATION FOR EACH SAMPLE LOCATION CALCULATED USING CONCENTRATIONS OF THE FOLLOWING PAHs AT THE LOCATION AND RESPECTIVE PRGs FOR THE VARIOUS PAH COMPOUNDS:
- | | |
|----------------------|------------------------|
| BENZO(A)ANTHRACENE | CHRYSENE |
| BENZO(A)PYRENE | DIBENZO(A,H)ANTHRACENE |
| BENZO(B)FLUORANTHENE | INDENO(1,2,3-CD)PYRENE |
| BENZO(K)FLUORANTHENE | |



IT CORPORATION

DEPARTMENT OF THE NAVY
SOUTHWEST DIVISION
NAVAL ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

FIGURE 1-5
PAH IN SOIL AS B(a)P EQUIVALENTS
DEPTHS 2-4 FT BGS
ALAMEDA POINT, CTO 076
ALAMEDA, CALIFORNIA

IMAGE X-REF OFFICE DRAWN BY CHECKED BY APPROVED BY DRAWING NUMBER
 ALATBASE CONCORD BJ 8/6/01 BKM 827-B3

The EBS sampling also analyzed samples for other organic chemicals. Methyl tertiary butyl ether (MtBE), a relatively recent gasoline additive, was identified in 4 of 43 soil samples in Estuary Park. Detections of MtBE were limited to an area in the eastern portion of Estuary Park. However, all but one of these detects were estimated values (J-qualified) and some of them were located adjacent to a parking area on the east side of Estuary Park. Endosulfan sulfate and dichlorodiphenyltrichloroethane (DDT) were each detected once in ten surface samples. However, detected concentrations were estimated values (J or JP-qualified) and were below (endosulfan sulfate) or within (DDT) the range of nondetect values. Methoxychlor was detected in two of ten samples with estimated values (J and JP-qualified). These estimated values are approximately tenfold higher than most of the nondetect values, indicating that these values are likely to be valid.

1.3 Report Organization

This Work Plan is organized into seven sections plus appendices. Section 1.0 provides information on the objectives and purpose of the investigation as well as a brief summary of the site conditions and background. Section 2.0 provides the rationale for the treatability study, including options that were evaluated, and the goals of the study. Section 3.0 describes the treatability study design and details the different application methods that will be implemented as part of the study. Section 4.0 details site restoration and demobilization following completion of the field activities. Section 5.0 discusses waste management, types of waste expected, and waste disposal methods. Section 6.0 discusses the reports that will be generated to document the specifics of the treatability study. Section 7.0 presents the references.

The Field Sampling Plan (FSP) is provided as Appendix A, the QAPP is provided as Appendix B, the Site Health and Safety Plan (SHSP) is provided in Appendix C, and the Project Quality Control Plan is provided in Appendix D. Appendix E provides the Environmental Protection Plan, which describes the methods of protecting environmental resources during fieldwork activities associated with the treatability study. Included in Appendix E is an attachment of photos used for documentation of pre-activity conditions.

1.4 Statutory Authority and Other Requirements

In September 1993, Alameda Point (including the Naval Aviation Depot) was designated for closure in accordance with the Base Closure and Realignment Act of 1988 and the Defense Base Closure and Realignment Act of 1990, as amended by the National Defense Authorization Act for Fiscal Year 1992 and 1993, collectively referred to as BRAC. The Alameda Point BRAC Cleanup Plan addresses the status and strategy developed for the fast-track cleanup portion of the

present program. The key elements of fast-track cleanup include establishing a cleanup team at every base; making clean parcels available for civilian use as quickly as possible; and accelerating the National Environmental Policy Act process, which analyzes the potential environmental consequences of the proposed community reuse plan.

Prior to the BRAC announcement, the Navy had implemented environmental programs to identify contaminated areas and clean up those areas posing a threat to human health or the environment. These programs include the IR Program and the Underground Storage Tank Assessment Program. As a result of the closure announcement, the environmental restoration and compliance programs were accelerated to expedite property reuse. Alameda Point's aggressive response to the challenges posed by the base closure have addressed all key elements of fast-track cleanup and provided a foundation for attaining expeditious property reuse and economic redevelopment. In addition, compliance with applicable Federal and California State laws and regulations will ensure that resource management practices, including waste management, implemented by the Navy and property lessees are carried out in a manner that protects human health and the environment.

This treatability study will be conducted in support of the on-going remedial investigation/feasibility study for IR Site 25 at Alameda Point. The U.S. Navy is the lead Federal agency responsible for the direction and conduct of this work. The EPA, the California Environmental Protection Agency – Department of Toxic Substances Control, and the Regional Water Quality Control Board provide regulatory oversight and support to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process.

2.0 Treatability Study Rationale

The rationale for the treatability study is the need to develop additional technical information in order for the Navy to assess the in situ remediation options for remediating the PAH-contaminated soil at IR Site 25. In situ treatment of the PAHs may potentially offer substantial benefit over the other remediation options (i.e., excavation and/or capping). However, technical data gaps exist that prevent consideration of in situ treatment. The in situ treatment of PAHs with KMnO_4 will be evaluated in the treatability study. This option was selected over others based on a screening-level assessment of the site remediation requirements. This section describes the baseline remediation options considered to date, provides an overview of alternative remediation technologies, and describes the goals of this treatability study.

2.1 Baseline Remediation Options

Although a feasibility study evaluation has not yet been completed for the site, previous analysis by the Navy and its contractors has indicated that the two primary options for treating the shallow PAH-contaminated soil are excavation and/or capping. Excavation and removal of the contaminated soil offers the advantage that it can completely remove the impacted soil over much of the site. However, excavation cannot be conducted immediately adjacent to buildings and other structures, and may be restricted in other areas due to the presence of subsurface utilities or other obstructions. As an alternative or supplement to excavation, placement of a surface cap over the contaminated soil may reduce the potential for human exposure to PAH-impacted soil. However, long-term maintenance of the cap would involve institutional controls to prevent any future exposure to the soil.

2.2 Alternative Remediation Technology Summary

The baseline remedial options of excavation and/or placement of a surface cap have been determined by the Navy to potentially involve significant limitations and logistical difficulties. Therefore, the Navy is interested in assessing other remediation options that are based on treating the contaminated soil. This section briefly summarizes a wide range of remediation technologies and describes their capability for treatment of PAH-contaminated soil. A discussion of the screening-level assessment is also provided.

Soil treatment technologies can be classified as either ex situ or in situ. Ex situ treatment involves excavation of the contaminated soil and subsequent treatment or disposal. In situ treatment involves application of a treatment process below the ground (i.e., in the subsurface). Since the Navy is seeking alternatives to excavation and/or capping, this review is limited to in

situ treatment technologies. This review was also limited to soil treatment (as opposed to groundwater treatment), since the target treatment zone is the shallow (upper 4 ft) soil at IR Site 25.

In situ soil treatment technologies can act by extraction or destruction. Extraction soil treatment technologies involve removing either soil vapor or liquids. Thus, the PAHs must first be desorbed from the soil and then removed. Since PAHs possess a very low aqueous solubility and volatility, PAHs are not amenable to removal by simple soil vapor extraction or water flooding. Extractive technologies that are potentially applicable for PAH removal involve the use of large volume surfactant or co-solvent flushes to assist in desorbing and mobilizing the PAH from the soil. These technologies are not commonly applied in situ because of the difficulty in collecting the flushing fluid along with the PAHs after they are mobilized. At IR Site 25, this would be especially true, since the target treatment zone is above the water table (i.e., unsaturated zone), and release of desorbed PAHs to groundwater is not an acceptable treatment mechanism.

PAH destruction technologies are more likely to succeed at the site because they do not require extraction of the PAH; rather, they require delivery of amendments that stimulate PAH destruction. However, PAH degradation requires an aggressive approach because PAHs possess a molecular structure that is more difficult to degrade than many other organic compounds, such as simple petroleum hydrocarbons. Previously demonstrated PAH degradation technologies include bioremediation and chemical oxidation.

Bioremediation involves the microbial degradation of contaminants, using naturally occurring, indigenous microbes. Indigenous soil microbes have been shown to be capable of degrading PAHs under conditions where nutrients and oxygen are applied as soil amendments. The rate and extent of biodegradation of PAHs are highly dependent on the ability to effectively distribute nutrients and oxygen in the subsurface. The most common technique for bioremediation in the unsaturated zone is referred to as bioventing. Bioventing involves subsurface injection of air to stimulate biodegradation. In some cases, atomized nutrients have also been added to the injected air.

In situ chemical oxidation is a destructive treatment technology that involves the subsurface addition of an oxidant to chemically react with the contaminants. The oxidant chemicals act by removing electrons from the contaminant molecules, breaking molecular bonds, and causing the contaminants to be destroyed. Oxidation has been used for treatment of organic compounds for over 100 years, but the use of chemical oxidants for in situ treatment is relatively new. In situ oxidation was developed in the 1990s to address the need for subsurface treatment of a range of

organic compounds, such as PAHs, which are resistant to other treatment approaches. In situ chemical oxidation has the advantages of being rapid and of being able to achieve high levels of contaminant destruction.

Three primary oxidation agents have been applied in the subsurface: Fenton's reagent, ozone gas, and permanganate. Fenton's reagent involves the subsurface application of hydrogen peroxide (H_2O_2) and ferrous iron (Fe^{2+}). The hydrogen peroxide reacts with the ferrous iron to produce hydroxyl radicals (OH^*), a short-lived but powerful oxidant. The production of hydroxyl radicals by Fenton's reactions requires acidic conditions, with the pH less than 4. Fenton's reagent is generally applied in a batch process, where H_2O_2 , Fe^{2+} , and an acid are injected into the subsurface as liquid solutions, and the oxidation proceeds for several days.

Ozone gas (O_3) is generated from oxygen on site using electrical equipment. The ozone gas is generated and injected into the subsurface in a continuous flow process. The O_3 gas either oxidizes the contaminant directly or reacts with soil transition metals to form the OH^* radical. Injection of the ozone gas over a period of months is required to deliver the required total oxidant dose for treatment.

Permanganate ion is a chemical oxidant that is commonly applied as a relatively stable liquid solution of either potassium permanganate ($KMnO_4$) or sodium permanganate. The stock material for $KMnO_4$ is a granular (crystalline) solid. Permanganate oxidation is a less energetic and less aggressive oxidation process than ozone or Fenton's reagent; therefore, it reacts more slowly. As a result, in situations where permanganate is adequately powerful to oxidize the target contaminants, it may offer performance advantages. Slower reaction allows additional contact time between contaminants and oxidant and allows desorption and diffusion processes to proceed. $KMnO_4$ oxidation typically proceeds for weeks as compared to days for Fenton's reagent and ozone.

The following discussion considers the benefits and technical challenges of bioremediation and the three primary chemical oxidants. A summary matrix is provided as Table 2-1, "Summary Matrix of Potential In Situ Polycyclic Aromatic Hydrocarbon Treatment Technologies," which presents the benefits and technical challenges, which are arranged into the three following categories: effectiveness, logistics, and safety.

Table 2-1
Summary Matrix of Potential In Situ Polycyclic Aromatic Hydrocarbon Treatment Technologies

Comparison Parameters	Bioremediation	Ozone Oxidation	Fenton's Oxidation	Permanganate Oxidation
Treatment System Logistics	Continuous Operation	Continuous Operation	Batch Operation	Batch Operation
Likely Duration	>3 years ¹	12 months ¹	~ 1- 3 months ¹	~ 1- 3 months ¹
Anticipated Effectiveness	Moderate	High	High	High
Applicability to Shallow Unsaturated Zone Soil	High	High	Low	Moderate
Safety Considerations	Low	High	High	Moderate

¹Data Gap exists on these values. Estimates represented here for preliminary comparison.

Chemical oxidation and bioremediation are both effective for the destruction of PAHs. Chemical oxidation via Fenton's Chemistry and ozone has been demonstrated at former manufactured gas plant sites. The effectiveness of Fenton's Chemistry may be limited in the unsaturated zone due to the difficulties in mixing the contaminants, hydrogen peroxide and ferrous iron, in solutions. In comparison, ozone gas has been demonstrated for PAH destruction in both the unsaturated and saturated zones. Ozone is produced as a gas and therefore is more applicable for use in the unsaturated zone where most of the soil pore volume is filled with gas. Chemical oxidation with the permanganate ion has been evaluated on the bench-top for PAH destruction. The bench-top evaluation demonstrated PAH destruction to concentrations below the method detection limit within 96 hours of KMnO₄ addition (IT, 2000). Further field testing of delivery of both solid and liquid forms of KMnO₄ is required prior to full-scale application.

Bioremediation of PAH-impacted soil has been demonstrated at a number of locations. Delivery of nutrients and oxygen to stimulate bioremediation may be achieved in the field. The effectiveness of bioremediation is often controlled by the accessibility of the PAH. A skinning, or weathering, may reduce the accessibility of the PAH phenomena over time, which may limit the bioavailability of the contaminants. In comparison, chemical oxidation will attack this skin and increase the availability of the PAH for chemical oxidation. Based on the desktop evaluation of effectiveness, chemical oxidation (by ozone gas and the permanganate ion) and bioremediation appear to be viable alternatives for in situ remediation of PAH.

Logistical issues often affect remedial technology selection due to constraints such as constructability, economics, and schedule. Bioremediation has been demonstrated as effective for PAH destruction (Mueller, et al., 1996). Nonetheless, the time scale for bioremediation is

often more than 3 years. Three years internment of residential property will not be acceptable to the Navy or U.S. Coast Guard. Given the existing residential use of the IR Site 25 area, bioremediation has been deemed unacceptable.

One logistical challenge that may preclude ozone gas use in residential areas is that this method requires industrial electrical power for production of the quantities necessary for oxidation of PAH. Ozone gas also requires a vertical offset between injection wells and a soil vapor extraction system to prevent fugitive emissions.

The logistics of permanganate aid in selection of this method for several reasons. Delivery of KMnO_4 may be simpler than ozone gas because KMnO_4 may be applied to dry soils as a solid and then mixed and watered into the soil. Also, even if injection of permanganate solution is the preferred method, the engineering of ozone gas injection is much more challenging in a shallow soil application than KMnO_4 addition. Furthermore, oxidation by the permanganate ion is likely to require far less time for treatment than ozone. Even though the delivery of the permanganate is labor intensive, over a short duration, this is followed by little-to-no additional intrusive activities for 3 to 6 months whereas ozone reacts quickly and is used up and requires continuous generation and injection resulting in more operations and maintenance activities.

Safety concerns are paramount when applying remedial technologies in areas of residential development. Potential exposure to PAHs in soil is common to all of the technologies under discussion in this section (see Appendix C) and therefore is not an appropriate criterion for screening technologies. Environmental factors, such as noise and heavy equipment operations, will also be common to all of the technologies considered in this section due to the need to remove sod prior to treatment. Safety topics that are useful for comparison of the remaining alternatives include worker or residential exposure potential. Treatment of PAH with O_3 gas is accomplished by injecting 50,000 parts per million (ppm) O_3 gas. The concentration of ozone that is immediately dangerous to life and health (IDLH) is 10 ppm. As a result of the shallow target interval at IR Site 25 and low IDLH for ozone, oxidation by ozone gas is considered inappropriate. Oxidative destruction with the permanganate ion, KMnO_4 , also has safety issues related to airborne exposure to fugitive KMnO_4 solids, but the duration of time for handling these solids is short; therefore, this hazard may be managed.

Ultimately, in situ destruction of PAH by KMnO_4 has the best mix of effectiveness, minimum logistical difficulties, and maximum possible safety. Intrusion into the subsurface will be minimized, destruction of the PAH will be achieved in-place, and a safe application can be performed.

2.3 Treatability Study Goals

The goals of the treatability study are to evaluate the treatment effectiveness, delivery methods, and dose requirements associated with in situ oxidation of PAH contaminants by KMnO_4 in the upper 4 ft of soil at the site.

2.3.1 Evaluate Treatment Effectiveness

The principal goal of the treatability study is to evaluate the PAH treatment effectiveness during KMnO_4 treatment under site-specific conditions. Treatment effectiveness will be measured by sampling and analysis of PAH concentrations in soil over time. PAH treatment effectiveness will be evaluated in terms of PAH mass destruction, percent reduction, and residual PAH concentrations. The treatability study will also assess the rate of treatment and the overall duration required for treatment.

2.3.2 Evaluate Permanganate Delivery Methods

Another important goal of the treatability study is to evaluate several options for how to contact oxidants with the contaminants. This is important because successful treatment requires uniform and predictable distribution of the KMnO_4 in the soil requiring treatment. The treatability study will evaluate three methods of KMnO_4 delivery that might be logistically and technically feasible at the site. The delivery methods to be evaluated include the following:

- Shallow subsurface injection using driven injection points
- Application and mixing of solid permanganate crystals into the shallow soil by tilling
- Surface irrigation of permanganate solutions

2.3.3 Evaluate Permanganate Dose Requirements

The final goal of the treatability study is to evaluate the KMnO_4 dose that is required for PAH treatment at the site. The KMnO_4 dose will be evaluated in terms of the mass (grams) of KMnO_4 required per mass (kilogram) of soil. This information is important to provide a basis for evaluating full-scale treatment costs as well as to provide a basis for design of full-scale treatment systems.

2.4 Community Health and Safety

This study has been designed to provide a basis to evaluate the effectiveness and feasibility of a particular remedial alternative at IR Site 25. The primary objective of any remedial approach that will be used at IR Site 25 is community health and safety. The long-term goals of reduced lifetime risks will follow from the implementation of an effective approach and method selected

through the feasibility study process. The short-term goals of community health and safety will be focused on the safe application, handling, and delivery of the KMnO_4 used in this treatability study.

KMnO_4 has been selected for use in this study because of its relatively benign nature as compared to other available oxidizing agents. The nature of KMnO_4 lends itself to potential application within inhabited areas. Several application methods have been chosen for this study that will allow an evaluation of effectiveness and an assessment of the relative safety should the technology and methods later be deployed as a preferred alternative within the housing area.

The application, handling, and delivery of KMnO_4 at the IR Site 25 treatability study cells will be conducted in a manner that is protective of human health and the environment. Care will be taken to minimize any nuisance factors that might arise for the use of KMnO_4 . Specifically, dust control measures will be implemented to address concerns that might arise from fugitive dust, which might be perceived as laden with KMnO_4 or PAHs.

All KMnO_4 (solids and solutions) and neutralizing solutions will be kept within the fenced confines of the treatability study area until fully reacted or legally disposed. These materials will also be kept within bermed areas within the fenced area to control potential spills or releases. As a further measure of safety, the test cells that will be treated with KMnO_4 , are anticipated to be situated at the northern end of Estuary Park and therefore will not be near the occupied housing.

In an effort to maintain an open community relations dialogue, the Navy will develop an informational flyer explaining the treatability study and schedule. This flyer will be distributed to all residents of the Coast Guard housing well before the application of KMnO_4 begins at IR Site 25.

3.0 Treatability Study Design

The treatability study design is intended to generate information to assess the effectiveness and operational requirements for KMnO_4 application to shallow subsurface soil at IR Site 25. The treatability study will mimic conditions that might be practical for full-scale application.

Treatment performance will be monitored over a 6-month period of time. A set of three test cells and three control cells will be constructed as described in Section 3.2 and shown on Figure 1-3.

3.1 Permanganate Delivery Methods

The treatability study will involve three permanganate delivery methods: (1) shallow subsurface injection using driven injection points, (2) application and mixing of solid permanganate crystals into the shallow soil by tilling, and (3) surface irrigation of aqueous permanganate solutions. All three methods will involve delivery of a single batch of permanganate, which will be allowed to infiltrate into the upper 4 ft of soil.

3.1.1 Shallow Subsurface Injection

Injection of KMnO_4 solution will be performed using a Hayward-Baker lime stabilization rig slightly modified for oxidant injection. This equipment can push up to five rods into the ground at the same time. The spacing of the rods may be adjusted from 3 to 5 ft on center across the rear of the vehicle. Injections will be made at 1, 2, and 3 ft bgs. The volume of injected KMnO_4 solution will be minimized by using the maximum concentration of solution and by performing these injections on closely spaced intervals.

Additional water may be applied to the injection cell if warranted. Soil water content, and other analytical parameters and their frequency of collection are discussed in Section 3.5, will be used to determine if and when additional water is required to continue the process.

3.1.2 Surface Tilling

This delivery method will involve the mixing of KMnO_4 solids (crystals) into the upper 18 to 24 in. of the soil using mechanical ripping. After tilling the KMnO_4 solids into the soil, water will be applied to the test cell in a controlled manner to drive dissolution and infiltration of the KMnO_4 into the upper 4 ft of soil. The water application will be controlled to maximize the KMnO_4 contact in the target treatment zone and to minimize KMnO_4 movement out of the treatment zone. Unsaturated zone monitoring instrumentation and frequency of collection are described in Section 3.5 will be used to provide real-time information that will guide the water application rates.

3.1.3 Surface Irrigation

The surface irrigation delivery method will involve the surface application of KMnO_4 solution by controlled flooding of the treatment cell. The irrigation rates and KMnO_4 solution concentration will be determined after completion of preliminary soil tests, which will support mathematical modeling of the irrigation/infiltration process. The KMnO_4 solution application rate will be designed to maximize KMnO_4 contact in the target treatment zone and to minimize movement of KMnO_4 solution below the treatment zone. Unsaturated zone monitoring instrumentation and sample frequency are described in Section 3.5 will be used to provide real-time information, which will guide the water application rates.

3.2 Treatability Study Preparation

The test cells will be prepared prior to delivery of the KMnO_4 . Preparation will include mobilization of equipment and personnel, construction of the test cells and support infrastructure, and staging of the chemicals.

3.2.1 Mobilization of Equipment and Personnel

This phase of work will involve mobilizing personnel, equipment, mobile lab trailer, and supplies to the project site. Rental equipment and subcontractor-provided equipment will be inspected upon delivery and the condition noted in the project files. Equipment will be rejected if any leaks of hydraulic fluid, fuel, coolant, or oil are present.

3.2.2 Utility Clearance

Each boring location will be cleared of subsurface obstructions using a subcontractor. Additionally, Underground Service Alert will be contacted to mark known utilities at the proposed locations. A 10-ft radius will be cleared around the proposed location of each boring (i.e., each Geoprobe® location). The subcontractor will note each cleared sampling location with paint or with a stake immediately upon clearing it. All suspected underground utilities, conduits, and structures will be marked with marking paint, which does not reflect the standards established by the American Public Works Association. This difference in marking is to alleviate confusion between the USA markings and the private utility locator company. If utilities or other obstructions or hazards are identified at any location, IT's field representative will identify a new location to be surveyed.

Surface geophysical methods that may be used include, but are not limited to, electromagnetic induction, geomagnetics, or any combination of these methods. Existing site utility maps may be used prior to conducting clearance surveys. Anticipated utilities to be cleared include, but are not limited to, tanks; pipelines for natural gas, water, fuel, etc. (generally anything metallic);

electrical lines; telephone or other transmission lines; drainage lines and sewers; foundations and other structures.

3.2.3 Support Facilities and Temporary Utilities

A field laboratory will be mobilized to the site that will be used to analyze the field parameters required for the treatability study. Electrical service will be supplied to the laboratory trailer either as a temporary power drop or generator.

The Estuary Park irrigation system will be tapped to provide irrigation water for the cells. In addition, the irrigation system will be tapped and connected to the mobile project trailer to provide wash water and safety shower service.

3.2.4 Construction of Test Area

A total of six cells will be constructed and then instrumented as shown on Figure 1-3. Three of the cells will be control cells to assess the effects of tilling and watering alone, while three of the cells will be used for KMnO_4 oxidation of PAHs. Each of the test cells will be treated with one of the delivery approaches described in Section 3.1.

First, the cells will be scraped with a blade to remove sod and the shallow root zone soil. The sod will be reused as berm fill material. All depths used for sampling soil and instrument installation will be based on the graded surface elevation. Dust control measures will take place during the sod removal and cell construction to minimize fugitive dust.

Next, an engineered berm will be constructed around each cell. The engineered berm will be used to prevent inflow of storm water, reduce the potential for fugitive dust in combination with covers, and to improve control of irrigation water and permanganate solutions. Access ways, or ramps, will be incorporated into the berms. Sod material will be used to construct a berm 1 to 2 ft high. A 30-mil high-density polyethylene sheet will be keyed into the base of the soil berm and extend over the top of the berm where it will be secured with sandbags or other appropriate material on 10-ft centers. Figure 1-3 shows a cross-section of the berm.

A chemical storage area will be constructed at the eastern edge of the test area adjacent to the asphalt parking area. The chemical storage area will be used to control the handling of the oxidant and neutralizer materials after receipt from the vendor and prior to use. Two 10-ft-by-10-ft bermed areas will be prepared in the same manner as the test cells, with the addition of a 30-mil high density polyethylene liner within the storage cells. One chemical storage area will be used for solid KMnO_4 storage and the second will be used for 20-percent sodium bisulfite solution storage. Since these materials are incompatible, they require isolated

storage cells. The sodium bisulfite will be used at a 5 percent diluted concentration for neutralization of excess KMnO_4 solutions and emergency response activities (see Appendix C).

Plastic covers will be designed to cover the test and control cells during nonworking hours. The covers will minimize visual impacts and deter nuisance pests from encountering the permanganate. Covers may also be required for portions of the storage cells to protect materials from the elements.

Finally, a chain-link fence will be installed around the entire work area to restrict access to the cells, chemical storage area, mobile laboratory trailer, and equipment storage box. This fence will have slats installed to minimize visual impacts to the surrounding residents. In addition, appropriate signage, including a Proposition 65 notification, project sign, and hazard warning and training requirement, will be installed.

3.2.5 Instrument Installation

This section describes the instruments that will be installed to collect data for monitoring the treatability study. The three main instruments that will be installed are lysimeters, piezometers, and the neutron probe access casing. Other field instruments will be used as discussed in Section 3.4, as well as in the FSP. The instruments will be installed and sampled prior to the application of the oxidant in the shallow subsurface injection test cell and the surface irrigation test cell, but will be installed and sampled after the application of the oxidant in the surface tilling cell.

3.2.5.1 Lysimeters

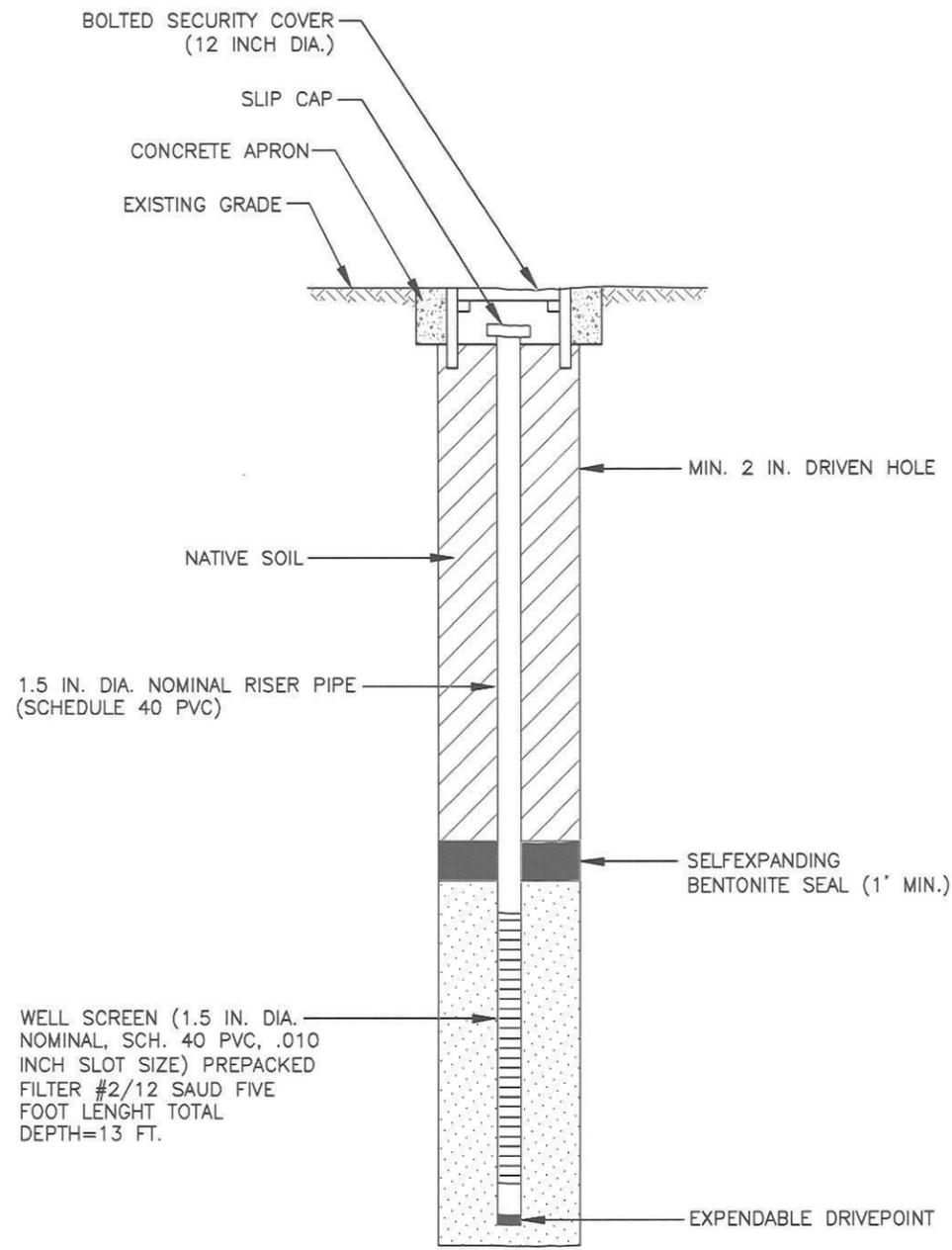
Lysimeters will be installed at the proposed nine locations identified in Figure 3-1, "Lysimeter, Piezometer, and Neutron Probe Casings Schematic." The exact location and number of lysimeters will be determined based on information derived from capillary moisture curves (Table 3-1, "Sampling Parameters, Rationale, and Collection Frequency"). The lysimeters will be dual level and will be installed to depths of 1 ft and 3 ft bgs using direct push drilling or hand augering methods.

The lysimeters will be built from the bottom of the boring upward. The preliminary specifications for the lysimeter construction are presented in Figure 3-1 using 1.9-in. PVC casing. After all lysimeters are installed, the elevation and horizontal position of the top of each casing will be surveyed by a subcontractor to a local benchmark as described in IT Standard Operating Procedure (SOP) 23.1.

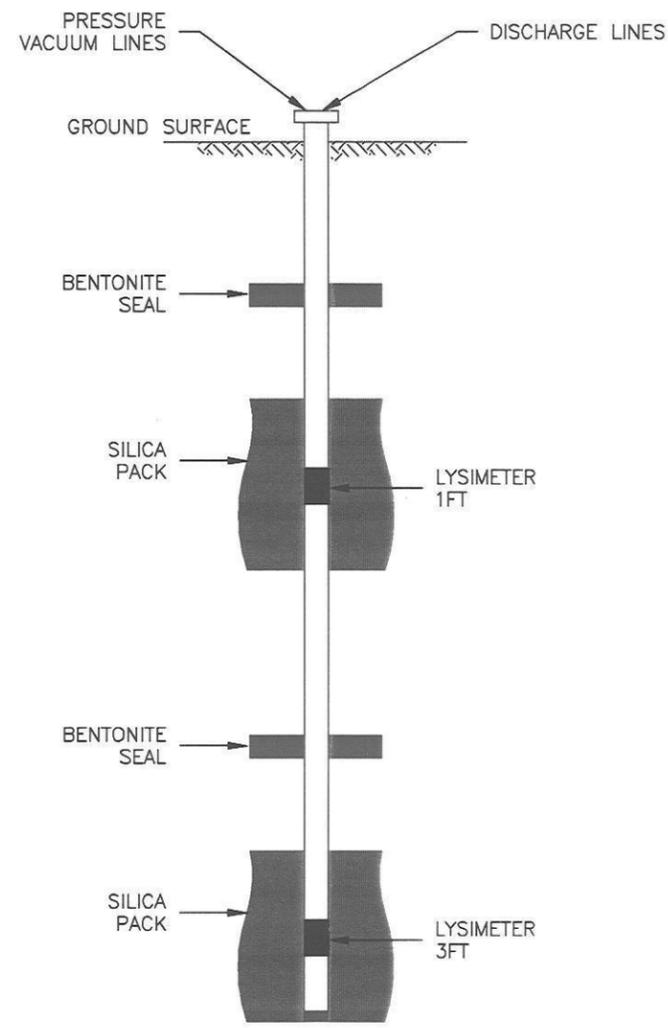
**Table 3-1
Sampling Parameters, Rationale, and Collection Frequency**

Parameter	Media	Sampling Rationale	Frequency
Capillary Moisture	Soil	The capillary moisture curves describe the unsaturated zone flow characteristics. Capillary moisture curves will be generated to establish the irrigation schedule.	Baseline
Permeability	Soil	The soil permeability represents how quickly the unsaturated soil transmits water. This will be used to establish the irrigation schedule.	Baseline
Porosity	Soil	The soil porosity indicates the fraction of a volume of soil that is void. This parameter will be used to establish the irrigation schedule.	Baseline
Soil Density	Soil	The soil density is the mass of a volume of soil. This parameter will be used in calculating the KMnO ₄ dose and irrigation schedule for the test cells.	Baseline
Soil Moisture	Soil	Soil moisture is the measurement of the moisture content of the soil. This parameter will be used to determine the irrigation schedule for each test cell.	Baseline, biweekly (operational)
Soil Oxidant Demand (SOD)	Soil	The soil oxidant demand is the amount of KMnO ₄ that will be consumed by organic matter found in the soil and is used to determine the KMnO ₄ dose rates.	Baseline, 1,3, and 6 months (performance)
B(a)P _{equiv}	Soil	B(a)P _{equiv} represents the extent of soil contamination existing at the site and will be monitored to determine if the contamination is being destroyed.	Baseline, 1,3, and 6 months (performance)
Manganese (Mn)	Soil	Manganese oxide is a known by-product of the reduction of KMnO ₄ . The Mn levels in soil will be measured to determine the additional Mn contribution to soil as a result of KMnO ₄ addition.	Baseline, 6 months
Potassium Permanganate (KMnO ₄)	Soil	The KMnO ₄ concentration in pore water will be measured via an extraction method to obtain data corresponding to KMnO ₄ dose. This data will be used to determine the rate of KMnO ₄ consumption and distribution.	Baseline, 1,3, and 6 months (performance)
pH	Pore Water	The pH level in pore water indicates the general pore water quality.	Baseline, biweekly (operational)
Oxidation-Reduction Potential (ORP)	Pore Water	The ORP levels in pore water may act as an indicator of the presence of KMnO ₄ . ORP will be monitored to help determine the extent of oxidant delivery.	Baseline, biweekly (operational)
Conductivity	Pore Water	The conductivity levels in pore water may act as an indicator of the presence of KMnO ₄ . Conductivity will be monitored to help determine the extent of oxidant delivery.	Baseline, biweekly (operational)
Potassium Permanganate (KMnO ₄)	Pore Water	KMnO ₄ concentrations in the pore water will be monitored to determine the extent of oxidant delivery and rate of oxidant consumption.	Biweekly (operational)

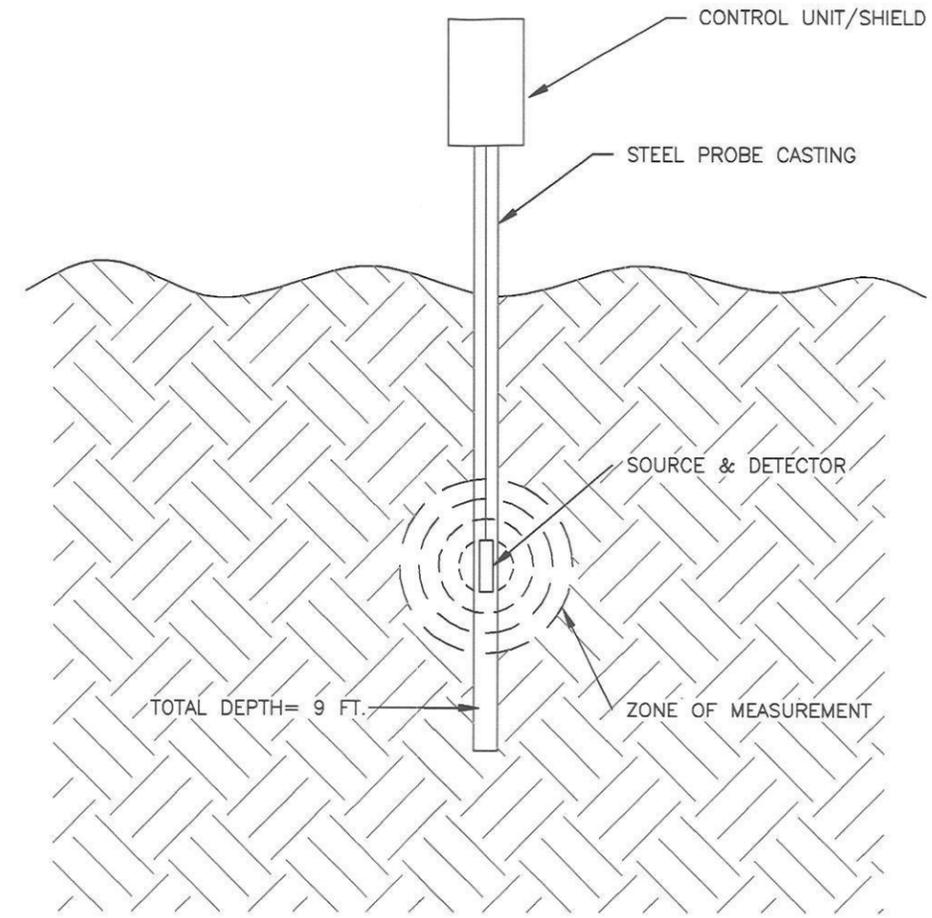
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 APPROVED BY BKM 8/6/01
 CHECKED BY MH 8/6/01
 DRAWN BY BJ
 OFFICE CONCORD
 X-REF ALA1BASE
 IMAGE



PIEZOMETER



CASING LYSIMETER



WATER CONTENT BY NEUTRON DEPTH PROBE METHOD

NOT TO SCALE

	DEPARTMENT OF THE NAVY SOUTHWEST DIVISION NAVAL ENGINEERING COMMAND SAN DIEGO, CALIFORNIA
FIGURE 3-1 LYSIMETER, PIEZOMETER AND NEUTRON PROBE CASTING SCHEMATIC ALAMEDA POINT, CTO 076 ALAMEDA, CALIFORNIA	

**Table 3-1 (continued)
Sampling Parameters, Rationale and Collection Frequency**

Parameter	Media	Sampling Rationale	Frequency
Hexavalent Chromium Cr(VI)	Groundwater	Cr(VI) concentrations in groundwater will be measured to determine if Cr(VI) concentrations exceed the maximum contaminant levels (MCLs) at the conclusion of the treatability study.	Baseline, 6 months
Arsenic (As)	Groundwater	As concentrations in groundwater will be measured to determine if As concentrations exceed the MCLs at the conclusion of the treatability study.	Baseline, 6 months
Atmospheric Conditions	Atmosphere	Atmospheric conditions will be recorded to monitor temperature and rainfall, which may affect the KMnO ₄ distribution and flow (i.e., recharge by rainfall).	Biweekly (operational)

All downhole equipment and lysimeter construction materials will be new or decontaminated prior to each lysimeter installation. Soil generated during drilling will be collected in 55-gallon drums for waste profile analysis and disposal as described in the FSP.

