FINAL REMEDIAL ACTION WORK PLAN
Implementation of Enhanced In Situ Bioremediation

INSTALLATION RESTORATION PROGRAM SITE 70
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

March 2008

Department of the Navy
Naval Facilities Engineering Command Southwest
San Diego, CA 92132

Environmental Multiple Award Contract
Contract Number N68711-04-D-1106, CTO 003
Document Control Number ECC-1106-0003-0002

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Prepared for:

Department of the Navy
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San Diego, CA 92132

Prepared by:

ECC
1240 Bayshore Highway
Burlingame, CA 94010

In association with:

2100 Main Street, Suite 150
Huntington Beach, CA 92648

Prepared under:
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Prepared by:

ECC
1240 Bayshore Highway
Burlingame, California 94010

in Association with

Geosyntec consultants
2100 Main Street, Suite 150
Huntington Beach, California 92648-2648

Prepared by: _____ Date: 3/18/08
David Major, Ph.D.
Geosyntec Consultants – Project Director

and _____ Date: 3/17/08
Mark Rogers, P.G.
ECC – Project Manager

March 2008

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ACRONYMS AND ABBREVIATIONS

%	percent
AOCs	areas of concern
APP	Accident Prevention Plan
ARARs	applicable or relevant and appropriate requirements
Bechtel	Bechtel Environmental, Inc.
bgs	below ground surface
Cal EPA	California Environmental Protection Agency
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
cm/sec	centimeters per second
COPCs	chemicals of potential concern
CTO	Contract Task Order
CVOCs	chlorinated volatile organic compounds
˚F	degrees Fahrenheit
Dhc/VCr	*Dehalococcoides* Vinyl Chloride Reductase Gene
DHG	dissolved hydrocarbon gases
DHS	Department of Health Services
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DON	Department of the Navy
DOT	Department of Transportation
DTSC	Department of Toxic Substances Control
ECC	Environmental Chemical Corporation
EISB	enhanced *in situ* bioremediation
ERSE	Extended Removal Site Evaluation
EVO	emulsified vegetable oil
EVS	Environmental Visualization Systems
Freon TF	trichlorotrifluoroethane
FS	Feasibility Study
FSB	First Sand Biobarrier
ft	feet
ft/ft	feet per foot
ft^3	cubic feet
GANNT	Schedule format
gal	gallon
Geosyntec	Geosyntec Consultants

ACRONYMS AND ABBREVATIONS (continued)

GIS	Geographic Information Systems
gpm	gallons per minute
HASP	Health and Safety Plan
HCl	Hydrochloric Acid
hr	hour
IDW	Injection Derived Waste
IR	Installation Restoration
IW	Injection Well
JEG	Jacobs Engineering Group
K	hydraulic conductivity
KB-1®	mixed consortia of dehalorespiring bacteria
Kg	kilogram
L	liter
LUC	land use controls
MCLs	maximum contaminant levels
µg/L	microgram per liter
mg/L	milligrams per liter
MNA	monitored natural attenuation
mV	millivolts
MW	Monitoring Well
NASA	National Aeronautics and Space Administration
NAVWPNSTA	Naval Weapons Station
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NAVFAC SW	Naval Facilities Engineering Command Southwest
NEPA	National Environmental Protection Act
OCHCA	Orange County Health Care Agency
OCWD	Orange County Water District
O&M	operation and maintenance
ORP	oxidation reduction potential
OSHA	Occupational Safety and Health Administration
PA	Preliminary Assessment
PCR	polymerase chain reaction
PMW	Performance Monitoring Well
POC	Point of Compliance
PVC	polyvinyl chloride
QA	quality assurance
QAO	Quality Assurance Officer
QC	quality control

ACRONYMS AND ABBREVATIONS (continued)

RA	Remedial Action
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDO	Remedial Design Optimization
RFS	Revised Feasibility Study
RI	Remedial Investigation
ROD	Record of Decision
ROI	radius of injection
ROICC	Resident Officer in Charge of Construction
RPM	Remedial Project Manager
RRSEM	Relative Risk Site Evaluation Model
RSE	Removal Site Evaluation
RT&E	Research, Testing, and Evaluation
RWQCB	Regional Water Quality Control Board
SAB	Source Area Biobarrier
SAP	Sampling Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SBNWR	Seal Beach National Wildlife Refuge
SCS	Soil Conservation Service
SHB	Shell Horizon Biobarrier
SOP	Standard Operating Procedures
SOW	Scope of Work
SPRP	Seal Beach Station Project Review Process
SSB	Second Sand Biobarrier
SWRCB	California State Water Resources Control Board
TCE	trichloroethene
TCGs	target cleanup goals
TDS	total dissolved solids
TOC	total organic carbon
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VFA	volatile fatty acids
VOCs	volatile organic compounds
WQCP	Water Quality Control Plan
WRD	Water Replenishment District of Southern California

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1. INTRODUCTION

1.1 Purpose and Scope

This Remedial Action Work Plan (RAWP) defines the technical and operational requirements for remediation of groundwater contaminated with chlorinated solvents at Naval Weapons Station (NAVWPNSTA) Seal Beach Installation Restoration (IR) Program Site 70 (IR Site 70), Seal Beach, California (Figure 1.1). Environmental Chemical Corporation (ECC), in collaboration with Geosyntec Consultants (Geosyntec), prepared this RAWP under contract N68711-04-D-1106, Contract Task Order (CTO) 003 to Naval Facilities Engineering Command, Southwest (NAVFAC SW).

NAVWPNSTA Seal Beach is an active federal facility that is being remediated under the IR Program. The station is not on the National Priorities List. The lead agency for remedial investigation (RI) and remedial action (RA) at this station is the Department of the Navy (DON). Regulatory agencies providing support and oversight include the California Environmental Protection Agency (Cal-EPA), Department of Toxic Substances Control (DTSC), and the California Regional Water Quality Control Board (RWQCB) Santa Ana Region.

The DON, NAVFAC SW, directs this remedial action in accordance with requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Upon review of the IR Site 70's operational history and site-specific groundwater data, the DON has determined that IR Site 70 groundwater contains elevated concentrations of trichloroethene (TCE) that require a response action. The DON has initiated the remedial action for the impacted groundwater at IR Site 70 to reduce potential threats to human health and the surrounding environment.

The purpose of this RAWP is to define the technical and functional requirements for remediation of groundwater contaminated with chlorinated solvents at IR Site 70. The scope of work (SOW) includes an enhanced *in-situ* bioremediation (EISB) treatment of the high concentration source area, use of passive *in-situ* biobarriers and monitored natural attenuation (MNA) to treat the dissolved-phase plume, and land use controls. The implementation, inspection, reporting, and enforcement of the land use controls will be conducted in accordance with the current NAVWPNSTA Seal Beach Remedial Design. An overview of the remedial process is presented in Section 1.2.

1.2 Overview of Remedial Action

Groundwater contamination at IR Site 70 exists in two distinct areas: (i) a source area with suspected residual dense, non-aqueous phase liquids (DNAPLs) and dissolved TCE concentrations exceeding 1,000 micrograms per liter (µg/L); and (ii) a dissolved-phase volatile organic compound (VOC) plume extending down-gradient in a south-southeasterly direction from the source. The areal extent of the dissolved TCE plume in groundwater as defined by Bechtel Environmental, Inc. (Bechtel) in the *Final Fifth Annual Groundwater Monitoring Report IR Sites 40 and 70, Naval Weapons Station Seal Beach, Seal Beach, California* (Bechtel, 2006) is approximately 4000 feet (ft) by 2200 ft, with vertical migration to depths of approximately 160 ft below ground surface (bgs). The water table is approximately 13 ft bgs.

The remedial approach for IR Site 70 was presented in the Revised Feasibility Study (RFS [Geosyntec, 2005]) and is summarized below and shown on Figures 1.2. In the suspected source area, EISB will be accomplished by injecting emulsified vegetable oil (EVO) and the dechlorinating culture KB-1® in a grid of injection wells, combined with a down-gradient biobarrier (source area biobarrier [SAB-1]). The dissolved-phase plume will be treated with five biobarriers installed in targeted hydrogeologic units, transecting the plume at a number of locations along the long axis of the plume (Figure 1.2). Two (2) biobarriers were installed in each of the First Sand (FSB-1 and FSB-2) and Shell Horizon (SHB-1 and SHB-3) hydrogeologic units and a single biobarrier was installed in the Second Sand (SSB-1) to treat TCE in their respective units. The design of the remediation system was based on the vertical and lateral extent of the 250 µg/L TCE plume (in order to avoid confusion in the remainder of the document, the 250 µg/L TCE plume will be referred to as the design basis plume). Each biobarrier consists of a number of injection wells spanning the width of the design basis plume that will be used to deliver EVO as a long-term electron donor and the dechlorinating culture KB-1® to facilitate a more rapid onset of complete reductive dechlorination of TCE to ethene (Figure 1.2). The dissolved-phase contaminants will be treated by EISB as groundwater flows through each biobarrier under ambient groundwater flow, and through MNA between the biobarriers.

Active remediation will be conducted within areas of TCE concentrations exceeding 200 µg/L. Active treatment consists of continued re-injection of EVO within the treatment areas (i.e., within the biobarriers and source zone). Active treatment will be terminated once the TCE concentrations in groundwater are reduced to below 200 µg/L. MNA will be employed after the active treatment phase until final cleanup goals are achieved. MNA will also be employed throughout the remainder of the plume not actively treated (i.e., where TCE concentrations are below 200 µg/L). It is estimated that active treatment of the dissolved-phase plume will be required for a maximum of 16 years (with shorter operation times for some biobarriers), followed by 35 years of

MNA to achieve target cleanup goals (TCGs). The duration of source area treatment cannot be accurately predicted due to the uncertainty of the mass estimates of DNAPL in the subsurface.

Site remedial activities involve the following major components:

- Installation of injection and monitoring wells (completed in 2007);
- Initial injections of EVO and KB-1®;
- Operation and maintenance, performance and MNA monitoring. Monitoring will consist of baseline sampling, bioremediation system performance monitoring, MNA monitoring, and point of compliance monitoring.
- Periodic maintenance of the biobarriers in the form of EVO re-injections, additional bioaugmentation, well rehabilitation, and other maintenance as needed.
- Installation of soil vapor monitoring points in the source area and monitoring of methane and hydrogen sulfide generated as a by-product of the bioremediation process.

Annual reviews of monitoring data will be conducted to assess biobarrier performance and the need for operation maintenance, plume migration, dechlorination activity, extent of microbial migration, changes to monitoring program based on trend analysis of monitoring data, and the adequacy of the remedial action to meet the TCGs. Annual reviews will be documented in a summary report issued to appropriate regulatory agencies. These reports may include suggested modifications to the cleanup program to increase remedial performance, changes to the monitoring program, and suggestions to reduce operation and maintenance (O&M) costs.

Documents referenced in order to develop this remedial work plan include the following:

- Final Groundwater Feasibility Study (FS) Report for IR Sites 40 and 70 (Bechtel, 2002);
- Final Revised Groundwater Feasibility Study (RFS) Report, Installation Restoration Site Program Site 70 (Geosyntec, 2005)
- Extended Removal Site Evaluation (ERSE) of IR Sites 40 and 70 (Bechtel 1999);

- Final Removal Site Evaluation (RSE) Report for the Research, Testing, and Evaluation Area, (Bechtel, 1996a);
- Summary of Results for the Relative Risk Site Evaluation Model (RRSEM) Data Collection Effort, (Bechtel, 1996b);
- Final Preliminary Assessment (PA) Report for the Research, Testing, and Evaluation Area, Naval Weapons Station Seal Beach, CA; (JEG, 1995)
- Final Fifth Annual Groundwater Monitoring Report IR Sites 40 and 70 (Bechtel, 2006)
- Record of Decision (ROD) Installation Restoration Program Site 70, Naval Weapons Station Seal Beach, Seal Beach, California (Geosyntec, 2006a);
- Final Remedial Design (RD) for IR Site 70 Enhanced In Situ Bioremediation, Naval Weapons Station Seal Beach, Seal Beach, California (Geosyntec, 2006b); and
- Pilot Study (Appendix D of the RD [Geosyntec, 2006b]), previously referred to as the Remedial Design Optimization (RDO) Investigation and Report.

1.3 Report Organization

The remainder of this document is organized as follows:

- Section 2 - Site Conditions and Background;
- Section 3 – Regulatory Framework;
- Section 4 – Remedial System Design;
- Section 5 – Land Use Controls
- Section 6 – Groundwater Monitoring Program;
- Section 7 – Full Scale Injection Operations;
- Section 8 - Waste Management;
- Section 9 - Reports;
- Section 10 - Project Management; and
- Section 11 – References.

2. SITE CONDITIONS AND BACKGROUND

2.1 Facilities and Site Conditions

IR Site 70 is located just south of Westminster Boulevard and east of Seal Beach Boulevard (Figure 2.1). IR Site 70 encompasses approximately 40 acres, but the groundwater plume extends beyond the site boundaries. Groundwater at IR Site 70 is impacted by the past use of chlorinated solvents (primarily TCE), with possible DNAPL and dissolved-phase chlorinated solvents reported by Bechtel National Inc. (Bechtel, 2002). Groundwater contamination extends from the water table near the source area to approximately 160 ft bgs. A site conceptual model was generated from the remedial investigation data and presented in the Feasibility Study (Bechtel, 2002).

IR Site 70, also known as the Research, Testing, and Evaluation (RT&E) area, consists of multistory office and production buildings, asphalt-paved parking areas, an assortment of aboveground tanks and attendant above- and below-ground piping distribution systems, and several concrete-lined sumps. From 1962 to 1973, the National Aeronautics and Space Administration (NASA) utilized the area for the design and manufacture of the Saturn II launch vehicle for the Apollo Program. Subsequent to NASA leaving the area, the United States Department of Energy and Garrett Engineering (Allied Signal) conducted pilot test assembly operations for a classified uranium enrichment process in portions of Building 112. These tests were conducted from 1980 to 1985 but did not include either the manufacture or enrichment of uranium. Currently, the building is used for storage, communications research, and office space.

The Removal Site Evaluation Report from Bechtel National, Inc. (Bechtel 1996a) for the IR Site 70 area addressed potential waste sources from:

- Bulkhead Fabrication Building 128;
- Vertical Assembly and Hydrotest Building 112;
- Pneumatic Test, Paint, and Packaging Building 122;
- Tool and Maintenance Building 130;
- Structural Test Tower; and
- Water Conditioning Plant.

Operations at these facilities included the use of diluted acids, VOCs including chlorinated solvents such as TCE, phenolic compounds, petroleum oils, sodium dichromate containing hexavalent chromium, detergents, metals containing paint wastes, and machine lubricating oil. Discharged wastewater contained high total dissolved solids (TDS), sodium, chloride, and had high or low pH.

2.2 Previous Investigations

In 1993, Jacobs Engineering Group (JEG) conducted a Preliminary Assessment of IR Site 70 (JEG 1995). Ten Areas of Concern (AOCs) were identified for further evaluation to assess the presence or absence of chemicals of potential concern (COPCs). These ten AOCs were identified based on historical activities, use of chemicals, and the likelihood of a potential threat to human health and the environment. The PA identified major COPCs as hexavalent chromium, TCE, phenolic compounds, trichlorotrifluoroethane (Freon TF), and heavy metals.

Bechtel conducted an RSE for the RT&E area (Bechtel 1996a) to address potential waste sources from IR Site 70. The RSE report recommended that process piping systems and facilities be decommissioned and that soil and groundwater in the area be investigated further (Bechtel 1996a). The report also recommended soil investigations for the presence of hexavalent chromium, vinyl chloride (VC), and heavy metals. Groundwater investigations were recommended to delineate the TCE plume and to determine a potential vadose zone source, as well as the nature and extent of hexavalent chromium, phenolic compounds, and heavy metals.

In 1996, soil and groundwater samples were collected at IR Site 70 to obtain analytical data necessary to populate a Relative Risk Site Evaluation Model (RRSEM) (Bechtel, 1996b). (By using data collected at NAVWPNSTA Seal Beach and 14 other bases, the RRSEM was used to assist in prioritizing funding for sites in the IR Program.) The samples indicated the presence of VOCs, semivolatile organic compounds, polychlorinated biphenyls, pesticides, and metals. Based on this and subsequent studies, including the ERSE of IR Sites 40 and 70 (Bechtel, 1999), the Navy determined that there was no immediate threat to the environment from groundwater at IR Site 70. The RI/FS (Bechtel, 2002) determined that groundwater at IR Site 70 was impacted and a remedial action was required to address the source area and dissolved-phase plume, based on a human health risk evaluation.

2.3 Physical Settings

NAVWPNSTA Seal Beach is situated at latitude 33° 45’ 27” N and longitude 118° 4’ 22” W, San Bernardino Baseline and Meridian. NAVWPNSTA Seal Beach is located within the Los Angeles-Orange County coastal plain. This northwest-trending structural basin is approximately 50 miles long and 20 miles wide with deposits as much as 20,000 ft thick. Basin morphology was developed through the mechanisms of folding, faulting, erosion, and fluctuating sea levels (JEG, 1995).

Most of the NAVWPNSTA Seal Beach lies on predominantly flat alluvial deposits in the southeastern portion of the Los Angeles Basin. The Los Angeles Basin is bounded on the north by the Santa Monica Mountains; on the northeast by the Repetto and Puente Hills; on the east and southeast by the Santa Ana Mountains and the San Joaquin Hills; and on the south, southwest, and west by the Palos Verdes Hills and the Pacific Ocean. The land at NAVWPNSTA Seal Beach slopes evenly from approximately 20 ft above sea level in the northwestern part of the NAVWPNSTA Seal Beach to sea level in the tidal flats of the Seal Beach National Wildlife Refuge (SBNWR) in the southeast. The most pronounced topographic feature at the NAVWPNSTA is part of Landing Hill on the southwest. Landing Hill reaches a maximum elevation of about 50 ft (JEG, 1995).

The area climate is classified as a marine-influenced southern California coastal region with mild winters that average 52 degrees Fahrenheit (°F) and summers that average 68 °F. Temperature ranges from winter lows in the 30s °F to summer highs in the 90s °F. Annual precipitation averages 12.5 inches, with approximately 90 percent occurring between the months of November and April. Although precipitation is low, a high humidity level is sustained because of the proximity of the Pacific Ocean (JEG, 1995). Prevailing winds average 3.8 miles per hour from the west. Occasional strong, dry winds from the northeast, known as the "Santa Anas," occur in the fall, winter, and early spring (JEG, 1995). Periodically, the region is subjected to a phenomenon called "El Nino," which brings unusually high precipitation, flooding, high winds, and temperatures outside the expected range. The NAVWPNSTA was subjected to this El Nino weather pattern in 1997 and 1998, resulting in extremely high winds, higher than normal tidal cycles, a rise in groundwater level, flooding, and ponding in otherwise dry areas.

2.4 Site Conditions

Two faults, the Seal Beach Fault and the Los Alamitos fault, traverse portions of the station. These two faults are part of the Newport-Inglewood fault zone. The Seal Beach fault is located in the southern portion of the Newport-Inglewood fault zone. It is a right lateral oblique fault with the south side displaced upward relative to the north side. Vertical displacement is approximately 5 ft in the upper Pleistocene units (Ebersold, 1997). Movement along the fault since or during recent alluvium deposition has not displaced recent sediments. On the station, the Seal Beach Fault has uplifted Upper Pleistocene deposits at Landing Hill and Hog Island, cutting diagonally across the station and parallel to the coast (JEG, 1995). Apparent movement is nearly vertical with the south side displaced upward relative to the north side. There is also evidence of apparent right lateral motion (Ebersold, 1997). The Los Alamitos Fault lies parallel to the Seal Beach Fault and about 2.25 miles northeast of the Alamitos Gap. The Los Alamitos Fault has little effect on the movement and quality of groundwater in the

Lower Pleistocene San Pedro Formation and is older than the active Seal Beach Fault (JEG, 1995).

Soils at the station contain abundant clay and silt and are poorly drained. Six soil types have been identified. The Bolsa series (JEG, 1995; SCS, 1978) covers approximately two-thirds of NAVWPNSTA Seal Beach including IR Site 70. These soils are moderately alkaline and calcareous and have developed from largely flat alluvial and coastal deposits. The soils extend to approximately 49 inches bgs and have moderate to slow permeability.

The sequence of the stratigraphy underlying NAVWPNSTA Seal Beach, from youngest to oldest, is:

- Recent Alluvium;
- Upper Pleistocene Lakewood Formation;
- Lower Pleistocene San Pedro Formation; and
- Pliocene Pico Formation.

The maximum thickness of Recent Alluvium deposits in the region is approximately 80 to 100 ft. The upper 50 ft consists of fine sands, silty clays, and clays, while the lower unit consists of sands and gravels, silty sands, silty clays, and clays.

Transitional, shallow marine and fluvial deposits of great variability are part of the Upper Pleistocene sand and clay deposits, starting at approximately 80 to 100 ft and continuing to depths beyond the scope of investigations at IR Site 70. Units are discontinuous and contain zones of high and low permeability. The maximum thickness of the Lakewood Formation is approximately 350 ft in the city of Lakewood (DWR, 1961).

NAVWPNSTA Seal Beach is located at the southwestern corner of the Orange County Basin. The Orange County Basin contains the Artesia, Gage, Hollydale, Jefferson, Lynwood, and Silverado aquifers. The Lynwood and Silverado aquifers are merged across most of the station (JEG, 1995). There are four general aquifer zones at the station (JEG, 1995) as listed below:

- Semi-perched, unconfined zone within the upper Recent Alluvium deposits;

- Confined fresh groundwater zone contained in lower Recent Alluvium deposits;

- Late and Early Pleistocene deposits of the Lakewood and San Pedro Formations, respectively, and in some parts, deposits of the Late Pliocene Pico Formation; and

- a confined zone of saline water underlying the freshwater zone.

Shallow groundwater underlying NAVWPNSTA (upper Recent Alluvium deposits) is within the Lower Santa Ana River Basin (Orange County management zone) (RWQCB, 1995, with Amendment R8-2004-0001). Beneficial uses of groundwater within the Orange County management zone include municipal and domestic supply, agriculture, industrial service supply, and industrial process supply. Shallow groundwater underlying IR Site 70 currently does not serve as a water source for any of the beneficial uses designated in the Water Quality Control Plan (WQCP), Santa Ana River Basin (Basin Plan) (RWQCB, 1995).

The principal freshwater body (lower Recent Alluvium deposits and Upper Pleistocene Lakewood Formation) is a large confined aquifer occupying two zones. The first zone is approximately 75 to 200 ft deep and saline. The second zone is approximately 250 to 1,000 ft deep and freshwater. This second zone is the primary water supply source for neighboring cities. Groundwater levels in this principal freshwater zone fluctuate from year to year due to variations in pumping, infiltration, and recharge. Recharge to this aquifer is primarily from unconfined areas upgradient and from unlined rivers that are hydraulically connected to the aquifer. Seasonal variations occur with highs in the wet winter months and lows in the dry summer months when large quantities of water are used for irrigation (JEG, 1995).

2.4.1 Site-Specific Hydrogeology

A site conceptual model was generated from the remedial investigation data and presented in the FS (Bechtel, 2002). The conceptual site model was refined based on further review of the remedial investigation and pilot study data and is presented in the Final RD (Geosyntec, 2006b). This conceptual site model consists of six separate hydrostratigraphic units. Working down from ground surface, these are:

- **Upper Fines Unit (ground surface to approximately 60 ft bgs).** Comprises three zones: a shallow zone of surficial soils and clayey sediments; an intermediate zone of interbedded silts, clays, and sandy silts and clays that include the semi-perched zone; and a lower zone of interbedded silts, clays, and fine to coarse-grained, silty to clayey sands. A zone of organic material, mainly wood chips, was encountered in a number of boreholes at a depth of approximately 45 to 50 ft bgs.

- **First Sand (approximately 60 to 105 ft bgs).** Poorly-graded fine-grained sands and silty sands. A coarse sand/fine gravel layer was encountered in several borings between 80 and 95 ft bgs. This coarse layer lies just above or slightly within the Shell Horizon (see below). The First Sand varies in thickness from approximately 30 to 50 ft.

- **Shell Horizon (approximately 105 to 135 ft bgs).** Characterized by a sequence of interbedded clays, silts, sands, and gravels below the source area grading to predominantly fine-grained sand in the vicinity of RDO-6A/B. This Unit has been subdivided into the Shell Horizon (Interbedded Clays) and Shell Horizon (Fine-grained Sands) to reflect differences in the plume migration behavior and hydrogeologic characteristics. Shell and gravel layers were encountered in some but not all borings, comprising interbeds within the Shell Horizon that do not appear to be spatially extensive. Wood chips were encountered in several borings at a depth of about 110 ft.

- **Second Sand (approximately 135 to 170 ft bgs).** Similar in character to the First Sand; however, this lower unit appears to be slightly coarser in its upper section.

- **Deep Clay (approximately 170 to 190 ft bgs).** An apparently continuous unit consisting mainly of clay to silty clay is encountered at depths between 164 to 176 ft bgs. The unit grades to clayey silt, silt, sandy silt, or sandy clay in some areas. It is 3 to 20 ft thick, extending to between 175 and 188 ft bgs. The unit is underlain by up to 6 ft of silty sand and sand to the maximum depth of the ERSE borings, which were 191 ft bgs.

- **Deep Sand (approximately 190 ft bgs and below).** Appears to be similar in character to the First and Second Sand Units; however, it has been logged in only a few sample points at IR Site 70 (Bechtel, 2002)

2.4.2 Site-Specific Hydraulic Conductivity, Heterogeneity

The hydraulic conductivities (K) of screened intervals in selected groundwater monitoring wells were determined on the basis of aquifer (slug and continuous discharge pumping) tests (Bechtel, 2003). Local relative vertical variability in hydraulic conductivities (indicating degree of soil heterogeneity) was evaluated using electromagnetic borehole flowmeter surveys in selected groundwater monitoring wells installed as part of the Pilot Study activities documented in the RD (Geosyntec, 2006b). Results of the tests are summarized as follows:

- **Upper Fines Unit:** Relatively low horizontal hydraulic conductivity based on limited lateral migration of dissolved-phase contaminants within this Unit. Vertical variability of hydraulic conductivities an order of magnitude or higher within a distance of a few ft was observed during Pilot Study activities, indicating significant heterogeneity in this Unit (Geosyntec, 2006b).

- **First Sand Unit:** Represented by a horizontal hydraulic conductivity of 2.4×10^{-2} cm/sec (centimeter per second) based on a slug test (Bechtel, 2003) this unit varies dramatically across the transect wells. The zone of highest relative permeability within this unit (at minimum an order of magnitude higher) in the area of the transect of wells installed during Pilot Study activities (RDO-1 to RDO-5) appears to be between 65 to 80 ft bgs (Geosyntec, 2006b).

- **Shell Horizon:** Estimated hydraulic conductivities range from 1×10^{-7} cm/sec horizontal and 1×10^{-7} cm/sec vertical near the source area where the Shell Horizon is predominantly interbedded clays, to 1×10^{-2} cm/sec horizontal and 8×10^{-4} cm/sec vertical for the area where the Shell Horizon is predominantly fine-grained sand (Bechtel, 2003). Localized variability in K in the region of the Shell Horizon where it grades to predominantly fine-grained sand ranges by an order of magnitude between layers with thicknesses typically on the order of one to two ft (Geosyntec, 2006b).

- **Second Sand Unit:** The bulk hydraulic conductivity of the Second Sand Unit is approximately 2.3×10^{-2} cm/sec horizontally and 1.5×10^{-3} cm/sec vertically based on the 2003 pump test (Bechtel, 2003). Vertical characterization of K variability in the upper coarser area of this unit, showed a smaller degree of heterogeneity than the Shell Horizon (Geosyntec, 2006b).

The hydraulic conductivities of the Deep Sand range from 3.5×10^{-3} to 3.5×10^{-2} cm/sec based on information from the Geologists Report Alamitos Barrier Improvement Project Construction Unit 12, Los Angeles and Orange Counties, California (December 30, 1997, Section 2.2, page 13). This is based on correlation of the Deep Sand Unit to the B aquifer. The hydraulic conductivities of the Deep Clay Unit are unknown (Geosyntec, 2006b).

2.4.3 Site-Specific Groundwater Flow and General Chemistry

The First and Second Sands are laterally continuous and are of sufficient horizontal and vertical conductivities to allow both vertical and horizontal migration to occur. The Upper Fines, Shell Horizon (Interbedded Clays) Units and the Deep Clay exhibit geologic layers that significantly hamper the migration of contaminants, likely due to their predominantly fine-grained character and a lack of connected layers of high permeability. However as the Shell Horizon grades to a slightly coarser unit to the southeast, it provides vertical continuity between the First and Second Sands allowing for vertical migration of contaminants and groundwater flow. The Deep Sand appears separated from the Second Sand in the study area by the Deep Clay.

Groundwater flow in the First Sand Unit is nearly south near the source area (approximately 170° from north), which is the direction of plume migration in the upgradient portion of the plume where it is primarily confined to this unit. Groundwater flow in the Second Sand Unit is more southeasterly, resulting in a shift in the plume migration direction where the plume migrates vertically into this Unit. Downgradient of this location, the groundwater flow direction within the First Sand Unit also appears to shift to a more southeasterly direction, although limited data is available in this area. The vertical head difference between hydrogeologic units indicates consistent downward migration of groundwater throughout the plume and source area, with some localized areas primarily near the MW-70-PMW07A well (Figure 1.2) demonstrating slight head differences that imply at least transient localized areas of upward migration of groundwater between the Second and First Sand Units.