3.2.5.2 Piezometer

Piezometers will be installed at the proposed eight locations identified in Figure 3-1. One piezometer will be installed in each test cell; only one control cell will have a piezometer, and four piezometers will be installed 20 ft from the corners of the end cells. The 4-in. diameter piezometers will be installed at each location to a depth of 13 ft bgs. The total length of screen will be 5 ft using direct push drilling techniques as described in IT SOP 8.1.

All downhole equipment and piezometer construction materials will be new or decontaminated prior to each piezometer installation, as described in the FSP. Soil generated during drilling will be collected in 55-gallon drums and sampled for waste profiling and transported for disposal as discussed in the FSP.

The piezometers will be constructed from 2-in. prepacked well screens and self-expanding annular seals. The preliminary specifications for piezometer construction are presented in Figure 3-1. The depth of each piezometer will be 13 ft bgs. The amounts of each material will be calculated after the depths are determined. The surface completion for the piezometer will include a flush-mounted concrete box with a bolted steel cover set in a 6-in.-high, sloped concrete collar. After all piezometers are installed, the elevation and horizontal position of the top of each casing will be surveyed by a subcontractor to a local benchmark as described in IT SOP 23.1.

3.2.5.3 Neutron Depth Probe

Soil moisture measurements will be collected using an instrument that measures the soil adsorption and reflection of neutrons (i.e., neutron probe). Access casing for the neutron density probe will be installed at the 18 proposed locations shown on Figure 1-3. The probe casing will be 2-in. diameter, steel casing with a welded drive point. The casing will be driven to approximately 9 ft bgs. The probe casing will project above the ground and be capped to prevent foreign material from entering.

The probe will be calibrated to the site conditions prior to use and a standard count taken before each sampling event following instructions in the operating manual. The same depth will be reproduced at each location for each sampling event with the use of depth position locks, which are clamped onto the cable. The neutron depth probe will be set for a 1-minute count. The preliminary specifications for the access casing are presented in Figure 3-1. After all probe casings are installed, the elevation and horizontal position of the top of each casing will be surveyed by a subcontractor to a local benchmark as described in IT SOP 23.1. The probe is removed from the casing after each measurement and stored in a secure area as required by state licensing.

3.3 Sampling and Analysis Rationale

Baseline sampling will be conducted at the test cells and control cells prior to the introduction of KMnO_4 in order to establish soil, pore water, and groundwater conditions. Baseline sampling strategy and description is described in the FSP. Atmospheric data will also be collected using a temporary weather station that will be installed on site.

Selected geophysical properties of the soil that are critical to the design process, including the capillary moisture curves, permeability, porosity, and soil density, were collected prior to initiating the treatability study. The data from these samples will be evaluated to assist in the site-specific design modifications. Two locations and two depths were sampled for these parameters to provide additional information to calculate the mass of permanganate necessary for the study.

Measurements of the soil, pore water, groundwater, and atmospheric conditions will be collected throughout the 6-month treatability study. These parameters, the rationale for their monitoring, and the frequency of measurement for each of the parameters are summarized in Table 3-1.

3.4 Sampling and Analysis Approach

This section discusses the types of sampling and frequency of sampling that will be conducted in each pair of test and control cells. All activities that are performed on the test cells will also be performed on the control cells, with the exception of the application of the oxidant.

Soil

Several soil measurements will be collected in the injection cells prior to and during the treatability study:

- **Soil Moisture Content:** The soil moisture content will be measured on a biweekly basis via a neutron probe instrument. Four neutron probe access casings will be installed in each test cell and two probes will be located in each control cell.

Therefore, six sets of soil moisture readings at 1-ft intervals will be collected from each pair of test and control cells.

- **Soil Oxidant Demand (SOD):** Two composites (0 to 2 ft bgs and 2 to 4 ft bgs) will be analyzed from each boring. There will be four borings and one duplicate sample at each test cell. Therefore, there will be a total of nine SOD samples collected at each test cell. The control test cell will have two borings with two 2-ft composite samples from within each boring over the same depth intervals (0 to 2 ft and 2 to 4 ft). A total of four SOD (two composites from two borings) samples will be collected at the control cells. Five samples will be collected from the control cells that will have a duplicate collected.
- **Contaminant Concentrations:** The concentrations of PAH will be determined in soil. Two composite soil samples from 0 to 2 ft and 2 to 4 ft will be collected and analyzed from each drive casing. There will be four probe casings and one duplicate sample at each test cell. Therefore, there will be a total of nine PAH samples collected at each test cell; the control test cell will have two probe casings with two 2-ft composite samples from within each drive casing. At the control cells, two probe casings will be completed with composite PAH samples being collected over the same depth intervals (0 to 2 ft bgs and 2 to 4 ft bgs). A total of four (five at the duplicate location) PAH samples will be collected at the control cells.
- **Manganese:** The soil manganese concentrations in the test cells will be measured prior to, and after, the delivery of KMnO_4 . Two composite soil samples will be collected (0 to 2 ft and 2 to 4 ft) and analyzed from each of the four probe casings. There will be four probe casings and one duplicate sample at each test cell. Therefore, there will be a total of nine Mn samples collected at each test cell. The control test cell will have two probe casings with two 2-ft composite samples from within each probe casing. Within the control cells, two probe casings will be completed with composite Mn samples being collected over the same depth

intervals (0 to 2 ft and 2 to 4 ft). A total of four (five at the duplicate location) Mn samples will be collected at the control cells.

- **KMnO₄:** Soil KMnO₄ concentrations will be measured in soil. Two composite soil samples will be collected (0 to 2 ft and 2 to 4 ft) and analyzed from each of the four probe casings. Two composite soil samples will be collected and analyzed from each boring. There will be four borings in each test cell and two borings in each control cell. Eight samples will be collected from the test cells, and four samples will be collected from the control cells.

Pore Water

The pore water samples will be collected from dual-level lysimeters. Two lysimeters will be located in each test cell and one lysimeter will be installed in each control cell. The dual-level lysimeters will allow samples to be collected at two depths, 1 ft bgs and 3 ft bgs. Therefore, four samples will be collected from each test cell and two samples from each control cell during each biweekly sampling event and analyzed using field instruments as shown in Table 3-1.

Groundwater

Groundwater samples will be collected from the piezometers. One piezometer will be located in the center of each test cell. One piezometer will also be installed 20 ft from each of the outside corners of the treatability study area (see Figure 1-3). The middle control cell will also have a piezometer installed in the center. One random duplicate sample will be collected from the piezometer in the test cells. The piezometers will be installed to a depth of 13 ft and will have 5-ft screens.

Atmospheric

Atmospheric conditions will also be recorded throughout the treatability study. The atmospheric data will be collected via a weather station located on site. Several atmospheric parameters will be monitored throughout the test duration, including temperature, pressure, rainfall, and humidity.

3.5 Sampling Frequency

The sampling frequency is outlined in Table 3-1 and described in the FSP. Each set of control and test cells will be sampled as identically as possible. This will allow direct comparison of the results from the three delivery modes to be tested. In general, soil samples will be collected prior to chemical addition, and 1, 3, and 6 months after KMnO₄ delivery to the test cell. Pore water samples will be collected biweekly. Groundwater samples will be collected before the study begins and after the study is complete, and if visual evidence of KMnO₄ is detected in

groundwater at any time. Soil moisture measurements will be collected weekly, and if conditions warrant on a more frequent basis.

3.5.1 Baseline Sampling

Baseline monitoring will be performed prior to KMnO_4 delivery to the test cells. The baseline conditions will be used for comparison to the performance monitoring data. The evaluation of effects versus variations in control cells will be made from this comparison. One round of baseline sampling will be performed for all media (soil, groundwater, and pore water).

Baseline samples include the following:

- Soil
 - Capillary moisture
 - Permeability
 - Porosity
 - Soil density
 - Soil moisture
 - SOD
 - B(a)P equivalent
 - Mn
 - pH
- Pore water
 - pH
 - ORP
 - Conductivity
- Groundwater
 - Hexavalent chromium
 - As
- Atmospheric

3.5.2 Operational Monitoring

The operational monitoring will be conducted at all six cells to assess the physical distribution of KMnO_4 and water during the delivery phase of the treatability study. Operational monitoring will be conducted immediately after initiation and biweekly thereafter. Operational monitoring will analyze soil, pore water, and groundwater for operational decision making.

Operational monitoring includes the following:

- Soil
 - Soil moisture
- Pore water
 - pH
 - ORP
 - Conductivity
 - KMnO_4
- Atmospheric

Soil

Soil monitoring during the application phase of the treatability study will entail visual evaluation of the KMnO_4 solution flow. The visual assessment will entail the watch for ponding, runoff, and surfacing of injection fluid. The soil moisture content will be measured via neutron probes installed in each of the test cells on a biweekly basis.

Pore Water

Pore water samples will be collected on a biweekly basis.

Groundwater

Groundwater samples from each of the three treatment cells will be observed biweekly for the presence of KMnO_4 . If KMnO_4 is visually detected (a purple color observed) in the piezometers, the application will cease and the KMnO_4 concentration will be determined and the groundwater will be sampled on a monthly basis.

3.5.3 Performance Monitoring

Performance monitoring during the IR Site 25 oxidation treatment treatability study will be conducted at 1, 3, and 6 months after delivery. Biweekly operational monitoring will be conducted concurrently. Soil, pore water, and groundwater will be analyzed during performance monitoring. Atmospheric data will be collected throughout the treatability study as indicated in Section 3.3.

Performance monitoring includes the following:

- Soil
 - B(a)P equivalent
 - Mn (6 months only)
 - KMnO_4

- Groundwater
 - Hexavalent chromium (6 months only)
 - As (6 months only)
- Pore water
 - Potassium permanganate (biweekly)

Soil

Several parameters of the soil media, including the SOD and PAH concentrations, in the treatment and control test cells will be measured during the 1-month, 3-month, and 6-month sampling events. All soil sampling will be conducted according to the FSP and will adhere to the schedule summarized in Tables 3-2 through 3-8.

**Table 3-2
Soil SOD Samples at 1 Month of Treatment**

Cell	Analysis	No. of Borings	Samples/Boring	Duplicates	Total No. Samples
Inject	SOD	4	2	1	9
Inject-Control	SOD	2	2	0	4
Till	SOD	4	2	1	9
Till-Control	SOD	2	2	1	5
Flood	SOD	4	2	1	9
Flood-Control	SOD	2	2	0	4

**Table 3-3
Soil SOD Samples at 3 Months of Treatment**

Test Cell	Analysis	No. of Borings	Samples/Boring	Duplicates	Total No. Samples
Inject	SOD	4	2	1	9
Inject-Control	SOD	2	2	1	5
Till	SOD	4	2	1	9
Till-Control	SOD	2	2	0	4
Flood	SOD	4	2	0	8
Flood-Control	SOD	2	2	0	4

**Table 3-4
Soil SOD Samples at 6 Months of Treatment**

Test Cell	Analysis	No. of Borings	Samples/Boring	Duplicates	Total No. Samples
Inject	SOD	4	2	1	9
Inject-Control	SOD	2	2	0	4
Till	SOD	4	2	1	9
Till-Control	SOD	2	2	1	5
Flood	SOD	4	2	1	9
Flood-Control	SOD	2	2	0	4

**Table 3-5
Soil PAH Samples at 1 Month of Treatment**

Test Cell	Analysis	No. of Borings	Samples/Boring	Duplicates	Total No. Samples
Inject	PAH	4	2	1	9
Inject-Control	PAH	2	2	0	4
Till	PAH	4	2	1	9
Till-Control	PAH	2	2	1	5
Flood	PAH	4	2	1	9
Flood-Control	PAH	2	2	0	4

**Table 3-6
Soil PAH Samples at 3 Months of Treatment**

Test Cell	Analysis	No. of Borings	Samples/Boring	Duplicates	Total No. Samples
Inject	PAH	4	2	0	8
Inject-Control	PAH	2	2	1	5
Till	PAH	4	2	1	9
Till-Control	PAH	2	2	0	4
Flood	PAH	4	2	1	9
Flood-Control	PAH	2	2	0	4

Table 3-7
Soil PAH Samples at 6 Months of Treatment

Test Cell	Analysis	No. of Borings	Samples/Boring	Duplicates	Total No. Samples
Inject	PAH	4	2	1	9
Inject-Control	PAH	2	2	0	4
Till	PAH	4	2	1	9
Till-Control	PAH	2	2	0	4
Flood	PAH	4	2	1	9
Flood-Control	PAH	2	2	1	5

Table 3-8
Soil Mn Samples at 6 Months of Treatment

Test Cell	Analysis	No. of Borings	Samples/Boring	Duplicates	Total No. Samples
Inject	Mn	4	2	1	9
Inject-Control	Mn	2	2	0	4
Till	Mn	4	2	1	9
Till-Control	Mn	2	2	0	4
Flood	Mn	4	2	0	8
Flood-Control	Mn	2	2	1	5

Groundwater

Groundwater samples will be collected and analyzed, as summarized in Table 3-9, 6 months after KMnO₄ delivery is complete. Groundwater will be observed (but not collected) during the 1-month, 3-month, and 6-month sampling events. If KMnO₄ is observed (a purple color) in the piezometers at anytime, groundwater samples will be collected, and sampling will commence on a monthly basis. Groundwater sampling will be conducted according to the FSP and will adhere to the schedule summarized in Table 3-9.

**Table 3-9
Groundwater Cr(VI) and As Samples at 6 Months of Treatment**

Piezometer	Analysis	No. of Samples	Duplicates	Total No. Samples
Inject	Cr(VI), As	1	0	1
Till	Cr(VI), As	1	0	1
Flood	Cr(VI), As	1	1	2
Till-Control	Cr(VI), As	1	0	1
Corner 1	Cr(VI), As	1	0	1
Corner 2	Cr(VI), As	1	0	1
Corner 3	Cr(VI), As	1	0	1
Corner 4	Cr(VI), As	1	0	1

Pore water

Pore water samples will be collected and analyzed, as summarized in Table 3-10. Pore water samples will be collected biweekly if possible. Modifications to the frequency of sampling will be made if production of water is limited from lysimeters.

**Table 3-10
Pore Water KMnO₄ Samples During 6 Months of Treatment**

Test Cell	Analysis	No. of Lysimeters	Samples/Lysimeter	Duplicates	Total No. Samples
Inject	KMnO ₄	2	1	1	3
Inject-Control	KMnO ₄	2	1	0	2
Till	KMnO ₄	2	1	1	3
Till-Control	KMnO ₄	2	1	0	2
Flood	KMnO ₄	2	1	0	2
Flood-Control	KMnO ₄	2	1	0	2

3.6 Permanganate Mixing and Delivery

Three styles of KMnO₄ delivery will be evaluated in this treatability study: shallow subsurface injection, surface tilling, and surface irrigation. Potassium permanganate is produced as a dry chemical. The KMnO₄ solids will be mixed with potable water to prepare a solution at a concentration of 35 grams per liter (g/L) for two of the test cells and delivered as a solid to the

third test cell. It is estimated that the IR Site 25 soil will require approximately 2.5 grams KMnO_4 per kilogram (kg) of soil. This dosage is only a planning value for use until site-specific SOD data is generated. Dosing at this level would result in approximately 700 milligrams Mn per kg soil added to the existing soil conditions in the target zone. The intent is to deliver the oxidant to each type of test cell at approximately the same time.

3.6.1 Shallow Subsurface Injection

Shallow subsurface injection will be evaluated for delivery of KMnO_4 to the 0 to 2 ft and 2 to 4 ft depth intervals. Injections will be conducted at 1, 2, and 3 ft bgs. This is the most commonly used delivery method for in situ chemical oxidation. The shallow depth of the target interval at IR Site 25 will present unique challenges for this approach.

3.6.1.1 Safety Considerations

Shallow injection of KMnO_4 will present unique safety challenges as compared to deeper applications by this method. Solution short-circuiting to the ground surface may occur and will be minimized by using low-pressure injection methods. Low-pressure injection will necessitate close injection location spacing (3 to 5 ft centers). Injection volumes will also be minimized to reduce the likelihood of KMnO_4 migration outside of the target interval. Personal protective equipment, including splash-protective equipment, will be used during shallow subsurface injections; details are provided in the SHSP.

3.6.1.2 Required Equipment

Shallow subsurface injection will be performed using an injection rig designed for lime-stabilization of railroad rights-of-way. The shallow injection equipment utilizes four steel rods on 3-ft centers mounted to the rear of a large truck. Solution preparation equipment including tanks, pumps, mixers, and a KMnO_4 solids eductor will be required. The specific sizes for this equipment will be completed once the soil SOD sample results are reduced and KMnO_4 dosage is determined.

3.6.1.3 Potassium Permanganate Solution Mixing

Potable water will be mixed with KMnO_4 solids to achieve solution concentrations at field solubility (approximately 35 g/L). The solution will be thoroughly mixed and delivered to the well points at low flow rates. The mixing system will be designed to deliver a maximum of 30 gallons per minute (gpm) of flow to a distribution system. The location of the mix plant is shown on Figure 1-3.

3.6.1.4 Potassium Permanganate Solution Injection

Potassium permanganate solution will be injected into four drive points at a time. The steel rods will be driven in 1-ft increments into the subsurface. KMnO_4 solution will be injected into the four rods simultaneously at 1, 2, and 3 ft bgs. If the truck-mounted injection system is not available, temporary well points will be driven manually to simulate operation of the truck-mounted lime stabilization rig. The maximum flow rate that will be used is 5 gpm per drive point. It is anticipated that a maximum of 10 pounds per square inch will be required to inject solution. These values are estimates and may be adjusted based on field conditions.

3.6.2 Surface Tilling

One test cell and one control cell will be tilled to a depth between 12 and 24 in. bgs. The test cell will have KMnO_4 solids and water for dust control added during the tilling operations. Both cells will then be irrigated to activate the KMnO_4 solids and transport the oxidant through 4 ft bgs. This delivery method is the most aggressive and uniform process that will be evaluated. As a result, this test cell will be used to evaluate the short-term oxidation of B(a)P equivalents and provide a "Go/No Go" decision point 1 month after tilling is complete.

3.6.2.1 Safety Considerations

Surface tilling has two unique safety considerations as compared to KMnO_4 solution delivery: first, mechanical hazards inherent to tilling operations, and second, airborne dust hazards associated with KMnO_4 solids. Mechanical hazards will be addressed in the Activity Hazard Analysis (see SHSP). Airborne dust hazards will be managed through the use of proper personal protective equipment including a full-face respirator with high-efficiency particulate air cartridges and by applying appropriate amounts of water to minimize both dust and clumping of materials.

3.6.2.2 Required Equipment

Surface tilling equipment will be adapted from the agricultural industry. Tilling, referred to as ripping, to 24 in. below grade is most common in fire control and heavy agriculture. Standard personal operated tilling equipment, such as the home "Rototiller," only reaches depths of 7 to 8 in.

The tilling will be performed with a small tracked tractor with a blade on the front and rear-mounted rippers. A Caterpillar Model D3C Series III Hystat, or equivalent, will be used. The D3C has a ground contact area of 16.7 square ft. The overall width of the ripper beam is 62 in., and there are five ripper teeth located on 14-in. centers. It is anticipated that three to five passes

will be required to rip to 24 in. below grade. It is likely that if this approach is favorable, more economical equipment will be located as the process is scaled up.

3.6.2.3 Potassium Permanganate Solids Delivery

Potassium permanganate solids will be added to the ground surface by the broadcast method prior to tilling operations. Additional KMnO_4 solids will be applied to the ground surface prior to each pass by the ripper.

3.6.2.4 Mixing Water Application

Water will be applied during tilling and ripping operations to minimize fugitive dust emissions. Additional water may be added to the tilled soil during delivery of the KMnO_4 to further activate the solid chemical. The mix and dust control water will be potable water from the Estuary Park irrigation system. Due to the logistics of tilling, the order of operations differs a little from the other two methods. The instruments (piezometer, lysimeter, and neutron probe) will be installed and sampled after tilling is complete and oxidant has been added. The intent is to schedule the application of the oxidant to all test cells at approximately the same time.

3.6.3 Surface Irrigation

The third delivery method that will be tested is surface irrigation. The surface irrigation cell will be periodically flooded with KMnO_4 solution for short periods of time to prevent ponding. The surface irrigation cell will then be further watered, as indicated by soil water moisture readings, to drive the KMnO_4 solution through the 4-ft depth interval. The amount and frequency of additional irrigation will be dependent of soil moisture readings, local geologic conditions, and the weather.

3.6.3.1 Safety Considerations

The safety considerations for surface irrigation are exposure to splashes by KMnO_4 solutions, vectors, and airborne dust. Personal protective equipment including Tyvek suits and face shields will be employed when free KMnO_4 solutions are present in the cell. Waterfowl may be attracted to the area if free liquids are allowed to accumulate. The test cells will be covered when unattended to minimize this risk. Preliminary calculations indicate that the volume of water required for surface irrigation will be small and should not result in ponding. Airborne dust hazards may exist as the surface soil dries and KMnO_4 solids accumulate on the ground surface. Regular wetting of the cells and maintenance of the covers will minimize the airborne dust hazards.

3.6.3.2 Required Equipment

The primary equipment required for surface irrigation is KMnO_4 solution preparation equipment. A mixing plant will be constructed from a 2,500-gallon cross-linked polyethylene tank, a 5-hp, multi-stage centrifugal pump, and solids eductor. The 5-hp pump will be used for both drawing the solids into solution and delivering the KMnO_4 solution to the test cell.

3.6.3.3 Potassium Permanganate Solution Mixing

Solution will be prepared at the field solubility limit, which is approximately 35 grams per liter (g/L). At this concentration, 3.43 gallons of solution are required to deliver 1 pound of KMnO_4 . The solution will be thoroughly mixed and delivered to the test cell at low-flow rates. The mixing system will be designed to deliver a maximum flow rate of 30 gpm.

3.6.3.4 Potassium Permanganate Surface Irrigation

The surface irrigation cell will be periodically flooded with KMnO_4 solution for short periods of time. Each flooding event will consist of adding 1 to 3 in. of solution to the test cell and then allowing the solution to infiltrate. A 1-in. flood is the equivalent of 1,550 gallons of solution. If 35 g/L solution is prepared and flooded 1-in. in depth, then 454 pounds of KMnO_4 will be added to the test cell. Approximately 6 days of flooding will be required to deliver the planning KMnO_4 dose (2.5 grams per kg soil). The surface irrigation cell will then be further watered to drive the KMnO_4 solution through the entire 4-ft depth interval. The amount and frequency of additional irrigation will be dependent of soil moisture readings, local geologic conditions, and the weather.

4.0 Demobilization and Site Restoration

After the treatability study is completed, the site will be returned to as close to the original condition as possible. All site-related equipment and personnel will be demobilized as items are no longer needed for the study.

4.1 Demobilization

Demobilizing personnel, equipment, mobile lab trailer, project-derived wastes, and supplies from the project site will occur as the specific items are no longer required. The final demobilization of the remaining items after the study is complete will be performed in two stages: first, personnel and equipment, and then, wastes. The chain link fence enclosing the treatability study area will be left in place.

Demobilization activities will involve transporting personnel, equipment, and supplies back to suppliers, vendors, and IT Corporation offices. Rental equipment and subcontractor-provided equipment will be cleaned and returned in a condition as good as, or better, than received.

Personnel and hand tools will be decontaminated after use as described in the FSP and the SHSP.

4.2 Site Restoration

After all equipment is demobilized from the site, the restoration process will begin. As the location of the treatability study is within Estuary Park, the restoration activities will consist of returning the field to grass.

IT Corporation will revegetate the treatability study area as follows:

- **Preparation**—The upper 3 in. of soil will be raked, or scarified, to loosen the soil. The area will be fertilized using a commercial fertilizer mix (NPK 10:10:1), applied at 300 pounds per acre by the broadcast method.
- **Seed**—A commercial seed mix consisting of a blend of tall fescue species. The grass will be applied by the broadcast method at 40 pounds per acre. The seed will be covered to a depth of approximately ¼ in. using a rake or disc harrow. The surface will then be covered with pretreatment sod and straw mulch, applied by hand at a rate of 2 tons per acre.
- **Maintenance**—The seeded area will be enclosed within the project fencing and marked with caution tape and stakes to prevent foot traffic. Periodic watering will be performed until demobilization from the project site is complete.

4.3 Wastes

Wastes generated by the treatability study will be held on site, in secure storage, until transportation to an approved treatment or disposal facility is arranged. Details concerning waste disposal, handling, and transportation are presented in Section 5.0. All wastes generated during the treatability study will be disposed of within 90 days of initial accumulation date marked on the container.

5.0 Waste Management

This section describes procedures and documentation controls that IT will use in managing waste generated during the treatability study of the in situ chemical oxidation process at IR Site 25.

Waste management procedures will be implemented under the direction of the project's assigned transportation and disposal coordinator in accordance with the Navy, federal, state, and local requirements.

5.1 Types of Wastes

Waste streams expected to be generated during this project include soil, liquid, personal protective equipment (PPE), and materials waste. Soil will be derived from construction activities and soil sampling activities. Liquid waste will be produced from piezometer development, decontamination, groundwater sampling, and excess oxidation and neutralization solutions.

5.2 Accumulation of Wastes

Soil (e.g., cuttings) will be accumulated in DOT-approved 55-gallon drums. The method of soil storage will depend upon the volume that is produced, but it is anticipated that 55-gallon drums will be used due to the relatively small volume of material anticipated.

Liquid wastes produced by this project will be containerized and stored in properly labeled DOT-approved drums. The volume of liquid waste generated from project activities is expected to be low. Groundwater sampling will be limited and will result in limited quantities of purge and decontamination water. Should the volume of liquid waste produced by the project increase, larger approved storage containers will be obtained and utilized.

All containerized materials and waste will be properly labeled and stored. Stored containers and waste stockpiles will be inspected regularly to ensure that they are properly identified and in working order. No wastes will be stored at any location beyond the 90-day temporary holding time.

5.3 Waste Disposal Methods

Remediation-derived materials will be characterized to determine the appropriate method of disposal. Waste characterization sampling will be performed in accordance with federal, state, and local requirements. For each unit or batch of waste, samples will be collected and analyzed for known site contaminants as required for disposal.

After characterization and acceptance of waste characterization results, waste soil will be transferred to an appropriate off-site disposal facility using the appropriate transport method and documentation (hazardous waste manifest, nonhazardous waste manifest, and/or bills of lading).

Provided the analytical results indicate that wastewater is not considered a hazardous waste, per 40 Code of Federal Regulations Part 262 Subpart C and 22 California Code of Regulations Part 66262, the water will be disposed of appropriately. If the analytical results indicate that the wastewater qualifies as hazardous waste, the wastewater will be transported to a licensed facility for proper disposal.

Plastic sheeting, PPE, and nonhazardous and hazardous debris will be properly containerized, labeled, and transferred to an appropriate waste disposal facility.

6.0 Treatability Study Reporting

A Treatability Study Technical Report (TSTR) will be prepared to summarize the results of the Treatability Study. The TSTR will be prepared within 90 days of completion of field activities. The treatability study activities will be documented, a summary of the process used to determine the outcome will be presented, and the project goals will be evaluated.

Recommendations will be made concerning the feasibility of in situ oxidation of PAHs with potassium permanganate. These recommendations will be based on the following factors:

- Benzo(a)pyrene-equivalent removal from soil
- Control and delivery of potassium permanganate to the target zones
- Effects of in situ chemical oxidation on soil manganese concentrations
- Effects of in situ chemical oxidation on redox-sensitive metals
- Order of magnitude cost-benefit of in situ treatment versus excavation

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**APPENDIX A
FIELD SAMPLING PLAN**

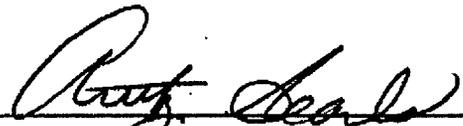
**FINAL
FIELD SAMPLING PLAN
CHEMICAL OXIDATION TREATABILITY STUDY
INSTALLATION RESTORATION SITE 25
ALAMEDA POINT
ALAMEDA, CALIFORNIA**

**Environmental Remedial Action
Contract Number N62474-98-D-2076
Contract Task Order 0076**

**Document Control Number 1859
Revision 0**

August 3, 2001

Approved by: _____


Anthony Searls
IT Project Manager

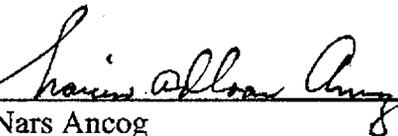
Date: August 7, 2001

Approved by: _____


Dwayne Ishida
IT Program Chemist

Date: August 7, 2001

Approved by: _____


Nars Ancog
U.S. Navy Quality Assurance Officer

Date: 8/08/01

Table of Contents

List of Figures.....	ii
List of Tables.....	ii
Acronyms and Abbreviations.....	iii
1.0 Introduction.....	1-1
1.1 Purpose and Objective.....	1-2
2.0 Sampling Strategy	2-1
2.1 Soil Sampling	2-1
2.2 Pore Water Sampling	2-3
2.3 Groundwater Sampling	2-4
2.4 Investigation-Derived Waste	2-4
2.4.1 Soil Cuttings.....	2-4
2.4.2 Wastewater.....	2-5-6
3.0 Analytical Requirements and Quality Control	3-1
3.1 Analytical Method References	3-1
3.2 Sample Containers, Preservatives, and Holding Times	3-2
3.3 Field Quality Control Samples.....	3-2
3.3.1 Field Duplicates	3-2
3.3.2 Equipment Rinsate Samples.....	3-2
3.3.3 Trip Blanks.....	3-4
3.3.4 Temperature Blanks.....	3-4
3.4 Laboratory Quality Control Samples	3-4
3.5 Summary of Soil and Water	3-5
4.0 Field Methods and Sampling Procedures.....	4-1
4.1 Test Pilot/Boring Location Staking	4-1
4.2 Utility Clearance.....	4-1
4.2.1 Underground Services Administration Notification	4-1
4.2.2 Geophysical Survey Markings.....	4-2
4.2.3 Base Utility Maps	4-2
4.3 Subsurface Soil Sampling Procedures.....	4-2
4.4 Groundwater/Piezometer Sampling Procedures	4-3
4.5 Neutron Probe Sampling Procedures	4-3
4.6 Lysimeter Sampling Procedures	4-4
4.7 Wastewater Sampling Procedures.....	4-4
4.8 Waste Soil Sampling Procedure	4-5
4.9 Decontamination Procedure.....	4-5
4.10 Sample Numbering	4-6
4.11 Sample Labeling	4-6
4.12 Sample Packaging and Shipping	4-7
4.13 Field Documentation	4-8
4.13.1 Chain of Custody	4-8
4.13.2 Field Logbooks.....	4-8
4.13.3 Borehole Logging.....	4-9

Table of Contents (continued)

4.13.4	Surveying.....	4-10
4.13.5	Document Corrections	4-10
5.0	References.....	5-1

List of Figures

Figure 1-1	Site Location Map.....	1-3
Figure 1-2	Chemical Oxidation Treatability Study Cell Layout.....	1-4
Figure 2-1	Lysimeter, Piezometer, and Neutron Probe Casing Schematic.....	2-5

List of Tables

Table 2-1	Chemical Oxidation Treatability Study Sampling Strategy.....	2-2
Table 3-1	Sample Containers, Preservatives, and Holding Times.....	3-3
Table 3-2	Summary of Soil and Water Sampling for Off-Site Laboratory Analysis	3-6
Table 3-3	Summary of Water and Soil Sampling for On-Site Analysis	3-8

Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
bgs	below ground surface
CCR	California Code of Regulations
COC	chain-of-custody
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
ft	foot (feet)
IDW	investigation-derived waste
IR	Installation Restoration
IT	IT Corporation
KMnO ₄	potassium permanganate
MS/MSD	matrix spike/matrix spike duplicate
NGVD29	National Geodetic Vertical Datum of 1929
PAH	polycyclic aromatic hydrocarbon
PPE	personal protective equipment
QAPP	Quality Assurance Project Plan
QC	quality control
SAP	Sampling and Analysis Plan
SOD	soil oxidant demand
SOP	standard operating procedure
SVOC	semivolatile organic compound
TPH	total petroleum hydrocarbons
USA	Underground Service Alert
VOC	volatile organic compound

1.0 Introduction

This Field Sampling Plan (FSP) addresses the requirements for sampling and analysis in support of the chemical oxidation treatability study for IR Site 25 to be conducted at Estuary Park (Parcel 182), located on Alameda Point, Alameda, California (Figure 1-1, "Site Location Map"). Installation Restoration Site 25 is comprised of approximately 42 acres, divided into three parcels (Parcels 181 through 183). U.S. Coast Guard employees and their families are currently occupying a portion of the multi-unit housing structures within Parcel 181, under lease from the Navy. Parcel 182 is also known as Estuary Park, and Parcel 183 is also known as the Coast Guard Housing Management Office.