The general groundwater flow direction in each hydrogeologic unit is consistent over time, with little seasonal variation. The magnitude of the average horizontal hydraulic gradients in each of the units also appears to remain consistent with time, although seasonal variations between summer and winter months are observed along with seasonal fluctuations in the water elevations ranging up to 7 ft in all layers. The horizontal hydraulic gradients in the winter months are generally a factor of two to three lower than those in the summer months. The horizontal gradients are highest in the First Sand Unit, by approximately a factor of three in comparison to those in the Upper Fines Unit and the Second Sand. The average horizontal hydraulic gradient in each unit ranges from 0.0006 feet per foot (ft/ft) in the Upper Fines Unit, to 0.0007 ft/ft in the Second Sand, and up to 0.002 ft/ft in the First Sand/Shell Horizon (Fine-Grained Sands). Gradient contour maps may be found in the Final Fifth Annual Groundwater Monitoring Report IR Sites 40 and 70 (Bechtel, 2006).

Potential external factors that may influence local gradients and vertical migration of groundwater include groundwater pumping (regional water supply wells) and aquifer recharge (e.g., Alamitos Injection Barrier) activities. Groundwater pumping and aquifer

recharge in the Orange County Groundwater Basin cause significant temporal fluctuations in the local groundwater elevations; however, the temporal consistency in the gradients and groundwater flow direction indicate that the overall impact to local groundwater flow migration is low. Tidal influences appear negligible in areas within IR Site 70 that will be impacted by remediation activities (Bechtel, 2003).

In the long-term, variability in the groundwater migration behavior on IR Site 70 may be caused by changes in operation of the Alamitos Injection Barrier. The Alamitos Injection Barrier, to the northwest of IR Site 70, is operated jointly by the Los Angeles County Department of Public Works, the Water Replenishment District of Southern California (WRD) and the Orange County Water District (OCWD) as a seawater barrier. This Barrier includes the injection of fresh water at depths as shallow as 27 ft bgs. The shallowest injection may affect the southeasterly gradient in the Second Sand Unit as well as the vertical gradient. The injection barrier may affect the direction of flow in the First Sand Unit to a lesser extent, due to lower injection rates. WRD does not currently anticipate any substantial changes to the Alamitos Barrier over the next 30 years; however, OCWD has long-term plans to expand the barrier farther into Orange County. OCWD will follow the required permitting procedures outlined by the Orange County Health Care Agency (OCHCA) within the DON's proposed IR Site 70 buffer zone, which include consultation with relevant stakeholders. In the event that OCWD does submit a permit request, the DON will review potential conflicts with the remediation system and take appropriate actions. Future changes will be monitored and evaluated under the long-term evaluation monitoring program

General groundwater chemistry data (Bechtel, 1999, 2006) indicates that IR Site 70 groundwater:

- varies from fresh to brackish;
- contains chloride as the major anion;
- contains sodium, calcium, and magnesium as the major cations;
- contains minor amounts of dissolved gases (methane and ethene);
- is generally hard to very hard based on alkalinity measurements;
- contains dissolved iron up to about 6 milligrams per liter (mg/L);
- highest concentrations of total organic carbon are along the center-of-plume location within the defined boundary of the VOC plume;
- the groundwater is slightly basic; and
- is under moderate to highly reduced conditions

In addition, X-ray diffraction mineralogical data obtained from eight IR Site 70 soil samples during the Pilot Study showed calcite to be present at 1 percent (%) to 5% by weight in all of the samples and dolomite [$CaMg(CO_3)_2$] in over 50% of the samples (Geosyntec, 2006b). The presence of these carbonate minerals is important because carbonate can buffer the pH to avoid pH changes from the production of acids that may be produced during the chlorinated solvent degradation process. Although the degradation of TCE is expected to produce 3 millimoles of hydrochloric acid (HCl) for each millimole of TCE, this HCl would be rapidly neutralized by the alkalinity of the groundwater and carbonate minerals. In addition, the decomposition of the EVO produces organic acids, which are expected to be also buffered for the same reason. The presence of carbonates in the minerals provides additional protection against low pH beyond the alkalinity of the groundwater.

2.4.4 Nature and Extent of Contamination

The spatial distribution of contaminants in groundwater at the IR Site 70 was reported in the RD (Geosyntec, 2006b). This distribution is based on groundwater sampling data collected during the 3rd quarter 2005 groundwater sampling event and the Pilot Study activities. The primary chlorinated volatile organic compound (CVOC) detected was TCE. TCE concentrations greater than 1,000 µg/L are present within the source area, suggesting the presence of TCE in the form of residual DNAPL. A dissolved-phase plume extends from the source are to the south-southeast. The ERSE (Bechtel, 1999) data represented in the 3D RFS data set (Geosyntec, 2005) suggest the presence of higher concentration of TCE (>10,000 µg/L) further downgradient within the plume near MW-70-40; however, the 3rd quarter 2005 groundwater monitoring data did not confirm the presence of this higher TCE concentration (Bechtel, 2005). The Remedial Design field investigation did detect TCE concentrations above 5,000 µg/L in the same vicinity (Geosyntec, 2006b). Given the more complete coverage (i.e., more depth discrete data points) in the ERSE (Bechtel, 1999) data set, the potential for the existence of localized higher concentrations in this area should be considered.

The lateral migration of dissolved contaminants within the Upper Fines Unit is mostly confined to the source area, due to the downward hydraulic gradients and the low horizontal hydraulic conductivity. Further downward migration of the dissolved-phase is prevented in areas of IR Site 70 where the Shell Horizon predominantly consists of interbedded clay layers (i.e., beneath the source area and the upgradient portion of the plume). The plume migrates in a horizontal south-southeasterly direction within the First Sand Unit. Downward migration of the plume into the Second Sand Unit is observed at downgradient locations where the Shell Horizon grades to predominantly fine-grained sands. See Figures 2.6 through 2.22 in the RD (Geosyntec, 2006b) for visualizations of the plume.

The design basis plume (greater than or equal to 250 µg/L TCE concentrations [Geosyntec, 2006b]) extends from just below ground surface to at least 160 ft bgs, and is approximately 2,300 ft long in a northwest-southeast direction, and is approximately 700 ft wide in a northeast-southwest direction (Figure 1.2). Of the total plume mass, 50% is estimated to be confined to the upgradient portion of the plume within the source area and the First Sand Unit. The area comprising an estimated 90% of the total plume mass extends to the toe of the plume into the Second Sand Unit (Geosyntec, 2006b).

Cis-1,2-dichloroethene (cis-1,2-DCE) is detected at low concentrations (a few hundred µg/L) throughout the plume, indicating a low level of natural biological attenuation. Similarly, VC is primarily detected at low concentrations (a few µg/L) within the source area, with sporadic detections further downgradient in the dissolved-phase plume at concentrations just above the detection limit. Preliminary results from the natural attenuation microcosm study (provided in Geosyntec, 2006b) indicate that natural degradation rates within the plume are low. An analysis of natural attenuation of TCE within the plume, based on concentration trends with distance along the axis of the plume, is presented in Appendix A of the RD (Geosyntec, 2006b). This analysis suggests that the apparent degradation half-life of TCE is on the order of 5 years (Geosyntec, 2006b).

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3. REGULATORY FRAMEWORK

3.1 Regulatory Overview

Cleanup at IR Site 70 is being conducted as part of the IR Program. The program identifies, assesses, characterizes, and cleans up or controls pollutants from past hazardous waste disposal operations and spills. The program was established to comply with federal requirements regarding cleanup of hazardous waste sites. These federal requirements are outlined in CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA).

CERCLA and NCP Requirements are as follows:

- Section 121(d) of the CERCLA (1980) states that remedial actions on CERCLA sites must attain (or the decision document must justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate.

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. The requirement is applicable if the jurisdictional prerequisites of the standard show a direct correspondence when objectively compared to the conditions at the site. If the requirement is not legally applicable, then the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations similar to the circumstances of the proposed response action and are well suited to the conditions of the site (United States Environmental Protection Agency [USEPA] 1988). The criteria for determining relevance and appropriateness are listed in Title 40, *Code of Federal Regulations* (CFR), Section 300.400(g)(2) (40 CFR 300.400[9][2], and include the following:

  - the purpose of the requirement and the purpose of the CERCLA action;

  - the medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site;

- the substances regulated by the requirement and the substances found at the CERCLA site;
- any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site;
- the type of place regulated and the type of place affected by the release or CERCLA action;
- the type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action; and
- any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resource at the CERCLA site.

The DON, under the Defense Environmental Restoration Program, follows the USEPA RI and FS protocols. An RI/FS involves characterizing the nature and extent of risk posed by hazardous waste sites and evaluating options for cleanup. The NCP [Title 40 Code of Federal Regulations (CFR) 300] provides the RI/FS protocols.

3.2 Applicable or Relevant and Appropriate Requirements (ARARs)

A full review of ARARs was completed as part of the RD (Geosyntec, 2006b). A discussion of ARARs may be found in Appendix A.

3.3 Target Cleanup Goals (TCGs)

Table 3.1 lists the TCGs that are applicable to IR Site 70, based on an analysis of federal and state ARARs (Appendix A). The values listed in the table are federal maximum contaminant levels (MCLs) for drinking water promulgated by USEPA or California MCLs established by the Department of Health Services (DHS), whichever is lower for a given constituent (Geosyntec, 2005). While MCLs have generally been established as TCGs for the purposes of developing the full-scale remedial design, this should not be construed as an acceptance by the DON of final remediation goals at IR Site 70. The DON believes establishing final target cleanup goals is an iterative process, taking into account site-specific factors such as aquifer classification and designated use, equal application of the remedial goal, and the site- and chemical-specific nature of the groundwater requiring remedial action.

The following TCGs were developed for IR Site 70 groundwater cleanup (Geosyntec, 2006b):

- Consistent with EPA, California State Water Resources Control Board (SWRCB), Cal EPA, and RWQCB Santa Ana Region policies and regulations, protect existing beneficial uses of the shallow aquifer underlying NAVWPNSTA Seal Beach to the extent practicable while preventing or minimizing VOC migration beyond the current NAVWPNSTA Seal Beach boundaries at concentrations exceeding site remediation goals;

- Prevent further degradation of groundwater quality (e.g., through DNAPL mobilization and/or spreading of dissolved-phase contamination related to remedial activities); and

- Protect human health by preventing extraction of VOC-impacted shallow groundwater for domestic use until site remediation goals are achieved.

Chloroform, 1,1-dichloroethene, TCE, 1,1-dichloroethane, cis-1,2-DCE, trans-1,2-DCE, and VC were identified as COPCs at IR Site 70 based on their contribution to the screening-level carcinogenic risk and frequency of occurrence at IR Site 70. The attainment area for this remedial action is the footprint of the TCE plume at IR Site 70 as defined by the area exceeding the MCL of 5 µg/L (Figure 3.1). See Figures 2.6 through 2.22 in the RD (Geosyntec, 2006b) for visualizations of the plume.

The DON has to established a Point of Compliance (POC) boundary along the station boundary to monitor the plume during the remedial action. POC monitoring wells were established at appropriate depth intervals for the respective zones (Upper Fines, First Sand, and Second Sand) outside the current plume boundaries (Figure 1.2). In addition, the DON provided POC wells within the Deep Sand down gradient and cross gradient of the current extent of the TCE plume. Some POC wells are outside the plume limit but not located at the boundary of the base (Figure 1.2). These wells will be used to verify the groundwater gradients and monitor the potential migration of the plume during the remedial action.

Because of the levels of contamination encountered, the affected medium (i.e., groundwater) will be addressed as two separate areas within the plume: (i) a suspected source area; and (ii) a dissolved-phase plume. Cleanup goals were evaluated accordingly.

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4. REMEDIAL SYSTEM DESIGN

The subsections below outline the conceptual design of the proposed full-scale remedial program for IR Site 70, including a brief overview of the design concept (Section 4.1), a summary of the process through which the remedial designs were developed (Section 4.2), and the resulting proposed remedial approach (Section 4.3).

4.1 Design Concept

Based on the analysis performed as part of the Revised Feasibility Study (Geosyntec, 2005), an EISB remedy was selected for full-scale treatment of dissolved-phase and source area contamination at IR Site 70. The proposed bioremediation approach consists of the following:

- Enhanced destruction of residual DNAPL phase through stimulating bioactivity within close proximity to the DNAPL/water interface to enhance the DNAPL dissolution rate.

- Dissolved-phase mass treated passively using linear biobarriers spaced along the plume and allowing ambient groundwater flow to flush contaminated groundwater through the biobarriers.

- Bioaugmentation with a commercially available dechlorinating culture KB-1® used to reduce uncertainty in biological performance and to reduce the time required to achieve measurable results.

- MNA incorporated into the remedy wherever contaminants can be naturally assimilated by the aquifer to reach treatment goals within a reasonable time frame (assumed to be 35 years after termination of the active treatment phase for design purposes).

- Ongoing O&M of the enhanced bioremediation remedy consisting of periodic reinjections of electron donor (as required to maintain biological activity) and monitoring to assess the ongoing biobarrier and MNA performance, the need for biobarrier maintenance, evidence for growth and dispersion of *Dehalococcoides* Vinyl Chloride Reductase Gene (*Dhc/VCr)*, and monitor the secondary water quality impacts.

- Land use controls are designed to prevent exposure to VOC-contaminated groundwater on the property overlying IR Site 70.

- Contingency measures incorporated into the bioremediation remedy to protect downgradient potential human and ecological receptors per USEPA guidance (USEPA 1998, 1999).

The TCGs, which the remedial design has been developed to address, are outlined in Section 3.3. For design purposes, it was assumed that the lower of State and Federal MCLs was the ultimate TCG for remediation of the plume and source area within the attainment area. Based on discussions with the RWQCB, the regions of the plume and source area to be targeted for active enhanced bioremediation treatment (i.e., areas amended with EVO and bioaugmented) will be confined to regions with TCE concentrations that exceed the design basis plume. The active treatment phase will be terminated once concentrations within the dissolved-phase plume and source area are reduced below 200 µg/L, after which MNA will be used to treat regions of the attainment area that contain TCE concentrations between the TCGs and 200 µg/L. Final IR Site 70 TCGs will be determined through an iterative process, taking into account site-specific factors such as aquifer classification and designated use, MNA performance, and the site- and chemical-specific nature of the groundwater requiring remedial action.

4.2 Remedial System Design Development Process

The subsections below outline the remedial design development process, including a summary of the basis of the design (Section 4.2.1) and an overview of the design approach (Section 4.2.2).

4.2.1 Design Basis

The design for the full-scale bioremediation system was developed based on the site hydrogeological conceptual model (see Section 2.4.1) that was developed as a result of the Pilot Study activities conducted for the RD (Geosyntec, 2006b), the ERSE (Bechtel, 1999) and the FS (Bechtel, 2002). The relevant features of the site hydrogeologic conceptual model that impact the remedial design of the source and plume treatment system include the following:

- The distribution of contaminants within the TCG attainment area, including the likely presence of residual DNAPL in the source area;

- The predominant groundwater flow directions in each unit, as indicated by plume morphology, groundwater elevation contours, and vertical head differences between hydrogeologic units; and

- Spatial and/or temporal variability in the plume migration pathways, hydraulic gradients, hydraulic conductivities, and soil heterogeneity.

Details on each of these features are included in Section 2.4. Other factors that were considered during the design process include the following:

- The achievable radius of injection (ROI) for the EVO within each of the targeted units, as determined during Pilot Study activities (Geosyntec, 2006b), which ranged from a minimum of 12 ft ROI in the First and Second Sand Units, down to ≤10 ft in the Shell Horizon (Fine-Grained Sands) and the Upper Fines Unit.

- The apparent rate of biologically induced natural attenuation and the enhanced biodegradation rates within bioremediation treatment zones, as determined from the microcosm study (Section 2.4 above and Geosyntec, 2006b).

- Potential reductions in soil hydraulic conductivity related to injection of the EVO in each unit, which are expected to be minor in the coarser-grained units (i.e., First and Second Sand Units) and are not expected to exceed 50% reductions in finer-grained soils (i.e., Shell Horizon and Upper Fines Units); (Geosyntec 2006b).

- The achievable rates of injection for electron donor amendment, which are expected to range from 2 to 5 gallons per minute (gpm) per 10 ft screened interval in a well in finer-grained units up to 12 gpm per 10 ft screened interval in a well in the more permeable units (Geosyntec, 2006b).

Specific design assumptions for the source treatment design are summarized in Table 4.1. Design assumptions upon which the dissolved-phase plume treatment design was based are summarized in Appendix A of the RD (Geosyntec, 2006b). These assumptions were incorporated into a numerical model to evaluate the impact and effect on design parameters (Geosyntec, 2006b).

4.2.2 Design Approach

The design approach was developed to account for the nature of the contaminant distribution, the soil lithology, groundwater flow behavior, access constraints, and with consideration of the TCGs. In the source area, the design approach was developed with the goals of: (i) treating residual DNAPL in a manner that will enhance the removal of the DNAPL phase and significantly reduce the required treatment duration and persistence of the DNAPL, and (ii) contain any untreated mass flux out of the DNAPL

source area to remove the source of the plume, which will aid in reducing dissolved-phase plume treatment duration.

In the dissolved-phase plume, the size of the plume and the distribution of contaminants in various lithological units increases the complexity of the treatment approach. The design approach for plume treatment was developed with the goals of designing a robust treatment system that will attenuate dissolved-phase contamination to meet the TCGs within an approximate 50-year timeframe, while reducing costs for implementation and maintenance over the treatment lifespan.

MNA will be incorporated into the remedy design where appropriate (i.e., where risk to potential receptors is acceptable and where contaminants will naturally attenuate to meet TCGs within the targeted 35 year post-active-treatment timeframe) to further reduce treatment costs. It is assumed that the DON would retain administrative control of IR Site 70 and that institutional controls would remain in effect until TCGs are achieved to protect existing monitoring wells, treatment infrastructure, and grant access for sampling, installing new monitoring wells, and implementing any additional remedial measures needed in the future.

Sections 4.2.2.1 and 4.2.2.2 below outline the design approach for the source area and dissolved-phase plume, respectively.

4.2.2.1 Source Area

The duration of treatment of source zones is typically required for as long as the source area remains, due to continuing dissolution of the DNAPL phase causing dissolved-phase mass flux that can continue to migrate downgradient and sustain the plume. Treatment duration may be shortened significantly through enhancement of the rate of DNAPL dissolution. For bioremediation systems, this is encouraged through the biodegradation of dissolved-phase mass within the vicinity of the DNAPL/water interface, which increases the concentration gradient between the DNAPL and groundwater, thus enhancing the dissolution rate. DNAPL dissolution enhancements on the order of 2 to 14 times have been observed in both field and lab settings within active bioremediation zones, resulting in 2 to >6 times reduction in the DNAPL lifespan (ESTCP, 2005).

To encourage DNAPL dissolution to the extent possible, the electron donor will be delivered throughout the source area through a grid of injection wells within the area containing >1,000 µg/L TCE (Figure 1.2 and Figure 4.1 in the RD [Geosyntec, 2006b]). A low solubility, long-lasting electron donor (EVO) will be used to allow for stimulation of continuous bioactivity over long periods of time with infrequent reinjections. EVO also has the added benefit of being an immiscible organic

compound, and thus may either partition into the DNAPL phase, thus providing electron donor directly to the DNAPL/water interface, or may sorb some of the DNAPL phase, thus potentially reducing mass flux from the source zone.

In addition to the grid of injection wells in the source area, a downgradient biobarrier will be installed within the First Sand Unit to address any untreated mass flux from the source area through biodegradation of remaining contaminants (Figure 1.2). This biobarrier will essentially cut off the source of mass that is sustaining the dissolved-phase plume, which will help shorten the duration of plume treatment.

To avoid spreading contamination within the plume during electron donor injection events, the EVO injection will use source area groundwater as the amendment water for injecting the EVO (i.e., the net fluid balance remains fairly constant). Groundwater will be extracted from wells located within close proximity to EVO injection wells, thus reducing mounding and enhancing the distribution of the EVO around the injection points. EVO injections will be staged such that groundwater is extracted and reinjected into areas of similar contaminant concentration profiles (i.e., groundwater containing higher concentrations of TCE will not be reinjected into areas with significantly lower concentrations).

Bioaugmentation will be implemented during electron donor amendment to minimize mobilizations to IR Site 70, enhance the distribution of *Dehalococcoides* bacteria in the KB-1® culture from the injection well, and reduce labor costs. To provide the appropriate geochemical environment for the *Dehalococcoides* to grow, the KB-1® injection will be conducted mid-way through the EVO injection, preceded and followed by a flush of anoxic water according to the procedure outlined in the standard operating procedures (SOPs [Attachment B-2 of Appendix B]).

Because of the long-term persistence of DNAPL, it is possible that multiple reinjections of electron donor may be required before the targeted treatment level is achieved in the source area. Electron donor will be reinjected as needed to sustain bioactivity levels. EISB performance will be monitored throughout the active remediation period, concurrent with MNA monitoring in areas where MNA is being employed, to track remedial progress and increase remedial performance.

4.2.2.2 Dissolved-Phase Plume

The vertical and lateral distribution of the VOCs in groundwater at IR Site 70 makes it infeasible to cost-effectively treat the entire dissolved-phase plume by a blanket EISB approach. To reduce the costs of plume treatment, MNA will be incorporated into the remedy where applicable, and the extent of the EISB zones will be reduced to provide cost-effective treatment of the plume to meet TCGs within a total 50-year timeframe.

Linear transects of EISB biobarriers spaced across the plume and oriented perpendicular to the general direction of groundwater flow (Figure 1.2) will be constructed. As VOCs entering the biobarriers under ambient groundwater flow are biodegraded, clean groundwater emerging from the biobarriers will flush downgradient VOCs towards the next biobarrier. VOC concentrations between biobarriers will also be decreased through MNA processes.

Because of the complexity of the contaminant distribution and the variability in the soil geology and hydrogeological properties within the plume, a numerical model of IR Site 70 was developed that incorporated IR Site 70 complexity and other factors that could impact remedial performance (e.g., potential permeability reductions within biobarriers) (Geosyntec, 2006b). The model was used to assess whether TCGs could be achieved within a total 50-year timeframe for each biobarrier option evaluated, as well as assess the required duration of active operation for each biobarrier and associated MNA monitoring program. This information was used to develop estimates for remedial costs for each design option, which provided the basis of selection of the full-scale remedy design. The numerical model was also used to perform sensitivity analyses to evaluate the impact of variability in particular parameters (e.g., seasonal variability in hydraulic gradient) on remedial effectiveness and treatment duration. The design of the biobarrier layouts were adjusted to account for potential parameter variability, thus providing a more robust treatment system. Additional details on the modeling process are included in Appendix A of the RD (Geosyntec, 2006b).

The design of each biobarrier was developed considering the local vertical and lateral extent of TCE concentration above 250 µg/L (design basis plume), the general direction of groundwater flow, the groundwater residence time, the ability to distribute electron donor (EVO) within the aquifer, and the enhanced rate of biodegradation within each biobarrier. In addition, ease of implementation and protection of downgradient receptors through acceptable plume migration under MNA were included in the final selection criteria. The biobarriers were constructed of a line of injection wells oriented perpendicular to the general direction of groundwater flow and spaced at a distance that is slightly less than the achievable ROI of the electron donor distribution (based on Pilot Test of the ROI), to ensure lateral continuity of the bioactive zones. The width of the biobarriers were designed to provide sufficient groundwater residence time within the EISB zone such that downgradient groundwater flux out of the biobarriers will meet treatment goals. The screened interval of the well screens are confined to unique hydrogeological units to avoid the potential for vertical migration of contaminants through injection wells. The selected plume treatment approach consists of a total of 6 biobarriers transecting the plume in the various depth intervals (3 biobarriers in the First Sand Unit, 2 biobarriers in the Shell Horizon, and 1 biobarrier in the Second Sand Unit).

Similar to the approach for the source area, EVO will be used as the electron donor. Spreading of the dissolved-phase plume will be reduced by use of local groundwater as the source of amendment water for injecting the EVO (i.e., the net fluid balance remains fairly constant). Groundwater will be extracted from wells located within close proximity to EVO injection wells, thus reducing mounding and enhancing the distribution of the EVO around the injection points. EVO injections will be staged such that groundwater is extracted and reinjected into areas of similar contaminant concentration profiles (i.e., groundwater containing higher concentrations of TCE will not be reinjected into areas with historically lower concentrations). Bioaugmentation with KB-1® will follow the same procedure as described in the SOPs (Attachment B-2 of Appendix B).

Based on the spacing of the biobarriers and the groundwater migration rate, multiple reinjections of electron donor may be required before the targeted treatment level is achieved in the dissolved-phase plume. Electron donor will be reinjected as needed to sustain bioactivity levels within the biobarriers. EISB performance will be monitored throughout the active remediation period, concurrent with MNA monitoring in areas where MNA is being employed, to track remedial progress and optimize remedial performance.

4.3 Proposed Remedial Approach

4.3.1 Proposed Remedial Design for the Source Area

The source area treatment system was developed following the design process outlined in Section 4.2.2.1 and considering design uncertainties discussed in the RD. The source treatment consists of a grid of EVO injection wells, used to directly target high concentration zones, combined with a downgradient source area biobarrier, which will intercept untreated mass flux from the source area and address continuing mass contribution to the dissolved phase plume. Table 4.2 contains a summary of the total number of EVO injection wells, EVO amendment concentrations, and required amendment volumes for both the source treatment area and the source area biobarrier. Both the grid injection and the biobarrier will include a one-time injection of KB-1® to allow for the complete dechlorination of the primary CVOC, TCE, to ethene. The source treatment EVO injection wells are screened within the Upper Fines Unit and distributed within the estimated 1,000 µg/L TCE contour on approximate 20 ft spacings, as shown in Figure 1.2. The area directly beneath this targeted treatment zone contains a large number of buried utilities, which required modification of the locations of the wells to avoid interference with these utilities during drilling activities. Source area biobarrier wells are screened within the First Sand Unit as shown on Figure 1.2, and consist of 14 wells spaced approximately 24 ft apart across the width of the design basis plume.

Section 7.3.2 provides a description of the long-term maintenance program for the source treatment zones. During injection of the EVO, injection rates and pressures will be limited to avoid any potential mobilization of DNAPL phase. Details on the injection protocols and procedures, the specific design of the various components of the remedial system (e.g., injection equipment, bioaugmentation equipment, etc.), and general injection well construction details are included in the SOPs (Attachment B-2 of Appendix B).

The operational objectives of the source area EISB system are as follows:

- to amend groundwater with soluble electron donor (EVO), to achieve a concentration of 0.5% volume in the source area and, if necessary, with pH-adjusting chemical(s) to maintain a neutral pH (6<pH<8);
- to bioaugment the injection wells with a volume of KB-1® sufficient to establish growth of *Dehalococcoides* with the vinyl chloride reductase gene in the source zone (after an initial pre-conditioning period in which electron donor alone will delivered to the treatment zone to achieve reducing conditions [described in the RD; Geosyntec, 2006b]);
- to reduce concentrations in the source area (defined by groundwater concentrations greater than 1,000 µg/L TCE; Figure B1.3) to levels consistent with treatment *via* MNA (i.e., < 200 µg/L);
- to monitor MNA trends and evaluate the need for more aggressive treatment outside of the 1,000 µg/L source treatment zone;
- to intercept groundwater emanating from untreated portions of the source area with the source area biobarrier transecting the width of the design basis plume to address the flux of contaminated groundwater to the downgradient dissolved-phase plume; and
- to monitor the source area system until performance objectives in the source area are met.

4.3.2 Proposed Remedial Design for the Dissolved-Phase Plume

The dissolved-phase plume treatment approach was developed following the design process outlined in Section 4.2.2.2 of the RD (Geosyntec, 2006b). The selected plume treatment approach consists of a total of five biobarriers transecting the plume in the various depth intervals (two biobarriers in the First Sand Unit, two biobarriers in the Shell Horizon, and one biobarrier in the Second Sand Unit) in addition to the source area biobarrier. The length of each biobarrier was chosen to effectively intercept the

design basis plume. Table 4.2 contains a summary of the total number of EVO injection wells, EVO amendment concentrations, and required amendment volumes for each biobarrier.

The operational objectives of the dissolved-phase plume EISB system are as follows:

- to amend groundwater with electron donor (EVO) to achieve a concentration of 0.5% volume and, if necessary, with pH-adjusting chemical(s) to maintain a neutral pH (6<pH<8);
- to bioaugment the injection wells with a volume of KB-1® sufficient to establish growth of *Dhc/VCr* (after an initial pre-conditioning period in which electron donor alone will be delivered to the treatment zone to achieve reducing conditions [described in the RD; Geosyntec, 2006b]);
- to intercept groundwater across the width of the design basis plume;
- to treat intercepted groundwater until upgradient TCE concentrations are reduced below a concentration of 200 µg/L; and
- to maintain the presence of the treatment zone at each biobarrier transect, reinjecting EVO as necessary, until performance objectives in the dissolved-phase plume are met.

MNA will also be utilized to treat groundwater laterally and vertically outside the extent of the biobarriers and following termination of the operation of the biobarriers to monitor CVOC concentrations to their respective TCGs.

Details on the injection protocols and procedures, the specific design of the various components of the remedial system (e.g., injection equipment, bioaugmentation equipment, etc.), and general injection well construction details are included in the SOPs (Attachment B-2 of Appendix B).