The area encompassing IR Site 25 existed as marshland and tidal flat prior to development in the early 1900s, at which time these areas were filled with dredged material of uncertain origin to create usable land for development. The dredge materials are believed to be the source of polycyclic aromatic hydrocarbon (PAH) contamination at the site.

Several sampling events have been conducted at the site from 1994 to 1999. The analytical results from these activities indicate that there is PAH contamination at depth at the site.

Three methods of application of potassium permanganate (KMnO_4) will be tested during this treatability study. Shallow subsurface injection, surface tilling, and surface irrigation will all be conducted concurrently. The cells will all be constructed prior to sampling or instrument installation. The instruments will be installed for the injection and irrigation prior to the collection of the baseline samples. Due to the logistics of the surface tilling, the baseline samples will be collected after the surface tilling cells are constructed and tilled. And finally, the instruments will be installed in the surface tilling cells. The schedule of the activities will allow the oxidant to be delivered by all three methods to their respective cells at approximately the same time. The oxidant will be applied in dry form for surface tilling. A KMnO_4 solution will be prepared for the shallow subsurface injection and surface irrigation method.

Baseline sampling will include soil, pore water, and groundwater sampling. After the oxidant has been delivered and the instruments installed, performance sampling will take place at 1, 3, and 6 months. Performance sampling will analyze soil samples only, but will be conducted with the biweekly sampling that falls at the correct interval. Operational sampling will be conducted biweekly. Operational sampling will analyze soil, pore water, and groundwater. Atmospheric conditions will be recorded daily.

This FSP, in conjunction with the Quality Assurance Project Plan (QAPP) (Appendix B), comprise the Sampling and Analysis Plan (SAP) for the chemical oxidation treatability study at IR Site 25.

1.1 Purpose and Objective

The purpose of this FSP is to provide field sampling procedures and data gathering methods that will be used during the in situ chemical oxidation treatability testing to be conducted at Estuary Park. The collected data will be evaluated to determine if chemical oxidation will be included as a potential remedial alternative in a future feasibility study.

The area within Estuary Park will be cleared for subsurface utilities prior to any invasive activities. The test cells will be constructed as shown on Figure 1-2, "Chemical Oxidation Treatability Study Cell Layout." Each cell will be 50 feet (ft) by 50 ft. Each test cell will have a corresponding control cell that will undergo all of the same activities, with the exception that no oxidant will be added to the control cell.

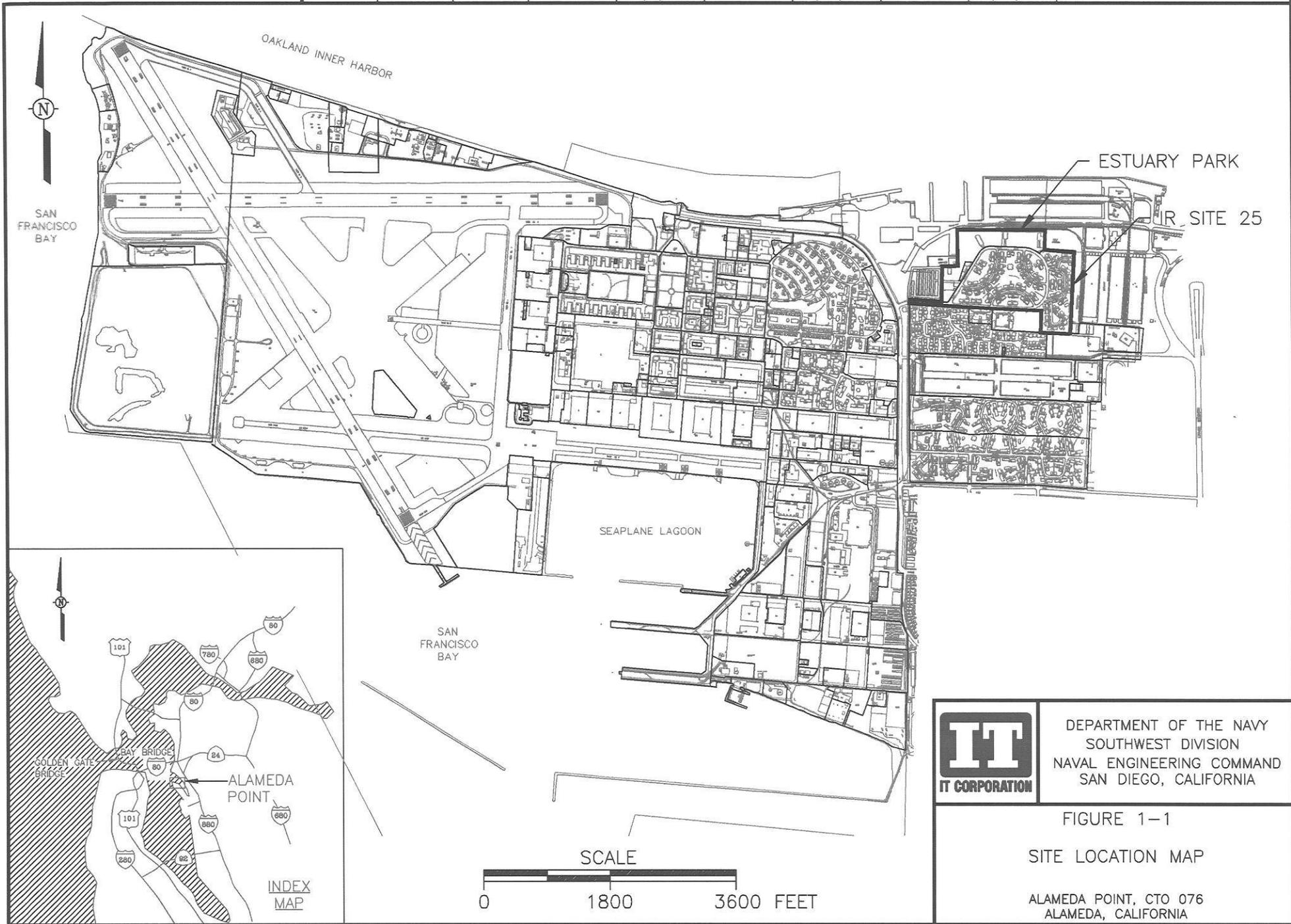
This FSP has the following objectives:

- Provide a rationale for field sampling activities.
- Describe the sampling strategy and design.
- Describe and establish consistent field sampling procedures.
- Establish data gathering, sample handling, and documentation methods that will be employed during field activities.
- Test the ability of three methods of in situ chemical oxidation, using KMnO_4 , to remediate PAH-contaminated soil.

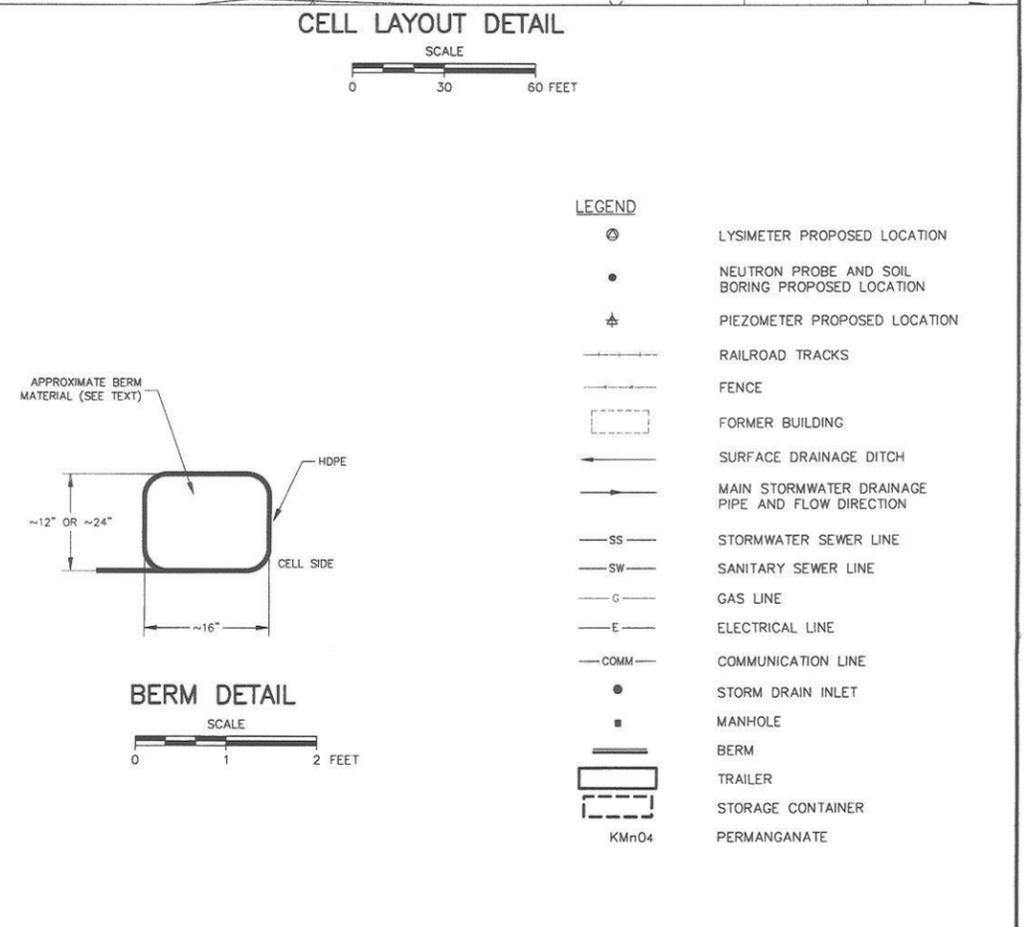
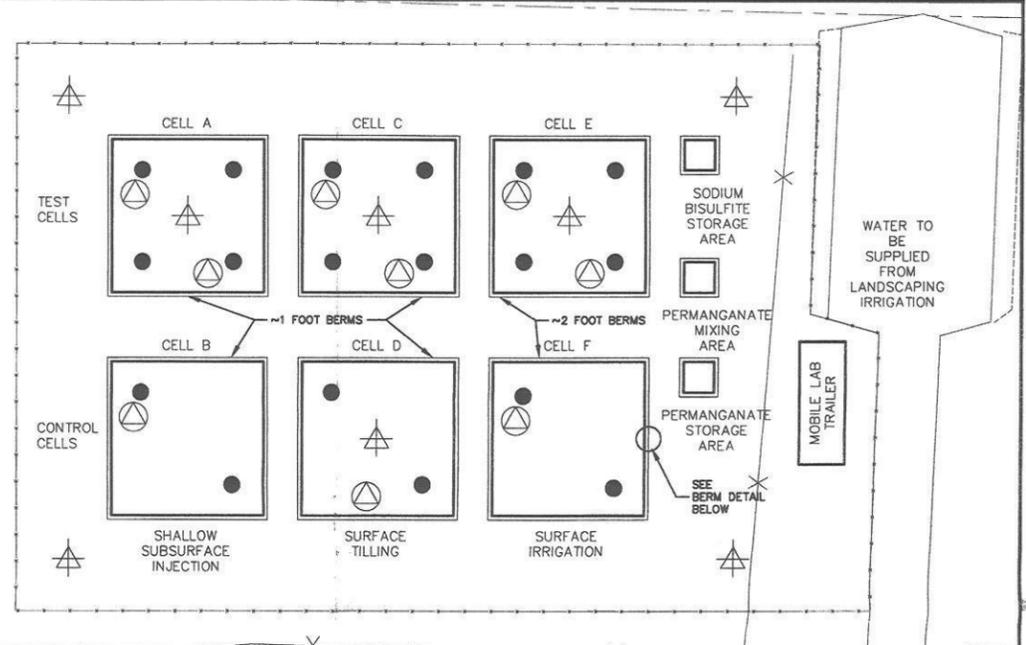
Various matrices will be sampled and analyzed to achieve the project objectives, such as soil, pore water, and groundwater. Analytical data collected under the provisions of this FSP will be used for the following purposes:

- Provide a baseline characterization of the soil, pore water, and groundwater.
- Determine the volume of oxidant to deliver to each method test cell.
- Monitor the effects of the treatability study on PAH concentrations.
- Monitor the concentration of oxidation-reduction sensitive metals.
- Quantify residual manganese concentration following permanganate treatment.
- Determine the optimal delivery method for a given dose of KMnO_4 .
- Dispose of investigation-derived waste.

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1-3



- LEGEND**
- ⊙ LYSIMETER PROPOSED LOCATION
 - NEUTRON PROBE AND SOIL BORING PROPOSED LOCATION
 - ⊕ PIEZOMETER PROPOSED LOCATION
 - RAILROAD TRACKS
 - FENCE
 - - - FORMER BUILDING
 - SURFACE DRAINAGE DITCH
 - MAIN STORMWATER DRAINAGE PIPE AND FLOW DIRECTION
 - SS — STORMWATER SEWER LINE
 - SW — SANITARY SEWER LINE
 - G — GAS LINE
 - E — ELECTRICAL LINE
 - COMM — COMMUNICATION LINE
 - STORM DRAIN INLET
 - MANHOLE
 - BERM
 - ▭ TRAILER
 - ▭ STORAGE CONTAINER
 - ▭ KMnO4 PERMANGANATE

PLAN VIEW
SCALE
0 140 280 FEET

DEPARTMENT OF THE NAVY
ENGINEERING FIELD DIVISION
SOUTHWEST DIVISION
SAN DIEGO, CALIFORNIA

FIGURE 1-2
CHEMICAL OXIDATION TREATABILITY STUDY
CELL LAYOUT
ALAMEDA POINT, CTO 076
ALAMEDA, CALIFORNIA

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2.0 Sampling Strategy

This section discusses the sampling and analysis strategy for soil, pore water, groundwater, and waste samples required to meet the project Data Quality Objectives, which are presented in Section 3.1 of the QAPP (Appendix B). Procedures for sample collection and handling are discussed in Sections 3.0 and 4.0. The Standard Operating Procedures (SOP) referenced in these sections are part of *IT Standard Quality Procedures and Standard Operating Procedures Manual* (2000).

Sampling will be conducted in three phases during the treatability study. These three phases are baseline sampling, operational sampling, and performance sampling. The baseline samples will be the starting point of the treatability study and the other data will be compared to the baseline to track results of the permanganate treatment. The operational samples will be collected biweekly and will allow close monitoring of the treatment conditions throughout the study. The performance samples will be collected at 1-, 3-, and 6-month intervals. These data will be used to determine how well the treatment is working over time.

Table 2-1, "Chemical Oxidation Treatability Study Sampling Strategy," presents the types of samples that will be collected during each phase of sampling. The following subsections present details of the sampling activities.

2.1 Soil Sampling

The proposed soil sample locations are shown in Figure 1-2. Samples will be collected from four locations within each test cell and at two locations within the control cells at depth intervals. After chemical addition, soil samples will be collected in as close proximity (less than 2 feet) as possible to the baseline soil core locations. For each location, two vertically composited samples will be collected from 0 to 2 ft below ground surface (bgs) and from 2 to 4 ft bgs, respectively, and submitted for laboratory analysis. The soil samples would be analyzed for the following properties:

- Moisture content by American Society for Testing and Materials (ASTM) D2216
- Soil moisture suction curves using ASTM D2325, Capillary-Moisture Relationships
- Manganese by U.S. Environmental Protection Agency (EPA) Method 6010B (1996)
- PAH with silica gel cleanup by EPA Method 8270 SIM
- Permanganate soil oxidant demand (SOD) by an IT Method
- KMnO_4 by spectrophotometer

**Table 2-1
Chemical Oxidation Treatability Study Sampling Strategy**

Matrix	Test	Baseline (start of study)	Operational (biweekly)	Performance (1, 3, and 6 months)
Soil	Moisture Content	X	X	X
	Geotechnical testing	X		
	Soil Moisture Suction Curves	X		
	Manganese	X		
	Polycyclic Aromatic Hydrocarbons	X		X
	Potassium Permanganate (KMnO ₄)			X
	Soil Oxidant Demand	X		X
Pore Water	pH	X	X	X
	Oxidation Reduction Potential	X	X	X
	KMnO ₄		X	X
	Conductivity	X	X	X
Groundwater	Water Level	X		X
	Chromium (VI) and Arsenic	X		X (6 months only unless indicated prior in piezometers)

Prior to testing activities, soil samples will be collected in Shelby tubes at two locations, from 0 to 2 ft bgs and from 2 to 4 ft bgs, for geotechnical analysis. The samples will be analyzed for permeability testing by ASTM D5084 (2000) as well as porosity, soil density, and moisture content (ASTM D2216).

In addition, in situ sampling will be conducted. Soil moisture will be measured using a 1.5- or 2-inch neutron probe according to ASTM D5220 (2000). The probe will be calibrated according to the operating manual to the site conditions prior to use. The probe casings will be left in place during the study, but the instrument will be lowered into the casing for each measurement. The neutron probe will be stored in a secure area as required by state licensing. The same depth will be reproduced at each location for each sampling event with the use of depth position locks, which are clamped onto the cable. Soil moisture samples will be collected and analyzed using Neutron Probe Sampling as described in Section 4.3. The probe casing will be a 2-inch diameter steel casing. There will be four casings installed in each test cell and two casings installed in

each control cell. The preliminary specifications for the access tubing and Neutron Depth Probe are presented in Figure 2-1, "Lysimeter, Piezometer, and Neutron Probe Casing Schematic."

Performance monitoring soil samples will be collected during the pilot test period at 1, 3, and 6 months. Soil samples will be collected from borings in the test and control cells using the same technique that is used during the initial sampling event. The boring locations will be placed as near to the initial boring locations as possible. Two soil samples will be collected from each boring at 0 to 2 ft bgs and 2 to 4 ft bgs. The performance monitoring samples will be analyzed for the following parameters:

- PAH with silica gel cleanup by EPA Method 8270 SIM
- Soil oxidant demand

2.2 Pore Water Sampling

Lysimeters will be installed at the proposed locations identified in Figure 2-1 using direct-push or hollow-stem auger methods. The exact location and number of lysimeters will be determined based on information derived from field activities. The lysimeters will be built using 1¾-inch polyvinyl chloride casing, and will be built inside the center of the auger as it is removed. Additionally, silica pack will be installed around each lysimeter interval. The preliminary specifications for the lysimeter construction are presented in Figure 2-1. After all lysimeters are installed, the elevation of the top of each casing will be surveyed by a survey subcontractor to a local benchmark as described in IT SOP 23.1 (2000). The horizontal location of each casing will be determined using the Global Positioning System technique. The lysimeters will be completed to collect water from two depth intervals, 1-ft and 3-ft bgs.

All downhole equipment and lysimeter construction materials will be decontaminated prior to lysimeter installation. Water collected from the lysimeters will be measured in the field using hand-held equipment for the following water quality parameters: pH, oxidation-reduction potential, and conductivity. Additionally, water samples will be collected and analyzed in the field using a spectrophotometer for permanganate concentrations.

Any excess water or soil generated during drilling will be collected and stored in U.S. Department of Transportation (DOT)-approved 55-gallon drums for waste profile sampling and appropriate disposal.

2.3 Groundwater Sampling

Piezometers will be installed at the proposed locations identified in Figure 2-1 using hollow-stem auger techniques as described in IT SOP 8.1 (2000). One piezometer will be located in the center of each test cell. One piezometer will also be installed 20 ft. from each of the outside corners of the treatability study area (see Figure 1-2). The middle control cell will also have a piezometer installed in the center. The piezometers will be built inside the center of the auger as it is removed. The preliminary specifications for piezometer construction are presented in Figure 2-1. The piezometers will be installed to a depth of 13 ft and they will have 5-ft screens. The surface completion for the piezometer will include a flush-mounted concrete box with a bolted steel cover. All downhole equipment and piezometer construction materials will be decontaminated prior to each piezometer installation, as described in Section 4.9.

Water levels will be measured in each piezometer in accordance with IT SOP 5.1 (2000). The groundwater will be visually monitored for purple color while measuring the water levels. If purple color is detected, the groundwater will be analyzed for chromium and arsenic at this time and during all subsequent sampling events. If no purple color is detected in the water, the groundwater will only be analyzed for chromium and arsenic at baseline and at 6 months. Groundwater samples will then be collected following IT SOP 9.1 (2000) using a peristaltic pump. Groundwater samples will be collected in the appropriate sample containers and will be packaged, labeled, and submitted to the laboratory for analysis according to Section 4.4.

Excess water from the purging and sampling and soil generated during drilling will be stored in respective DOT-approved 55-gallon drums pending waste profile sampling and appropriate disposal.

2.4 Investigation-Derived Waste

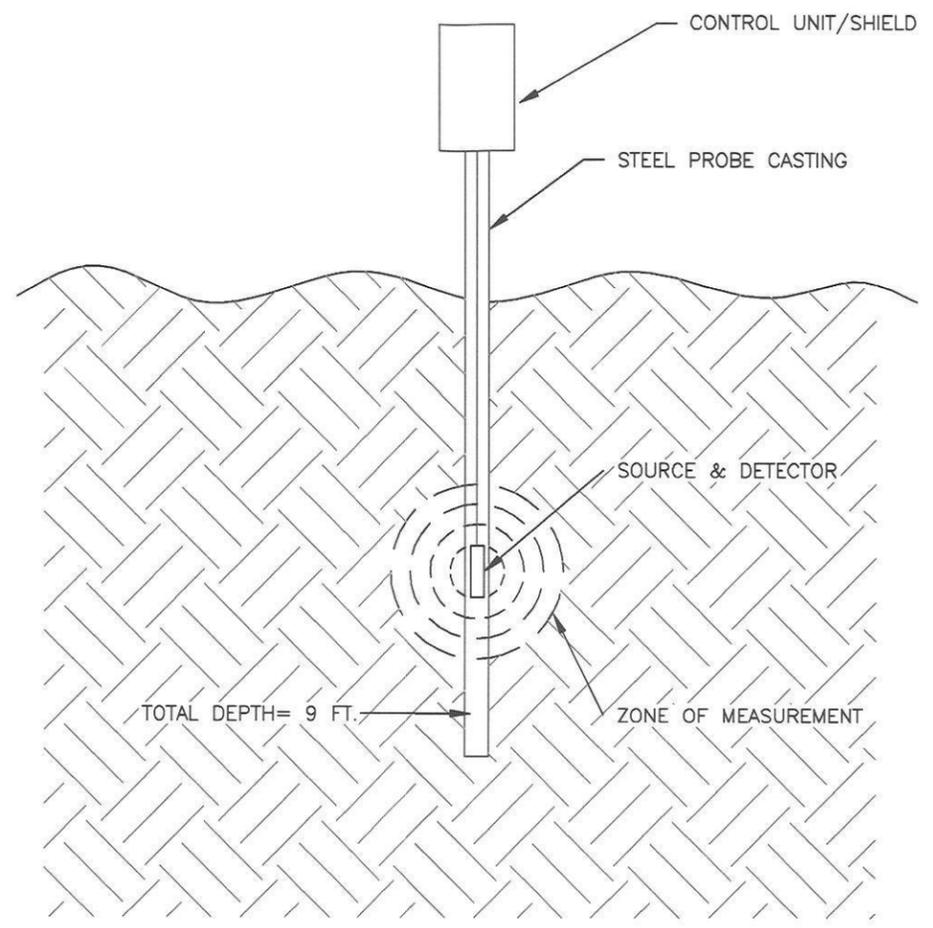
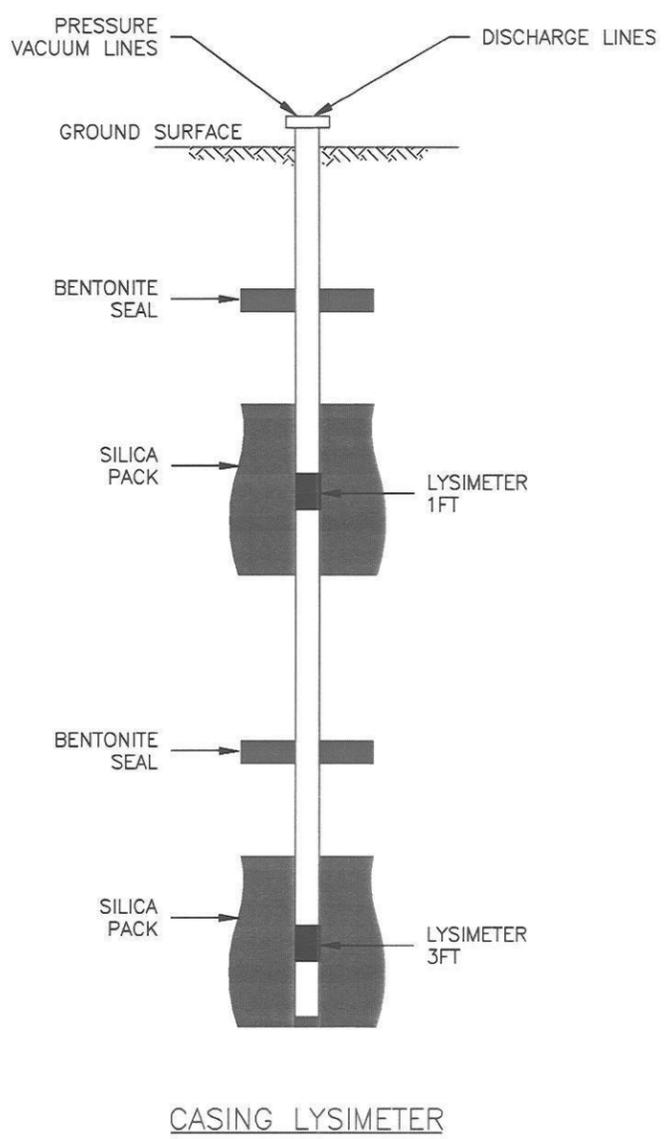
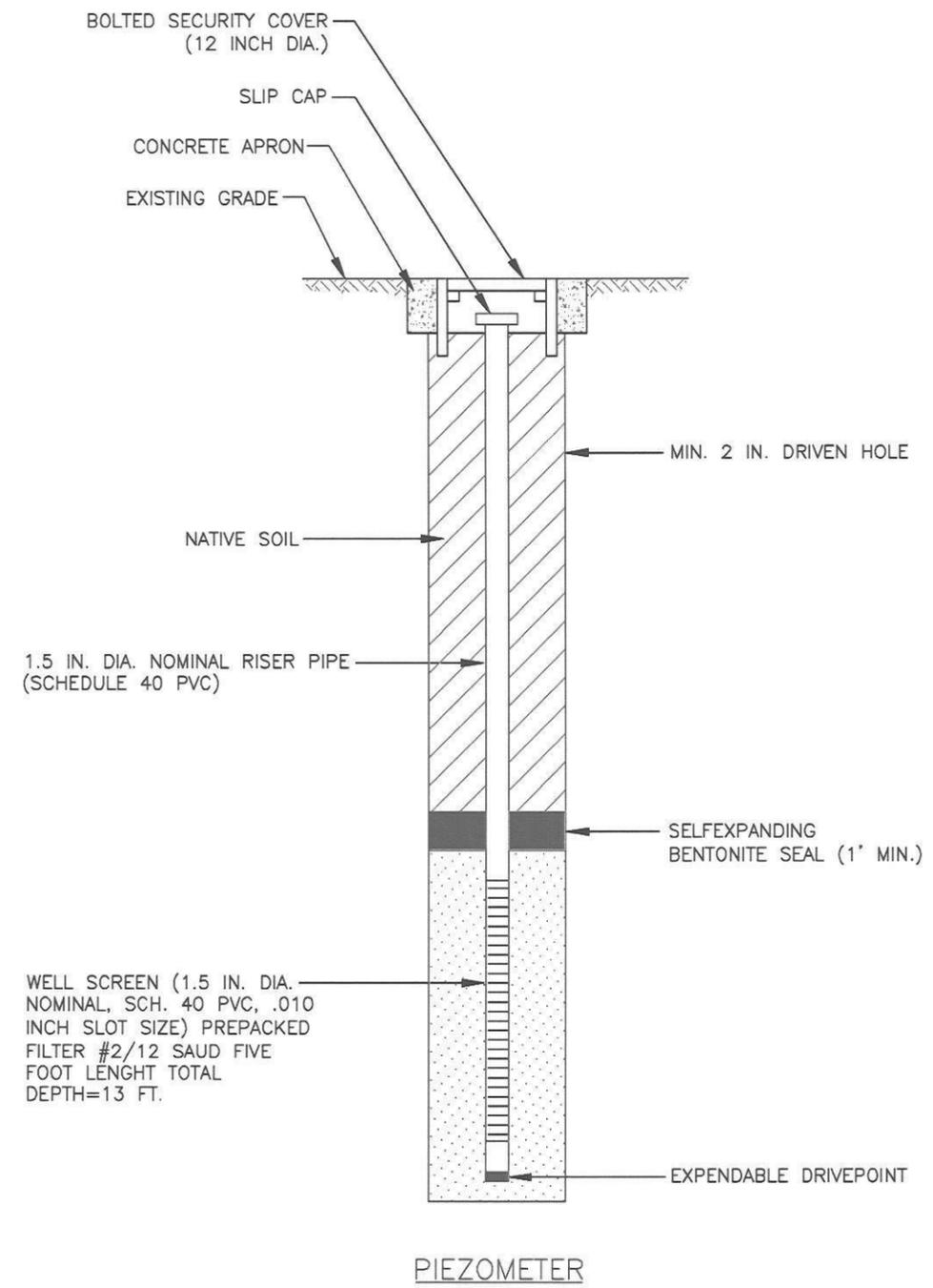
The project investigation-derived waste (IDW) streams will consist of excess soils, groundwater, and wastewater generated during drilling and sampling activities.

Additionally, personal protective equipment (PPE) used during the work will be treated as disposable refuse. No samples will be required for disposal.

2.4.1 Soil Cuttings

Soil cuttings from installation of the piezometers, lysimeters, and neutron probe access casing will be contained in DOT-approved 55-gallon drums. The soil cuttings will be handled as one waste stream for the activities. One 4-point composite soil sample representing no more than

DRAWING NUMBER 827 1-B4
 APPROVED BY BKM 8/6/01
 CHECKED BY MH 8/6/01
 DRAWN BY BU 8/1
 OFFICE CONCORD
 X-REF ALA/BASE
 IMAGE



WATER CONTENT BY
 NEUTRON DEPTH PROBE METHOD

NOT TO SCALE

	DEPARTMENT OF THE NAVY SOUTHWEST DIVISION NAVAL ENGINEERING COMMAND SAN DIEGO, CALIFORNIA
	FIGURE 2-1 LYSIMETER, PIEZOMETER AND NEUTRON PROBE CASTING SCHEMATIC ALAMEDA POINT, CTO 076 ALAMEDA, CALIFORNIA

500 cubic yards of IDW soil will be collected to represent the waste stream. The composite sample will be analyzed for the following parameters:

- Total petroleum hydrocarbons (TPH) measured as diesel and motor oil by EPA Method 8015B Modified
- Semivolatile organic compounds (SVOCs) by EPA Method 8270C
- California Code of Regulations (CCR) Title 22 Metals by EPA Methods 6010B/7000A

One discrete sample to profile the volatile organic compounds (VOCs) will be collected using an EnCore™ sampler. The discrete sample will be analyzed for VOCs by EPA Method 8260B. Analytical results will be provided to the IT transportation and disposal coordinator for evaluation. The soil will be shipped for proper disposal within 90 days of the accumulation start date.

2.4.2 Wastewater

Excess groundwater and equipment decontamination wastewater will be combined and stored in DOT-approved 55-gallon drums or in a storage tank. One sample, representing the wastewater, will be collected and analyzed for the following parameters to determine the appropriate disposal options:

- TPH measured as diesel and motor oil by EPA Method 8015B Modified
- SVOCs by EPA Method 8270
- VOCs by EPA Method 8260B
- Reactivity by EPA SW-846 Chapter 7 (1993)
- Corrosivity by EPA Method 9045C
- Ignitability by EPA Method 1010 or 1020
- CCR Title 22 Metals by EPA Methods 6010B/7000A

All IDW analyses will be completed using standard 14-day turnaround time. Reactivity, corrosivity, and ignitability testing will be performed only if determined to be appropriate based on field observations.

3.0 Analytical Requirements and Quality Control

This section describes analytical methods, container and preservative requirements, and field and laboratory quality control (QC) samples.

3.1 Analytical Method References

The following analytical methods will be used to obtain the data for this project:

- *Test Methods for Evaluating Solid Waste, SW-846* (EPA, 1996)
 - PAH by EPA Method 8270 SIM
 - Reactivity by EPA Method SW-846 Chapter 7 (IDW samples)
 - SVOCs by EPA Method 8270C (IDW samples)
 - Corrosivity by EPA Method 9045C (IDW samples)
 - VOCs by EPA Method 8260B (IDW samples)
 - Ignitability by EPA Method 1010/1020 (IDW samples)
 - CCR Title 22 Metals by EPA Method 6010B/7000 series (IDW samples)
 - TPH measured as diesel and motor oil by EPA Method 8015B Modified (IDW samples)
- *American Society for Testing and Materials (2000)*
 - Pore-Liquid Sampling from the Vadose Zone by ASTM D4696
 - Water Content of Soil and Rock In-Place by the Neutron Depth Probe Method by ASTM D5220
 - Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084
 - Capillary-Moisture Relationships for Coarse- and Medium-Textured Soil by Porous-Plate Apparatus by ASTM D2325
- *Other*
 - Permanganate SOD by IT Method

Detailed information on methods, calibration criteria, project-required reporting limits, and QC acceptance criteria are presented in the QAPP (Appendix B).

3.2 Sample Containers, Preservatives, and Holding Times

Sample containers for soil and water will be certified precleaned according to EPA protocols. Table 3-1, "Sample Containers, Preservatives, and Holding Times," lists the sample container, preservative, and holding time requirements for water and soil samples.