4.3.3 Criteria for Termination of EISB Activities

Based on the results of the modeling studies, it appears that TCE concentrations on the order of 200 µg/L may be successfully attenuated below TCGs 35 years after termination of the active treatment phase. Therefore, the initial criteria for switching from active EISB treatment to MNA will be based upon achievement of 200 µg/L throughout upgradient areas (i.e., for termination of operation of each biobarrier, the region of the aquifer that is upgradient of that biobarrier and downgradient of the next biobarrier should have maximum TCE concentrations less than 200 µg/L prior to termination of active treatment). This evaluation will be made from the upgradient

monitoring well for each biobarrier. Ongoing monitoring and evaluation of natural attenuation rates and plume migration behavior will provide data to allow for a periodic reevaluation of this active treatment goal, as changing conditions and/or model refinement may require a revision of the target active treatment goal to achieve similar results.

Similarly, the initial criteria, TCGs, for termination of MNA are State MCLs. Final IR Site 70 MNA TCGs will be determined through an iterative process, taking into account site-specific factors such as aquifer classification and designated use, MNA performance, equal application of TCGs for remedial sites, and the site- and chemical-specific nature of the groundwater requiring remedial action.

5. LAND USE CONTROLS

Land Use Controls (LUCs) will be implemented to prevent exposure to VOC-contaminated groundwater by preventing the use of contaminated groundwater, protect remediation equipment, allow access for sampling, provide access to install new monitoring or injection wells, implement any remedial measures that may be needed in the future, and to maintain the integrity of the remedial action until remediation goals are achieved. The land-use controls required by this alternative will be applied to the overlying footprint of the existing areas of contamination (approximately 50 acres) and two associated buffer zones (Figure 5.1) that will extend from and encircle the interpreted limits of the VOC plume. A half-mile-radius buffer zone (which extends off NAVWPNSTA) will be established for groundwater from the surface to a depth of approximately 495 ft bgs and a 250-foot-radius buffer zone (which extends off station) around the plume limits for groundwater beneath the deep aquitard at depths greater than 495 ft bgs (Figure 5.1). This dual zone thereby creates a three-dimensional buffer zone by depth.

These LUCs will be implemented by restricting well permits via the OCHCA Environmental Health Department in a manner similar to what exists for the nearby Alamitos Barrier. The permit restrictions will require that OCHCA, the DON, and other appropriate stakeholders (identified by the DON) review well permit applications prior to granting said permits within the controlled area to determine compliance with applicable sections of the County of Orange Ordinance 2607 (OCHCA, 2006). County of Orange Ordinance 2607 authorizes the OCHCA to regulate the construction and destruction of wells. Section 4-5-14 of the Ordinance states, "It is the purpose of this article to control the construction and reconstruction of wells to the end that the groundwater of this County will not be impaired in quality and that water obtained from such wells will be suitable for the purpose for which used and will not jeopardize the health, safety or welfare of the people of this County…" (OCHCA, 2006). This restriction will apply to water supply wells and injection wells within the buffer zones.

Off-station LUCs will be evaluated by the DON under the annual review process. As part of this review, the DON will request information (at a minimum) from the following agencies: DTSC, RWQCB, OCHCA, OCWD, and WRD. Implementation and enforcement of LUCs is a statutory requirement of the DON as part of its CERCLA activities and authority; however, enforcement of LUCs outside the Station requires cooperation of other regulatory agencies and stakeholders. The LUC survey of off-station agencies and stakeholders will request, at a minimum, the following information:

- Addition of new wells within the buffer zone;

- Changes to the operation of wells within the limits of the respective buffer zones; and

- Removal of wells within the buffer zone.

LUCs inside NAVWPNSTA have commenced following the approval of the RD and are being implemented consistent with current NAVWPNSTA Seal Beach policies outlined in the National Environmental Policy Act (NEPA) Compliance Procedures Handbook (DON, 1998). The LUCs will be implemented through the NAVWPNSTA Seal Beach Station Project Review Process (SPRP). The SPRP will evaluate building restrictions and use restrictions for IR Site 70. If any projects are proposed within IR Site 70 boundaries, conformance with the LUCs associated with this site shall be reviewed as part of the SPRP. LUCs will remain in effect until monitoring data show that the remediation goals established in the Record of Decision (Geosyntec, 2006a) have been achieved.

Specifically, the following policies will be implemented during the LUCs for the IR Site 70 groundwater plume and the aforementioned buffer zone:

- New groundwater extraction, injection, or drinking water wells shall not be installed within the IR Site 70 groundwater plume or associated buffer zone without prior review and written concurrence from the DON, DTSC, and RWQCB.

- Injection and monitoring wells and associated permanent piping and equipment that are included in the remedial action shall not be altered, disturbed, or removed without the prior review and written concurrence from the DON, DTSC, and RWQCB.

- The DON, DTSC, RWQCB, and their authorized agents, employees, contractors, and subcontractors shall have the right, with the permission of the DON, to:

  – enter the premises to conduct investigations, tests, or surveys and inspect field activities;

  – construct, operate, and maintain the remedial action described in this RD; and

  – undertake any other remedial response or remedial action as required or necessary under the cleanup program.

LUCs inspection and reporting will be conducted on an annual basis. LUCs inspection will involve documenting and reporting any changes, including addition or removal of injection wells, monitoring wells, or drinking water wells within the buffer zone and any alterations to the injection wells, monitoring wells, and permanent remediation equipment. The inspection data will be summarized and, along with all changes, will be documented in the annual groundwater monitoring reports and submitted to agencies for review. IR Site 70 investigation testing, field inspection, or construction activities conducted within the buffer zone will also be documented in the inspection report. Other operations within the IR Site 70 boundary such as paving, demolition, or other operations will be evaluated for impact to the EISB system.

LUCs on the Station will be controlled through the SPRP process. Activities identified through this process will be discussed within the annual monitoring reports. In addition to the SPRP review process, additional controls will be used to minimize impacts to IR Site 70. These include the following institutional controls:

- Access onto the base is restricted to people that have been passed through the security gate;
- The Station is fenced and patrolled to limit access into the IR Site 70 area;
- The flush-mounted well head vaults will be closed and bolted shut to restrict access; and
- Above ground well head vaults will be locked to restrict access.

If control of IR Site 70 is transferred to another federal agency, the DON shall advise the recipient federal agency of all obligations contained in the ROD (Geosyntec, 2006a) and the RD (Geosyntec, 2006b) and will require the recipient federal agency to enforce LUC objectives contained in the RD (Geosyntec, 2006b). If the DON transfers control of IR Site 70 to a non-federal entity, the DON will provide information to that entity regarding the LUCs contained in the RD (Geosyntec, 2006b) and the obligation to record a state land-use covenant pursuant to 22 CCR Section 67391.1. The deed transferring IR Site 70 property to a non-federal entity will include institutional controls and resource restrictions equivalent to those contained in the State Land Use Covenant and the RD (Geosyntec, 2006b). The DON will provide notification to the regulators for planned property conveyance, corrective action required, and/or response to actions inconsistent with LUCs for the IR Site 70 remedy.

The DON will evaluate the implementation and performance of the LUCs during the 5-year review to ensure that human health and the environment are being protected by the remedial action as required by Section 121(c) of CERCLA.

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6. GROUNDWATER MONITORING PROGRAM

Monitoring of various groundwater parameters is required over the course of the remedial action to ensure that groundwater treatment is occurring as planned. Monitoring and analytical procedures are outlined in the following subsections. Detailed procedures for groundwater sampling, well rehabilitation, and well purging are presented in the SOPs (Attachment B-2 of Appendix B).

The following subsections outline the design of the monitoring program including a summary of the analytical parameters (Section 6.2), the baseline monitoring (Section 6.4), the MNA performance (Section 6.5), and the evaluation of ongoing EISB performance in both the source and dissolved-phase plume areas (Section 6.6), including rationale for selection of the sampling locations/depths, analytes, and sampling frequency.

6.1 Field Preparation

Before conducting the actual field work, the team must gain access to IR Site 70 and subcontract the appropriate laboratories. These specifics are explained further in the SOPs (Attachment B-2 of Appendix B). Field preparations include notification of the proper authorities and organizations of the schedule and scope of the field work and procurement and mobilization of the equipment (appendix C) and subcontractors. Furthermore, no field work can be done without proper equipment layout approval and utility clearance. All field work will be conducted in compliance with the accident prevention plan (APP) and the site-specific Health and Safety Plan (HASP) found in appendix D.

6.2 Parameters

Groundwater analyses will include both laboratory sample analyses and field measurements. The groundwater analytes are summarized in Table 6.1 and Section 6.2.2 below. The rationale and information gained from each analyte is also summarized in Table 6.1. Detailed analytical parameters and methodologies are discussed in the sampling and analysis plan (SAP) (Appendix B)

6.2.1 Field Parameters

Field parameters will be monitored using a flow-through cell equipped with multiple monitoring probes for analysis of pH, temperature, turbidity, conductivity, oxidation reduction potential (ORP), and dissolved oxygen (DO). Further details can be found in the SOPs (Attachment B-2 of Appendix B).

6.2.2 Analytes

Chloroform, 1,1-dichloroethene, TCE, 1,1-dichloroethane, cis-1,2-DCE, trans-1,2-dichloroethene, and VC were identified as the primary COPCs at IR Site 70 based on their contribution to the screening-level carcinogenic risk and frequency of occurrence at the site. The TCGs for IR Site 70 groundwater are found in Table 3.1

The values listed in Table 3.1 are federal MCLs for drinking water promulgated by U.S.EPA or California MCLs established by the DHS, whichever is lower for a given constituent (Geosyntec, 2005). While MCLs have generally been established as TCGs for the purposes of developing the full-scale bioremediation design, this should not be construed as an acceptance by the DON of final remediation goals at IR Site 70. The DON believes establishing final remediation goals is an iterative process, taking into account site-specific factors such as aquifer classification and designated use, technical practicability to achieve the stated cleanup goals, and the site- and chemical-specific nature of the groundwater requiring remedial action.

6.3 Sampling Protocols

Groundwater samples for laboratory analysis will be collected according to procedures outlined in the SAP (Appendix B) and the SOPs (Attachment B-2 of Appendix B).

The groundwater samples will be collected using low-flow sampling techniques to minimize aquifer disturbances and to obtain a representative sample. The objective of low-flow purging is to remove water from the screened interval at a rate that is comparable to the ambient groundwater flow rate. This minimizes aquifer drawdown in the well and limits the mixing of water within the screened interval with overlying stagnant water in the well casing. Low-flow purging allows for collection of representative groundwater samples with minimal disturbance and low turbidity. During purging, DO, pH, conductivity, ORP, turbidity, and temperature data will be collected using an appropriate field instrument equipped with a flow-through cell. Should EVO affect the turbidity of samples in the field, the samples will be collected when the other field parameters have stabilized.

The sampling frequency for the initial three years of the remediation program is summarized in Table 6.2, which shows the analytical suites, wells, and sampling frequency for both the source area and the biobarriers. After three years, the monitoring program will be optimized accounting for the geochemical trends observed during the initial three years of operation. Source area performance monitoring wells and indicated biobarrier injection wells will be sampled prior to EVO injection (baseline) and then quarterly for the first year and semi-annually thereafter after EVO injection.

MNA wells will be sampled less frequently, either annually or biannually and for a smaller subset of parameters to track MNA trends.

6.4 Baseline Monitoring

The baseline groundwater sampling event is a one-time measurement prior to start of treatment, which is used to evaluate progress of implemention and monitoring the progress of the EISB. Sampling locations for the baseline sampling event may be found in Table 6.3. Field parameters and analytes will be monitored to check for conditions conducive to remediation as described in Section 6.2.

6.4.1 Baseline Monitoring Plans

The objective of baseline monitoring is to check the initial conditions and concentrations at the wells that will be used for monitoring progress and performance. The baseline monitoring will be done in the POC wells, MNA wells, performance monitoring wells (PMWs), and select injection wells (Figure 6.1). POC wells will be monitored in the baseline groundwater sampling event to establish existing conditions prior to start of remediation. The baseline sampling of POC wells for each specific zone of remediation will be used as the reference point to determine possible plume expansion.

Baseline sampling of the PMW network will provide a point of reference on existing conditions prior to the start of remediation. Baseline sampling of the MNA wells will allow ongoing comparisons to evaluate intrinsic degradation rates outside of the "treatment" areas. The baseline MNA groundwater results will be used to monitor trends within the plume and to allow early detection of changes within the dissolved-phase plume.

Baseline monitoring will also include wells up and down gradient from biobarriers and source area.

6.4.2 Baseline Monitoring of Source Area

The baseline monitoring will be a one time sampling event of the source area contamination and First Sand source area biobarrier. Refer to Figure 6.1 for locations of these wells. The baseline wells include the PMW, MNA, POC, and select injection wells. The baseline sampling event for the source area will include sampling in the PMW, MNA, and POC wells for the First Sand unit to provide data on the initial conditions within that zone prior to start of remediation.

6.4.3 Baseline Monitoring of Dissolved-Phase Plume

Baseline monitoring will be a one time sampling event conducted prior to implementation of the RA within each stratigraphic unit at IR Site 70. For the remaining First Sand biobarriers, the baseline event will be performed before the injection of the EVO and KB-1® culture into the First Sand biobarriers. Subsequently, baseline monitoring will be performed for the Shell Horizon and Second Sand prior to the injection of the EVO and KB-1® culture into the biobarriers installed in each of those stratigraphic units. Figure 6.1 illustrates the location and placement of the baseline wells for the dissolved-phase plume.

6.5 Monitored Natural Attenuation Performance

6.5.1 Assessment of Monitored Natural Attenuation

The natural attenuation monitoring program was developed with the primary objectives of minimizing long-term monitoring costs while assessing progress of the attenuation of contaminants and the need for implementation of contingency measures. In developing the monitoring program, the following factors were considered:

- *Environmental risk.* The risk to potential ecological and human receptors created by periods of decreased biobarrier performance (e.g., related to consumption of the EVO) at IR Site 70 is negligible as long as current groundwater use restrictions remain in place on the Site. The results of the numerical modeling suggest that the potential plume migration prior to attenuation to achieve IR Site 70 TCGs is not expected to impact any nearby extraction wells.

- *Groundwater seepage velocity.* Seepage velocities in all known impacted units on IR Site 70 are fairly low (not exceeding 85 ft /year), and the expected plume migration will be lower due to retardation of the contaminants.

- *Natural attenuation.* From an analysis of the concentration trends with distance in the plume, it appears that natural attenuation is occurring on IR Site 70 with a TCE half-life on the order of 5 years (see Appendix A of RD for details).

Sections 6.5.2 and 6.5.3 below outline the proposed MNA monitoring programs in more detail for the source and dissolved-phase plume treatment zones respectively. Monitoring programs have been developed for only the first three years of monitoring, after which the sampling locations, frequency and analytes monitored should be optimized for the long-term monitoring program. Passive sensors tracking key

geochemical parameters may also be incorporated into the monitoring program at that time, if appropriate, to further reduce sampling and analytical costs. The sampling program may be refined as necessary within the initial three year period, based on the data collected.