3.3 Field Quality Control Samples

Field QC samples will be collected and analyzed during the project to assess the consistency and performance of the sampling program. Field QC samples for this project will include field duplicates for groundwater and soil samples, equipment rinsates, trip blanks for water samples, and temperature blanks.

3.3.1 Field Duplicates

Field duplicates consist of two samples (a primary sample and its duplicate) of the same matrix collected at the same time and location to the extent possible, using the same sampling techniques. The purpose of field duplicate samples is to assess the overall sample matrix variability of the site. Field duplicates for groundwater and soil will be collected at a frequency of one per ten samples and will be analyzed for the same parameters as the primary sample. Field duplicates will not be collected for waste samples.

3.3.2 Equipment Rinsate Samples

Equipment rinsate samples will be collected for nondisposable sampling equipment, such as split spoon. Rinsate samples consist of reagent-grade water collected from the final rinse of the decontamination process. Rinsate samples will be collected from the sample equipment, placed in appropriate precleaned containers supplied by the analytical laboratory, and analyzed for the same analytes as the field samples. Equipment rinsate samples evaluate the effectiveness of the decontamination procedure and potential cross-contamination during sampling events. Because this is a pilot study project, the possibility of cross-contamination affecting results is not a matter of concern. For this reason, equipment rinsate samples will be collected once at the beginning of the project to verify that decontamination procedures are effective.

**Table 3-1
Sample Containers, Preservatives, and Holding Times**

Analytes	Method	Container ¹	Preservative	Holding Time
Groundwater and Wastewater				
TPH measured as diesel and motor oil	EPA 8015B	Two 1-liter amber bottles, Teflon™-lined lid	Cool at 4±2°C	7 days before extraction, 40 days after extraction
VOCs	EPA 8260B	Three 40-mL vials, Teflon™-lined septum	HCl to pH<2 Cool at 4±2°C	14 days preserved
SVOCs (including PAH)	EPA 8270 SIM	Two 1-liter amber bottles, Teflon™-lined lid	Cool at 4±2°C	7 days before extraction, 40 days after extraction
CCR Title 22 Metals	EPA 6000/7000 Series	500 mL HDPE	HNO ₃ to pH<2	180 days for all metals except mercury 28 days for mercury
Chromium VI	EPA 7196A	500 ml HDPE	HNO ₃ to pH<2	24 hours
Arsenic (groundwater)	EPA 6010B	500 ml HDPE	HNO ₃ to pH<2	180 days
Soil				
TPH measured as diesel and motor oil	EPA 8015B	Brass sleeve or 8-oz. glass jar with a Teflon™-lined lid	Cool at 4±2°C	14 days
VOCs	EPA 8260B	3 EnCore™ devices or equivalent	Cool at 4±2°C	48 hours to preserve, 14 days from sample collection after preservation
CCR Title 22 Metals	EPA 6010B/7000A series	One brass sleeve or one 8-oz. glass jar with a Teflon™-lined lid	Cool at 4±2°C	180 days for all metals except mercury 28 days for mercury
Manganese	EPA 6010B	4-oz. glass jar	Cool at 4±2°C	180 days
Soil Oxidant Demand (SOD)	IT Corporation Method	4-oz. glass jar	Cool at 4±2°C	Not specified
SVOC (including PAH)	EPA 8270C	Brass sleeve or 8-oz. glass jar with a Teflon™-lined lid	Cool at 4±2°C	14 days
PAH	EPA 8270 SIM	Brass sleeve or 8-oz. glass jar with a Teflon™-lined lid	Cool at 4±2°C	14 days
Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter	ASTM D5084	Shelby Tubes	Not Applicable	Not specified
Pore Water				
Pore-Liquid Sampling from the Vadose Zone	ASTM D4696	Not Applicable	Not Applicable	Not specified
Water Content of Soil and Rock In-Place by the Neutron Depth Probe Method	ASTM D5220	Not Applicable	Not Applicable	Not specified

Table 3-1 (continued)
Sample Containers, Preservatives, and Holding Times

Analytes	Method	Container¹	Preservative	Holding Time
Capillary-Moisture Relationships for Coarse- and Medium-Textured Soil by Porous-Plate Apparatus	ASTM D2325	4 to 5 lbs in a plastic bag	No ice	Not specified

Notes:

Additional sample containers will be provided for matrix spike/matrix spike duplicate analyses.
°C denotes degrees Celsius.
ASTM denotes American Society for Testing and Materials.
CCR denotes California Code of Regulations.
EPA denotes U.S. Environmental Protection Agency.
HCl denotes hydrochloric acid.
HDPE denotes high-density polyethylene.
HNO₃ denotes nitric acid.

lbs denotes pounds.
mL denotes milliliter.
oz. denotes ounces.
PAH denotes polycyclic aromatic hydrocarbon.
PCBs denotes polychlorinated biphenyls.
SVOCs denote semivolatile organic compounds.
TPH denotes total petroleum hydrocarbons.
VOCs denote volatile organic compounds.

3.3.3 Trip Blanks

Each cooler containing water samples for VOC analysis will contain a trip blank. Trip blanks are 40 milliliter volatile organic analysis vials of organic-free water, which are kept with the field sample containers from the time they leave the laboratory until the time they are returned to the laboratory. The purpose of trip blanks is to determine if samples have been contaminated with VOCs during transportation or sample collection. One trip blank is needed for 1-day sampling of groundwater samples for VOC analysis. Trip blanks will not be used with wastewater or soil samples.

3.3.4 Temperature Blanks

Each cooler will be shipped with a temperature blank. A temperature blank is a sample container filled with tap water and stored in the cooler during sample collection and transportation. The laboratory will record the temperature of the temperature blank immediately upon receipt of the samples.

3.4 Laboratory Quality Control Samples

The laboratory will analyze a matrix spike and matrix spike duplicate (MS/MSD) for every 20 project samples. For the laboratory to prepare a project-specific MS/MSD, field personnel will collect triple the sample volumes for water samples. Field personnel will designate one sample of groundwater for MS/MSD analysis on the chain-of-custody (COC) form. Waste samples will not be submitted as MS/MSD samples.

3.5 Summary of Soil and Water

Table 3-2, "Summary of Soil and Water Sampling for Off-Site Laboratory Analysis," and Table 3-3, "Summary of Water and Soil Sampling for On-Site Analysis," present a summary of field sampling and analysis for the chemical oxidation treatability study at IR Site 25.

**Table 3-2
Summary of Soil and Water Sampling for Off-Site Laboratory Analysis**

Time	Test Cell	Sample Point	Number of Samples per Boring/Well	Total Number of Samples	Number of QC Samples	Analysis
Baseline Sampling	N/A	Two Borings Total	2 Composite Soil Samples (0 to 2 feet and 2 to 4 feet)	4	0	Soil Analyses (method): Capillary Moisture (ASTM D2325) Permeability Porosity Soil Density
	A, C, E	Four Borings Each	2 Composite Soil Samples (0 to 2 feet and 2 to 4 feet)	36 Composite Soil Samples	4 Composite Soil Duplicates	Soil Analyses (method): PAH (EPA Method 8270 SIM) Manganese (EPA Method 6010B) SOD (duplicates from on-site only) Capillary Moisture (ASTM D2325) Permeability Porosity Soil Density Soil Moisture
	B, D, F	Two Borings Each				
Immediate Monitoring	A, C, E	Visual Assessment	—	—	—	No Samples Collected
	B, D, F	Visual Assessment	—	—	—	No Samples Collected
Performance Monitoring at 1 Month	A, C, E	Four Borings Each	2 Composite Soil Samples (0 to 2 feet and 2 to 4 feet)	36 Composite Soil Samples	4 Composite Soil Duplicates	Soil Analyses (method): PAH (EPA Method 8270 SIM) SOD (duplicates from on-site only)
	B, D, F	Two Borings Each				
Performance Monitoring at 3 Months	A, C, E	Four Borings Each	2 Composite Soil Samples (0 to 2 feet and 2 to 4 feet)	36 Composite Soil Samples	4 Composite Soil Duplicates	Soil Analyses (method): PAH (EPA Method 8270 SIM) SOD (TAL)
	B, D, F	Two Borings Each				

Table 3-2 (continued)
Summary of Soil and Water Sampling for Off-Site Laboratory Analysis

Time	Test Cell	Sample Point	Number of Samples per Boring/Well	Total Number of Samples	Number of QC Samples	Analysis
Performance Monitoring at 6 Months	A, C, E	Four Borings Each	2 Composite Soil Samples (0 to 2 feet and 2 to 4 feet)	36 Composite Soil Samples	4 Composite Soil Duplicates	Soil Analyses (method): PAH (EPA Method 8270 SIM) Manganese (EPA Method 6010B) SOD (duplicates from on-site only)
	B, D, F	Two Borings Each				
Baseline Sampling	A, C, E	One Piezometer	1 Grab for Groundwater	8 Groundwater Samples	1 Grab Groundwater Duplicate	Groundwater Analyses (method): Chromium, Arsenic (EPA Method 6010B)
	D	One Piezometer				
6 Months	A, C, E	One Piezometer	1 Grab for Groundwater	8 Groundwater Samples	1 Grab Groundwater Duplicate	Groundwater Analyses (method): Chromium, Arsenic (EPA Method 6010B)
	D	One Piezometer				

ASTM denotes American Society for Testing and Materials.

EPA denotes U.S. Environmental Protection Agency.

PAH denotes polycyclic aromatic hydrocarbon.

QC denotes quality control.

SOD denotes soil oxidant demand.

**Table 3-3
Summary of Water and Soil Sampling for On-Site Analysis**

Time	Test Cell	Sample Point	Number of Samples per Boring/Well	Total Number of Samples	Number of QC Samples	Analysis
Baseline Sampling	A, C, E	Two Lysimeters Each	2 Grab for Pore Water	18 Grab Pore	1 Grab Pore Water Duplicate	Pore Water Analyses (method): pH (probe) ORP (probe) Conductivity (probe) Soil and SOD (IT)
	B, D, F	One Lysimeter Each				
	A, C, E	One Piezometer	1 Groundwater Sample	4 Groundwater Samples	1 Grab Groundwater Duplicate	Water Level
	D	One Piezometer				
Biweekly (Operational) Monitoring	A, C, E	Two Lysimeters Each	2 Grab for Pore Water	18 Grab Pore	1 Grab Pore Water Duplicate	Pore Water Analyses (method): pH (probe) ORP (probe) Conductivity (probe) KMnO ₄ (Spectrophotometric)
	B, D, F	One Lysimeter Each				
	A, C, E	One Piezometer	1 Groundwater Sample	4 Groundwater Samples Every 2 Weeks	1 Grab Groundwater Duplicate	Groundwater Analyses (method): KMnO ₄ (Spectrophotometric) Water Level
	D	One Piezometer				
Performance Sampling 1, 3, and 6 months	A, C, E	Approximately Four Borings Each	Approximately 2 Grab Soil Samples (0 to 2 ft and 2 to 4 ft)	Approximately 36 Grab Soil Samples	4 Soil Duplicates	Soil Analyses (method): KMnO ₄ (Soil Extraction)
	B, D, F	Approximately Two Borings Each				
SOD 1, 3, and 6 months						

ORP denotes oxidation-reduction potential.

KMnO₄ denotes potassium permanganate.

4.0 Field Methods and Sampling Procedures

The descriptions provided in this section summarize the important points of the IT SOPs included in the *IT Standard Quality Procedures and Standard Operating Procedures Manual* (2000). Copies of the SOPs will be made available to the overseeing regulatory agency upon written request to the Navy Remedial Project Manager.

4.1 Test Pilot/Boring Location Staking

The field superintendent (or designee) will complete location staking. Staking will consist of placing a stake or hair nail in the ground and/or marking on the pavement the proposed test pilot/boring location. Marking will be done using either a permanent, waterproof marker or paint.

4.2 Utility Clearance

Each test pilot/boring location will be cleared of subsurface obstructions using a subcontractor. Surface geophysical methods that may be used include, but are not limited to, electromagnetic induction, geomagnetics, or any combination of these methods. Anticipated utilities to be cleared include, but are not limited to, tanks; pipelines for natural gas, water, fuel, etc. (generally anything metallic); electrical lines; telephone or other transmission lines; drainage lines and sewers; and foundations and other structures. Additionally, Underground Service Alert will be contacted to mark known utilities at the proposed locations. The subcontractor will note each cleared sampling location with paint or with a stake immediately upon clearing it. All suspected underground utilities, conduits, and structures will be marked with color-coded marking paint, which differs from the standards established by the American Public Works Association. This difference in marking colors is to alleviate confusion between the Underground Service Alert (USA) markings and those of the private utility locator company. If utilities or other obstructions or hazards are identified at any location, IT's field representative will identify a new location to be surveyed. Additional details are presented below.

4.2.1 Underground Services Administration Notification

In the past, on military installations, notification was made to the USA for clearance for invasive activities. USA, however, in the past has not provided coverage of military installations. The transition of real estate between military and public sector has proven to be a challenge to all involved. In this case, USA was not notified prior to the drilling activities. The work locations must be clearly marked in white paint, and USA must be notified (1-800-227-2600) a minimum of 48 hours prior to any intrusive activities. This includes all drilling or excavations.

Recognizing that this is a transitional period on this installation and that USA may not have fully applicable information, we must at least allow them the opportunity to convey that information to the field crews. It is very important that we must make sure to get a confirmation ticket number from the USA, as they are not always prompt to notify us when their survey is complete.

4.2.2 Geophysical Survey Markings

Our subcontracts require that, "All suspected underground utilities, conduits, and structures will be marked with color coded marking paint according to standards established by the American Public Works Association" and that a site drawing be provided indicating the utilities and cleared location. IT Corporation must assure that the geophysical survey subcontractor marks the areas in accordance with contractual requirements. To this end, IT will ensure that all geophysical survey preparatory phase inspections require the use of appropriate color-coding and will verify that it is being done correctly during our initial and follow-up inspections.

4.2.3 Base Utility Maps

A set of Base Utility Maps will be maintained at the IT Site Office upon the setup of that facility. In the interim, a set of Base Utility Maps will be maintained by the field crew for each contract task order. While the scale and accuracy of the available Base Utility Maps are not 100 percent reliable, they can provide a secondary check for the USA and Geophysical Utility Clearance personnel. If work is to be performed in an area that is anticipated to have extensive underground utilities, the Resident Officer in Charge of Construction can be solicited to provide as-built drawings of all underground utilities and structures.

4.3 Subsurface Soil Sampling Procedures

Two Shelby tubes will be collected prior to site activities. These will be sent to a geotechnical laboratory for analysis by ASTM Method D2325, Capillary-Moisture Relationship (2000).

Two composite soil samples are proposed to be collected from each of 18 borings using direct-push drilling or hand auger methods. At each location shown in Figure 1-2, vertically composited samples will be collected from 0 to 2 ft bgs and from 2 to 4 ft bgs.

Composite samples will be prepared by:

- Transferring the soil into a decontaminated stainless steel bowl
- Homogenizing the entire 2-ft interval by thoroughly mixing the soil in the stainless steel bowl
- Removing rocks, debris, or plant material from the sample

- Thoroughly homogenizing the sample by dividing the soil into four equal portions, discarding the two opposite portions, and then recombining the remaining portions
- Completely filling the sample containers with soil to provide the maximum amount of material for laboratory analysis

All nondisposable soil sampling equipment will be decontaminated before and after sampling according to the decontamination procedures outlined in Section 4.9.

4.4 Groundwater/Piezometer Sampling Procedures

Piezometers will be installed in locations shown on Figure 1-2. Figure 2-1 shows the construction of the piezometers. Groundwater samples will be collected during baseline sampling and upon completion of the treatability study. According to the frequency specified in Table 3-2, sampling will be conducted following IT SOP 9.1 using a peristaltic pump or bailer.

Following the installation and development of piezometers, the water level will be measured in accordance with IT SOP 5.1 (2000). The piezometers will be purged before sampling using peristaltic pumps or bailers. Purge water will be stored in DOT-approved 55-gallon drums and sampling equipment will be decontaminated between sample points according to Section 4.9. A flow-through cell may be installed in the pump discharge to allow for measurement of parameters using direct reading field instruments. After the parameters have been recorded, groundwater samples will be collected in the appropriate sample containers for analytical laboratory testing. The samples will be labeled and submitted to the laboratory for analysis.

4.5 Neutron Probe Sampling Procedures

Access tubing (casing) for the Neutron Depth Probe will be installed at the proposed locations (four locations in test cells and two locations in control cells). The access tubing for the Neutron Depth Probe will be 2-inch diameter black iron casing with a drive point. The casing will be driven to the desired depth with the endpoint sealed to prevent water seepage into the tube. The tube will project above the ground and be capped to prevent foreign material from entering.

The probe will be calibrated to the site conditions prior to use and a standard count taken before each sampling event. Biweekly soil moisture readings will be recorded. The same depth will be reproduced at each location for each sampling event with the use of depth position locks, which are clamped onto the cable. To ensure precision of the probe reading, the neutron depth probe will be set at a 1-minute count.

4.6 Lysimeter Sampling Procedures

Lysimeters will be used to collect and analyze pore water quality. Pore water samples will be collected from two intervals in the dual zone lysimeters (1 ft and 3 ft). To collect a sample, suction is applied to the sampler, and the suction line is clamped shut. After the sample has been collected in the body tube, it is retrieved through a discharge line extending above the soil surface. At the surface, the line is connected to a sample collection flask. Suction is applied to the flask, and liquid is pulled from the sampler, up the discharge line, and into the collection flask.

Water quality parameters will be measured using hand-held instruments. Laboratory analytical samples will be collected using containers supplied by the laboratory. Samples will be labeled according to Section 4.11, packaged, and prepared for shipment to the laboratory in accordance with the IT SOPs 2.1, 17.1, and 17.2 (2000). The samples will then be transferred to cold storage immediately after collection. Sampling equipment will be fully decontaminated between lysimeter sampling according to Section 4.9.

4.7 Wastewater Sampling Procedures

Wastewater samples from on-site storage containers will be collected using a disposable bailer. Samples will be collected using the following procedure:

- Obtain an unused disposable bailer for each sampling event.
- Put on a new, clean, and chemical-resistant pair of disposable gloves and other appropriate PPE.
- Tie the bailer to a nylon cord.
- Lower the bailer into the drum or storage tank. Allow sufficient time for the bailer to fill with water.
- Retrieve the bailer and fill appropriate bottle(s) for analyses being requested.
- Cap the bottle(s) and wipe any moisture from the outside of the bottle(s).
- Place a sample label completed with the information described in Section 6.11 on the bottle.
- Place the bottle in a resealable bag.
- Package and prepare the samples for shipment to the laboratory in accordance with the IT SOPs 2.1, 17.1, and 17.2 (2000). Transfer the samples to cold storage immediately after collection.

4.8 Waste Soil Sampling Procedure

Soil samples from the drums will be collected with a slide hammer or disposable sampling scoops. The following steps summarize the sampling procedures to be performed:

- Obtain brass sleeves or 8-ounce glass jars.
- Put on a new, clean, and chemical-resistant pair of disposable gloves.
- Fill the sample sleeve or glass jar with soil.
- Cover both ends of sleeves with the Teflon™ sheets and the plastic caps. Place a sample label completed with the information described in Section 4.11 on the sleeve or jar.
- Collect samples for VOCs following IT SOP 3.5 (2000) using EnCore™ sampling device.
- Place a sample label completed with the information described in Section 4.11 on the bottle.
- Place the sample container in a resealable bag.
- Package and prepare the samples for shipment to the laboratory in accordance with the IT SOPs 2.1, 17.1, and 17.2 (2000). Transfer the samples to cold storage immediately after collection.

4.9 Decontamination Procedure

Decontamination of nondisposable sampling equipment that comes in contact with samples (such as sleeve rings and the split-spoon sampling device) will be performed according to IT SOP 6.1 (2000) to prevent the introduction of extraneous material into samples and to prevent cross-contamination between sampling events. A summary of the procedure is presented below. All sampling equipment will be decontaminated by steam cleaning or by washing with a nonphosphate detergent, such as Liquinox™ or equivalent. Decontamination water will be collected in 55-gallon DOT-approved drums or a poly-tank.

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

- Rinse with potable water. Change the water frequently. This step will decrease the gross contamination and reduce the frequency at which the nonphosphate detergent and water solution need to be changed.
- Wash with the nonphosphate detergent and water solution. Dilute the nonphosphate detergent as directed by the manufacturer. This step will remove remaining contamination from the equipment.

- Rinse with potable water. Change the water frequently. This step will rinse the detergent solution away from the equipment.
- Rinse with deionized water. This step will rinse any detergent solution and potable water residues. Rinsing will be accomplished by applying the deionized water from a stainless steel Hudson-type sprayer or Nalgene™ squeeze bottle while holding equipment over a 5-gallon bucket.

Decontamination of drilling and heavy equipment will be accomplished via hot water pressure washing according to IT SOP 6.2 (2000).

4.10 Sample Numbering

All samples submitted to the analytical laboratory will be uniquely numbered according to IT SOP 17.2 (2000), and to be consistent with the Alameda Point protocols, in the following format:

Sample Locations	IT076 -182 -YYY
Sample ID:	IT -182 -YYYY

Where:

“X” is the type of sample (e.g., S for soil, G for groundwater, P for pore water)

and

“YYY” is a sequential sample number for this project

Groundwater samples will be labeled using the well sample identification number. The sample number will be recorded in the field logbook at the time of sample collection. A complete description of the sample and sampling circumstances will be recorded in the Field Log and Field Activity Daily Log, and referenced to the unique sample identification number.

4.11 Sample Labeling

Sample labels will be filled out with indelible ink and affixed to each sample container. Each sample label will be covered with clear tape according to IT SOP 17.1 (2000). Containers with soil and water samples will be placed in resealable plastic bags to protect from moisture during transportation to the laboratory. Each sample container will be labeled with the following, at minimum a:

- Sample identification number
- Sample collection date (month/day/year)
- Time of collection (24-hour clock)
- Project number (i.e., 827557)

- Sampler's initials
- Analyses to be performed
- Preservation (if any)
- Location (i.e., Alameda Point)

4.12 Sample Packaging and Shipping

Samples will be shipped to the analytical laboratory by land delivery services according to DOT regulations. The International Air Transportation Association regulations will be adhered to when shipping samples by air courier services. Transportation methods will be selected to ensure that the samples arrive at the laboratory in time to allow testing according to established holding times and project schedules. No samples will be accepted by the receiving laboratory without a properly prepared COC record and properly labeled and sealed shipping container(s).

Packaging of sample containers will be based on the level of protection a sample will require during handling, shipping, and storage. Protection may vary according to sample type, sample media, suspected amount of hazardous substances, required testing, and handling and storage conditions. Proper packaging will be based on the following considerations:

- Type and composition of inner packing (e.g., plastic bags, metal cans, absorbent packing material, and ice for preservation)
- Type and composition of overpacks (e.g., metal or plastic coolers, cardboard box, rock core box, and undisturbed tube rack)
- Method of overpack sealing (e.g., strapping tape, custody seals)
- Marking and labeling of overpacks (e.g., laboratory address, any appropriate DOT Hazard Class Labels, and handling instructions)

Upon collection, samples will be handled according to IT SOP 2.1 (2000). Immediately after sample collection, sample labels will be affixed to each sample container. Each sample label will be covered with clear tape. Containers with soil and water samples will be placed in a resealable plastic bag to keep the sample container and label dry. All glass sample containers will be protected with bubble wrap. A temperature blank will be placed in every cooler with samples. Custody seals will be placed on each cooler prior to shipping or pickup.

Samples to be shipped by commercial carrier will be packed in a sample cooler lined with a plastic bag. Ice, double bagged in resealing bags, will be added to the cooler in sufficient quantity to keep the samples cooled to 4 plus or minus 2 degrees Celsius for the duration of the

shipment to the laboratory. Sample cooler drain spouts will be taped from the inside and outside of the cooler to prevent any leakage. Saturday deliveries will be coordinated with the laboratory.

If samples are picked up by a laboratory courier service, the COC form will be completed and signed by the laboratory courier. The cooler will then be released to the courier for transportation to the laboratory.

If a commercial carrier is used, the COC form will include the airbill number in the “transfers accepted by” column, and will be sealed in a resealable bag. The COC form will then be taped to the inside of the sample cooler lid. The cooler will be taped shut with strapping tape, and two custody seals will be taped across the cooler lid: one seal in the front and one seal in the back. Clear tape will be applied to the custody seals to prevent accidental breakage during shipping. The samples will then be shipped to the analytical laboratory. A copy of the courier airbill will be retained for documentation.

4.13 Field Documentation

At a minimum, sampling information will be recorded on a COC form and in the Field Activity Daily Log. All entries will be legible and recorded in ink. Sampling locations documented in the Field Activity Daily Log will include:

- Sample point ID
- Depth of soil samples
- Sample matrix
- Analytical requests
- Depth to groundwater

4.13.1 Chain of Custody

The COC form will be completed according to the requirements of IT SOP 1.1 (2000), and as described in Section 5.0 of the QAPP (Appendix B).

4.13.2 Field Logbooks

A permanently-bound field logbook with consecutively numbered pages will be assigned to this project. All entries will be recorded in indelible ink. Corrections will be made following the procedure described in Section 4.13.5. At the end of each workday, the logbook pages will be signed by the responsible sampler and any unused portions of a logbook page will be crossed out, signed, and dated.

If it is necessary to transfer the logbook to another person, the person relinquishing the logbook will sign and date the last page used, and the person receiving the logbook will sign and date the next page to be used.

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

- Project name and location
- Date and time
- Personnel in attendance
- General weather information
- Work performed
- Field observations
- Sampling performed, including specifics such as location, type of sample, type of analyses, and sample identification
- Field analyses performed, including results, instrument checks, problems, and calibration records for field instruments
- Descriptions of deviations from this FSP
- Problems encountered and corrective action taken
- Identification of field QC samples
- QC activities
- Verbal or written instructions
- Any other events that may affect the samples

4.13.3 Borehole Logging

Detailed boring logs will be prepared for each boring and corehole. Sample and cutting descriptions, drilling parameters, and results from vapor monitoring will be recorded. Unconsolidated material, cores, and cuttings will be logged in accordance with ASTM Method D2488-93 *Description and Identification of Soils, Visual-Manual Procedure* (1993). This ASTM procedure is predicated upon Unified Soil Classification System. Munsell color schemes will also be added to the soil descriptions. A California-registered geologist will review all logs. Additionally, photographs of the cores will be taken.

4.13.4 Surveying

Each boring location will be surveyed following sampling to properly locate boring positions. All surveying will be completed under the supervision or direction of a State of California Registered Land Surveyor. Ground surface elevations for each point will be determined to the nearest 0.1 foot. The horizontal coordinates of each survey point will be determined to the nearest 1.0 foot and referenced to the California State Plane Coordinate System. Horizontal coordinates shall be based on the California State Plane Coordinate System, Zone III (NAD83.92), as published by the National Geodetic Survey. Elevations shall be based on the National Geodetic Vertical Datum of 1929 (NGVD29) as adjusted by the National Geodetic Survey in June 1991 and converted to NGVD29. If not already present, a minimum of one permanent control monument will be installed within a distance of 1,000 ft of each point to be surveyed.

4.13.5 Document Corrections

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

5.0 References

American Society for Testing and Materials (ASTM), 1993, *Description and Identification of Soils, Visual-Manual Procedure*, Method D2488-93, West Conshohoken, Pennsylvania.

American Society for Testing and Materials (ASTM), 2000, *Annual Book of ASTM Standards*, West Conshohoken, Pennsylvania.

IT Corporation, 2000, *IT Standard Quality Procedures and Standard Operating Procedures Manual*, August

U.S. Environmental Protection Agency, 1996, *Test Methods for Evaluating Solid Waste, Physical Chemical Methods, SW-846*, Update III, Washington, D.C., September.

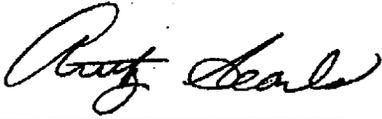
APPENDIX B
QUALITY ASSURANCE PROJECT PLAN

FINAL
QUALITY ASSURANCE PROJECT PLAN
CHEMICAL OXIDATION TREATABILITY STUDY
INSTALLATION RESTORATION SITE 25
ALAMEDA POINT
ALAMEDA, CALIFORNIA

Environmental Remedial Action
Contract Number N62474-98-D-2076
Contract Task Order 0076

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August 3, 2001

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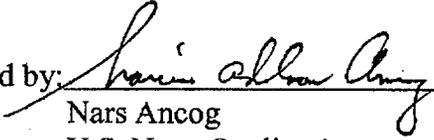
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Table of Contents

List of Figures.....	iii
List of Tables.....	iii
Acronyms and Abbreviations.....	iv
1.0 Introduction.....	1-1
1.1 Objective.....	1-3
1.2 Background.....	1-3
2.0 Project Organization.....	2-1
3.0 Quality Assurance Objectives.....	3-1
3.1 Data Quality Objectives.....	3-1
3.1.1 Stating the Problem.....	3-1
3.1.2 Identifying the Decisions.....	3-1
3.1.3 Identifying Inputs to the Decisions.....	3-2
3.1.4 Defining the Boundaries.....	3-3
3.1.5 Developing a Decision Rule.....	3-3
3.1.6 Specifying Limits on Decision Error.....	3-4
3.1.7 Optimizing the Design for Obtaining Data.....	3-4
3.2 Analytical Data Quality Objectives.....	3-4
3.2.1 Laboratory Quality Control Checks.....	3-5
3.2.2 Laboratory Control Samples.....	3-5
3.2.3 Laboratory Duplicates.....	3-5
3.2.4 Matrix Spikes.....	3-5
3.2.5 Surrogate Standards.....	3-6
3.2.6 Internal Standards.....	3-6
3.2.7 Method Blanks.....	3-6
3.2.8 Instrument Blanks.....	3-6
3.3 Data Quality Indicators.....	3-7
3.3.1 Post-Digestion Spikes and the Method of Standard Addition.....	3-7
3.3.2 Precision.....	3-7
3.3.3 Accuracy.....	3-8
3.3.4 Representativeness.....	3-9
3.3.5 Comparability.....	3-10
3.3.6 Completeness.....	3-10
3.4 Analytical Method Requirements.....	3-10
3.5 Project-Required Reporting Limits.....	3-11
4.0 Sample Collection.....	4-1
4.1 Sample Locations.....	4-1
4.2 Sample Containers, Preservatives, and Holding Times.....	4-1
4.3 Sample Packaging and Shipping.....	4-1
5.0 Sample Custody and Documentation.....	5-1
5.1 Chain-of-Custody.....	5-1
5.2 Analysis Request.....	5-2
5.3 Field Sample Custody.....	5-2

Table of Contents (continued)

5.4	Field Documentation	5-3
6.0	Analytical Quality Control Procedures	6-1
6.1	Laboratory Qualifications	6-1
6.2	Laboratory Quality Assurance and Quality Control Program.....	6-1
6.2.1	Calibration.....	6-2
6.2.2	Preventive Maintenance	6-3
6.2.3	Training.....	6-3
6.2.4	Supplies and Consumables	6-4
6.2.5	Software Quality Assurance.....	6-4
6.2.5.1	Software Validation.....	6-4
6.2.5.2	Software Security	6-5
6.2.5.3	Manual Integration.....	6-5
6.3	Laboratory Corrective Action.....	6-5
6.3.1	Batch Corrective Action	6-6
6.3.2	Method Blank.....	6-8
6.3.3	Laboratory Control Sample	6-8
6.3.4	Matrix Spike and Matrix Spike Duplicate.....	6-9
6.3.5	Individual Sample Corrective Action	6-9
7.0	Data Management.....	7-1
7.1	Data Reduction, Verification, and Reporting	7-1
7.1.1	Data Reduction	7-1
7.1.2	Laboratory Data Verification and Review.....	7-1
7.1.3	Data Reporting.....	7-3
7.1.4	Electronic Deliverables	7-4
7.2	Data Validation.....	7-4
7.3	Data Review.....	7-5
7.4	Data Quality Assessment Report.....	7-5
8.0	Quality Assurance Oversight.....	8-1
8.1	Laboratory Assessment and Oversight.....	8-1
8.1.1	Naval Facilities Engineering Service Center Laboratory Audits	8-1
8.1.2	Technical Systems Audits.....	8-1
8.1.3	Performance Evaluation Audits.....	8-2
8.1.4	Magnetic Tape Audits	8-3
8.1.5	Performance Evaluation Sample Programs	8-3
8.2	Field Audits	8-3
8.3	Quality Assurance Project Plan Revision or Amendment.....	8-4
9.0	References.....	9-1

List of Figures

Figure 1	Project Organization Chart
Figure 2	Chain-of-Custody Record
Figure 3	Custody Seal

List of Tables

Table 1	Project Personnel and Chemical Data Collection Responsibilities
Table 2	Reporting Limits U.S. Environmental Protection Agency Method 8260B (Volatile Organic Compounds)
Table 3	Reporting Limits Metal Analyses
Table 4	Reporting Limits U.S. Environmental Protection Agency Method 8270C (Semivolatile Organic Compounds)
Table 5	Reporting Limits EPA Method 8270C SIM (Polynuclear Aromatic Hydrocarbons)
Table 6	Reporting Limits U.S. Environmental Protection Agency Method 8015B (Nonhalogenated Organics Using Gas Chromatography/Flame Ionization Detector)
Table 7	Summary of Calibration Requirements, Quality Control Procedures, and Corrective Action for Chromatography Methods Conducted per the Test Methods for Evaluating Solid Waste (SW-846), Update III
Table 8	Summary of Calibration Requirements, Quality Control Procedures, and Corrective Action for U.S. Environmental Protection Agency Methods 8260B and 8270C Methods Conducted per the Test Methods for Evaluating Solid Waste (SW-846), Update III
Table 9	Summary of Calibration Requirements, Quality Control Procedures and Corrective Action for U.S. Environmental Protection Agency Method 6010B Conducted per the Test Methods for Evaluating Solid Waste (SW-846), Update III
Table 10	Summary of Quality Control Requirements and Corrective Action for Inorganic Analyses
Table 11	Reporting Units
Table 12	Gas Chromatography/Mass Spectrometry Data Deliverables Package Requirements
Table 13	Gas Chromatograph or High-Performance Liquid Chromatography Data Deliverables Package Requirements
Table 14	Metals Data Deliverables Package Requirements
Table 15	Inorganic Data Deliverables Package Requirements

Acronyms and Abbreviations

°C	degrees Celsius
ASTM	American Society for Testing and Materials
B(a)P _{equiv}	benzo(a)pyrene equivalents
bgs	below ground surface
COC	chain of custody
CTO	Contract Task Order
DQAR	Data Quality Assessment Report
DQO	data quality objective
EDD	electronic data deliverable
EDT	electronic data transfer
EFA-West	Engineering Field Activity–West
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
ft	foot (feet)
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
IR	Installation Restoration
IT	IT Corporation
ITEMS	IT Environmental Management System
KMnO ₄	potassium permanganate
LCD	laboratory control duplicate
LCS	laboratory control samples
MDL	method detection limit
MS	matrix spike(s)
MSA	Method of Standard Addition
MSD	matrix spike duplicate(s)
NIST	National Institute for Standards and Testing
PAH	polycyclic aromatic hydrocarbons
PARCC	precision, accuracy, representativeness, comparability, and completeness
PE	performance evaluation
PQL	practical quantitation limit
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RL	reporting limit
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SDG	Sample Delivery Group
SOD	soil oxidant demand
SOP	Standard Operating Procedure
SWDIV	U.S. Navy Southwest Division
VOC	volatile organic compound

1.0 Introduction

IT Corporation (IT) has prepared this Quality Assurance Project Plan (QAPP) to address requirements for sampling and analysis in support of the chemical oxidation treatability study (pilot test) that will be conducted at Estuary Park (Parcel 182) on Alameda Point, Alameda, California. The goal of this project is to evaluate remediation of polycyclic aromatic hydrocarbon (PAH) contamination at Installation Restoration (IR) Site 25 using chemical oxidation. The chemical oxidation method will use potassium permanganate (KMnO₄) in the soil at the site and evaluate site-specific characteristics and application techniques that may affect the remediation. Following the testing of three different methods of application of the chemical oxidant, the data will be evaluated from an engineering standpoint to verify effectiveness of the technology at this site. The results of the treatability study will be used to determine the effectiveness of chemical oxidation at this location, and to possibly add a remediation alternative to the feasibility study for IR Site 25.