In general, the MNA sampling locations were chosen to provide one of two forms of information: (i) "sentinel" wells were selected to provide early indications of undesired plume migration (which may warrant optimization) and to provide information with regards to attenuation of lower concentrations of TCE on the fringe of the plume; and (ii) performance assessment wells located along the core of the plume between biobarriers were selected to provide some indication of potential biobarrier operation timeframe. Vertical monitoring intervals will be confined to 10 ft intervals, per USEPA guidance (USEPA, 1986), with screened intervals in monitored natural attenuation wells corresponding to the approximate center of the targeted treatment depth interval.

Table 6.2 summarizes the parameters that will be monitored during the initial three-year MNA monitoring program and the information that may be obtained. Sampling frequency for each well was selected in consideration of the attenuation rate of TCE (targeting a minimum of two samples per half-life), as well as considering the potential plume migration rate in each hydrogeologic unit. Accordingly, both sentinel and biobarrier MNA wells will be sampled annually during the initial three year program (Table 6.3). Targeted analytes include VOCs, dissolved hydrocarbon gases (DHGs), *Dhc/VCr* polymerase chain reaction (PCR) assays (to assess potential migration of dechlorinating microorganisms outside of the active treatment zone and any related impact to the attenuation rate in these areas; between biobarrier wells only), depth to water (to monitor changes in groundwater flow direction) and field parameters. MNA sample locations for each zone are shown on Figure 6.2.

6.5.2 Source Area

The MNA monitoring program for the source area was developed with the following objectives:

- Monitor MNA trends and evaluate the need for more aggressive treatment outside of the 1,000 µg/L source treatment zone; and
- Collect sufficient data for evaluating the need for implementation of contingency measures.

The critical areas for evaluating MNA performance in the source area are: (i) within the Upper Fines Unit outside of the grid treatment area, but within the area of elevated (>100 µg/L) TCE concentrations; (ii) within the Upper Fines Unit at a location

downgradient of the grid treatment area and within an area of lower (<100 µg/L) TCE concentrations; and (iii) within the First Sand Unit and upgradient of the source area biobarrier but downgradient of the area in which mass flux from the Upper Fines Unit is expected to enter the First Sand Unit. Figure 1.2 illustrates the proposed sampling locations in relation to the TCE concentrations within the Upper Fines Unit and the proposed grid treatment area and downgradient source area biobarrier location.

6.5.2.1 Sampling Locations

MNA wells within the source area will be located within each stratigraphic unit where active remediation will take place. The locations are shown on Figure 6.2.

6.5.2.2 Sampling Frequency

Annual MNA sampling will be performed in the source area. Further details are provided in Section 10.1.

6.5.3 Dissolved-Phase Plume

The MNA monitoring program for the dissolved-phase plume was developed with the following specific objectives:

- Monitor temporal MNA trends and evaluate the effectiveness of natural attenuation processes at reducing VOC concentrations within the plume; and
- Monitor VOC trends in critical monitoring locations to evaluate impact to the plume size and mass distribution over time.

The critical areas for evaluating MNA performance in the dissolved-phase plume are: (i) at the outer edges of each biobarrier to evaluate plume bypass related to decreased permeability in the biobarrier, as well as evaluate impacts to the plume due to EVO injection activities; (ii) at the toe of the plume to evaluate dissolved-phase plume migration rate during the treatment duration; and (iii) between biobarriers to evaluate plume attenuation rate between the treatment zones. Figure 1.2 illustrates the proposed sampling locations in relation to the TCE concentrations within the First Sand, Shell Horizon and Second Sand Units respectively and the proposed biobarrier locations. The evaluation of the MNA data during the initial three year active treatment phase may be continued, reduced, or increased based on the results of the concentration trend analyses.

6.5.3.1 Sampling Locations

MNA wells within the dissolved-phase plume will be located within each stratigraphic unit where active remediation will take place. The locations are shown on Figure 6.2.

6.5.3.2 Sampling Frequency

Annual MNA sampling will be performed in the dissolved-phase plume. Further details are provided in Section 10.1

6.6 Performance Monitoring of the EISB System

The following subsections outline the design of the monitoring program including a summary of performance metrics in Section 6.6.1. This section provides an evaluation of ongoing EISB performance as described in Section 6.6.2 for both the source and dissolved-phase plume areas, including a rationale for selection of the sampling locations/depths, analytes, and sampling frequency. More details on the sampling schedules and sampling implementation procedures are included in Sections 6.6.3 and 6.6.4.

6.6.1 Performance Metrics

Certain criteria should be met for maintaining optimal EISB performance, including the following:

- Complete dechlorination of TCE to ethene within the biobarriers;
- Localized and/or minimal secondary groundwater quality impacts; and
- Growth of *Dehalococcoides* bacteria to concentrations exceeding 10^7 cells/L, and distribution of these bacteria throughout the active treatment zones.

Similarly, criteria for MNA performance include indications of reducing TCE concentrations with time and minimal expansion of the plume beyond the current extents. Indicators of these success measures will be tracked throughout the remediation program as outlined in Sections 6.6.3 and 6.6.4 below.

6.6.2 Assessment of EISB System Performance

The EISB biobarrier performance monitoring program was developed with the primary objectives of minimizing long-term monitoring costs while collecting sufficient data to assess long-term EISB performance and the need for EISB maintenance and/or

implementation of contingency measures. In developing the monitoring program, the following factors were considered:

- *Environmental risk.* The risk to potential ecological and human receptors created by periods of decreased biobarrier performance (e.g., related to consumption of the EVO) at IR Site 70 is negligible as long as current groundwater use restrictions remain in place on IR Site 70. The results of the numerical modeling suggest that the potential plume migration prior to attenuation to achieve IR Site 70 TCGs is not expected to impact any nearby extraction wells.

- *Groundwater seepage velocity.* Seepage velocities in all known impacted units on IR Site 70 are fairly low (not exceeding 85 ft /year), and the expected plume migration will be lower due to retardation of the contaminants. As a result, decreased biobarrier performance for a period of 6 months will likely only result in plume migration to a maximum extent of 20 to 30 ft downgradient.

- *Natural attenuation.* From an analysis of the concentration trends with distance in the plume, it appears that the natural attenuation half-life of TCE is on the order of 5 years. Any contaminant mass that is not fully treated within the active treatment zones will continue to attenuate naturally.

- *EVO consumption rate.* From a preliminary estimate, it appears that the EVO is likely to persist for a minimum of 5 years in most treatment areas. Geochemical trends should be monitored closely for at least one EVO consumption cycle. The field parameters and analytical data will be evaluated for changes to various geochemical parameters with EVO consumption, which will allow for more accurate determination of biobarrier maintenance needs

- *Potential adverse impacts to secondary groundwater quality.* Stimulation of biodegradation in an anaerobic and reducing environment may lead to production of undesirable compounds, including methane, dissolved metals (e.g., iron, manganese), hydrogen sulfide, and elevated groundwater turbidity and specific conductance. Some of these compounds represent a potential health and safety risk; others impact the groundwater aesthetics (i.e., appearance, odor and taste).

- *Growth and distribution of the Dehalococcoides* bacteria. The indigenous bacteria at IR Site 70 do not appear to possess the ability to completely dechlorinate TCE to innocuous end products such as ethene (Geosyntec, 2006b). Sustained growth and distribution of *Dehalococcoides* bacteria is necessary to achieve TCGs. Microorganisms tend to be fairly robust and can typically withstand adverse conditions for limited periods of time. For example, endogenous decay of biomass upon consumption of the EVO will result in a slow decrease in biobarrier performance over time. Even if reamendment of more culture is necessary, the associated costs may be lower than implementation of a monitoring program that would prevent failure of microbial activity.

Sections 6.6.3 and 6.6.4 below outline the proposed EISB performance monitoring programs in more detail for the source and dissolved-phase plume treatment zones respectively. Monitoring programs have been developed for only the first three years of monitoring (approximately corresponding to one EVO consumption cycle in at least one biobarrier), at which point the sampling locations, frequency and analytes monitored should be optimized for the long-term monitoring program. Passive sensors tracking key geochemical parameters may also be incorporated into the monitoring program at that time, if appropriate, to further minimize sampling and analytical costs. The sampling program may be refined as necessary within this timeframe and/or extended as appropriate, based on the data collected.

In general, the number of EISB performance monitoring sampling locations per treatment area will be confined to one or two locations selected from those areas that will provide early indications of EVO consumption (and thus the need to reinject) and/or locations where biobarrier performance is most likely to be lowest (e.g., due to insufficient residence time, higher initial TCE concentrations requiring more degradation half-lives to meet treatment goals, etc.). In this way, the sampling and analytical costs may be reduced while continuing to collect critical information. Vertical monitoring intervals will be confined to 10 ft intervals, per USEPA guidance (USEPA, 1986), and nested wells will be used to monitor treatment zones that exceed 25 ft in vertical depth. If at any time decreasing EISB performance is detected at these "sentinel" wells indicating the need for biobarrier maintenance, then selected other locations will be sampled to evaluate the extent of the region within the treatment area that requires maintenance and appropriate corrective action will be taken.

Table 6.1 summarizes the analytes that will be monitored during the initial three-year monitoring program and the information that may be obtained from each analyte. A number of parameters will be sampled from wells located within active treatment zones on a quarterly basis for the first year of operation (to confirm the successful stimulation of desired bioactivity levels), followed by semi-annual monitoring (to assess

ongoing treatment levels and the need for biobarrier maintenance) for the remainder of the three year period. Targeted analytes include VOCs, DHGs; innocuous end products of the dechlorination reaction, including ethene and ethane, and methane, inorganic anions (particularly chloride, which is another daughter product of the dechlorination process), PCR assays specific to *Dhc/VCr*; the microorganisms responsible for complete dechlorination of TCE to ethene, depth to water (to monitor groundwater flow direction) and field parameters (particularly pH, ORP and DO, which are measures of geochemical conditions required for anaerobic microbial activity).

To assess the continuing presence of EVO within the treatment zone, qualitative measures of EVO presence will also be monitored in these locations on a semi-annual basis, including total organic carbon (TOC) and volatile fatty acids (VFAs) acetic, butyric, lactic and propionic acids (breakdown products of EVO fermentation). Typical concentration trends of these analytes are an initial increase shortly after EVO injection, then slow decreases to an asymptotic level as the biomass grows with a corresponding increase in the rate of the soluble organic released from the EVO. Depending on the sustained level of bioactivity, the asymptotic TOC and VFA concentrations may or may not be above background levels, and thus the usefulness of these parameters in providing a surrogate indicator of EVO presence may be limited. The information gained from these analytes will be evaluated on an ongoing basis and modifications to the sampling program may be made as appropriate.

To evaluate the potential impact on secondary groundwater quality and the contaminant distribution in the plume, samples will be obtained from targeted locations downgradient of the biobarriers on a semi-annual basis for the first three years. To provide a baseline comparison, samples will also be obtained from upgradient locations at similar sampling intervals. Targeted analytes include all of the bioremediation performance indicators listed above (i.e., VOCs, DHGs, inorganic anions, *Dhc/VCr*, depth to water, and field parameters including turbidity and specific conductance), as well as secondary groundwater quality parameters including dissolved metals (e.g., iron, manganese, arsenic), and sulfide.

6.6.3 Source Area EISB Performance Monitoring Program

The monitoring program for the source area treatment was developed to meet the following specific objectives:

- Monitor bioremediation performance and assess the need for treatment system maintenance, which could consist of reamendment of EVO, rebioaugmentation, well rehabilitation and similar activities;

- Monitor the continuing flux of contaminant mass from the source area upgradient of the source area biobarrier, to evaluate the need to expand the source grid treatment to the First Sand Unit;
- Monitor for occurrence and persistence of adverse impacts (e.g., mobilization of metals, excessive methane generation, etc.); and
- Collect sufficient data to evaluate whether EISB activities may be terminated and MNA initiated.

The wells to be used for monitoring system performance in the source area treatment are outlined in Table 6.3. The locations of these wells are shown on Figure 6.3. For the source grid treatment area, EISB performance will be monitored at two key locations using two well nests (proposed new well installations MW-70-PMW-1A/B and existing well nest MW-70-27 and MW-70-28 [Figure 1.2]). These locations were selected as they represent locations where both the electron donor demand and the EVO consumption rate is likely to be highest, due to the presence of elevated TCE concentrations and DNAPL. For the source area biobarrier, EISB performance will be monitored at a location within the core of the plume along a transect of three well nests through the biobarrier. The transect of wells will consist of MW-70-PM02A/B (upgradient wells), EVO injection well IW-70-SAB06, and MW-70-PMW03A/B (downgradient wells). The location of this transect was chosen to approximately coincide with the higher concentration core of the plume, where the EVO is likely to be consumed first.

If changes in VOCs and other EISB indicators suggest lowering of bioactivity levels in the monitored locations (e.g., related to consumption of the EVO), then further investigation of selected other regions of the source grid treatment area or source area biobarrier will be undertaken to evaluate the extent of the source area treatment system that require further maintenance and only those areas will be targeted. In this way maintenance of the EISB treatment system may be improved to reduce remediation costs while increasing effectiveness.

6.6.3.1 Sampling Location

In order to understand the performance of the barrier systems each biobarrier will have at least one upgradient and one downgradient performance sampling point. Table 6.3 presents a summary of the wells to be used for the performance monitoring program. The sampling locations for performance monitoring are shown on Figure 6.3.

6.6.3.2 Sampling Frequency

Sampling during the first year of the RA will be conducted quarterly (4 events). This monitoring will be conducted to ensure the success of the initial injections. Sampling during the next 2 years of the RA will proceed on a semi-annual basis.

6.6.4 Dissolved-Phase Performance Monitoring Program

The monitoring program for the dissolved-phase plume area treatment was developed with the following objectives:

- Monitor bioremediation performance and assess the need for biobarrier maintenance, which could consist of reamendment of EVO, rebioaugmentation, etc.;
- Monitor for adverse impacts that may require further action;
- Collect sufficient data to evaluate whether EISB activities may be terminated and MNA initiated; and
- Collect sufficient data for evaluating the need for implementation of contingency measures.

The wells to be used for monitoring system performance in the dissolved-phase plume are outlined in Table 6.3. The locations of these wells are shown on Figure 6.3 for the First Sand Unit, Shell Horizon, and Second Sand Unit. For each biobarrier, EISB performance will be monitored at a location within the core of the plume along a transect of three well nests through the biobarrier. The transect of wells will consist of upgradient, EVO injection, and downgradient wells. The location of each transect was chosen to approximately coincide with the higher concentration core of the plume, where the EVO is likely to be consumed first. The only exception to this is the second transect through Biobarrier FSB-1 situated to the southwest end of the biobarrier (i.e., transect of MW-70-PMW-4A/B, IW-70-FSB108, and MW-70-PMW-5A/B [Figure 1.2]). This second biobarrier was included in the monitoring program due to the extended length of this biobarrier and to provide one monitoring location with a lower influx of TCE to provide a secondary measure of EVO longevity in areas with a lower electron donor demand.