This work will be conducted under Contract Task Order (CTO) 0076 of Naval Facilities Engineering Command Engineering Field Activity–West (EFA–West) Environmental Remedial Action Contract No. N62474-98-D-2076.

This QAPP is based on the requirements of the following documents:

- *Naval Facilities Engineering Command Navy Installation Restoration Chemical Data Quality Manual* (Naval Facilities Engineering Service Center, 1999)
- *Guidance for the Data Quality Objectives Process, EPA QA/G-4* (2000)
- *Guidance for Quality Assurance Project Plans, EPA QA/R-5* (1999a)
- *Quality Control Program Plan for Environmental Remedial Actions Contract No. N62474-98-D-2076* (IT, 2000)
- *Environmental Work Instruction 4EN.1 – Chemical Data Validation* (U.S. Navy Southwest Division [SWDIV], 1999a)
- *Environmental Work Instruction 4EN.2 – Review, Approval, Revision, and Amendment of Field Sampling Plans and Quality Assurance Project Plans* (SWDIV, 1999b)
- *Environmental Work Instruction 4EN.3 – Laboratory Quality Assurance Program* (SWDIV, 1999c)

This QAPP and the preceding document, Field Sampling Plan (FSP), constitute the Sampling and Analysis Plan (SAP). The FSP has the following objectives:

- Describe the sampling strategy and design
- Describe and establish consistent field sampling procedures
- Establish data gathering, sample handling, and documentation methods that will be employed during field activities

Quality control requirements associated with the sampling activities are presented in the FSP and will not be repeated here.

In accordance with the U.S. Environmental Protection Agency (EPA), the QAPP elements are categorized into four groups that have been addressed as follows:

- *Group A. Project Management*
 - Title and Approval Sheet
 - Table of Contents
 - Project/Task Organization – QAPP Section 2.0
 - Data Quality Objectives – QAPP Section 3.0
 - Documentation and Records – in the FSP and QAPP Section 5.0
- *Group B. Measurement/Data Acquisition*
 - Sampling Methods Requirements – in the FSP
 - Sample Handling and Custody Requirements – in the FSP and QAPP Section 5.0
 - Analytical Method Requirements – QAPP Section 3.4
 - Quality Control Requirements – QAPP Sections 3.2 and 6.2
 - Instrument/Equipment Testing, Inspection, and Maintenance Requirements – QAPP Section 6.2.2
 - Instrument Calibration and Frequency – QAPP Section 6.2.1
 - Acceptance Requirements for Supplies and Consumables – QAPP Section 6.2.4
- *Group C. Assessment/Oversight*
 - Assessments and Response Actions – QAPP Sections 6.3 and 8.0
 - Reports to Management – QAPP Section 8.0

- *Group D. Data Validation and Usability*
 - Data Review, Validation, and Verification Requirements – QAPP Section 7.1
 - Validation and Verification Methods – QAPP Section 7.2
 - Reconciliation with User Requirements – QAPP Section 7.4

1.1 Objective

This QAPP has been prepared to ensure that the data collected over the course of the project are of known quality to meet their intended use, and that all components of data acquisition are thoroughly documented, verifiable, and defensible. This document describes the project data quality objectives (DQOs) and based on these DQOs derives appropriate quality assurance (QA) objectives and quality control (QC) requirements to ensure that the acquired data are valid and usable. This QAPP outlines the criteria for data quality in terms of precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters.

1.2 Background

This information is provided in the FSP.

2.0 Project Organization

The project organization consists of representatives from the Navy, providing technical direction and QA oversight, and the IT Team. The project organization, which is shown in Figure 1, "Project Organization Chart," consists of the following members:

- Remedial Project Manager, Southwest Division
- U.S. Navy QA Officer
- Project Manager, IT
- Program QC Manager, IT
- Program Chemist, IT
- Program Health and Safety Manager, IT
- Site Health and Safety Officer, IT
- Technical Manager, IT
- Superintendent/Construction Manager, IT
- Project QC Manager, IT
- Project Engineer, IT
- Project Chemist, IT
- Field Technician, IT

The responsibilities of the team members associated with data acquisition activities are presented in Table 1, "Project Personnel and Chemical Data Collection Responsibilities."

3.0 Quality Assurance Objectives

Data quality objectives are qualitative and quantitative statements that clarify the project objectives, specify the most appropriate type of data for the project decisions, determine the most appropriate conditions from which to collect data, and specify tolerable limits on decision errors. Data quality objectives are based on the end uses of the data and are determined through a seven-step process as described in QA/G-4 (EPA, 2000).

In addition to the project objectives, the DQOs specify data collection boundaries and limitations, the most appropriate type of data to collect, and the level of decision error that will be acceptable for the decision.

3.1 Data Quality Objectives

The DQO process is a series of planning steps based on scientific methods that are designed to ensure that the type, quantity, and quality of environmental data used for decision-making are appropriate for the intended application. The DQO process, as defined by EPA, consists of seven steps that are designed to provide a systematic approach to resolving issues that pertain to the site investigation and remediation (EPA, 2000). This section of the QAPP describes the outcome of the seven-step DQO process for data collection activities under CTO 76.

3.1.1 Stating the Problem

Step 1: Summarize the problem that requires environmental data acquisition and identify the resources available to resolve the problem. IR Site 25 at Alameda Point is contaminated with PAHs derived from sediments and/or fill materials used to create the site. These PAHs, expressed as benzo(a)pyrene equivalents ($B(a)P_{equiv}$) pose a threat to human health. Based on preliminary laboratory studies, in-situ chemical oxidation with $KMnO_4$ has been proposed as a remedial alternative. The chemical oxidation treatability study will be conducted at Estuary Park (Parcel 182) to investigate site-specific characteristics and application techniques that may affect this approach. IT will perform the treatability test according to the budget and schedule approved by the U.S. Navy in 2001.

3.1.2 Identifying the Decisions

Step 2: Identify the decision that requires acquisition of environmental data. Identify the intended use of the data. The decision that requires environmental data acquisition is whether PAH concentrations can be reduced in-situ with $KMnO_4$ within the test cells. Samples of soil, pore water, groundwater, and atmospheric conditions will be collected and analyzed as described

in the FSP. The data acquired over the course of the project activities will be used to answer the following question:

- Should KMnO_4 chemical oxidation remediation technology be considered in the feasibility study?

If $\text{B(a)P}_{\text{equiv}}$ concentrations are not reduced during the pilot study, the technology will not be considered for IR Site 25 remediation.

3.1.3 Identifying Inputs to the Decisions

Step 3: Identify the information needed to support the decision and specify the inputs requiring environmental measurements. There is no numerical basis for evaluating the level of success of the treatment process for this project. Professional judgment will be used to evaluate the effectiveness of the treatability study. The primary basis for the decision action level is the reduction in average $\text{B(a)P}_{\text{equiv}}$ concentration in soil and the KMnO_4 consumption rate in each test cell. Based on the combination of these two parameters, a decision on the efficacy of the treatment will be made. The secondary decision action levels are the maximum concentration levels for dissolved chromium and arsenic in groundwater and risk-based concentration of residual manganese in soil. The following list describes the inputs required for the decision and whether the data will be generated in the laboratory or in the field:

- $\text{B(a)P}_{\text{equiv}}$ concentrations over time—laboratory
- KMnO_4 concentrations in pore water over time—laboratory
- Dissolved chromium and arsenic concentrations in groundwater over time (t_0 and t_f)—laboratory
- Mn concentrations in soil at t_0 and t_f —laboratory
- Soil moisture content—laboratory and field
- Soil oxidant demand (SOD)—laboratory and field
- Soil moisture suction curves, porosity, permeability—laboratory
- Pore water quality—field
- Atmospheric data—field

3.1.4 Defining the Boundaries

Step 4: Specify the spatial and temporal aspects of the environmental media that the data must represent to support the decision. Three test cells and three control cells will be constructed to conduct the treatability test. These cells will each be 50 feet (ft) by 50 ft. The concentration of B(a)P_{equiv} in the upper 4 ft of soil is the first target population of interest. Subpopulations of the data will be considered from 0 to 2 ft below ground surface (bgs) and 2 to 4 ft bgs. The second population of interest is the metals concentration in groundwater below the test cells. The treatability study will be conducted for six months. The practical constraints on the collection of this data include weather, schedule, and budget.

3.1.5 Developing a Decision Rule

Step 5: Develop a logical "If...then" statement that defines the conditions that would cause the decision-maker to choose among alternative actions. Decision rules will be evaluated by using averages of the populations of interest in each test cell and depth interval. Treatment effectiveness will be evaluated in terms of B(a)P-equivalent mass reduction, percent reduction, and residual concentrations. Additionally, treatment effectiveness will take into account the residual manganese concentrations at the site from the potassium permanganate. If the evaluation criteria are considered favorable and the minimum percent reduction in B(a)P-equivalent concentration is 50 percent, then the in-situ chemical oxidation technology will be evaluated in the IR Site 25 feasibility study. However, if the treatment is not considered effective based on the evaluation criteria, then the treatment technology will not be evaluated in the IR Site 25 feasibility study.

If a positive outcome is obtained in the previous decision criteria, then the following two decision criteria will be evaluated:

- If the residual manganese in soil or groundwater does not exceed risk-based criteria, the technology will be considered in the IR Site 25 feasibility study. If the residual manganese in soil or groundwater exceeds risk-based criteria, the technology will not be considered in the IR Site 25 feasibility study.
- If mobilized metals (arsenic or chromium) concentrations in groundwater do not significantly increase at the completion of the treatability study, the technology may be considered in the IR Site 25 feasibility study. If mobilized metals (arsenic or chromium) concentrations in the groundwater significantly increase, at the completion of the treatability study, further monitoring may be required, and implementation of the technology may not be feasible.

3.1.6 Specifying Limits on Decision Error

Step 6: Specify the decision-maker's acceptable limits on decision errors, which are used to establish appropriate performance goals for limiting uncertainty in environmental data.

To limit uncertainty in obtained environmental data, criteria for the PARCC parameters and reporting limits for the contaminants of concern have been developed. The data that meet these criteria will be of definitive quality and of less uncertainty than the estimated data that do not meet the criteria. Limits on decision errors cannot be quantified because of judgmental sampling.

Judgmental sampling was selected due to the limited size of the test cells and heterogeneous distribution of contamination in Estuary Park. Systematic spatially distributed sampling will allow several rounds of paired sample comparison in addition to averaging of sample results. A vigorous analysis of geostatistical sampling approaches will be made during full-scale implementation sample design if the treatability study is successful.

3.1.7 Optimizing the Design for Obtaining Data

Step 7: Identify the most resource-effective sampling and analysis design for generating data that are expected to satisfy project DQOs. The treatability study cells will be located in an area with high PAH contamination in order to monitor successful remediation. Soil, groundwater, and pore water samples will be collected to provide additional characterization for future project decisions. The optimized sampling design is presented in the FSP.

3.2 Analytical Data Quality Objectives

A laboratory with appropriate capabilities and accreditation will produce analytical data required for the project using EPA methods of analysis. Analytical DQOs will be assessed through application of the PARCC parameters. Laboratory QC checks that allow deriving the PARCC parameters and the applicable QC criteria are defined in this section. Because precise and accurate information may be expressed in several ways, only the definitions for these indicators that are provided in this section will be used for data quality assessment. This section also provides information on the analytical methods to be used and the project-required reporting limits for the target analytes.

3.2.1 Laboratory Quality Control Checks

The recovery of known additions is a part of laboratory analytical protocols. The use of additives at known concentrations allows detecting the matrix interferences and estimating the impact of these interferences when present. It also allows evaluating the efficiency of extraction procedures and overall accuracy of analysis. Laboratory internal QC checks will include:

- Laboratory control samples (LCS)
- Laboratory control duplicates (LCD)
- Matrix spikes (MS)
- Matrix spikes duplicates (MSD)
- Laboratory duplicates
- Surrogate standards
- Internal standards
- Method and instrument blanks
- Post-digestion spikes

3.2.2 Laboratory Control Samples

Laboratory control samples are matrix-equivalent QC check samples (analyte-free water, laboratory sand, or sodium sulfate) spiked with a known quantity of specific analytes that are carried through the entire sample preparation and analysis process. The spiking solution used for LCS/LCD preparation is of a source different from the stock that was used to prepare calibration standards.

3.2.3 Laboratory Duplicates

For laboratory sample duplicate analyses, a sample is prepared and analyzed twice. Laboratory sample duplicates are prepared and analyzed with each batch of samples for most inorganic analyses.

3.2.4 Matrix Spikes

Matrix spikes are QC check samples that measure matrix-specific method performance. An MS sample is prepared by adding a known quantity of target analytes to a sample before sample digestion or extraction. In general, for organic compound and metal analyses, an MS/MSD pair is prepared and analyzed with each preparation batch or for every 20 field samples. The frequency of MS/MSD analysis depends on the project DQOs. For inorganic compound analysis, a single MS and a laboratory sample duplicate are often prepared and analyzed with each batch. The LCS results, together with matrix spike results, allow verifying the presence of MS.

3.2.5 Surrogate Standards

Organic compound analyses include the addition, quantitation, and recovery calculation of surrogate standards. Compounds selected to serve as surrogate standards must meet all of the following requirements:

- Are not the target analytes
- Do not interfere with the determination of target analytes
- Are not naturally occurring, yet are chemically similar to the target analytes
- Are compounds exhibiting similar response to target analytes

Surrogate standards are added to every analytical and QC check sample at the beginning of the sample preparation. The surrogate standard recovery is used to monitor matrix effects and losses during sample preparation. Surrogate standard control criteria are applied to all analytical and QC check samples, and if surrogate criteria are not met, re-extraction and re-analysis may be performed.

3.2.6 Internal Standards

Some organic compound analyses include the addition, quantitation, and recovery calculation of internal standards. Internal standards are usually synthetic compounds, which are similar in chemical behavior to the target analytes. They are added to sample extracts at the time of instrument analysis and are used to quantitate results through internal standards calibration procedure. Internal standard recoveries are used to correct for injection and detector variability. Gas chromatography/mass spectrometry (GC/MS) must use internal standards and have acceptability limits for internal standard areas. Use of internal standard quantitation for gas chromatography (GC) methods is optional.

3.2.7 Method Blanks

A method blank is used to monitor the laboratory preparation and analysis systems for interferences and contamination from glassware, reagents, sample manipulations, and the general laboratory environment. A method blank is carried through the entire sample preparation process and is included with each batch of samples. Some methods of inorganic analysis do not have a distinctive preparation step. For these tests the instrument blank, which contains all reagents used with samples, is considered to be the method blank.

3.2.8 Instrument Blanks

An instrument blank is used to monitor the cleanliness of the instrument portion of a sample analysis process. Instrument blanks are usually just the solvent or acid solution of the standard used to calibrate the instrument. During metals analyses one instrument blank is usually

analyzed for every ten samples. For GC and GC/MS analysis, instrument blanks are analyzed on an as-needed basis for troubleshooting and chromatography column carryover determination purposes.

3.3 Data Quality Indicators

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

3.3.1 Post-Digestion Spikes and the Method of Standard Addition

A post-digestion spike is used during metal analysis to assess analytical interferences that may be caused by general matrix effects or high concentrations of analytes present in the sample. A digested sample is spiked with the analyte of interest at a known concentration, and the spike recovery is used to estimate the presence and magnitude of interferences.

If a post-digestion spike recovery fails to meet acceptance criteria, the Method of Standard Addition (MSA) will be used to quantitate the sample result. The MSA technique compensates for a sample constituent that enhances or depresses the analyte signal. To perform the MSA, known amounts of a standard at different concentrations are added to two to three aliquots of digested sample, and each spiked sample and the original unspiked sample are analyzed. The absorbance is then plotted against the concentration, and the resulting line is extrapolated to zero absorbance. The point of interception with the concentration axis is the indigenous concentration of the analyte in the sample.

3.3.2 Precision

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

$$\text{Precision as RPD} = \frac{2 \times (\text{Result} - \text{Duplicate Result})}{\text{Result} + \text{Duplicate Result}} \times 100\%$$

The laboratory uses MS/MSD pairs to assess the precision of analytical procedures, with one MS/MSD pair analyzed for every batch of up to 20 samples. According to the Navy requirements, analytical laboratories perform MS/MSD on the Navy project samples. This helps determine whether matrix interferences may be present.

The laboratory uses LCS/LCD pairs when MSs are not practical due to the nature of sample or analytical method used, and they are prepared and analyzed with each batch of samples instead of MS/MSD. Laboratory control samples/LCD may also be prepared in place of MS/MSD in the

case that a sufficient sample volume was not obtained in the field to perform the MS/MSD analysis. For inorganic analyses, analytical precision is usually calculated based on the sample and sample duplicate results.

The analytical laboratory will have statistically based acceptability limits for RPDs established for each method of analysis and sample matrix. The laboratory will review the QC samples to ensure that internal QC data lies within the limits of acceptability. Any suspect trends will be investigated and corrective actions taken. The analytical precision acceptability limits for this project will be as follows:

- **Soil:** 20 percent for metals and 30 percent for all other analyses
- **Water:** 20 percent for all analyses

Field precision of sampling procedures is evaluated by collecting and analyzing “blind” field duplicate samples (field QC samples) at a rate of one for every ten samples. Sampling precision will be evaluated based on the RPD for field duplicate samples. The field precision acceptability limits will be as follows:

- **Soil:** 50 percent for all analyses
- **Water:** 30 percent for all analyses

Field precision will be monitored for evaluating the sampling techniques and sample handling procedures. Analytical data will not be qualified during the data validation process, based on the field precision values.

3.3.3 Accuracy

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

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

Percent recoveries for MS, MSD, and LCS that are analyzed for every batch of up to 20 samples serve as a measurement of analytical accuracy. Surrogate standards are added to all samples,

blanks, MS, MSD, and LCS analyzed for organic contaminants to evaluate accuracy of the method and help to determine matrix interferences.

As a general rule, the recovery of most compounds spiked into samples is expected to fall within a range of 70 to 130 percent. This range represents the EPA advisory acceptability limits for MS, MSD, and LCS for all organic analysis methods. The surrogate standard advisory acceptability limits are also 70 to 130 percent for all organic analyses with the exception of GC/MS methods, where the advisory limits are specified in the methods for each matrix. Laboratories may use the advisory limits until the in-house statistically based control limits are developed for each method of organic analysis and sample matrix. U.S. Environmental Protection Agency SW-846 (1996) mandates the recovery acceptance limits for metal analysis at 75 to 125 percent.

Control limits are defined as the mean recovery, plus or minus three standard deviations, of the 20 data points, with the warning limits set as the mean plus or minus two standard deviations. The laboratory will review the QC samples and surrogate standard recoveries for each analysis to ensure that internal QC data lie within the limits of acceptability. The laboratory will investigate any suspect trends and take appropriate corrective actions.

3.3.4 Representativeness

Unlike precision and accuracy, which can be expressed in quantitative terms, representativeness is a qualitative parameter. Representativeness is the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. It is a qualitative parameter that depends on proper design of the sampling program.

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

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

3.3.5 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 interlaboratory studies. The use of standardized field and analytical procedures ensures comparability of analytical data.

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

3.3.6 Completeness

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

Completeness is evaluated using the following equation:

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

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

3.4 Analytical Method Requirements

The following analytical methods will be used to obtain the data for this project:

- *Test Methods for Evaluating Solid Waste, SW-846* (EPA, 1996)
 - PAH by EPA Method 8270C SIM
 - SVOC by EPA Method 8270C
 - Metals by EPA Method 6010B/7000 series
 - Flash point by EPA Method 1010
 - Volatile organic compounds (VOCs) by EPA Method 5035/5030/8260B
 - Total petroleum hydrocarbons by EPA Method 8015B

- Reactivity by EPA SW-846, Chapter 7
- Corrosivity by EPA Method 9045C
- Ignitability by EPA Method 1010 or 1020
- Polychlorinated biphenyls by EPA Method 8082
- *American Society for Testing and Materials (2000)*
 - ASTM D4696 *Standard Guide for Pore-Liquid Sampling from the Vadose Zone*
 - ASTM D5220 *Standard Test Method for Water Content of Soil and Rock In-Place by the Neutron Depth Probe Method*
 - ASTM D5084 *Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*
 - ASTM D2325 *Standard Test Method for Capillary-Moisture Relationships for Coarse- and Medium- Textured Soils by Porous-Plate Apparatus*
- IT Corporation Methods
 - SOD

Laboratories will conduct these analyses according to the requirements of the method and the laboratory SOPs.

3.5 Project-Required Reporting Limits

The laboratory will determine the method detection limits (MDLs) for each method, instrument, analyte, and matrix by using the procedure described in 40 Code of Federal Regulations Part 136 Appendix B. The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero.

An MDL study involves preparation/digestion and analysis of seven replicates of a given MS with target analytes at concentrations 2 to 5 times greater than the estimated MDL. The MDLs for metals in soil will be derived from the MDLs for metals in water. At a minimum, the laboratory will conduct annual MDL studies. The laboratory will select the reporting limits (RLs) for all analytes at concentration levels that exceed the calculated MDLs by a factor of 2 to 10.

Reporting limits for the project are presented in Tables 2 through 6. These limits may be elevated for individual samples if matrix interferences are encountered.

4.0 Sample Collection

Sample collection procedures are described in the FSP and are not repeated here.

4.1 Sample Locations

Sample locations and the number of samples to be collected are described in the FSP and are not repeated here.

4.2 Sample Containers, Preservatives, and Holding Times

Sample containers, preservatives, and holding times are described in the FSP and are not repeated here.

4.3 Sample Packaging and Shipping

Sample packaging and shipping requirements are presented in the FSP and are not repeated here.

5.0 Sample Custody and Documentation

This section describes sample custody and field documentation procedures that IT will follow at the project site.

5.1 Chain-of-Custody

An overriding consideration for data resulting from laboratory analyses is the ability to demonstrate that the data are legally defensible, such as that the samples were obtained from the locations stated and that they reached the laboratory without alteration. To accomplish this, evidence of collection, shipment, laboratory receipt, and laboratory custody until disposal will be documented through the Chain-of-Custody (COC) record. A sample is considered to be in custody if it is:

- In actual possession or in view of the person who collected the samples
- Locked in a secure area
- Placed in an area restricted to authorized personnel
- Placed in a container and secured with an official seal, such that the sample cannot be reached without breaking the seal

Figure 2, "Chain-of-Custody Form," presents a copy of the COC record that will be used for the EFA-West Remedial Action Contract projects. The COC record lists each sample and the individuals performing the sample collection, shipment, and receipt. The sample COC procedures will be implemented according to IT SOP 1.1 (2000). Figure 3, "Custody Seal," presents an example of a custody seal that will seal a cooler with samples during transportation to the laboratory.

On project sites, samples will be stored in locked refrigerators at 2 to 6 degrees Celsius (°C). Sample custody will be the responsibility of the Project Chemist or an on-site designee from the time of sample collection until the samples are accepted by the courier service for delivery to the laboratory. Thereafter, the laboratory performing the analysis will maintain custody.

5.2 Analysis Request

In addition to providing a custody exchange record for the samples, the COC record serves as a formal request for sample analyses. The COC records will be completed, signed, and distributed as follows:

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

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

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

5.3 Field Sample Custody

The COC record will be the controlling document to ensure that sample custody is maintained. The COC record will be initiated in the field by sampling personnel upon collecting a sample. Each individual who has the sample(s) in his/her possession will sign the COC. Each time the sample custody is transferred, the former custodian will sign the COC in the "Relinquished by" line, and the new custodian will sign the COC in the "Received by" line. The date, time, and the name of the project or company affiliation will accompany each signature.

The waybill number or courier name will be recorded on the COC when a commercial carrier is used. The shipping container will be secured with two custody seals, thereby allowing custody to be maintained by the shipping personnel until receipt by the laboratory. Custody seals will not be placed on individual sample containers because the project is not evidential in its nature.

If the laboratory sample custodian judges sample custody to be invalid (e.g., custody seals on the cooler have been broken), the laboratory will initiate a Nonconformance Report. The Project Chemist will be immediately notified. The Project Chemist will, in turn, notify the Project Manager and the Project QC Manager. The Project Manager will make a decision, in consultation with the client, as to the fate of the sample(s) in question on a case-by-case basis. The sample(s) will either be processed "as-is" with custody failure noted along with the analytical data, or rejected with resampling scheduled, if necessary. The nonconformance associated with the samples will be noted on the appropriate certificate or analysis or case history.

5.4 Field Documentation

Field documentation procedures are described in the FSP.

6.0 Analytical Quality Control Procedures

This section describes analytical QC procedures, including laboratory qualifications and QA program, and QC procedures associated with analytical methods.

6.1 Laboratory Qualifications

The analytical laboratories selected to analyze samples for this project will be certified by the California Department of Health Services through the Environmental Laboratory Accreditation Program for all the analytical methods required for the project. In addition, the laboratory will successfully complete Naval Facilities Engineering Command Laboratory Evaluation Program before sampling activities and maintain that status throughout the project.

Laboratories selected for the project must be capable of providing the required turnaround times, project QC, and data deliverables required by this QAPP and the FSP.

6.2 Laboratory Quality Assurance and Quality Control Program

Quality assurance is a set of operating principles that, if strictly followed during sample collection and analysis, will produce defensible data of known quality. Included in quality assurance are quality control and quality assessments. Quality control is a set of measures within a sample analysis methodology to ensure that the process is in control. Quality assessment consists of procedures for determining the quality of laboratory measurements by use of data from internal and external quality control measures.

A properly designed and executed QC program will result in a measurement system operating in a state of statistical control, which means that errors have been reduced to acceptable levels. An effective QA program includes the following elements:

- Certification of operator competence
- Internal QC checks, such as recovery of known additions through use of surrogate standards, matrix spikes, and laboratory control samples
- Analysis of externally supplied standards
- Analysis of reagent blanks
- Calibration with standards using internal or external standard procedures
- Calibration verification with second source standard
- Analysis of duplicates

- Maintenance of control charts

Strict adherence to Good Laboratory Practices and consistent use of SOPs are also essential for a successful QC program. The laboratory will have the current revisions of the SOPs readily available for all staff. At a minimum, SOPs will be written for the following procedures and methods: sample receipt, control, and disposal; sample preparation and extraction; sample analysis; result calculation; database management; health and safety; and corrective action.

The analytical laboratory will have written SOPs defining the instrument operation and maintenance, tuning, calibration, method detection limit determination, QC acceptance criteria, blank requirements, and stepwise procedures for each analytical method. The SOPs will be available to the analysts in the laboratory. Any method that is subcontracted by the laboratory to another laboratory or sent to another facility of the same network of laboratories will have prior approval of the IT Project Chemist.

6.2.1 Calibration

All instruments will be calibrated and the calibration acceptance criteria met before samples are analyzed. Calibration standards will be prepared with National Institute for Standards and Testing (NIST)-traceable standards and analyzed according to methods requirements. Initial calibration acceptance criteria documented in the laboratory SOPs will meet those of applicable guidance documents. The initial calibration will meet one of the following requirements:

- The lowest concentration of the calibration standard is less than or equal to the practical quantitation limit (PQL) based on the final volume of extract or sample.
- For each target analyte, at least one of the calibration standards will be at or below the regulatory limit (action level) as defined by the DQOs.

Before samples are analyzed, initial calibration will be verified with a second source standard prepared at the mid-point of the calibration curve. Initial calibration verification will meet the acceptance criteria which are expressed in the laboratory SOPs.

Daily calibration verification will be conducted at the method-prescribed frequencies and will meet the acceptance criteria of applicable guidance documents. Daily calibration verification will not be used for quantitation of target analytes.

Calibration data (calibration tables, chromatograms, instrument printouts, and laboratory logbooks) will be clearly labeled to identify the source and preparation of the calibration standard and therefore be traceable to the standard preparation records.

Calibration requirements and acceptance criteria for organic and inorganic analysis are summarized in Tables 7 through 10.

6.2.2 Preventive Maintenance

The primary objective of a preventive maintenance program is to help ensure the timely and effective completion of a measurement effort by minimizing the down time of crucial analytical equipment due to expected or unexpected component failure. In implementing this program, efforts are focused in three primary areas: maintenance responsibilities, maintenance schedules, and adequate inventory of critical spare parts and equipment.

Maintenance responsibilities for laboratory equipment are assigned to the respective laboratory managers. The laboratory managers then establish maintenance procedures and schedules for each major equipment item. These are contained in the maintenance logbooks assigned to each instrument.

The effectiveness of any maintenance program depends to a large extent on adherence to specific routine maintenance for each major equipment item. Other maintenance activities may also be identified as requiring attention on an as-needed basis. Manufacturers' recommendations and/or sample throughput provide the basis for the established maintenance schedules, and manufacturers' service contracts provide primary maintenance for many major instruments (e.g., GC/MS instruments, atomic absorption spectrometers, analytical balances, etc.). Maintenance activities for each instrument are documented in a maintenance log.

Along with a schedule for maintenance activities, an adequate inventory of spare parts is required to minimize equipment down time. This inventory emphasizes those parts (and supplies) that are subject to frequent failure, have limited useful lifetimes, or cannot be obtained in a timely manner should failure occur.

The respective laboratory managers are responsible for maintaining an adequate inventory of necessary spare parts. Sufficient equipment is to be on hand to continue analyses in the event that an instrument encounters problems. In addition to backup instrumentation, a supply of spare parts such as gas chromatography columns, fittings, septa; atomic absorption lamps, mirrors, diaphragms; graphite furnace tubes; and other ancillary equipment is to be maintained.

6.2.3 Training

The laboratory will have an established policy and procedure on training and documenting of the analyst's competency. Staff members who perform sample preparation and analysis will demonstrate their proficiency through preparation and analysis of four LCS as described in

SW-846 (EPA, 1996). An analyst will be considered proficient if the acceptance criteria for method accuracy and precision are met. The laboratory will maintain all training records on file.

6.2.4 Supplies and Consumables

The laboratory will inspect supplies and consumables before their use in analysis. The materials specifications in the analytical methods will be used as a guideline for establishing the acceptance criteria for these materials. Purity of reagents will be monitored by analysis of method blanks. An inventory and storage system for materials and supplies will ensure use before manufacturers' expiration dates and storage under safe and chemically compatible conditions.

6.2.5 Software Quality Assurance

The generation, compilation, and reporting of electronic data are critical components of laboratory operations. To produce defensible data of known quality, the laboratory will develop a software QA plan or an SOP that describes activities related to data generation, reduction, and transfer with modern tools of data acquisition, as well as the policies and procedures for procurement, modification, and use of computer software.

6.2.5.1 Software Validation

The laboratory will have procedures in place to ensure that all software for data reduction, reporting, and transfer adequately and correctly performs all intended functions and does not perform any unintended functions.

The laboratory will verify, validate, and document the proper functioning of the software immediately after any new data acquisition and/or management systems have been installed at the laboratory. The baseline verification and validation may include the following actions:

- Comparison of the computer printouts with reduced data and the raw data
- Manual calculations to confirm correctness of all computer calculations
- Comparison of analytical report to the electronic deliverable files

Baseline software validation will be documented in laboratory QA files. Continuing software verification will take place during sample analysis. To eliminate data entry errors during analytical sequence set-up, as part of data package review, the correctness of results will be checked by one manual calculation per QC batch during data review. This verification will be documented in the QA/QC checklist for each data file.

6.2.5.2 Software Security

Only authorized and trained laboratory personnel will have access to the operating and data management software. Each analyst will be trained in software use for operating different functional areas of the software systems and have a password that allows access to these areas.

6.2.5.3 Manual Integration

Manual integration is sometimes necessary for proper compound quantitation in cases of overlapping or tailing peaks and sloping baselines. When justified, manual integration can be conducted for standards, samples, and QC check samples.

Manual integration may include valley-to-valley baselines, vertical peak separation or slope integration. The type of manual integration is a judgment call of an analyst experienced in GC.

If a need for manual integration arises, the analysts performing analysis will select a proper approach based on their professional judgement. Manual integration will be then conducted and documented in the data file. Once an approach has been selected, it will be consistently used for the similarly affected peaks.

Manual integration documentation will include a copy of a computer-integrated chromatogram, a copy of a manually integrated chromatogram, a brief justification description, and the name of the person who performed the manual integration. The Laboratory Manager will review and approve all manual integrations performed by analysts.

6.3 Laboratory Corrective Action

Corrective action takes place when a circumstance arises that has a negative impact on the quality of the analytical data generated during sample analysis. For corrective action to be initiated, awareness of a problem must exist. In most instances, the individuals performing laboratory analyses are in the best position to recognize problems that will affect data quality. Keen awareness on their part can frequently detect minor instrument changes, drifts, or malfunctions which can then be corrected, thus preventing a major breakdown in the quality control system in place. If major problems arise, they are in the best position to recommend the proper corrective action and initiate it immediately, thus minimizing data loss. Therefore, the laboratory personnel will have a prime responsibility for recognizing a nonconformance and the need for implementing and documenting the corrective action.

If a situation arises requiring corrective action, the following closed-loop corrective action process will be used:

1. Define the problem
2. Assign responsibility for investigating the problem
3. Investigate and determine the cause of the problem
4. Determine corrective action course to eliminate the problem
5. Assign responsibility for implementing the corrective action
6. Determine the effectiveness of the corrective action and implement the correction
7. Verify that the corrective action has eliminated the problem
8. If not completely successful, return to step 1

The personnel identifying or originating a nonconformance will document it to include the following items:

- Identify the individual(s) discovering or originating the nonconformance
- Describe the nonconformance
- Obtain required approval signatures
- Identify method(s) for corrective action or describe the variance granted
- Prepare a schedule for completing corrective action

All affected project samples will be listed on the Nonconformance/Corrective Action Report. The laboratory Project Manager will notify the IT Project Chemist of any laboratory nonconformance affecting the samples. Nonconformance/Corrective Action Reports will be submitted to IT as part of data packages. Corrective action procedures for different types of analysis are presented in Tables 7 through 10.

6.3.1 Batch Corrective Action

Analytical laboratory processes are batch processes, and the batch is a basic unit for the frequency of some quality control elements. A batch is a group of samples of similar matrix that behave similarly relative to the procedures being employed. The following three types of batches can be identified at the analytical laboratory:

- Preparation batch
- Instrument batch
- Sample delivery group (SDG)

A preparation batch is a group of up to 20 field samples that are prepared (e.g., extracted or digested) simultaneously or sequentially without interruption. Samples in each batch are of similar matrix (e.g., soil, sludge, liquid waste, water), are treated in a similar manner, and are

processed with the same lots of reagents. For organic compound analyses each batch will contain a method blank, an LCS, and an MS/MSD pair. For inorganic compound analyses, each batch will contain a method blank, an LCS, an MS, and a sample duplicate. These QC check samples are not counted in the maximum batch size of 20.

An instrument batch is a group of samples that are analyzed within the same analytical run sequence. If the continuous operation of an instrument is interrupted (shut down for maintenance, etc.), a new instrument batch must be started. The instrument batch includes an instrument blank, calibration check standards, extracts/digestates of the field samples, and QC check samples. The number of samples in the analytical batch is not limited, but the frequency of the calibration check standard and instrument blank analysis is mandated in each particular method.

For VOC analyses by GC or GC/MS, the preparation and instrument batch are the same, since the sample preparation (purge and trap) is performed as part of the instrument analysis. For these analyses, a batch is defined as a group of up to 20 field samples that are sequentially loaded on the instrument and analyzed as a single analytical run sequence. Laboratory QC check samples (method blank, an LCS, an MS/MSD pair) will be analyzed as part of the batch in addition to 20 field samples, as well as the calibration standard per method requirements.

For Contract Laboratory Program analyses, an SDG is defined as a group of 20 or fewer samples within a project that are received over a period of 14 days or less. An SDG is primarily a reporting format and is not limited to sample receipt groups, preparation batches, or analytical batches.

Method quality control acceptance criteria determine whether a method is performing within acceptable limits of precision and accuracy. There is a method component and a "matrix" component to this determination. The method component measures the performance of the laboratory analytical processes during the sample analyses. The matrix component measures the method performance on a specific matrix. Some quality control elements uniquely measure the laboratory component of method performance but all QC elements measuring the matrix component contain the method component.

Method blanks and laboratory control samples uniquely measure the method performance. Matrix spikes, matrix spike duplicates, laboratory sample duplicates, surrogate standards, and post-digestion spikes measure the matrix component of method performance.

6.3.2 Method Blank

The method blank measures laboratory-introduced contamination for the sample batch, and batch corrective action is initiated when contamination is found. It may include reanalysis of the blank, reanalysis of the samples, reparation and reanalysis of the blank, QC, and samples, and assessment of the impact of the contamination on batch sample data. Although it is a goal to have no detected target analytes in the method blanks, analytes may be periodically detected in blanks due to the nature of the analysis or the reporting limit for the analyte. For example, methylene chloride, acetone, and 2-butanone may sometimes be found in blanks for VOC analysis, and the phthalate esters may sometimes be found in the blanks for semivolatile organic compound analyses.

A method blank will be considered acceptable if the following conditions are met:

- Target analytes are present at concentrations less than one-half of the PQLs.
- Target analytes are present at concentrations less than 5 percent of the regulatory limits for these analytes.
- Target analytes are present at concentrations less than 5 percent of the sample results for these analytes.

If the method blank results do not meet these acceptance criteria, the laboratory will initiate corrective action.

The first step of corrective action is to assess the effect on the samples. For example, if an analyte is found only in the blank but not in any of the associated samples or if the target analyte in the blank is less than 1/20 the value in the sample, no corrective action is necessary.

If corrective action is required, the method blank and any samples containing the same contaminant will be reanalyzed. If the contamination remains, the contaminated samples of the batch would be re-extracted and re-analyzed with a new method blank and QC check samples.

6.3.3 Laboratory Control Sample

An LCS must meet the accuracy acceptance criteria for target analytes for the batch to be considered acceptable. If the target analytes are outside of the acceptance limits, corrective action will be initiated. Corrective action will include re-extraction and reanalysis of the whole batch, including method blank, samples, and QC check samples.

If matrix spikes are not conducted, an LCS/LCD pair will be analyzed with each batch of samples. If the LCS/LCD are outside method acceptance criteria for accuracy and precision, the

whole batch will be re-extracted and reanalyzed, including method blank, samples, and QC check samples.

6.3.4 Matrix Spike and Matrix Spike Duplicate

An MS/MSD pair is included with each batch of samples for organic compound analyses and MS and laboratory sample duplicate are included with each batch of samples for inorganic compound analysis. These QC check samples allow evaluating the accuracy and precision of analysis and the influence of matrix effects.

Matrix spike data evaluation is more complex than blank or LCS data evaluation since matrix spikes measure matrix effects in addition to sample preparation and analysis effects. Sample heterogeneity, lithological composition of soil, and presence of interfering chemical compounds often negatively affect accuracy and precision of analysis. If the native concentration of target analytes in the sample chosen for spiking is high relative to the spiking concentration, the differences in the native concentration between the unspiked sample and the spiked samples may contribute a significant error in the precision and accuracy. The accuracy and precision in this case are not representative of the true method and matrix performance.

If the accuracy of MS/MSD analysis is outside the acceptability limits for any target analyte, the LCS will be evaluated. If the LCS accuracy limits are met, the MS/MSD recovery problem will be identified as matrix effect and no further action will be required. If the LCS accuracy limits are not met, corrective action will be implemented and the affected samples and associated QC samples will be reprepared and reanalyzed.

If the MS/MSD or sample/sample duplicate pair fail in precision due to observed matrix interferences, sample inhomogeneity or the nature of the contaminant, corrective action will not be required, and the laboratory will make an appropriate notation in the case narrative.

6.3.5 Individual Sample Corrective Action

In addition to batch corrective action, individual samples within a batch may also require corrective action. Re-extraction and reanalysis of individual samples will take place in the following situations:

- Surrogate standard recoveries are outside acceptability limits.
- Internal standard areas for GC/MS analyses are outside acceptability limits.
- Errors have been made during sample preparation, and results of analysis are not conclusive.

7.0 Data Management

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

7.1 Data Reduction, Verification, and Reporting

All analytical data generated by the laboratory in support of the EFA-West Remedial Action Contract projects will be reviewed before reporting to ensure the validity of reported data. This internal laboratory data review process will consist of data reduction, three levels of documented review, and reporting. Review processes will be documented using appropriate checklist forms or logbooks that will be signed and dated by the reviewer.

7.1.1 Data Reduction

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

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

7.1.2 Laboratory Data Verification and Review

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

Level 1. Technical (Peer) Data Review. Analysts will review the quality of their work based on an established set of guidelines, including the QC criteria established in each method, in this QC Plan and as stated within the laboratory QA Manual. This review will, at a minimum, ensure that the following conditions have been met:

- Sample preparation information is correct and complete.
- Analysis information is correct and complete.
- Appropriate SOPs have been followed.
- Calculations are verified.
- There are no data transposition errors.
- Analytical results are correct and complete.
- QC samples are within established control limits.
- Blanks and laboratory control samples are within appropriate QC limits.
- Special sample preparation and analytical requirements have been met.
- Documentation is complete; for example, any anomalies and holding times have been documented and forms have been completed.

Level 2. Technical Data Review. This review will be performed by a supervisor or data review specialist whose function is to provide an independent review of data packages. This review will also be conducted according to an established set of guidelines and will be structured to verify the following finding of Level 1 data review:

- All appropriate laboratory SOPs have been followed.
- Calibration data are scientifically sound, appropriate to the method, and completely documented.
- QC samples are within established guidelines.
- Qualitative identification of contaminants is correct.
- Manual integrations are justified and properly documented.
- Quantitative results and calculations are correct.
- Data are qualified correctly.
- Documentation is complete; for example, any anomalies and holding times have been documented and appropriate forms have been completed.

- Data are ready for incorporation into the final report.
- The data package is complete and is in compliance with contract requirements.

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

If any problems are found with the data package, an additional 10 percent of the sample results will be checked back to the sample preparatory and analytical bench sheets. This cycle will then be repeated until either no errors are found in the data set checked or until all data have been checked. All errors and corrections noted will be documented.

Level 3. Administrative Quality Assurance Data Review. The Laboratory QA Manager will review 10 percent of all data packages. This review should be similar to the review as provided in Level 2 except that it will provide a total overview of the data package to ensure its consistency and compliance with project requirements. All errors noted will be corrected and documented.

7.1.3 Data Reporting

This section details the requirements for data reporting and data package formats that will be provided by the laboratory. All definitive soil results will be reported on a dry weight basis. Reporting units are presented in Table 11.

Hard copy deliverables: All relevant raw data and documentation, including (but not limited to) logbooks, data sheets, electronic files, final reports, etc., will be maintained by the laboratory for at least seven years. The laboratory will notify IT 30 days before disposal of any relevant laboratory records.

IT will maintain copies of all COC forms until receipt of the laboratory report. Laboratory reports will be logged in upon receipt and filed in chronological order. The second copy of the report will be sent for third-party data validation.

Data packages will be prepared to meet the requirements for data package contents that are presented in Tables 12 through 15. For groundwater samples, one data package is expected to be generated that will meet the Level III requirements. Data packages for waste characterization or vapor samples will require a standard laboratory package.

7.1.4 Electronic Deliverables

The electronic data deliverable (EDD) will be in ASCII format and will follow the IT Environmental Management System (ITEMS) electronic data transfer (EDT) format specifications. At project closeout, IT will submit a Navy Electronic Data Transfer System-compatible electronic file to the Navy.

The laboratory will certify that the EDD and the hard copy reports are identical. Both the EDD and the hard copy will present results to two or three significant figures. For inorganic results, two significant figures will be used for results that are less than 10, and three significant figures will be used for results that are greater than 10. For organic results, one significant figure will be used for results that are less than 10, and two significant figures will be used for results that are greater than 10. The EDD for each sample delivery group will be due at the same time as the hard copy, 14 days after the last sample of the sample delivery group has been delivered to the laboratory.

Field information (date and time collected, sample identification, etc.) will be entered directly into the main database from the COC form or uploaded from electronic files generated in the field.

Upon receipt by IT, the electronic data may be uploaded into a temporary access database by the ITEMS Data Manager. Uploaded data will be printed and proofread relative to the hard copy submitted by the laboratory. The reader will also check for irregularities in analyte identities, concentrations, and units. Uploaded data will also be processed to compare the fields against a list of required values. If any errors are returned by the program, the file will be manually edited or regenerated by the laboratory. If no errors are returned, the data will be uploaded into the main database. The laboratory database will be merged with the field database, and reports will be generated from the merged database.

7.2 Data Validation

Data validation will be performed according to the Navy requirements (SWDIV, 1999a). Because the data is part of a pilot study, a third-party data validation company will not be used to validate the data. The data packaged will be reviewed according to Section 7.3.

All data will be reviewed by an IT Project Chemist.

7.3 Data Review

The Project Chemist will review the laboratory data packages for all samples to establish that the holding times for extraction and analysis and the calibration and internal QC check requirements have been met.

7.4 Data Quality Assessment Report

Based on data validation and review, the Project Chemist will determine if the project DQOs have been met and will calculate data completeness. To reconcile the collected data with project DQOs and to establish and document data usability, the Project Chemist will prepare a Data Quality Assessment Report (DQAR). The DQAR will discuss the following topics:

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

The DQAR will be included in the Final Project Report.

8.0 Quality Assurance Oversight

The QA oversight for this project will include system audits of field activities and of the laboratory subcontracted by the Navy to perform the analysis.

8.1 Laboratory Assessment and Oversight

Systems and performance audits will be carried out by IT as independent assessments of sample collection and analysis procedures. The systems audit is a qualitative review of the overall sampling or measurement system, while the performance audit is a quantitative assessment of a measurement system.

Audit results are used to evaluate if the analytical laboratories are able to produce data that fulfill the objectives established for the program and identify any areas requiring corrective action.

8.1.1 Naval Facilities Engineering Service Center Laboratory Audits

The laboratories will successfully complete an Naval Facilities Engineering Command laboratory audit. A Naval Facilities Engineering Command audit conducted in the past for a different project is an acceptable qualification, provided it is still current.

8.1.2 Technical Systems Audits

A technical systems audit is an on-site, qualitative review of the sampling or analytical system to ensure that the activity is being performed in compliance with the SAP specifications and that the collected data fulfill the project DQOs.

Laboratories performing under this program may be required to have a pre-qualification (or periodic) systems audit performed by IT, depending on the scope of services to be provided, past performance, or other factors indicating a need to evaluate quality in this manner. Subsequently, the laboratories will respond to and address any project or technical concerns resulting from the audits. A follow-up audit may be performed to verify resolution of findings and observations as well as review the corrective measures taken. Laboratories found deficient will not be used on a project until the deficiencies are corrected and the laboratory accepted. Laboratories previously qualified for the types of testing to be performed on the project will not require pre-qualification provided that pre-qualification has been within the past year and the work performed has been acceptable.

The laboratory systems audit results will be used to review laboratory operations and to ensure that any outstanding corrective actions have been addressed. A laboratory systems audit will include the following critical areas:

- Sample custody procedures
- Calibration procedures and documentation
- Completeness of data forms, notebooks, and other reporting requirements
- Data review procedures
- Storage, filing, and record-keeping procedures
- QC procedures and documentation
- Operating conditions of facilities and equipment
- Documentation of training and maintenance activities
- Systems and operations overview
- Security of laboratory automated systems

After the audit, a debriefing session will be held for all participants to discuss the preliminary audit results. The auditor will then complete the audit evaluation and submit to the Project Manager and the laboratory an audit report including observations of the deficiencies and the necessary recommendations for corrective actions. Follow-up audits will be performed before completion of the project to ensure corrective actions have been taken.

8.1.3 Performance Evaluation Audits

Performance audits quantitatively assess the data produced by a measurement system. A performance audit involves submitting project-specific performance evaluation (PE) samples for analysis for each analytical method used in the project. The performance audit answers questions about whether the measurement system is operating within control limits and whether the data produced will meet the project DQOs. If there is a concern about the laboratory performance, or per the Navy request, IT will administer performance evaluation samples for the target analytes.

Review of PE results include the following elements:

- Correct identification and quantitation of the PE sample analytes
- Accurate and complete reporting of the results
- Measurement system operation within established acceptance limits for accuracy

The concentrations reported for the PE samples will be compared with the known or expected concentrations spiked in the samples. The percent recovery will be calculated and the results assessed according to the acceptance limits, which are based on inter-laboratory studies. If the

accuracy criteria are not met, the cause of the discrepancy will be investigated and a second PE sample will be submitted. PE sample results review will be documented in a report to the Project Manager.

8.1.4 Magnetic Tape Audits

Magnetic tape audits involve the examination of the electronic media used in the analytical laboratory to acquire, report, and store data. These audits are used to assess the authenticity of the data generated and assess the implementation of good automated laboratory practices. IT may perform magnetic tape audits of the off-site laboratory when warranted by project PE samples results, or by other circumstances.

8.1.5 Performance Evaluation Sample Programs

The off-site laboratory will participate in the EPA PE Water Supply and Water Pollution Studies programs or equivalent programs for state certifications. Satisfactory performance in these PE programs also demonstrates proficiency in methods used to analyze project samples. The laboratory will document the corrective actions to unacceptable PE results to demonstrate resolution of the problems.

8.2 Field Audits

The IT and U.S. Navy Southwest Division QA Officers may schedule audits of field activities at any time to evaluate the execution of sample collection, identification, and control in the field. The audit will also include observations of COC procedures, field documentation, instrument calibrations, and field measurements.

Field documents and COC forms will be reviewed to ensure that all entries are printed or written in indelible ink, dated, and signed.

Sampling operations will be reviewed and compared with the FSP, the QAPP, and other applicable SOPs. The auditor will verify that the proper sample containers are used, the preservatives are added or are already present in the container, and the documentation of the sampling operation is adequate.

Field measurements will be reviewed by random spot-checking to determine that the instrument is within calibration, that the calibration is completed at the appropriate frequency, and that the sensitivity range of the instrument is appropriate for the project.

Audit findings will be documented in a report to the IT Program QC Manager and the Project Manager. Corrective action will be implemented as needed.

8.3 Quality Assurance Project Plan Revision or Amendment

When circumstances arise that impact the original project DQOs, such as a significant change in work scope, the QAPP document will be revised or amended. The modification process will be based on EPA guidelines and direction from the Navy and QA Officer.

9.0 References

American Society for Testing and Materials (ASTM), 2000, *Annual Book of Standards*, Conshohocken, PA.

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IT Corporation, 1997, *Soil and Groundwater Characterization Report Building 397 Fuel Release*, Navy Aviation Depot, Naval Air Station Alameda, Alameda, California, June.

Naval Facilities Engineering Service Center, 1999, *Naval Facilities Engineering Command Navy Installation Restoration Chemical Data Quality Manual*.

U.S. Environmental Protection Agency, September 1996, *Test Methods for Evaluating Solid Waste, Physical Chemical Methods, SW-846, Update III*, Washington, D.C.

U.S. Environmental Protection Agency, 1999a, *Guidance for Quality Assurance Project Plans, EPA QA/R-5*, Washington, D.C.

U.S. Environmental Protection Agency, 2000, *Guidance for the Data Quality Objectives Process EPA QA/G-4*, Washington, D.C.

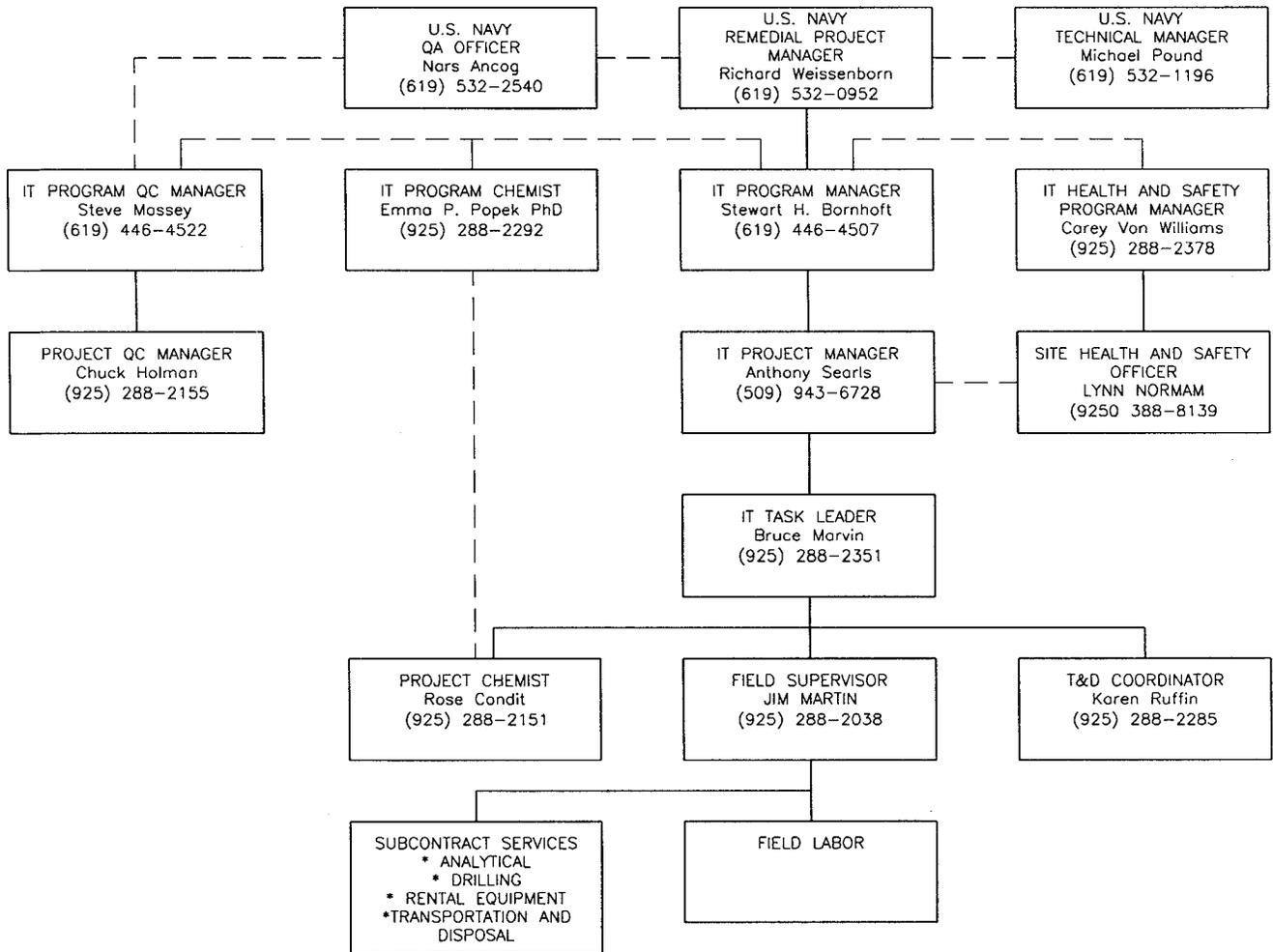
U.S. Navy Southwest Division, 1999a, *Environmental Work Instruction 4EN.1—Chemical Data Validation*, October.

U.S. Navy Southwest Division, 1999b, *Environmental Work Instruction 4EN.2—Review, Approval, Revision, and Amendment of Field Sampling Plans (FSP) and Quality Assurance Project Plans (QAPP)*.

U.S. Navy Southwest Division, 1999c, *Environmental Work Instruction 4EN.3—Laboratory Quality Assurance Program*.

FIGURES

IMAGE	X-REF	OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
---	AL99BASE	CONC	T.R.S.	8/6/01	ALE	6/21/01	BKM	6/21/01	827557-A3



LEGEND

- DIRECT REPORT
- LINE OF COMMUNICATION

	DEPARTMENT OF THE NAVY SOUTHWEST DIVISION NAVAL ENGINEERING COMMAND SAN DIEGO, CALIFORNIA
	FIGURE 1 PROJECT ORGANIZATION

ALAMEDA POINT, CTO 076
ALAMEDA, CALIFORNIA



ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 545664
Page 1 of ____

Project Name/No. ¹ _____
Sample Team Members ² _____
Profit Center No. ³ _____
Project Manager ⁴ _____
Purchase Order No. ⁶ _____
Required Report Date ¹¹ _____

Samples Shipment Date ⁷ _____
Lab Destination ⁸ _____
Lab Contact ⁹ _____
Project Contact/Phone ¹² _____
Carrier/Waybill No. ¹³ _____

Bill to: ⁵ _____
Report to: ¹⁰ _____

ONE CONTAINER PER LINE

Sample Number ¹⁴	Sample Description/Type ¹⁵	Date/Time Collected ¹⁶	Container Type ¹⁷	Sample Volume ¹⁸	Pre-servative ¹⁹	Requested Testing Program ²⁰	Condition on Receipt ²¹	Disposal Record No. ²²

FOR LAB USE ONLY

Special Instructions: ²³ _____

Possible Hazard Identification: ²⁴ Non-hazard Flammable Skin Irritant Poison B Unknown Sample Disposal: ²⁵ Return to Client Disposal by Lab Archive _____ (mos.)

Turnaround Time Required: ²⁶ Normal Rush GC Level: ²⁷ I II III Project Specific (specify): _____

1. Relinquished by ²⁸ (Signature/Affiliation)	Date: _____ Time: _____	1. Received by ²⁸ (Signature/Affiliation)	Date: _____ Time: _____
2. Relinquished by (Signature/Affiliation)	Date: _____ Time: _____	2. Received by (Signature/Affiliation)	Date: _____ Time: _____
3. Relinquished by (Signature/Affiliation)	Date: _____ Time: _____	3. Received by (Signature/Affiliation)	Date: _____ Time: _____

Comments: ²⁹ _____

FIGURE 2
Chain-of-Custody Record

White: To accompany samples
Yellow: Field copy
* See back of form for special instructions.

Figure 3
Custody Seal

<p>CUSTODY SEAL</p> <p>Date: _____</p> <p>Signature: _____</p>

TABLES
(Notes to Tables follow Table 15)

Table 1
Project Personnel and Chemical Data Collection Responsibilities

Position	Responsibility
U.S. Navy QAO	<ul style="list-style-type: none"> • Provides governmental oversight of the IT QA Program. • Provides quality-related directives through Contracting Officer's Technical Representative. • Provides technical and administrative oversight of IT surveillance audit activities. • Acts as point of contact for all matters concerning QA and the Navy's Laboratory QA Program. • Prepares governmental budget estimates for all QA functions included in IT contracts. • Coordinates training on matters pertaining to generation and maintenance of quality of data. • Authorized to suspend project execution if QA requirements are not adequately followed.
Program Chemist	<ul style="list-style-type: none"> • Reviews and approves the SAP. • Guides the selection of subcontract analytical laboratories. • Conducts field and laboratory audits. • Serves as a point of contact for the Navy QAO. • Develops corrective action as required. • Serves as a technical advisor to the project.
Project Chemist	<ul style="list-style-type: none"> • Develops the project DQOs and prepares the SAP. • Selects qualified subcontract laboratories. • Implements chemical data QC procedures and performs auditing of field performance. • Reviews laboratory data before use. • Coordinates data validation of laboratory data. • Reviews data validation report. • Prepares the appropriate sections of the report summarizing the project activities.
Field Technician	<ul style="list-style-type: none"> • Performs all sampling in accordance with approved SAP. • Ensures that field QC samples are collected as specified in the FSP. • Completes field documentation. • Coordinates laboratory and field sampling activities. • Implements field corrective actions as required.

Table 2
Reporting Limits
U.S. Environmental Protection Agency Method 8260B (Volatile Organic Compounds)

Compound Name	Soil, $\mu\text{g}/\text{kg}$	Water, $\mu\text{g}/\text{L}$
Benzene	5.0	2.0
Bromobenzene	5.0	2.0
Bromochloromethane	5.0	2.0
Bromodichloromethane	5.0	2.0
Bromoform	10	2.0
Bromomethane	5.0	2.0
n-Butylbenzene	5.0	2.0
sec-Butylbenzene	5.0	2.0
tert-Butylbenzene	5.0	2.0
Carbon Tetrachloride	5.0	2.0
Chlorobenzene	5.0	2.0
Chloroethane	10	2.0
Chloroform	5.0	2.0
Chloromethane	10	2.0
2-Chlorotoluene	5.0	2.0
4-Chlorotoluene	5.0	2.0
Dibromochloromethane	5.0	2.0
Dibromochloropropane (DBCP)	5.0	2.0
Dibromomethane	5.0	2.0
Dichlorodifluoromethane	10	2.0
Dichloromethane (Methylene Chloride)	5.0	2.0
1,2-Dichlorobenzene	5.0	2.0
1,2-Dichloroethane	5.0	2.0
1,3-Dichlorobenzene	5.0	2.0
1,2-Dichloropropane	5.0	2.0
1,3-Dichloropropane	5.0	2.0
1,4-Dichlorobenzene	5.0	2.0
2,2-Dichloropropane	5.0	2.0
1,1-Dichloroethane	5.0	2.0
1,1-Dichloroethene	5.0	2.0
1,1-Dichloropropene	5.0	2.0
1,2-Dibromoethane (EDB)	5.0	2.0
trans 1,2-Dichloroethene	5.0	2.0

Table 2 (continued)
Reporting Limits
U.S. Environmental Protection Agency Method 8260B (Volatile Organic Compounds)

Compound Name	Soil, $\mu\text{g}/\text{kg}$	Water, $\mu\text{g}/\text{L}$
cis 1,2-Dichloroethene	5.0	2.0
Ethylbenzene	5.0	2.0
Hexachlorobutadiene	5.0	2.0
Isopropylbenzene	5.0	2.0
4-Isopropyltoluene	5.0	2.0
Naphthalene	5.0	2.0
n-Propylbenzene	5.0	2.0
Styrene	5.0	2.0
Toluene	5.0	2.0
Trichloroethene (TCE)	5.0	2.0
Trichlorofluoromethane	5.0	2.0
1,1,1,2-Tetrachloroethane	5.0	2.0
1,1,1-Trichloroethane	5.0	2.0
1,1,2,2-Tetrachloroethane	5.0	2.0
Tetrachloroethene (PCE)	5.0	2.0
1,1,2-Trichloroethane	5.0	2.0
1,2,3-Trichlorobenzene	5.0	2.0
1,2,3-Trichloropropane	5.0	2.0
1,3,5-Trimethylbenzene	5.0	2.0
1,2,4-Trichlorobenzene	5.0	2.0
1,2,4-Trimethylbenzene	5.0	2.0
m&p-Xylenes	5.0	2.0
o-Xylene	5.0	2.0
Vinyl Chloride	10	2.0

Hazardous Substance List

Acetone	100	100
Carbon Disulfide	100	100
2-Butanone (MEK)	100	100
4-Methyl-2-Pentanone (MIBK)	50	50
2-Hexanone	50	50

Table 3
Reporting Limits
Metal Analyses

Metal	Soil, mg/kg	Water, µg/L
EPA Method 6010B (ICP)		
Antimony (Sb)	10	50
Arsenic (As)	5.0	50
Barium (Ba)	10	100
Beryllium (Be)	0.2	2.0
Cadmium (Cd)	0.2	2.0
Chromium (Cr)	1.0	10
Chromium, hexavalent	0.5	10
Cobalt (Co)	1.0	10
Copper (Cu)	1.0	10
Lead (Pb)	1.0	5.0
Manganese (Mn)	1.0	10
Mercury (Hg)	0.0002	0.2
Molybdenum (Mo)	5.0	100
Nickel (Ni)	4.0	40
Selenium (Se)	10	20
Silver (Ag)	1.0	5.0
Thallium (Tl)	1.0	10
Vanadium (V)	1.0	10
Zinc (Zn)	2.0	20

Table 4
Reporting Limits
U.S. Environmental Protection Agency Method 8270C (Semivolatile Organic Compounds)

Compound name	Soil, $\mu\text{g}/\text{kg}$	Water, $\mu\text{g}/\text{L}$
Bis (2-chlorethyl)ether	330	10
2-Chlorophenol	330	10
1,3-Dichlorobenzene	330	10
1,4-Dichlorobenzene	330	10
1,2-Dichlorobenzene	330	10
2-Methylphenol	330	10
Bis (2-chloroisopropyl)ether	330	10
4-Methylphenol	330	10
N-Nitroso-di-n-Propylamine	330	10
Hexachloroethane	330	10
Nitrobenzene	330	10
Isophorone	330	10
2-Nitrophenol	330	10
2,4-Dimethylphenol	330	10
Bis (2-chlorethoxy) Methane	330	10
2,4-Dichlorophenol	330	10
1,2,4-Trichlorobenzene	330	10
Naphthalene	330	10
4-Chloroaniline	330	10
Hexachlorobutadiene	330	10
4-Chloro-3-Methylphenol	330	10
2-Methylnaphthalene	330	10
Hexachlorocyclopentadiene	330	10
2,4,6-Trichlorophenol	330	10
2,4,5-Trichlorophenol	1700	50
2-Chloronaphthalene	330	10
2-Nitroaniline	1700	50
Dimethyl Phthalate	330	10
Acenaphthylene	330	10
3-Nitroaniline	1700	50
Acenaphthene	330	10
2,4-Dinitrophenol	1700	50
4-Nitrophenol	1700	50
Dibenzofuran	330	10

Table 4
Reporting Limits (continued)
U.S. Environmental Protection Agency Method 8270C (Semivolatile Organic Compounds)

Compound name	Soil, $\mu\text{g}/\text{kg}$	Water, $\mu\text{g}/\text{L}$
2,4-Dinitrotoluene	330	10
2,6-Dinitrotoluene	330	10
Diethyl Phthalate	330	10
4-Chlorophenyl Phenyl Ether	330	10
Fluorene	330	10
4-Nitroaniline	1700	50
2-Methyl-4,6-Dinitrophenol	1700	50
N-Nitrosodiphenylamine ¹	330	10
4-Bromophenyl Phenyl Ether	330	10
Hexachlorobenzene	330	10
Pentachlorophenol	1700	50
N-Nitrosodimethylamine	330	10
Phenol	330	10
Phenanthrene	330	10
Anthracene	330	10
Di-n-Butyl Phthalate	330	10
Fluoranthene	330	10
Pyrene	330	10
Butyl Benzyl Phthalate	330	10
3,3'-Dichlorobenzidine	660	20
Benzo(a)anthracene	330	10
Bis(2-ethylhexyl) Phthalate	330	10
Chrysene	330	10
Di-n-Octyl Phthalate	330	10
Benzo(b)fluoranthene	330	10
Benzo(k)fluoranthene	330	10
Benzo(a)pyrene	330	10
Indeno(1,2,3-cd)pyrene	330	10
Dibenz(a,h)anthracene	330	10
Benzo(g,h,i)perylene	330	10
Benzoic Acid	1700	50

¹ N-Nitrosodiphenylamine subject to co-identification with diphenylamine.

² Analyte reported as a Tentatively Identified Compound (TIC) at an estimated concentration.

$\mu\text{g}/\text{kg}$ denotes microgram per kilogram.

$\mu\text{g}/\text{L}$ denotes microgram per liter.

Table 5
Reporting Limits
EPA Method 8270C SIM (Polynuclear Aromatic Hydrocarbons)

Compound name	Soil, $\mu\text{g}/\text{kg}$	Water, $\mu\text{g}/\text{L}$
Naphthalene	25	1
2-Methylnaphthalene	25	1
Acenaphthylene	25	1
Acenaphthene	25	1
Fluorene	25	1
Phenanthrene	25	1
Anthracene	25	1
Fluoranthene	25	1
Pyrene	25	1
Benzo(a)anthracene	25	1
Chrysene	25	1
Benzo(b)fluoranthene	25	1
Benzo(k)fluoranthene	25	1
Benzo(a)pyrene	25	1
Dibenz(a,h)anthracene	25	1
Benzo(ghi)perylene	25	1
Indeno(1,2,3-cd)pyrene	25	1

$\mu\text{g}/\text{kg}$ denotes microgram per kilogram.

$\mu\text{g}/\text{L}$ denotes microgram per liter.

Table 6
Reporting Limits
U.S. Environmental Protection Agency Method 8015B (Nonhalogenated Organics Using Gas Chromatography/Flame Ionization Detector)

Compound name	Soil, mg/kg	Water, mg/L
Total petroleum hydrocarbons as gasoline, carbon range C ₆ to C ₁₂	1.0	0.5
Total petroleum hydrocarbons as diesel fuel, carbon range C ₁₂ to C ₂₄	10	0.5
Total petroleum hydrocarbons as motor oil, carbon range C ₂₀ to C ₃₆	100	1.0

mg/kg denotes milligram per kilogram.

mg/L denotes milligram per liter.