If changes in VOCs and other EISB indicators suggest lowering of bioactivity levels in the monitored locations (e.g., related to consumption of the EVO), then further investigation of other regions of the impacted biobarrier will be undertaken to evaluate the extent of the biobarrier that requires further maintenance and only those areas will

be targeted. In this way maintenance of the EISB treatment system may be improved to reduce remediation costs while increasing effectiveness.

6.6.4.1 Sampling Location

In order to understand the performance of the barrier systems each biobarrier will have at least one upgradient and one downgradient performance sampling point. The sampling locations for performance monitoring are shown on Figure 6.3 and listed in Table 6.3.

6.6.4.2 Sampling Frequency

Sampling during the first year of the RA will be conducted quarterly (4 events). This monitoring will be conducted to ensure the success of the initial injections. Sampling during the next 2 years of the RA will proceed on a semi-annual basis.

6.7 Point of Compliance (POC) Monitoring Program

6.7.1 POC Monitoring Plan

The POC for IR Site 70 will be the boundary of NAVWPNSTA Seal Beach. In order to determine if the plume is migrating off the station, a monitoring well network has been established. This network is comprised of existing wells that have no or very low previous detections of TCE. Wells were selected such that the contaminated groundwater zones each have a POC well network. Additionally, POC wells have been installed into the Deep Sand. The POC network is shown in Figure 6.4. Since TCE has not been detected in the deeper aquifers immediately upgradient to the source zone and there is a consistent southeasterly gradient supported by the Alamitos barrier injection to the northwest, only the Upper Fines and First Sand units will be monitored for POC along the northwestern base boundary. The POC wells will be monitored for groundwater gradient in addition to groundwater chemistry, should the gradient change significantly in the lower aquifers additional wells may be installed upgradient. Should TCE be detected in POC wells above the MCL, the DON will consider additional remedial actions and/or new POC wells between the station boundary and the plume.

Sampling events are expected to occur at no more than an annual frequency. Sampling and groundwater levels will be measured within each respective zone during each sampling event. The analyses will be defined in the sampling analysis plan.

Subsequent sampling events will be based on an assessment of groundwater flow rates, distance from the leading edge of the plume, and historic groundwater flow rates for each unit.

6.7.2 POC Monitoring

The goals of POC monitoring are to check the groundwater, conditions, flow, and chemistry to monitor that the plume does not migrate outside the effective remediation system and to provide information to determine if it is necessary to refine the remedial approach.

6.7.2.1 Sampling Location

The POC wells re located outside the current extent of the design basis plume (Figure 6.4). These wells will be used to monitor that the plume does not expand beyond the current remediation site.

6.7.2.2 Sampling Frequency

The POC Monitoring program will be an annual event that is run in concurrence with other performance and MNA monitoring for the source area zone. Sampling during the first year of the RA will be conducted annually (1 event). Sampling during the next 2 years of the RA will proceed on an annual basis.

6.7.2.3 POC Monitoring Well Installation

POC monitoring wells have been installed at the locations shown in Figure 6.4. The wells denoted as MW-70-POC01 through MW-70-POC04 were installed at the locations shown on Figure 6.4 and constructed consistent with the monitoring well construction diagram shown in Figure 6.5. The construction details for these wells are shown in Table 6.4. These locations have been chosen in accordance with the goals laid out in the above text.

6.8 Soil Vapor Monitoring

Electron donor in the form of emulsified vegetable oil acts to reduce the ORP of the aquifer as it is consumed through biological reactions in the subsurface. When the aquifer becomes sufficiently reduced, sulfate reduction and methanogenic reactions can occur. These reactions result in the production of hydrogen sulfide and methane gas.

The rate at which these gases are generated depends on numerous environmental factors. Factors that may contribute to methane generation include the amount of excess donor added, the amount of VOCs present (chlorinated ethenes in elevated quantities can suppress methanogens and limit methane production (DiStefano et al., 1991)), and IR Site 70 geology (e.g., confining layers). Factors contributing to hydrogen sulfide generation include amount of donor added and amount of sulfate present in the aquifer. Both methane and sulfide can be degraded aerobically.

Furthermore, hydrogen sulfide can react with ferrous iron in the aquifer and precipitate out as iron sulfide.

6.8.1 Soil Vapor Probe Installation

Soil vapor probes will be installed at the locations shown in Figure 6.6 by using methods described in the SOPs (Attachment B-2 of Appendix B). These locations have been chosen to correspond with areas above high concentrations of electron donor and near active buildings or utility corridors. Additional soil vapor probes will also be installed around the source area (Figure 6.6) and downgradient to monitor for the migration of these gases.

6.8.2 Soil Vapor Probe Monitoring

Soil vapor probes will be sampled for methane and hydrogen sulfide at the same frequency as the performance monitoring groundwater wells. Further details of the sampling plan and sampling protocol can be found in the SAP (Appendix B) and the SOPs (Attachment B-2 of Appendix B), respectively.

6.9 Additional Injection Well Installation

Due to an ongoing test project in the source area, twenty-two (22) of the planned fifty-seven (57) injection wells remain to be installed. As part of the implementation, these wells will be installed at the locations shown in Figure 6.7 and constructed consistent with the injection well construction diagram shown in Figure 6.8. The construction details for these wells are shown in Table 6.5. These injection wells will be installed per the SOPs found in Attachment B-2 of Appendix B. The wells will be completed similar to the injection wells previously installed in the source area.

6.10 Well Packer Installation and Operation

6.10.1 Well Packer Objectives

The use of well packers will be evaluated for both the amendment injection phase and during the groundwater monitoring program. Well packers provide a method for sealing the well bore against vertical flow during injection and sampling programs. During construction some wells were constructed with blank sections between two screen intervals.

During the amendment injection it may be necessary to inject in one portion of the screen versus another due to the permeability of the surrounding zone. The use of well packers will provide a method for sealing one portion of the well from another when there is a blank casing between the screened well sections.

6.10.2 Well Packer Equipment

Well packer equipment will be identified and added to the SOP as an addenda once a vendor and model(s) have been determined. The packer will be compatible with the chemicals and well materials within the treatment wells. There are two general types of packers that will be considered; mechanical and inflatable packers. Mechanical packers are placed within a well and fixed into position through mechanical means (screw into place such as compression fittings, etc.). An inflatable packer will have an expandable section that can be inflated to seal the well bore. Both type of packers can be removed after placement should that be necessary.

6.10.3 Well Packer Installation and Operation

The packer installation and operation will be in compliance with the manufacturer guidance. The packers will be placed during operational phases and may or may not be removed during the long term remediation phase. The determination to leave packers in place will be dependent on the application of the packers. When a packer is placed to allow differential injection within the same treatment zone, such as the First Sand, it can be removed after the injection phase is complete. Where a packer is used between two different treatment zones such as the First Sand and the Shell Horizon (eg., SHB-3) then the packer may be left for extended periods of time.

7. FULL SCALE INJECTION OPERATIONS

This section discusses the field approach for the injection of the emulsified oil and the KB-1® culture. The amendment procurement is outlined in Section 7.1, the EVO injection procedures in Section 7.2 and the EVO injection staging in Section 7.3. All field work will be conducted in compliance with the APP and the HASP found in appendix D.

7.1 Amendment Procurement and Storage

7.1.1 EVO

Newman's Zone (standard product) EVO will be procured from Remediation and Natural Attenuation Services, Inc. The product contains 49 % by volume soybean oil and 6% sodium lactate.

The EVO will be shipped to IR Site 70 in 1,000 liter (L) totes. EVO totes for near-term use will be kept in a designated area at each site as shown in Figures 7.1, 7.2, 7.3, and 7.4 in a shaded area to mitigate product spoilage during hot weather. The totes stored onsite will be loaded onto a trailer or a stakebed truck and transported over to the active injection area. The totes will be off loaded by an all-terrain forklift. A refrigerated warehousing facility in the greater LA area will be used for longer-term storage of the EVO totes. Delivery of totes from the refrigerated storage to the site will be sequenced to minimize time of storage on site.

7.1.2 KB-1®

KB-1® dechlorinating culture will be procured from SiREM (Guelph, Ontario, Canada), shipped to IR Site 70 in stainless-steel pressure vessels and stored on site for a maximum of 14 days prior to injection. The KB-1®dechlorinating culture is capable of completely dechlorinating TCE to VC and ethene and requires anaerobic conditions for growth and survival.

Cylinders of pressurized argon gas will be required to create an anaerobic blanket within each injection well during KB-1® injection activities to mitigate oxygen exposure during injection activities. Argon cylinders will be procured from local suppliers shortly before the KB-1® injections and stored on-site for limited periods of time in secure areas.

7.1.3 Anaerobic Water

To provide ideal conditions for KB-1® survival and growth *in situ*, anaerobic water will be injected before and after KB-1® addition. Two 6,500 gallon (gal) water tanks,

located as shown on Figures 7.1 through 7.4, will be filled with either potable water supplied from a fire hydrant or groundwater several days prior to the KB-1® injection. The oxygen within this water will be consumed by indigenous microorganisms through the addition of appropriate amounts of a soluble electron donor, such as sodium lactate, and seeding of oxygen-consuming bacteria through either the addition of groundwater containing indigenous bacteria or an equivalent method. The water will be ready for injection when the DO value drops below 0.5 mg/L and ORP decreases below –75 millivolts (mV). Both tanks will be replenished immediately upon draining to ensure a constant supply of anoxic water as needed during KB-1® injections.

7.2 EVO Injection Process and Equipment

7.2.1 Process Overview

EVO will be added to the subsurface to achieve a target oil saturation of 0.5% for both the source area and dissolved-phase plume biobarrier treatment areas. The concentrated Newman Zone EVO (49% oil) will be diluted with groundwater to produce a 1% emulsion (equivalent to 0.5% oil). Groundwater will be extracted from adjacent or nearby wells with similar groundwater contaminant levels using submersible pumps and a multi-channel manifold. The groundwater will be pumped to a central dosing unit, amended with concentrated emulsified oil and reinjected through a multi-channel manifold into a series of injection wells (the number of injection wells may vary based on injection rates and pumping rates). A simplified process flow schematic is provided in Figure 7.5.

Fifty percent of the 1% EVO target volume will be injected into each well before the introduction of KB-1®. To provide ideal conditions for the KB-1® *in situ*, 200 to 300 gal of anoxic water will be injected before and after KB-1® injection. A trash pump will be used to transfer anaerobic water from a 6,500-gal water tank to the injection wells *via* the same multi-channel EVO manifold. After addition of the anaerobic water, the injection well will be flushed with argon gas to purge any residual oxygen from the water in the well and from the air standing in the well bore. The argon gas will then be used to transfer the desired volume of culture from the shipping vessel to the delivery vessel. Three liters of KB-1® will be delivered through a drop line to the middle of the screened interval of each injection well, using argon gas to push solution from the delivery vessel into the well. Following KB-1® injection, an additional 200 to 300 gal of anaerobic water will be injected into each injection well before proceeding with the injection of the remaining EVO. The standard operating procedure for EVO injection and KB-1® addition is detailed in Attachment B-2 of Appendix B.

7.2.2 Equipment

The EVO injection equipment includes EVO totes, transfer hoses, injection skid (manifolds and dosing pumps), and amendment point well-head fittings as illustrated in Figure 7.6 and detailed in Appendix C. In addition to the EVO injection equipment, a 2L KB-1® delivery vessel, 80 cubic feet (ft^3) argon gas cylinders and two 6,500 gal water tanks are required for bioaugmentation. The individual components of the EVO injection system are discussed below (Figure 7.6).

EVO Totes. The totes each contain approximately 1,000 L [2,100 pounds (954 kilograms, or kg)] of emulsion. Each tote has two access ports, one on the top and one at the base. Each tote is attached to a pallet for shipment.

Injection skid. A trailer-mounted injection system will be constructed as illustrated in Figure 7.6 to receive source water *via* a multi-channel manifold, dose in the EVO at a selected rate using one or more dosmatic pumps and then distribute the emulsion to another multi-channel manifold used to direct the dilute emulsion to the injection wells. The specifications of the dose pumps are selected based on the expected flow rate of source water and the target injection flow rates. The manifolds and/or well-head fittings will be capable of measuring both positive and negative pressures (vacuum and compound gauge). The equipment required is listed in Appendix C.

Amendment Well Head Fittings. The injection well head fittings will be equipped with a flange to connect to the injection well flange a rubber gasket (Figure 7.6). The remainder of the well head fitting will consist of a 2-inch diameter clear polyvinyl chloride (PVC) riser tube and a 2-inch PVC cross fitted with a vent valve, vacuum/pressure gauge, and a flow control valve with cam-and-groove fittings to which the amendment injection manifold will be connected to the injection well. All connections will be solvent welded with the possible exception of threaded fittings for the ball valves (2-inch) and the pressure gauge (1/4-inch) brass.

7.3 EVO and KB-1® Injection Staging

EVO and KB-1® injection staging is described below for the two portions of the plume. Sections 7.3.1 and 7.3.2 discuss operations for the Source Area, and Section 7.3.3 discusses operations for the dissolved-phase biobarriers.

7.3.1 Source Area and Source Area Biobarrier Operations

EVO and KB-1® will be injected in stages into the 57 source area wells in the source grid treatment area within the Upper Fines Unit, as well as into the 14 injection wells that form the source area biobarrier in the First Sand as shown in Figure 7.1. The EVO injection for these two areas (and other source area wells) may not occur concurrently.

For both areas, the targeted oil amendment rate will be 0.5% or approximately 1% EVO. The system layout for anaerobic water, oil, and dosing equipment for the source area is shown in Figure 7.1. The required total EVO, EVO dilution water, anaerobic water and KB-1® culture volumes, as well as the estimated injection duration for each area of the source treatment are summarized in Table 7.1.

The EVO injection rate of the source grid treatment area is anticipated to be 10 gpm per well, requiring a total of 51 totes of EVO and 1,313,000 gal of groundwater. KB-1® injections will require 171 L of KB-1®, 22,800 gal anoxic water, and 10 argon gas cylinders (80 ft^3 size cylinders). The EVO injection will be conducted in 7 stages, in a manner that will permit a 2-person team to effectively manage the injection of up to 10 wells simultaneously. The staging of the injections is summarized in Table 7.1 and illustrated in Figure 7.1. The staging process includes extraction of groundwater from one set of wells while reinjecting into nearby wells after mixing with the EVO with the goal of minimizing the net fluid balance in the subsurface to mitigate spreading of the contamination. Groundwater will be extracted from wells with similar contaminant profiles as that of the injection wells, and injections will work inwards and upgradient to the extent possible. Injection will be done by groups of wells, commencing with Group 1 wells, with Group 2 wells acting as extraction wells and so on (see Table 7.1 for details). The extracted groundwater to be used for injection into Group 6 and 7 wells will come from wells in which EVO injection has been completed. Although a small percentage of previously injected oil and KB-1® is expected to be pumped into the Group 6 and 7 injection wells and injection flow rates are anticipated to be lower (assumed to be approximately half), this is preferable to storing large quantities of water on-site for the injection of the last groups of wells. Prior experience with EVO injections indicates that only a small percentage of the EVO remains mobile, and that the majority of the EVO will quickly sorb (within a few days) to the soil and remain relatively immobile.