Table 7
Summary of Calibration Requirements, Quality Control Procedures, and Corrective Action for Chromatography Methods Conducted per the Test Methods for Evaluating Solid Waste (SW-846), Update III

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Five-point initial calibration for target analytes	Initial calibration before sample analysis	Target analyte CF or RF RSD less than or equal to 20% ¹ Mean CF or RF RSD less than or equal to 20% ¹	Correct problem, then repeat initial calibration.
Second-source calibration verification	Once per five-point initial calibration	Less than 20% difference for most target analytes, 25% for difficult compounds	Correct problem, then repeat initial calibration.
Daily calibration verification	Before sample analysis and every 10 samples or every 12 hours, as specified by the method	Less than 15% difference for all target analytes	Correct problem, then repeat initial calibration.
Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once	QC acceptance criteria per method's requirements	Recalculate results; locate and fix the problem, if exists, rerun demonstration of those analytes that did not meet acceptance criteria.
Retention time window study	Establish initially, verify during daily calibrations	Within ± 3 standard deviations of each analyte retention time from the initial study	Correct problem, re-evaluate analyte identification.
8081A: DDT and Endrin breakdown check	Daily before analysis of samples and every 10 samples	Degradation $\leq 15\%$	Clean the system, repeat breakdown check.
Internal standards (optional)	Every sample, spiked sample, standard, and method blank	Laboratory established QC acceptance criteria	Correct problem, re-extract and re-analyze affected samples.
Method blank	One per analytical batch (VOCs) and one per preparation batch (SVOCs)	No analytes detected above the RL	Correct problem, then re-extract and re-analyze method blank and all samples processed with the contaminated blank.
MS/MSD	One MS/MSD pair conducted on Navy samples per each analytical/preparation batch	Advisory recovery limits: 70 to 130%	Identify problem. If not related to matrix interference, re-extract and re-analyze MS/MSD and all associated batch samples.
LCS or LCS/LCD pair if there is not enough sample for MS/MSD	One LCS or LCS/LCD pair per analytical/preparation batch	Advisory recovery limits: 70 to 130%	Correct problem, then re-extract and re-analyze the LCS and all associated batch samples.
Surrogate standards	Every sample, spiked sample, standard, and method blank	Advisory recovery limits: 70 to 130%	Correct problem, then re-extract and re-analyze all affected samples.
MDL study	Once per 12-month period	Detection limits established will be below the RLs	Correct problem, repeat the MDL study.

¹If RSD for any analyte is > 20%, regression fit may be used for the calibration curve for that analyte. Acceptance criteria for first order regression is $r^2 \geq 0.99$.

Table 8
Summary of Calibration Requirements, Quality Control Procedures, and Corrective Action for U.S. Environmental Protection Agency Methods 8260B and 8270C Methods Conducted per the Test Methods for Evaluating Solid Waste (SW-846), Update III

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Five-point initial calibration for target analytes	Initial calibration before sample analysis	8260B: The minimum average SPCC RF for Chloromethane, 1,1-Dichloroethane, Bromoform is 0.1; for Chlorobenzene and 1,1,2,2-Tetrachloroethane is 0.30. 8270C: The minimum average SPCC RF is 0.050. 8260B and 8270C: RSD is less than or equal to 15% for target analytes, and is less than or equal to 30% for CCC ¹ .	Correct problem, then repeat initial calibration.
Second-source calibration verification	Once per five-point initial calibration	Less than 25% difference for all target analytes and CCCs	Correct problem, then repeat initial calibration.
Daily calibration verification	Before sample analysis and every 12 hours of analysis time	Less than 20% difference for all target analytes and CCCs	Correct problem, then repeat initial calibration.
Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once	QC acceptance criteria per method's requirements	Recalculate results; locate and fix the problem, if exists, rerun demonstration of those analytes that did not meet acceptance criteria.
Check of mass spectral ion intensities (tuning procedure) using BFB (8260B) and DFTPP (8270C)	Before initial calibration and calibration verification	Must meet the method's requirements before samples are analyzed	Retune instrument and verify the tune acceptability.
Internal Standards	During data acquisition of calibration standard, samples and QC check samples	Areas within -50% to +100% of last calibration verification (12 hours) for each	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.
Method blank	One per analytical batch (8260B) and one per preparation batch (8270C)	No analytes detected above the RL	Correct problem, then re-extract and reanalyze method blank and all samples processed with the contaminated blank.
MS/MSD	One MS/MSD pair conducted on Navy samples per analytical/preparation batch	Advisory recovery limits: 70 to 130%	Identify problem. If not related to matrix interference, re-extract and reanalyze MS/MSD and all associated batch samples.
LCS or LCS/LCD pair if there is not enough sample for MS/MSD	One LCS or LCS/LCD per analytical/preparation batch	Advisory recovery limits: 70 to 130%	Correct problem, then re-extract and reanalyze the LCS (LCS/LCD) and all associated batch samples.

Table 8 (continued)
Summary of Calibration Requirements, Quality Control Procedures, and Corrective Action for U.S. Environmental Protection Agency Methods 8260B and 8270C Methods Conducted per the Test Methods for Evaluating Solid Waste (SW-846), Update III

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Surrogate standards	Every sample, spiked sample, standard, and method blank	Advisory QC acceptance criteria per method's requirements (per Method 8260B Table 8 and Method 8270A Table 8 ²)	Correct problem, then re-extract and re-analyze all affected samples.
MDL study	Once per 12-month period	Detection limits established will be below the RLs	Correct problem, repeat the MDL study.

¹ If RSD for any analyte is >15%, regression fit may be used for the calibration curve for that analyte. Acceptance criteria for first order regression is $r^2 \geq 0.99$.

² For Method 8270C use the surrogate standard acceptance criteria of Method 8270A, Revision 1, July 1992.

Table 9**Summary of Calibration Requirements, Quality Control Procedures and Corrective Action for U.S. Environmental Protection Agency Method 6010B Conducted per the Test Methods for Evaluating Solid Waste (SW-846), Update III**

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Initial calibration (IC) per manufacturer's instructions with a minimum of one standard and a calibration blank	Initial calibration prior to sample analysis	Accepted if the initial calibration verification (ICV) passes	Correct problem, repeat initial calibration.
Second-source ICV, prepared at the calibration mid-point	Once per initial calibration	Less than 10% difference from IC for all target analytes	Correct problem, repeat initial calibration.
Continuing calibration verification (CCV), same source as IC	Following IC, after every 10 samples and the end of the sequence	Less than 10% difference from IC for all target analytes; $\pm 5\%$ RSD for a minimum of two integrations	Correct problem, repeat initial calibration.
Calibration blank	After IC, before CCV calibration, after every 10 samples, and at the end of the sequence	All target analytes are within three times the IDLs	Prepare and analyze the blank again, recalibrate the instrument.
Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once	QC acceptance criteria per method's requirements	Recalculate results; locate and fix the problem, if exists, rerun demonstration of those analytes that did not meet acceptance criteria.
IDL study	Once per 12-month period	IDLs will be below the MDLs	Correct problem, repeat the IDL study.
MDL study (water only)	Once per 12-month period	MDLs will be below the RLs	Correct problem, repeat the MDL study.
Method blank	One per digestion batch	No analytes detected above the RLs	Correct problem, then prepare and analyze again the method blank and all samples processed with the contaminated blank.
Interference check solution (ICS)	At the beginning of an analytical run	Within $\pm 20\%$ of expected value	Terminate analysis; correct problem; reanalyze ICS; reanalyze all affected samples.
MS/MSD for all analytes	One MS/MSD pair conducted on Navy samples per each preparation batch	QC acceptance criteria: 75 to 125% accuracy, 20% precision	Identify problem, reprepare and re-analyze the MS/MSD pair and all samples in the associated batch.
LCS or LCS/LCD pair if there is not enough sample for MS/MSD	One LCS or LCS/LCD pair per each preparation batch	QC acceptance criteria: 75 to 125% accuracy, 20% precision	Terminate analysis, identify and correct the problem, prepare and analyze all affected samples and QC checks again.
Dilution test	Each new sample matrix	1:5 dilution must agree within $\pm 10\%$ of the original determination	Perform post digestion spike addition.
Method of standard addition (MSA), single or multi-level	When interferences are suspected or and for new sample matrix	Linearity of a multi-level MSA	Correct problem, repeat MSA.
Post-digestion spike addition	When dilution test fails	Recovery within 75 to 125% of expected results	Correct problem, reanalyze post digestion spike addition.

Table 10
Summary of Quality Control Requirements and Corrective Action for Inorganic Analyses

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Initial three-point calibration (IC) and a blank	Initial calibration before sample analysis	Correlation coefficient >0.99	Correct problem, repeat initial calibration
Second-source ICV, prepared at the calibration mid-point	Once per initial calibration	Per method's requirements or laboratory-established criteria	Correct problem, repeat initial calibration
Continuing calibration verification (CCV), same source as IC	After every 10 samples and at the end of the sequence	Per method's requirements or laboratory-established criteria	Correct problem, re-analyze previous 10 samples
Calibration blank	After IC, before CCV calibration, after every 10 samples, and at the end of the sequence	All target analytes not detected above the RL	Prepare and analyze the blank again, recalibrate the instrument.
Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once	QC acceptance criteria per method's requirements	Recalculate results; locate and fix the problem, if exists, rerun demonstration of those analytes that did not meet acceptance criteria
MDL study (water only)	Once per 12-month period	MDL will be below the RL	Correct problem, repeat the MDL study
Method blank	One per preparation batch	No analytes detected above the RL	Correct problem, then prepare and analyze again the method blank and all samples processed with the contaminated blank
MS for all analytes	One MS conducted on Navy samples per each preparation batch	Advisory recovery limits 70-130%	Identify problem. If not related to matrix interference, re-extract and re-analyze MS/MSD and all associated batch samples.
Sample duplicate (SD) or MS/MSD pair	One SD or MS/MSD pair conducted on Navy samples per each preparation batch	30% RPD for soil, 20% RPD for water Advisory recovery limits 70-130%	Identify problem. If not related to matrix interference, re-extract and re-analyze MS/MSD or SD and all associated batch samples.
LCS or LCS/LCD pair if there is not enough sample for MS/MSD or SD	One LCS or LCS/LCD pair per each preparation batch	30% RPD for soil, 20% RPD for water Advisory recovery limits 70 to 130%	Correct problem, re-prepare and re-analyze LCS/LCD and the affected batch

ICV = Initial Calibration Verification

RL = Reporting Limit

MDL = Method Detection Limit

Table 11
Reporting Units

Analytes	Soil Samples	Aqueous Samples
Organic parameters	µg/kg	µg/L
Inorganic parameters	mg/kg	µg/L

Table 12
Gas Chromatography/Mass Spectrometry Data Deliverables Package Requirements

Method	Deliverable Requirement	Equivalent EPA Form	CLP or CLP-like Package Level IV	SW-846 Package, Level III	Standard Laboratory Report
Organic Analysis by GC/MS	Case Narrative		X	X	X
	Corrective Action Report(s)		X	X	X
	Cross-reference of field sample numbers, laboratory IDs, and analytical QC batches		X	X	X
	Chain-of-Custody Form, Cooler Receipt Form		X	X	X
	Sample log-in sheet	DC-1	X		
	Complete SDG file inventory sheet	DC-2-1	X		
	Data summary for each blank and sample (1)	I	X	X	X
	Tentatively identified compounds (TIC) for each sample (ten peaks)	I, TIC	X	X	
	Lab Control Sample/Laboratory Control Duplicate (LCS/LCD) report (including concentration spiked, percent recovered, percent recovery acceptance limits, relative percent difference (RPD), and RPD acceptance limits)	III (modified)	X	X	X
	Surrogate recovery report (including concentration spiked, percent recovered, and percent recovery acceptance limits)	II	X	X	X
	Matrix Spike/Matrix Spike Duplicate (MS/MSD) report (including concentration spiked, percent recovered, percent recovery acceptance limits, RPD, and RPD acceptance limits)	III	X	X	X
	Instrument performance check (tuning) report	V	X	X	
	Initial calibration data (including acceptance limits)	VI	X	X	
	Continuing calibration data (including acceptance limits)	VII	X	X	
	Internal standard areas and retention time reports (including acceptance limits and out-of-control flags)	VIII	X	X	
	Reconstructed ion chromatogram for each sample and rerun, blank, spike, duplicate, and standard		X		
	Instrument quantitation report		X	X	
	Raw and background-subtracted mass spectra for each target analyte found		X		
	Mass spectra of TICs with library spectra of 5 best-fit matches		X		
	Sample preparation bench sheets		X	X	
	Gel permeation chromatography clean-up logs		X		
	Method blank summary	IV	X		
	Standard preparation logs		X	X	
Analysis run logs	VIII	X	X		
Percent moisture		X	X	X	
pH		X (2)			

1) Must include: field sample ID, laboratory ID, date/time sampled, date received, extracted/analyzed, RL, MDL, dilution factor(s), results, comments, approval signature/date.

2) For water samples volatile analysis only.

Table 13
Gas Chromatograph or High-Performance Liquid Chromatography Data Deliverables
Package Requirements

GC/HPLC	Deliverable Requirement	Equivalent EPA Form	CLP or CLP-like Package, Level IV	SW-846 Package, Level III	Standard Laboratory Report
Organic Analysis by GC or HPLC	Case Narrative		X	X	X
	Corrective Action Report(s)		X	X	X
	Cross-reference of field sample numbers, laboratory IDs, and analytical QC batches		X	X	X
	Chain-of-Custody Form, Cooler Receipt form		X	X	X
	Sample log-in sheet	DC-1	X		
	Complete SDG file inventory sheet	DC-2-1	X		
	Data summary for each blank and sample (1)	I	X	X	X
	Lab Control Sample/Laboratory Control Duplicate (LCS/LCD) report (including concentration spiked, percent recovered, percent recovery acceptance limits, relative percent difference (RPD), and RPD acceptance limits)	III (modified)	X	X	X
	Surrogate recovery report (including concentration spiked, percent recovered, and percent recovery acceptance limits)	II	X	X	X
	Matrix Spike/Matrix Spike Duplicate (MS/MSD) report (including concentration spiked, percent recovered, percent recovery acceptance limits, RPD, and RPD acceptance limits)	III	X	X	X
	Initial calibration data for each column (indicate which column was used for quantitation)	VI	X	X (summary only)	
	Continuing calibration data (indicate which column was used for quantitation) and calibration verification data	VII	X	X (summary only)	
	Chromatograms for each sample (and reruns), confirmation runs, blank, spike, duplicate, and standards		X	X (3)	
	Instrument quantitation report		X		
	Method blank summary	IV	X		
	Pesticide identification summary	X	X		
	Sample preparation bench sheets		X	X	
	Gel permeation chromatography (GPC) clean-up logs		X		
	Standard preparation logs		X	X	
	Analysis run logs	VIII	X	X	
Percent moisture		X	X	X	

1) Must include: field sample ID, laboratory ID, date/time sampled, date received, extracted/analyzed, Practical Quantitation Limit, Method Detection Limit, dilution factor(s), comments, approval signature/date. Results from the primary and secondary columns/detector shall be reported.

3) For petroleum fuels or PCB analyses chromatograms for samples with compound detection only.

**Table 14
Metals Data Deliverables Package Requirements**

Method	Deliverable Requirement	Equivalent EPA Form	CLP or CLP-like Package, Level IV	SW-846 Package, Level III	Standard Laboratory Report
Metals Analysis	Case Narrative		X	X	X
	Corrective Action Report(s)		X	X	X
	Cross-reference of field sample numbers, laboratory IDs, and analytical QC batches		X	X	X
	Chain-of-Custody Form, Cooler Receipt form		X	X	X
	Sample log-in sheet	DC-1	X		
	Complete SDG file inventory sheet	DC-2-1	X		
	Data summary for each blank and sample (1)	I-IN	X	X	X
	Lab Control Sample/Laboratory Control Duplicate (LCS/LCD) report (including concentration spiked, percent recovered, percent recovery acceptance limits, relative percent difference (RPD), and RPD acceptance limits)	VII-IN	X	X	X
	Matrix Spike/Matrix Spike Duplicate (MS/MSD) report (including concentration spiked, percent recovered, percent recovery acceptance limits, RPD, and RPD acceptance limits)	V (Part 1)-IN	X	X	X
	Post-digestion spike recovery	V (Part 2)-IN	X	X	X
	Duplicate sample report	VI-IN	X	X	X
	Blank results	III-IN	X	X	X
	Initial and continuing calibration data	II (PART I)-IN	X	X (summary only)	
	ICP interference check sample report	IV-IN	X	X	
	Standard addition results	VIII-IN	X	X	
	ICP serial dilution results	IX-IN	X		
	Preparation logs	XIII-IN	X	X	
	Analysis run logs	XIV-IN	X	X	
	Standard preparation logs		X	X	
	CRDL standard report	II (Part 2)-IN	X		
	Instrument detection limits	X-IN	X		
	ICP interelement correction factors	XI-IN	X	X	
	Data and instrument printouts		X		
	Percent moisture		X	X	X
	pH			X (2)	

1) Must include: field sample ID, laboratory ID, date/time sampled, date received, extracted/analyzed, Practical Quantitation Limit, Method Detection Limit, dilution factor(s), results, comments, approval signature/date.

2) For water samples only.

**Table 15
Inorganic Data Deliverables Package Requirements**

Method	Deliverable Requirement	Equivalent EPA Form	CLP or CLP-like Package	SW-846 Package	Standard Laboratory Report
Inorganic Chemistry	Case narrative		x	x	x
	Corrective action report(s)		x	x	x
	Cross-reference of field sample numbers, laboratory IDs, and analytical QC batches		x	x	x
	Chain-of-Custody Form, Cooler Receipt Form		x	x	x
	Sample log-in sheet	DC-1	x		
	Complete SDG file inventory sheet	DC-2-1	x		
	Data summary for each blank and sample (1)	I-IN	x	x	x
	Laboratory Control Sample/Laboratory Control Duplicate (LCS/LCD) report (concentration spiked, percent recovered, percent recovery acceptance limits, relative percent difference (RPD), and RPD acceptance limits)	VII-IN	x	x	x
	Matrix Spike (MS) report (concentration spiked, percent recovered, percent recovery acceptance limits)	V(PART1)-IN	x	x	x
	Duplicate sample report	VI-IN	x	x	x
	Calibrations, initial and verification	II(PART1)-IN	x	X (summary only)	
	Copies of sample preparation logs	XIII	x	x	
	Copies of analysis run logs	XIV	x	x	
	Raw data and instrument printouts		x		
	Copies of standard preparation logs		x	x	
Percent moisture		x	x	x	

1) Must include: field sample ID, laboratory ID, date/time sampled, date received, extracted/analyzed, analytical results, dilution factors, RLs, MDLs, comments, approval signature/date.

Notes to Tables

µg/kg denotes microgram per kilogram
µg/L denotes microgram per liter
BFB denotes Bromofluorobenzene
CCC denotes Calibration Check Compounds
CCV denotes continuing calibration verification
CF denotes Calibration Factor
CRDL denotes Contract Required Detection Unit
DDT denotes Dichlorodiphenyltrichloroethane
DFTPP denotes Decafluorotriphenylphosphine
IC denotes initial calibration
ICP denotes inductively coupled plasma
ICS denotes interference check solution
ICV denotes initial calibration verification
IDL denotes instrument detection limit
LCS/LCD denotes laboratory control sample/laboratory control duplicate
MDL denotes method detection limit
mg/kg denotes milligram per kilogram
mg/L denotes milligram per liter
MS/MSD denotes matrix spike/matrix spike duplicate
MSA denotes method of standard addition
PQL denotes practical quantitation limit
QA denotes quality assurance
QAO denotes Quality Assurance Officer
QC denotes quality control
RF denotes Response Factor
RL denotes reporting limit
RPD denotes relative percent difference
RSD denotes Relative Standard Deviation
SAP denotes Sampling and Analysis Plan
SDG denotes sample delivery group.
SPCC denotes System Performance Check Compounds
SVOC denotes semivolatile organic compounds
VOC denotes volatile organic compounds

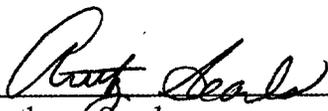
APPENDIX C
SITE HEALTH AND SAFETY PLAN

**FINAL
SITE HEALTH AND SAFETY PLAN
CHEMICAL OXIDATION TREATABILITY STUDY
INSTALLATION RESTORATION SITE 25
ALAMEDA POINT
ALAMEDA, CALIFORNIA**

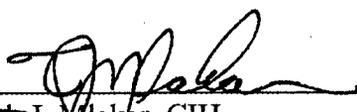
**Environmental Remedial Action
Contract Number N62474-98-D-2076
Contract Task Order 0076**

**Document Control Number 1859
Revision 0**

August 3, 2001

Approved by: 
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Date: August 7, 2001

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Table of Contents

List of Tables.....	ii
List of Figures.....	ii
List of Attachments.....	ii
Acronyms and Abbreviations.....	iii
Policy Statement	iv
Objective	v
Site Health and Safety Plan Acknowledgment	vi
1.0 Site Description and Scope of Work.....	1-1
1.1 Site Description.....	1-1
1.2 Scope of Work	1-1
2.0 Responsibilities	2-1
3.0 Project Hazard Analysis	3-1
3.1 Activity Hazard Analysis.....	3-1
3.2 Chemical Contaminants of Concern	3-1
3.3 Material Safety Data Sheets	3-2
3.4 Confined Spaces.....	3-2
4.0 Personal Protective Equipment	4-1
4.1 Personal Protective Equipment Upgrade/Downgrade.....	4-1
4.2 Respirator Cartridge Changeout Schedule	4-1
5.0 Site Control.....	5-1
5.1 Work Zones.....	5-1
5.1.1 Exclusion Zone	5-1
5.1.2 Contamination Reduction Zone.....	5-1
5.1.3 Support Zone	5-2
5.2 Hazard Briefing	5-2
5.3 Access Controls	5-2
5.4 Visitor Access	5-2
6.0 Decontamination	5-2 6-1
6.1 Personnel Hygiene and Decontamination Facilities and Procedures.....	6-1
6.2 Equipment Decontamination Facilities and Procedures	6-1
7.0 Site Monitoring	6-2 7-1
7.1 Air Monitoring.....	7-1
7.1.1 Real-Time Air Monitoring Frequency and Location	7-1
7.1.2 Integrated Personal Exposure Monitoring.....	7-1
7.2 Monitoring of Physical Hazards.....	7-1
8.0 Employee Training	8-1
8.1 Tailgate Safety Meetings	8-1
8.2 Hazardous Waste Training.....	8-1
8.3 Hazard Communication	8-1
8.4 Site-Specific Training	8-1
8.5 First Aid and Cardiopulmonary Resuscitation	8-2
9.0 Medical Surveillance Program.....	8-2 9-1

Table of Contents (continued)

10.0	Emergency Response Plan and Contingency Procedures	9-1 10-1
10.1	Project Superintendent	10-1
10.2	Site Health and Safety Specialist	10-1
10.3	List of Emergency Contacts and Notification.....	10-1
10.4	Fire Control	10-1
10.5	Site Evacuation Procedures.....	10-2
10.6	Spills or Leaks.....	10-3
10.7	Medical Emergency Response	10-3
10.8	Personal Exposure or Injury.....	10-3
10.9	List of Emergency Contacts and Notifications.....	10-4
11.0	References.....	11-1

List of Tables

Table 1	Chemical Properties and Exposure Limits For Contaminants in Site 25
Table 2	Action Levels

List of Figures

Figure 1	Installation Restoration Site 25 Exclusion Zone and Muster Location Map
Figure 2	Site Map and Route to Nearest Hospital

List of Attachments

Attachment 1	Site-Specific Health and Safety Plan Amendment Form
Attachment 2	Emergency Telephone Numbers
Attachment 3	Activity Hazard Analyses
Attachment 4	Material Safety Data Sheets

Acronyms and Abbreviations

AHA	activity hazard analysis
CCR	California Code of Regulations
CIH	Certified Industrial Hygienist
CPR	cardiopulmonary resuscitation
CRC	contaminant reduction corridor
CRZ	contamination reduction zone
EZ	exclusion zone
HSO	Health and Safety Officer
IR	Installation Restoration
IT	IT Corporation
MSDS	material safety data sheets
NAS	Naval Air Station
PAH	polycyclic aromatic hydrocarbon
PHSP	Program Health and Safety Plan
PPE	personal protective equipment
PS	Project Superintendent
SHSP	Site Health and Safety Plan
SHSS	Site Health and Safety Specialist
SZ	support zone

Policy Statement

IT Corporation maintains a policy of providing a safe and healthful work environment for all employees and subcontractors. No phase of operations or administration is afforded greater importance than injury and illness prevention. Safety shall take precedence over expediency or shortcuts, and all reasonable precautions shall be taken to reduce the possibility of injuries, illnesses, or accidents.

This Site Health and Safety Plan, in conjunction with the IT Corporation *Program Health and Safety Plan for Environmental Remedial Actions, Contract No. N62474-98-D-2076*, describes the procedures that IT will follow during project operations. Operational changes that could affect the health or safety of personnel, the community, or the environment will not be made without the prior approval of the IT Program Certified Industrial Hygienist. The provisions of this Site Health and Safety Plan are mandatory for all IT Corporation personnel, Project Managers, and subcontractor personnel.

Objective

The objective of this Site Health and Safety Plan (SHSP) is to provide the guidelines for the contract task orders issued under contract with the Department of the Navy, Engineering Field Activity-West. The procedures and guidelines contained herein are based on the best information available at the time of the plan's preparation. This SHSP describes the specific health and safety requirements and procedures that IT will use while conducting fieldwork.

A SHSP is developed for each contract task order. In combination with the Program Health and Safety Plan and IT Corporation's Health and Safety Policies and Procedures Manual, the SHSP serves as the Code of Safe Work Practices. Each of these documents are required to be on site and available for immediate reference. Collectively, they contain the essential elements of each project site's Health and Safety program. Section 1.0 of this SHSP describes the project site and the scope of work.

Changes to the SHSP must be approved by the Health and Safety Officer, Health and Safety Manager and the Project Manager or Project Superintendent, and recorded on the Site Health and Safety Plan Change Approval Form (see Attachment 1). The Navy Technical Representative may acknowledge the change but is not required to sign the form. The Project Health and Safety Manager will forward a copy of the SHSP Change Approval Form to the Contracting Officer.

1.0 Site Description and Scope of Work

1.1 Site Description

Alameda Point is a former U.S. Navy installation, located at the western end of Alameda Island within the San Francisco Bay, California. The installation, formerly known as Naval Air Station (NAS) Alameda, served as a Naval aircraft maintenance, repair, and refit center and as a base of operation for Naval surface craft before World War II until its closure in 1997. During its operational life, NAS Alameda included two large tenants: the Navy Public Works Center and Naval Aviation Depot Alameda. Upon closure in April 1997, NAS Alameda was renamed Alameda Point in a reorientation of the facility towards civilian use.

The 42-acre installation known as Operable Unit 5 is shown on Figure 1, "Installation Restoration Site 25 Exclusion Zone and Muster Location Map." Operable Unit 5 consists of land Parcels 181 (Coast Guard Housing Area), 182 (Estuary Park or Installation Restoration [IR] Site 25), and 183 (Coast Guard Housing Management Office). Approximately 40 percent of the site area are covered with structures and cement or asphalt paving, the remainder of the site is open space, covered with vegetation and soil. The site is bordered by the Fleet and Industrial Supply Center Oakland Alameda Annex Facility (Alameda Annex) to the north and east, Alameda Point Environmental Baseline Survey Parcels 178 through 180 to the south, and privately held property to the west. A set of railroad tracks is immediately north of the site. Todd Shipyard borders the site to the northwest.

During the course of environmental investigations in the vicinity of NAS Alameda and at IR Site 25, organic chemical analyses have revealed the presence of polycyclic aromatic hydrocarbons (PAH) in the soil and groundwater. The fill material used to create portions of Alameda Island, where there were historically marshes or shallow bay, has been identified as contaminated with PAHs. These PAHs are believed to have originated from historical industrial activities in adjacent areas and are ubiquitous in the fill material. Currently, investigations are being conducted at IR Site 25 to collect data and fill data gaps to assist with risk assessment activities and to further characterize the concentrations of inorganic chemicals in the fill.

1.2 Scope of Work

This project is a field treatability study that is intended to assess treatment of PAH contamination in shallow soils at IR Site 25 at Alameda Point, Alameda, California by in-situ chemical oxidation. The PAH soil contamination was derived from contaminated sediments dredged from San Francisco Bay, beginning in the early 1900s. The need to assess PAH treatment is driven by

the fact that the PAHs are located at shallow depths within a residential area. Furthermore, options evaluated to date for removing the potential health hazard associated with the PAHs involve either capping or excavation of the PAH contaminated soils. Implementing these options in a residential area may pose significant logistical and technical challenges and limitations. Therefore, the U.S. Navy has been seeking to determine if alternative treatment methods are available to remove the PAHs from the soil. One such alternative is in-situ chemical oxidation with potassium permanganate (see Section 3.1 for Activity Hazard Analysis).

2.0 Responsibilities

Project personnel are responsible for their own health and safety, for completing tasks in a safe manner, and for reporting any unsafe acts or conditions to their supervisor and the Project Superintendent (PS). All persons on site are responsible for continuous adherence to health and safety procedures during the performance of any project work. In no case may work be performed in a manner that conflicts with the intent of, or the inherent safety precautions expressed in this Site Health and Safety Plan (SHSP). After due warning, persons who violate procedures or work rules may be dismissed from the site, be terminated, or have their contract revoked. Blatant disregard or repeated infractions of health and safety policies are grounds for disciplinary action up to, and including, dismissal and/or removal from the project.

All IT Corporation (IT) and subcontractor personnel are required to read and acknowledge their understanding of this SHSP. All project personnel are expected to abide by the requirements of this SHSP and to cooperate with project management and safety representatives to ensure a safe and healthful work site. Site personnel are required to immediately report any of the following to the PS:

- Accidents and injuries, no matter how minor
- Expected or uncontrolled release of chemical substances
- Any sign or symptoms of chemical exposure
- Any unsafe or malfunctioning equipment
- Any changes in site conditions that may affect the health and safety of project personnel

Key project personnel are identified in Attachment 2, "Emergency Phone Numbers", of this SHSP.

3.0 Project Hazard Analysis

3.1 Activity Hazard Analysis

The activity hazard analysis (AHA) identifies potential safety, health, and environmental hazards and identifies measures to protect personnel, the community, and the environment. The AHA describes the sequence of work, the specific hazards anticipated, and the control measures that will be used to minimize or eliminate each hazard. Attachment 3, "Activity Hazard Analyses", contains an AHA for each major task associated with this project and is supplemented by the following sections.

IT Corporation will perform various tasks associated with the remedial actions at Alameda Point. The various remedial actions may include one or more of the following major tasks, which are also detailed by AHA (Attachment 3):

- Mobilization/demobilization
- Delivery and storage of hazardous chemicals
- Chemical handling/mixing/injection
- Soil and water sampling
- Groundwater well drilling, installation, and monitoring
- Spill and emergency response
- Site restoration
- Decontamination of equipment
- Tilling contaminated soils
- Low-pressure chemical injection
- Waste management

All employees have the right and duty to stop work when conditions are unsafe, or when established safety procedures are being disregarded. Whenever an employee determines that workplace conditions present an immediate uncontrolled risk of injury or illness, immediate resolution with the appropriate supervisor shall be sought. Should the supervisor be unable or unwilling to correct the unsafe conditions, the employee is authorized and required to issue a Stop Work Order in accordance with SH040, "Stop Work Authority" (IT, 2000). The specific activity or operation in question shall be discontinued until the issue is resolved.

3.2 Chemical Contaminants of Concern

Chemicals of concern are presented in Table 1, "Chemical Properties and Exposure Limits For Contaminants in Site 25." The State of California Safe Drinking Water and Toxic Enforcement

Act of 1986 (Proposition 65) requires notification of all persons who may be exposed to substances that have been determined by the State of California to cause cancer, birth defects, or other reproductive harm.

Table 1, "Chemical Properties and Exposure Limits For Contaminants in Site 25", identifies the properties and exposure limits of those contaminants of concern that may pose a significant health risk to site workers.

3.3 Material Safety Data Sheets

Material Safety Data Sheets (MSDS) are provided in Attachment 4, "Material Safety Data Sheets", for all materials that may be used during the course of project operations.

3.4 Confined Spaces

Confined space entry is not anticipated.

4.0 Personal Protective Equipment

The initial levels of personal protective equipment (PPE) required for project tasks are specified in the AHAs given in Attachment 3, "Activity Hazard Analyses."

4.1 Personal Protective Equipment Upgrade/Downgrade

As site activities progress, levels of PPE are subject to change or modification. Personal protective equipment may be upgraded when action levels are exceeded or whenever the need arises to protect the safety and health of site personnel. Personal protective equipment level upgrades or downgrades are customarily communicated between the Program CIH and the Site Health and Safety Officer and are based on the results of air sampling data. Levels of PPE will not be downgraded without prior approval from the Program Certified Industrial Hygienist (CIH).

No work requiring Level B PPE will be permitted without the authorization and concurrence of the Program CIH. No work requiring Level A will be permitted without the authorization and concurrence of the Program CIH and the Vice President of Health and Safety.

4.2 Respirator Cartridge Changeout Schedule

Should Level C PPE become necessary, a respirator cartridge change out schedule will be determined based on air monitoring data, the chemicals of concern, and the cartridge service life program supplied by the cartridge manufacturer. As a minimum, respirator cartridges will be changed at the end of each shift or when a contaminant warning property, such as odor or irritation is detected inside the respirator.

5.0 Site Control

This section presents details on the access control mechanisms, briefing requirements, and tracking mechanisms that will be instituted to maintain site control.

5.1 Work Zones

To prevent migration of contamination caused through tracking by personnel or equipment, work areas and PPE are clearly specified prior to beginning operations. Each site will be set up separately taking into consideration, the working space, the type of contamination, and the activities to be performed. This access control may require fences, barricades, traffic control devices, use of flaggers, caution tape, and other means to keep the site secure and to provide a visual barrier to help keep the curious or the public from entering the site. For sites requiring modified Level D or higher, the work area will be divided into three work zones based on the exposure to contaminated materials or anticipated hazards associated with the work: an exclusion zone (EZ), a contamination reduction zone (CRZ), and a support zone (SZ).

5.1.1 Exclusion Zone

The EZ will consist of areas where inhalation, oral contact, or dermal contact with contaminants may be possible (Figure 1, "Installation Restoration Site 25 Exclusion Zone and Muster Location Map"). This zone will be established at least 10 feet from the hazardous waste activities. The EZ perimeter may be indicated with barricade tape, usually red in color, or the entire area may be fenced to restrict entry to the area to those individuals with the proper training, medical certification, and PPE.

5.1.2 Contamination Reduction Zone

The CRZ, or transition zone, will be established between the EZ and SZ. The CRZ, where possible, will extend 20 feet beyond in all directions from the EZ. In this area, personnel will begin the sequential decontamination process required to exit the EZ. To prevent off-site migration of contamination and for personnel accountability, all personnel will enter and exit the EZ through a corridor in the CRZ. The corridor between these two zones is called the contaminant reduction corridor (CRC). The zones will be delineated with yellow barricade tape.

In the CRC, both personnel and equipment decontamination will be performed. Personnel decontamination will require removal of PPE and hand washing. Tools and materials used in this area will be moved to a station set up for that purpose. Some tools and materials may be disposable, in which case they will be placed in the container set up in the CRC.

5.1.3 Support Zone

The SZ will consist of a clearly marked area where the support equipment and sanitation facilities (i.e., toilets, drinking, and washing water) are staged. Smoking, drinking, and eating will be allowed only in designated areas in the SZ. An emergency eyewash will be staged in this area.

5.2 Hazard Briefing

No person will be allowed on the site during site operations without first being given a site hazard briefing. In general, the briefing will consist of a review of this SHSP and the tailgate safety meeting. All persons on the site, including visitors, must sign the SHSP Acknowledgement Sheet (page vii of this SHSP) and the tailgate safety meeting form. The tailgate safety meetings will be held daily before site activities begin.

5.3 Access Controls

The HSO and the PS will establish the physical boundaries of each zone and shall instruct all workers and visitors on the limits of the restricted areas. No one will be allowed to enter the restricted area without the required protective equipment for that area. The PS will ensure compliance with all restricted area entry and exit procedures.

The PS shall also designate a decontamination point for personnel to exit from the contaminated area and to enter into the clean area where personnel may rest and drink.

5.4 Visitor Access

Only authorized visitors will be allowed access to the EZ. Visitors requiring access to the EZ will be escorted by IT personnel and will be required to

- Submit proof of current HAZWOPER training pursuant to 8 California Code of Regulations (CCR) 5192 (e)
- Submit documentation of a medical certification pursuant to 8 CCR 5192 (f)
- Use the protective equipment designated for the site

Access to EZs will be denied if any one of these conditions are not met.

6.0 Decontamination

See Section 7.0 of the Program Health and Safety Plan (PHSP) (IT, 2000) for decontamination procedures for project personnel and equipment. Additional site-specific decontamination procedures are given below.

6.1 Personnel Hygiene and Decontamination Facilities and Procedures

Personnel decontamination will be established by IT on site to ensure that personnel maintain a high degree of personal hygiene and to minimize the possibility of exposure to chemical hazards.

A personnel decontamination area will be established in the CRZ immediately outside the EZ to facilitate decontamination and PPE removal. All personnel exiting the EZ will pass through the decontamination area and remove any contamination.

Personnel are required to wash hands, face, and other exposed skin areas before leaving the CRZ for breaks or lunch. With the exception of work in the SZ, no disposable work clothing, shoes, or boots will be worn or carried out of the CRZ. Boots and respirators will be decontaminated before being taken into the SZ.

6.2 Equipment Decontamination Facilities and Procedures

Any item or vehicles taken into an EZ must be assumed to be contaminated and must be carefully inspected and/or decontaminated before leaving that particular EZ. A visual inspection of the frame and tires of all vehicles and equipment leaving an EZ will be completed. For a vehicle or equipment to pass inspection, it must be in broom-clean condition, water washed, and free of loose dirt or sludge material on tailgates, axles, wheels, buckets, and so on.

A steam pressure washer will be on site so that any vehicles or equipment can be steam cleaned if the Program CIH or HSO deem necessary. All pressure-washing activities will be conducted in accordance with Health and Safety Operating Procedure 303, "Pressurized Water Cleaning and Cutting Equipment" (IT, 2001).

The equipment decontamination area will be used to remove soil from all equipment leaving the work area. Decontamination procedures are covered in detail in the FSP. A special "clean area" will be used by personnel who must come in contact with equipment during vehicle maintenance and repair. All equipment requiring maintenance or repair will be staged in a CRZ before servicing.

Personnel assigned to vehicle decontamination will wear the protective equipment, clothing, and respiratory equipment consistent with this SHSP. Seats and flooring in equipment and vehicles that are to be used in the EZ will be covered with disposable polyethylene to the greatest extent possible.

7.0 Site Monitoring

This section details the monitoring requirements for airborne contaminants and physical hazards.

7.1 Air Monitoring

Personal air monitoring is essential to ensure that all field personnel are adequately protected from airborne contaminants. The action levels specified in Table 2, "Action Levels", have been established based on contaminants of concern, the potential routes of entry, duration of exposure, and the permissible exposure levels established by the California Division of Occupational Safety and Health, and the immediately dangerous to life or health levels established by National Institute for Occupational Safety and Health (1994).

7.1.1 Real-Time Air Monitoring Frequency and Location

Requirements for real-time air monitoring for each activity are detailed in the activity hazard analyses given in Attachment 3, "Activity Hazard Analyses."

7.1.2 Integrated Personal Exposure Monitoring

Integrated breathing zone air sampling including collection on activated charcoal and analysis by gas chromatography may be conducted at the discretion of the Project CIH.

7.2 Monitoring of Physical Hazards

The Site Health and Safety Specialist (SHSS) may monitor physical hazards such as noise, temperature, wind speed, and dust under the direction of the Program CIH. The specific requirements for monitoring noise and evaluating heat and cold stress are discussed in detail in the PHSP as well as in the IT *Health and Safety Policies and Procedures Manual* (2001).

8.0 Employee Training

This section details the training requirements for personnel who will be performing field work or who will otherwise be involved in on-site activities.

8.1 Tailgate Safety Meetings

Prior to the start of the project, all personnel will participate in an initial tailgate safety meeting. During the initial tailgate safety meeting, the PHSP and this SHSP will be discussed. The PS will ensure that the anticipated site hazards are summarized and explained to all personnel, and that those personnel are aware of the precautions they must take to minimize their exposure to the hazards. Tailgate safety meetings will be held at the start of each work shift. All new employees will be required to attend a Site Health and Safety orientation. Attendance records and meeting notes will be maintained with the project file.

8.2 Hazardous Waste Training

All personnel entering the EZ or CRZ will have completed at least 40 hours of hazardous waste operations training with annual refreshers, and supervisors will have had an additional 8-hour supervisory training as required by Title 8, California Code of Regulations, Section 5192 (e). Additional job or function-specific training requirements are specified in Attachment 3, "Activity Hazard Analyses."

8.3 Hazard Communication

All personnel performing field activities will receive basic hazard communication training. This training involves a review of the IT written hazard communication program (IT Health and Safety Procedure HS060 [2001]), MSDSs for chemicals used on site, container labeling, and chemical health hazards. Material Safety Data Sheets will be obtained for all materials purchased or brought on site that require a MSDS, and the MSDS will be kept on site with this SHSP.

8.4 Site-Specific Training

Site-specific training will be accomplished through an initial review of this SHSP by the SHSS and through the daily tailgate safety meetings. Attendance for such training will be tracked by obtaining signatures of all attendees and will be documented in the project files.

8.5 First Aid and Cardiopulmonary Resuscitation

At least two employees, current and certified in first aid and cardiopulmonary resuscitation (CPR) will be assigned to the project. At least one of these will be on the site whenever operations are ongoing. Where multiple work groups are dispersed throughout a project site, more than two employees will be current and certified in first aid and CPR. The extent of coverage will be determined relative to the number of employee groups. First aid trained personnel will also be trained in bloodborne pathogen hazards. IT Corporation requires refresher training in first aid and CPR for such individuals to maintain a current certificate. The SHSS will be current and certified in first aid and CPR training.

9.0 Medical Surveillance Program

IT Corporation uses the services of Health Resources for medical surveillance requirements for all projects. All IT personnel and IT subcontractors working on site within the CRZ or EZ are required to have completed an occupational medical examination within the last 12 months as specified by 8 CCR 5192(f). Such individuals are also required to have written clearance in their record to work on hazardous waste sites and to wear a respirator if required by the job.

10.0 Emergency Response Plan and Contingency Procedures

Site personnel must be prepared to respond and act quickly in the event of an emergency. Emergency preparedness and response procedures will aid in protecting site workers and the surrounding environment. Preplanning measures will include employee training, fire and explosion prevention and protection, chemical spill and discharge prevention and protection, and safe work practices to avoid personal injury or exposure. These items will be discussed in the daily tailgate safety meetings.

10.1 Project Superintendent

At all times during scheduled work activities, a designated PS will be present on the site. This individual is responsible for implementing any emergency response or contingency procedures. Depending upon the circumstances, and time permitting, the PS will review proposed response actions with the SHSS.

10.2 Site Health and Safety Specialist

The SHSS is responsible for implementing, communicating, and enforcing health and safety policies and procedures during the course of the project. The SHSS will also assist in the evaluation of health and safety concerns with respect to environmental releases and emergency response actions. In the event of an injury, contact the Concord Health and Safety Administrator for notification of the medical incident and reporting of it to the Health Resource case manager.

10.3 List of Emergency Contacts and Notification

The PS and SHSS will be notified immediately in the event of an emergency. The PS will immediately evaluate the incident and, if necessary, notify the fire department and other emergency contacts listed in Attachment 2, "Emergency Telephone Numbers."

10.4 Fire Control

In the event of a fire or explosion, or imminent danger of fire or explosion, all activities will halt, and the fire department listed in Attachment 2, "Emergency Telephone Numbers", will be notified immediately. If it is safe to do so, site personnel may use fire-fighting equipment available on site to remove and isolate flammable or other hazardous materials, which may contribute to the fire.

The following measures will be implemented during site activities to minimize the risk of fire and/or explosion:

- Smoking will be prohibited on site except in designated smoking areas
- Good housekeeping procedures will be required on site
- Material storage methods will comply with manufacturers' recommendations
- Flammable liquids will be stored in approved containers only
- All storage, handling, or use of flammable and combustible materials will be conducted by trained personnel only
- Entry and exit pathways will be kept clear of debris or obstacles
- Work areas will be cleared of excess vegetation and obstructions
- Hot Work Permits will be required on site

10.5 Site Evacuation Procedures

Prior to field activities, the PS will determine emergency egress routes and discuss them with all personnel who will be conducting fieldwork. Initial planning includes establishing emergency warning signals and evacuation routes in case of an emergency. The site route map to the hospital is located in Figure 2, "Site Map and Route to Nearest Hospital." The initial evacuation muster points and EZs are shown on Figure 1, "Installation Restoration Site 25 Exclusion Zone and Muster Location Map." Usually these areas are located upwind of project areas. As work progresses, the HSO may alter these assembly areas depending on site and weather conditions. The site-specific evacuation procedures will be discussed in detail at the daily safety tailgate meeting.

The authority to order personnel to evacuate the work area rests with the PS and the SHSS. In the event that site evacuation is required, a continuous, uninterrupted air horn or vehicle horn (back up) will be sounded for approximately ten seconds. Personnel working in the EZ will immediately make their way to the muster point for a head count.

The EZ, evacuation route, and emergency equipment locations have been included on Figure 1, "Installation Restoration Site 25 Exclusion Zone and Muster Location Map." This map will be posted at each entrance to the EZ. During an emergency, the evacuation routes noted on this map should be followed. If conditions, such as wind direction or physical hazards do not allow access to the prescribed evacuation routes, evacuate by the safest route available.

10.6 Spills or Leaks

IT Corporation will maintain the following equipment and materials in the CRZ for use during spill response activities:

- Absorbent pads
- Granular absorbent material
- Polyethylene sheeting
- 55-gallon drums
- Shovels and assorted hand tools

10.7 Medical Emergency Response

In the event of severe physical or chemical injury, the fire department listed in Attachment 2, “Emergency Telephone Numbers”, will be summoned for emergency medical treatment and ambulance service. Once an initial assessment is made by the emergency medical technicians, the decision to use ground or air transportation for the victims will be made. Minor injuries will be treated on site by qualified first aid providers and if additional treatment beyond first aid is required, the injured personnel will be transported to the designated hospital. Transportation routes and maps will be placed in each site vehicle before on-site activities begin. Maps from the sites to applicable hospitals are included in Figure 2, “Site Map and Route to Nearest Hospital.”

10.8 Personal Exposure or Injury

In the event of personal exposure to contaminants, the following general guidelines will be adhered to:

- **Contact/Absorption** – Copious amounts of distilled or tap water will be used to flush contaminants from the skin for at least 20 minutes. Flushing will be started while removing contaminated clothing. If irritation persists, flushing will be repeated. The condition of the individual will be assessed, and transport to a medical center will be arranged if necessary. The victim shall not be transported unless the recommended flushing period has been completed or flushing can be continued during transport.
- **Inhalation** – The victim will be moved immediately to an area providing fresh air. The victim will be decontaminated and provided artificial respiration if necessary. The condition of the individual will be assessed, and transport to a medical center will be arranged if necessary.
- **Ingestion** – The local poison control center will be contacted immediately. The victim will be decontaminated, if necessary, and transported to a medical facility.

10.9 List of Emergency Contacts and Notifications

The SSHS will immediately evaluate the incident and, if necessary, notify emergency support services. If not previously notified, the Project Manager and location contact will be advised of the situation. Telephone numbers for emergency personnel are listed in Attachment 2, "Emergency Telephone Numbers." This list will be maintained with current contacts, and telephone lists will be kept along with other emergency telephone numbers in each site vehicle.

The information provided to the notified person should include the nature of the incident and the exact location and suspended materials involved. Information regarding the incident that should be reported to the emergency operator includes the following:

- Name and telephone number of the individual reporting the incident
- Location and type of incident
- Nature of the incident (fire, explosion, spill, or release) and substances involved
- Number and nature of medical injuries
- Movement or direction of spill/vapor/smoke
- Response actions currently in progress
- Estimate of quantity of any released materials
- Status of incident
- Other pertinent information.

11.0 References

California Code of Regulations, Title 8.

IT Corporation, 2001, *Health and Safety Policies and Procedures Manual*, Concord, California.

IT Corporation, 2000, *Program Health and Safety Plan for Environmental Remediation Actions*, Contract No. N62474-98-D-2076, Revision No. 0, June.

National Institute for Occupational Safety and Health, 1994, *Pocket Guide to Hazardous Chemicals*, U.S. Department of Health and Human Services, Publication 94-116, Washington, D.C.

TABLES

Table 1
Chemical Properties and Exposure Limits For Contaminants in Site 25

Contaminant (Synonyms)	Physical Description	Chemical & Physical Properties	Incompatibilities	Exposure Limits	Symptoms of Exposure
Benzene	Colorless liquid with aromatic odor	VP: 75 mm FP: 12°F LEL: 1.3% UEL: 7.1% IP: 9.25 eV	Chlorine, Bromine with iron, strong oxidizers	PEL: 100 ppb STEL: 1 ppm IDLH: 500 ppm	Irritation of eyes, nose, respiratory system, headache, nausea, dizziness, fatigue, anorexia, dermatitis, abdominal pain, bone marrow, depression
Benzo(a)pyrene And as surrogate for.. Benz(a)anthracene Benz(b)fluoranthene Benzo(e)pyrene Benzo(g,h,i)perylene Benzo(k)fluoranthene Chrysene Fluoranthene Indeno(1,2,3-cd)pyrene Pyrene Carbazole Benzo(b)thiophene	Yellow Crystals or black/dark-brown amorphous residue	VP: N/A FP: N/A LEL: N/A UEL: N/A IP: N/A	Strong Oxidizers	PEL: 100 ppb STEL: N/A IDLH: 80 ppm	Dermatitis, bronchitis, lung, kidney, and skin cancer
Carbon Disulfide	Colorless to faint yellow liquid with a sweet ether-like odor.	VP: 297 mm FP: -22°F LEL: 1.3% UEL: 50.0% IP: 10.08 eV	Strong Oxidizers chemically-active metals such as sodium, potassium and zinc, azides, rust, halogens, amines.	PEL: 1 ppm STEL: 10 ppm IDLH: 500 ppm	Dizziness, headache, poor sleep, nervousness, anorexia, low weight, psychosis, polyneuropathy, Parkinson-like syndrome, ocular changes, coronary heart disease, gastritis, kidney, and liver damage, eye and skin burn, dermatitis
Ethylbenzene	Colorless liquid with aromatic odor	VP: 10 mm FP: 55°F LEL: 1.3% UEL: 6.7% IP: 8.76 eV	Strong Oxidizers	PEL: 100 ppm STEL: 125 ppm IDLH: 800 ppm	Irritation of eyes, mucous membranes, dermatitis, headache, narcosis, coma

Table 1 (continued)
Chemical Properties and Exposure Limits For Contaminants in Site 25

Contaminant (Synonyms)	Physical Description	Chemical & Physical Properties	Incompatibilities	Exposure Limits	Symptoms of Exposure
Naphthalene And as surrogate for... 2-Methylnaphthalene Ancenaphthene Ancenaphthylene Fluorene Phenanthrene 2-Phenylnaphthalene 1-Methylnaphthalene	Colorless to brown solid with an odor of mothballs	VP: 0.08 mm FP: 174°F LEL: 0.9% UEL: 5.9% IP: 8.12 eV	Strong Oxidizers, chromic anhydride	PEL: 75 ppm STEL: N/A IDLH: 150 ppm	Eye irritation, excitement, headache, confusion, malaise, nausea, vomiting, abdominal pain, irritation to bladder, profuse sweating, jaundice, renal shutdown, and dermatitis.
1,4-Dichlorobenzene	Colorless to pale liquid with a pleasant, aromatic odor.	VP: 1.3 mm FP: 150°F LEL: 2.5% UEL: N/A IP: 8.98 eV	Strong Oxidizers,	PEL: 50 ppm STEL: IDLH: 200 ppm	Eye and skin irritation, blisters, liver and kidney damage
3,4-Dichlorobenzoic Acid Used as surrogate for... 9-Hexadecenoic Acid Dodecanoic Acid Hexadecanoic Acid Nonanoic Acid	White	VP: N/A FP: 207°C LEL: N/A UEL: N/A IP: N/A	Oxidizing agents	PEL: N/A STEL: N/A IDLH: N/A	Irritation to eyes, skin, irritation to respiratory tract, vomiting, nausea
Diesel (TPH)	Brown slightly viscous	VP: Varies FP: 125°F LEL: 0.6% UEL: 7.5% IP: Varies	Strong Oxidizers	PEL: N/A STEL: N/A IDLH: N/A	Headache, nausea, central nervous system, depression, anorexia, pulmonary adema, kidney and liver damage

Table 1 (continued)
Chemical Properties and Exposure Limits For Contaminants in Site 25

Contaminant (Synonyms)	Physical Description	Chemical & Physical Properties	Incompatibilities	Exposure Limits	Symptoms of Exposure
Ethyl Alcohol As surrogate for... 2-Ethyl-1-Hexanol Trimethyl-silanol	Clear odorless liquid with a weak ethereal, vinous odor	VP: 44 mm FP: 55°F LEL: 3.3% UEL: 19% IP: 10.47 eV	Strong Oxidizers, potassium dioxide, bromine pentafluoride, acetyl bromide, acetyl chloride, platinum, sodium	PEL: 1,000 ppm STEL: N/A IDLH: 3,300 ppm	Irritation to eyes, skin, nose, head, drowsiness, fatigue, narcosis, coughing, liver damage, anemia
Gasoline (TPH)	Clear liquid with a characteristic odor	VP: 38 – 300 mm FP: -45% LEL: 1.4% UEL: 7.6% IP: N/A	Strong Oxidizers such as peroxides, nitric acid and perchlorates	PEL: N/A STEL: N/A IDLH: N/A	Irritation of skin, eyes, respiratory system, headache, nausea, dizziness, coma, death, pulmonary edema, bronchitis
Isopropylbenzene	Colorless liquid with a characteristic odor.	VP: 2 mm FP: 129°F LEL: 1.9% UEL: 6.1% IP: 8.35 eV	Oxidizers, peroxides, halogens, catalysts for vinyl or ionic polymers, aluminum, iron chloride, copper.	PEL: 50 ppm STEL: 100 ppm IDLH: 700 ppm	Irritated eyes, skin, nose, throat, drowsiness, dermatitis
Phthalic Anhydride	White solid (flakes) or a clear colorless liquid with characteristic odor	VP: 0.0015 mm FP: 305°F LEL: 1.7% UEL: 10.5% IP: 10.00 eV	Strong oxidizers, water	PEL: 1 ppm STEL: N/A IDLH: 10 ppm	Irritated eyes, skin, upper respiratory system, congestion, nasal ulcer bleeding, bronchitis, bronchial asthma, dermatitis
Sulfur Oxide Used as surrogate for Sulfur	Colorless gas with a characteristic irritating, pungent odor	VP: 3.2 atm FP: N/A LEL: N/A UEL: N/A IP: 12.30 eV	Powdered alkali metals (such as sodium and potassium) water, ammonia, zinc, Al, brass, copper.	PEL: 10 ppm STEL: N/A IDLH: N.D.	Irritation to eyes, nose, throat, choking, coughing, reflex bronchoconstriction.

Table 1 (continued)
Chemical Properties and Exposure Limits For Contaminants in Site 25

Contaminant (Synonyms)	Physical Description	Chemical & Physical Properties	Incompatibilities	Exposure Limits	Symptoms of Exposure
Toluene	Colorless liquid with an aromatic odor like benzene	VP: 22 mm FP: 40°F LEL: 1.3% UEL: 7.1% IP: 8.82 eV	Strong Oxidizers	PEL: 100 ppm STEL: 150 ppm IDLH: 500 ppm	Dermatitis, weakness, fatigue, dizziness, euphoria, dilated pupils, photophobia
Xylene	Colorless liquid with an aromatic odor	VP: 7.9 mm FP: 81 to 90°F LEL: 1% UEL: 7% IP: 8.44 eV	Strong Oxidizers	PEL: 100 ppm STEL: 150 ppm IDLH: 900 ppm	Eye, nose, and throat irritation, dermatitis, corneal lesions, dizziness, poor equilibrium, anorexia, vomiting, abdominal pain

IDLH denotes immediately dangerous to life or health level established by the National Institute for Occupational Safety and Health.

PEL denotes permissible exposure limit expressed as an 8 hour time-weighted average, enforced by the California Division of Occupational Safety and Health.

STEL denotes short-term (15 minute) exposure limit enforced by the California Division of Occupational Safety and Health

VP denotes vapor pressure (millimeters mercury)

FP denotes flash point (degrees Fahrenheit [°F])

LEL denotes lower explosive limit (%)

UEL denotes upper explosive limit (%)

IP denotes ionization potential (electron volts: eV)

ppb denotes parts per billion

ppm denotes parts per million

N/A denotes not applicable

°C denotes degrees Celsius

mm denotes millimeters

TPH denotes total petroleum hydrocarbon

N.D. denotes non detect

**Table 2
Action Levels**

Contaminant	Action Level ^a	Required Action ^b
Dust	up to 5 mg/m ³ BZ	Level D
	>5 mg/m ³ BZ	Increase dust suppression efforts and/or upgrade to Level C
VOCs by PID	> up to 50 ppm BZ	Use colorimetric detector tube for benzene
	> 100 to 500 ppm BZ	Use colorimetric detector tube for petroleum hydrocarbons, or gasoline
Benzene by colorimetric detector tube	up to 1 ppm BZ	Level D
	> 1 ppm BZ	Upgrade to Level C
	> 50 ppm BZ	Stop work, contact CIH for Level B approval ^c
Petroleum Hydrocarbons by colorimetric detector tube	up to 300 ppm BZ	Level D
	> 300 ppm BZ	Upgrade to Level C
	> 1,000 ppm BZ	Contact CIH for level B approval
O ₂	< 19.5% or > 23.5%	Stop work; increase ventilation, contact CIH ^c
LEL	> 10% of LEL	Stop work; increase ventilation, determine cause, contact CIH ^c

^a Five excursions above the action level in any 15-minute period or a sustained reading in excess of the action levels for 5 minutes will trigger a response.

^b Frequency of air monitoring may be adjusted by the CIH after sufficient characterization of site contaminants has been completed, tasks have been modified, or site controls have proven effective.

^c Contact with the Program CIH must be made before work continues. The Program CIH may then initiate integrated air sampling along with additional controls.

BZ denotes breathing zone.

CIH denotes Program Certified Industrial Hygienist.

LEL denotes lower explosive limit.

mg/m³ denotes milligrams per cubic meter.

ppm denotes parts per million.

PID denotes photoionization detector.

O₂ denotes oxygen.

VOC(s) denotes volatile organic compound(s).

No one is permitted to downgrade levels of personal protective equipment without authorization from the Program Certified Industrial Hygienist.

FIGURES

IMAGE X-REF OFFICE DRAWN BY CHECKED BY APPROVED BY DRAWING NUMBER
 --- ALA/BASE CONCORD BU 6/29/01 ALE 6/21/01 BKM 827557-B7



ESTUARY PARK

BRAVENUE

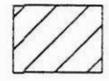
MUSTER POINT

CHEMICAL OXIDATION TREATABILITY STUDY AREA

BOAT STORAGE

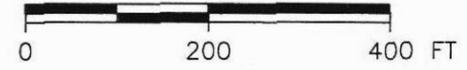
IR SITE 25

LEGEND



EXCLUSION ZONE

SCALE



DEPARTMENT OF THE NAVY
 SOUTHWEST DIVISION
 NAVAL ENGINEERING COMMAND
 SAN DIEGO, CALIFORNIA

FIGURE 1
 INSTALLATION RESTORATION SITE 25
 EXCLUSION ZONE AND MUSTER POINT
 LOCATION MAP
 ALAMEDA POINT, CTO 076
 ALAMEDA, CALIFORNIA

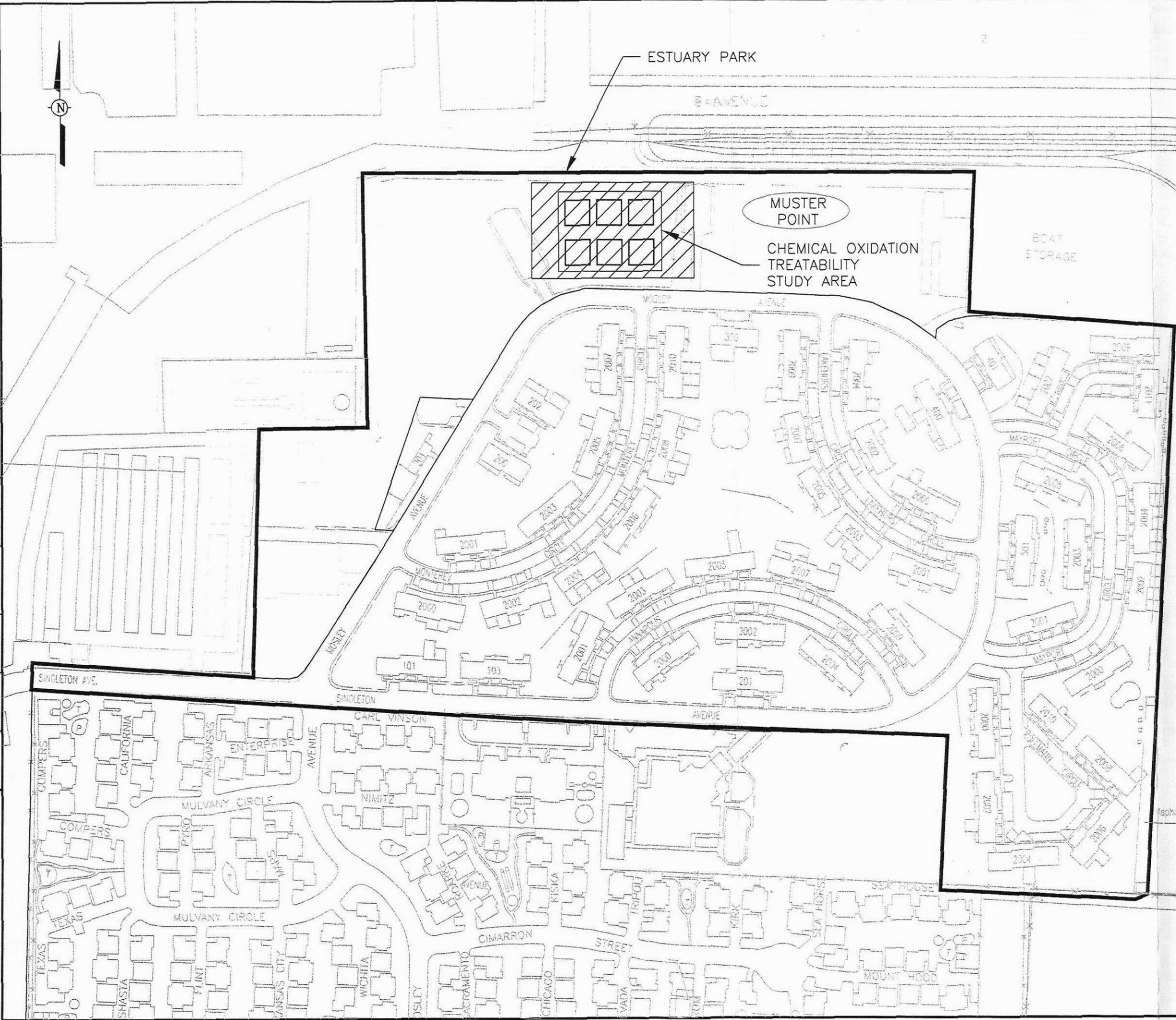
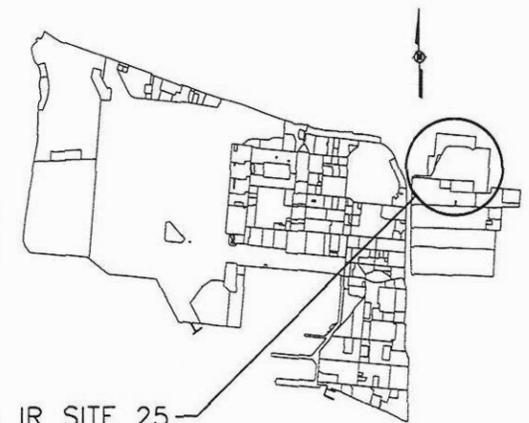
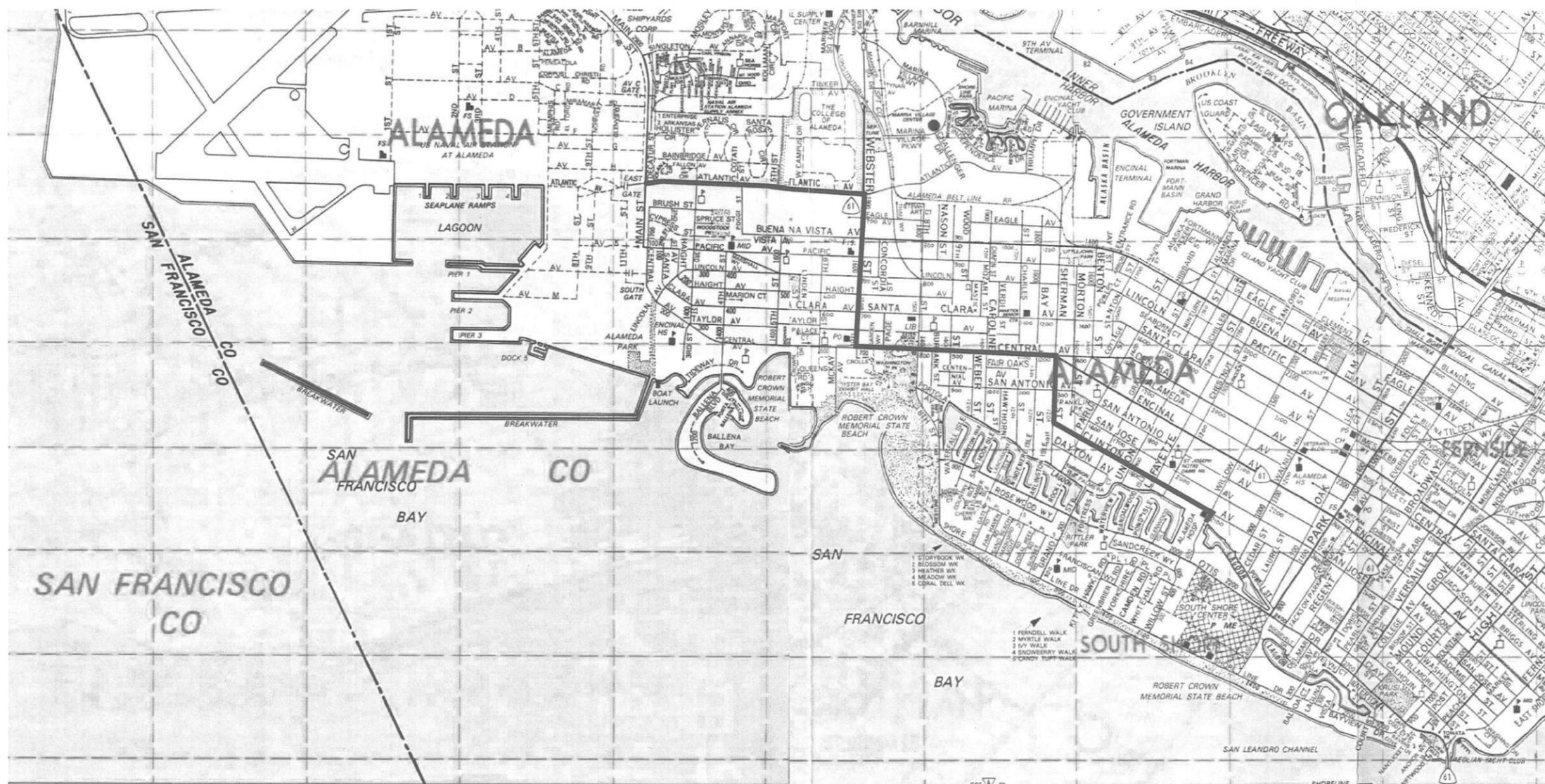


IMAGE X-REF OFFICE DRAWN BY CHECKED BY APPROVED BY DRAWING NUMBER
 PH1.JPG PH2.JPG R. LANGSTON 8/6/01 ALE 8/6/01 DLS 827557-B9



DIRECTIONS TO ALAMEDA HOSPITAL

FROM THE MAIN GATE,
 TAKE MARINER SQUARE LOOP TO WEBSTER ST.
 (HWY 61) AND TURN RIGHT. AFTER APPROXIMATELY
 8 BLOCKS TURN LEFT (EAST) ON CENTRAL AVE.
 CONTINUE ON CENTRAL AVE., TURN RIGHT ON SHERMAN ST.
 (SOUTH) FROM SHERMAN ST., TURN LEFT ON CLINTON AVE.
 CONTINUE ON WILLOW ST., TURN RIGHT TO HOSPITAL,
 CORNER OF CLINTON AND WILLOW ST.

ALAMEDA HOSPITAL
 2070 CLINTON AVE.
 (510) 523-4357

REFERENCE:
 THOMAS BROS. MAPS
 NOT TO SCALE



ALAMEDA POINT
 ALAMEDA, CA

FIGURE 2
 SITE AND HOSPITAL
 ROUTE MAP

ALAMEDA POINT
 ALAMEDA, CALIFORNIA

ATTACHMENT 1
SITE-SPECIFIC HEALTH AND SAFETY PLAN AMENDMENT FORM

**ATTACHMENT 2
EMERGENCY TELEPHONE NUMBERS**

Emergency Phone Numbers

Contact	Phone Number
Alameda Fire Department Emergency	911 (from land line)
Alameda Police/Security Department Emergency	911 (from land line)
Alameda HAZMAT Response Emergency	911 (from land line)
Hospital: Alameda Hospital Emergency Room Information Directions To Alameda Hospital: From the main gate, take Mariner Square Loop to Webster St. (Hwy 61) and turn right. After approximately 8 blocks, turn left (East) on Central Ave. Turn right onto Sherman St. (south). After two blocks turn left on Clinton (SE). The hospital is 6 blocks down Clinton on the right, on the corner of Willow and Clinton.	911 (510) 523-4357
Key Project and IT Corporation Personnel	
IT Corporation Program Manager: Stewart Bornhoft	(925) 288-2081
Program Certified Industrial Hygienist (CIH): Fred Mlakar, CIH	(949) 660-5413 Pager: (949) 451-7658
Project Manager: Tony Searls	(509) 366-2748
Site Health & Safety Specialist: Lynn Norman	(510) 525-3838
Site Health & Safety Specialist Alternate: Chuck Holman	(925) 288-2155
Site Health & Safety Technician: Lynn Norman	To Be Determined
Health & Safety Administrator: Carey Von Williams	(925) 288-2378 Pager: (888) 537-9657
Occupational Physician: Health Resources	(800) 350-4511
Medical Incident Reporting: Virginia Gutierrez Health Resources	(508) 647-0923 (508) 651-8939
Navy Contact: ROICC: Rob Perricone	(510) 749-5942
Navy Contact Alternate: Shirley Ng	(510) 749-5939
Navy On-Scene Coordinator: Steve Eddie	(510) 749-5952