A similar EVO injection approach will be taken with the source area biobarrier. The EVO injection rate of the source area biobarrier is anticipated to be 10 gpm per well, and will require a total of 26 totes of EVO and 655,900 gal groundwater. For the KB-1® injection, 42 L of KB-1®, 9,000 gal anoxic water, and 3 argon gas cylinders. The EVO injection will be conducted in 3 stages, as detailed in Table 7.1 and illustrated in Figure 7.1, following a similar rationale as that used for the source grid treatment area.

Injection durations were estimated by dividing the total target amendment volume by the total estimated injection flow rate and assuming a 10 hour (hr) day. In addition to the actual injection time, it is assumed that one day each will be required for the start-up of each injection stage, for KB-1® injection, and for decontamination. If the total injection time exceeds one five-day work week, then one day for every five days of

injection is assumed to be required for cleaning of hose and equipment for storage over the weekend and setup upon return.

During all injections, EVO injection rates, pressures, total EVO and water volumes will be tracked for each of the injection wells. EVO injection monitoring forms can be found in Attachment B-2 of Appendix B. Between each injection stage, the lines, well and filter pack will be injected with unamended groundwater to flush EVO away from the well to minimize biofouling. The system will then be decontaminated.

7.3.2 Maintenance of EISB Biobarriers and Source Treatment

EVO within the biotreatment zone will gradually dissolve and degrade ultimately producing hydrogen (electron donor), which is used by dechlorinating bacteria to reductively dechlorinate the TCE, cis-1,2-DCE, and VC (electron acceptors). In addition to dechlorinating bacteria, other bacteria that use electron acceptors such as nitrate, ferric iron, and sulfate can compete for the hydrogen produced from the EVO. The longevity of the EVO can be estimated by the electron acceptor demand and using stoichiometry to determine how long the EVO will persist.

The volume of oil amended into the Upper Fines Unit in the source grid treatment area is estimated to be sufficient to biodegrade all contaminant mass currently existing as dissolved-phase, including demand on electron donor exerted by other electron acceptors (e.g., oxygen, nitrate, sulfate, etc.) and a safety factor of 2 to account for ferric iron and manganese reduction processes that are not explicitly accounted for in the stoichiometric calculations (Geosyntec, 2006b). If DNAPL is present, additional EVO injections will likely be required. Neither the EVO longevity nor the number of EVO injections required in the source grid treatment area can be determined *a priori* as they depend upon the rate of EVO consumption and the potential mass of TCE DNAPL present.

The longevity of EVO in the source area biobarrier is estimated to be 6 years, based upon the current flux of contaminant mass and other electron acceptors (particularly sulfate) through the biobarrier, and assuming that the source area EISB will reduce further mass flux of VOCs. The stoichiometric calculations assume a safety factor of 2 is appropriate for IR Site 70. A safety factor of 2 is used to increase the calculated electron donor demand above the stoichiometric amount to include any mass consumption pathways not specifically accounted for in the equations (Geosyntec, 2006b). Electron donor demand from iron and/or manganese reduction may potentially exceed this, and thus introduces uncertainty in the estimated longevity of the EVO, with probable longevity being somewhere in the range of 2 to 6 years.

To verify and monitor the longevity of EVO in the field, groundwater samples will be taken from 4 monitoring wells (2 sets of 2 nested wells) within the source grid treatment area (MW-70-PMW-1A, MW-70-PMW-1B, MW-70-27 and MW-70-28) and 4 monitoring wells and 1 injection well in a transect perpendicular to the source area biobarrier to analyze for VOCs, TOC, VFAs, DO, ORP, and *Dhc/VCr* (see Section 6.5 for the detailed monitoring program). Population densities of *Dehalococcoides* bacteria determined through molecular analysis (i.e., PCR) will be monitored. A decline in the population levels could be an indication of possible electron donor limited conditions particularly if the VOC flux concentrations and flux are relatively constant. Higher DO and ORP, and less efficient VOC biodegradation are other indications that the electron donor has been consumed. A decreasing trend in TOC and VFAs concentrations may also be indicative of EVO depletion.

The duration of operation of EISB in the source area and the source area biobarrier is unknown because of uncertainty of the mass of TCE DNAPL. VOC sampling and EVO reinjections will continue until TCE levels have declined to levels below 200 µg/L. Should subsequent reinjections of EVO be required, it will only be amended in areas where TCE concentrations are above 200 µg/L. Additional sampling of the wells in the source may be required to better delineate treatment areas caused by residual TCE mass that is causing TCE concentrations to exceed the 200 ug/L target.

If reduced flow rates are observed during sampling of injection wells and subsequent EVO injections are planned, downhole video will be used to assess the nature of well fouling (i.e., biofouling versus inorganic fouling). The well will then be rehabilitated by using an appropriate method for the type of fouling.

7.3.3 Dissolved-Phase Plume Biobarrier Operations

Details of the EVO injection staging for the two First Sand biobarriers are presented in Table 7.2 and for the Shell Horizon and Second Sand biobarriers in Table 7.3. The EVO will be injected in a similar manner as that used for the source area biobarrier, using extraction wells within the biobarrier for makeup groundwater where possible. Anaerobic water and KB-1® will be amended in the same manner as for the source area. Each biobarrier is discussed briefly below. For each injection well, the EVO injection rates, pressures, total EVO and water volumes will be monitored.

7.3.3.1 Biobarrier FSB-1

Biobarrier FSB-1 will consist of 32 injection wells installed on 24 ft centers and spanning the design basis plume as shown in Figure 1.2. The injection rate is anticipated to be 10 gpm per well. Each well will require 47,327 gal of amendment (representing 476 gal of EVO and 46,851 gal of water) and 3 L of KB-1®. The entire

biobarrier will require 16,660 gal, or 64 totes of EVO, and 1,639,785 gal groundwater. KB-1® injections will require a total of 105 L of culture, 22,400 gal of anoxic water, and 6 argon gas cylinders. EVO equipment staging locations are shown on Figure 7.2. It is anticipated that EVO can be injected into the biobarrier in 4 stages as detailed in Table 7.2 and illustrated in Figure 7.2.

7.3.3.2 Biobarrier FSB-2

Biobarrier FSB-2 will consist of 29 injection wells installed on 24 ft centers and spanning the design basis plume near the toe of the plume in this unit as shown in Figure 1.2. The injection rate is anticipated to be 10 gpm per well. Each well will require 36,810 gal of amendment (representing 370 gal of EVO and 36,440 gal of groundwater) and 3 L of KB-1®. The entire biobarrier will require 10,730 gal, or 41 totes of EVO, and 1,056,760 gal of groundwater. KB-1® injections will require 87 L of culture, 14,500 gal of anoxic water, and 5 argon gas cylinders. EVO equipment staging locations are shown on Figure 7.2. It is anticipated that EVO can be injected into the biobarrier in 3 stages as detailed in Table 7.2 and illustrated in Figure 7.2.

7.3.3.3 Biobarrier SHB-1

Biobarrier SHB-1 will consist of 37 injection wells on 20 ft centers spanning the design basis plume as shown in Figure 1.2. The injection rate is anticipated to be 5 gpm per well. Depending on screen interval, each well will require between 11,583 - 19,304 gal of amendment (representing 117 - 194 gal of EVO and 11,466 - 19110 gal of water, respectively) and 3 L of KB-1®. The entire biobarrier will require 6,321 gal, or 26 totes of EVO, and 622,986 gal of groundwater. KB-1® injections will require 111 L of culture, 12,950 gal of anoxic water, and 7 argon gas cylinders. EVO equipment staging locations are shown on Figure 7.3. It is anticipated that EVO can be injected into the biobarrier in 4 stages as detailed in Table 7.3 and illustrated in Figure 7.3.

7.3.3.4 Biobarrier SHB-3

Biobarrier SHB-3 will consist of 20 injection wells on 20 ft centers spanning the design basis plume as shown in Figure 1.2. The injection rate is anticipated to be 5 gpm per well. Depending on screen interval, each well will require between 47,378 – 54,146 gal of amendment (representing 477 - 545 gal of EVO and 46,901 – 53,601 gal of water, respectively) and 3 L of KB-1®. The entire biobarrier will require 10,832 gal or 44 totes of EVO, 1,065,320 gal of groundwater. KB-1® injections will require 60 L of culture, 7,000 gal of anoxic water, and 6 argon gas cylinders. EVO equipment staging locations are shown on Figure 7.3. It is anticipated that EVO can be injected into the biobarrier in 2 stages as detailed in Table 7.3 and illustrated in Figure 7.3.

Based on remedial observations, packers may be required for SHB-3 wells in the event that preferential injection is required. Packers will be installed per the selected manufacturer's SOPs between the two screen intervals at approximately 80-100 ft bgs and approximately 110-130 ft bgs.

7.3.3.5 Biobarrier SSB-1

Biobarrier SSB-1 will consist of 22 injection wells on 24 ft centers spanning the toe of the design basis plume in the Second Sand Unit as shown in Figure 1.2. The injection rate is anticipated to be 25 gpm per well. Each well will require 42,068 gal of amendment (representing 423 gal of EVO and 41,645 gal of water) and 3 L of KB-1®. The entire biobarrier will require 9,306 gal, or 36 totes of EVO, and 916,190 gal of groundwater. KB-1® injections will require 66 L of culture, 12,320 gal of anoxic water and 4 argon gas cylinders. EVO equipment staging locations are shown on Figure 7.4. It is anticipated that EVO can be injected into the biobarrier in 3 stages as detailed in Table 7.3 and shown in Figure 7.4.

7.3.4 Maintenance of Biobarriers

The longevity of the EVO can be predicted by estimating the electron acceptor demand and using stoichiometry and calculations of the estimated contaminant mass discharge through each biobarrier to determine how long the EVO will persist. Each EVO injection into Biobarriers FSB-1, FSB-2, SHB-1, SHB-3, and SSB-1 is expected to last approximately 6, 5, 10, 15, and 15 years, respectively (Table 4.2).

To verify and monitor the longevity of EVO in the field, groundwater samples will be taken from 3 to 5 monitoring wells, including an injection well, in transect(s) perpendicular to the biobarrier to analyze for VOCs, TOC, volatile fatty acids, DO, ORP, and *Dehalococcoides* population densities (see Section 6.5 for the detailed monitoring program). A decline in the population levels could be an indication of possible electron donor limited conditions particularly if the VOC flux concentrations and flux are relatively constant. Higher DO and ORP, and less efficient VOC biodegradation are other indications that the electron donor has been consumed. A decreasing trend in TOC and VFAs concentrations may also be indicative of EVO depletion.

Modeling suggests that the biobarriers may require operation periods ranging from 8 to 16 years (Geosyntec, 2006b). If the EVO is required to last 5 to 15 years in practice, then only 1 to 3 applications of EVO may be required within each biobarrier.

If reduced flow rates are observed during sampling of injection wells and subsequent EVO injections are planned, downhole video will be used to assess the nature of well fouling (i.e., biofouling versus inorganic fouling). The well will then be rehabilitated by using an appropriate method for the type of fouling.

8. WASTE MANAGEMENT

Investigation Derived Waste (IDW) will be managed according to the IDW Plan presented in Appendix E.

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9. REPORTS

Annual reviews of monitoring data will be conducted to assess biobarrier performance and the need for maintenance, plume migration, dechlorination activity, extent of microbial migration, and the adequacy of the remedial action to meet TCGs. Annual reviews will be documented in a summary report issued to appropriate regulatory agencies. These reports may include suggested modifications to the cleanup program to increase remedial performance, changes to the monitoring program, and suggestions to reduce O&M costs.

The data obtained from the injection activities will be tabulated, reviewed, and interpreted to determine bioremediation design parameters. Upon completion of the field work and final receipt of the project analytical data, a report containing detailed data collection methods, and the data generated during the field work will be prepared.

As stated in section 5 above, LUCs inspection and reporting will be conducted on an annual basis. LUCs inspection will involve documenting and reporting any changes, including addition or removal of injection wells, monitoring wells, or drinking water wells within the buffer zone and any alterations to the injection wells, monitoring wells, and permanent remediation equipment. The inspection data will be summarized and, along with all changes, will be documented in the annual groundwater monitoring reports and submitted to agencies for review. IR Site 70 investigation testing, field inspection, or construction activities conducted within the buffer zone will also be documented in the inspection report. Other operations within the IR Site 70 boundary such as paving, demolition, or other operations will be evaluated for impact to the EISB system.

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10. PROJECT MANAGEMENT

The project management team will be responsible for all technical and administrative aspects of the remedial action. Included among the responsibilities of the team are the project schedule, staffing, data management, quality assurance audits, health and safety audits, document control, project meetings, and reporting.

10.1 Project Schedule

The proposed schedule for implementation of the remedial action is included in this remedial work plan as Figure 10.1. The schedule is presented in a schedule format (GANTT) chart format with critical path delineated for the first phase. The schedule is based on a three year initial operation. Upon award of the contract, the schedule will be updated and tracked against plan to monitor project performance. Due to the size of the remedial activities the project has been broken up into discrete phases. A scope of work and specification will be developed for the subsequent phases including a GANNT chart schedule for each phase. These will consist of the following:

- Phase 1: Source Area EISB, which includes the grid of EVO injection wells within the area containing TCE concentrations exceeding 1,000 µg/L within the Upper Fines Unit in the RT&E area. The source area treatment also includes a biobarrier placed immediately down gradient of the source area, within the First Sand. This biobarrier is located at this point to intercept the dissolved-phase plume emanating from the Source Area. This phase will also involve the installation of treatment wells as defined in the RD which were postponed due to the ESTCP project, soil vapor probes, and POC wells. The source area groundwater monitoring program will be implemented in Phase 1. The schedule shows the baseline, MNA, POC, and performance monitoring events for the Source Area EISB operation.

- Phase 2: First Sand Biobarriers FSB-1 and FSB-2, which are shown in Figure 1.2. Biobarrier FSB-1 is located on the west side of Kitts Highway and runs parallel to Kitts Highway for most of its length. Biobarrier FSB-2 is located in proximity to 2nd Street. The First Sand Biobarrier groundwater monitoring program will be implemented in Phase 1. The schedule shows the baseline, MNA, POC, and performance monitoring events for the First Sand Biobarriers EISB operation.

- Phase 3: Second Sand Biobarrier SSB-1, which is located at the leading edge of the plume, at the end of the warehouse area just prior to the wetland area. This biobarrier is shown in Figure 1.2. The Second Sand

biobarrier groundwater monitoring program will be implemented in Phase 1. The schedule shows the baseline, MNA, POC, and performance monitoring events for the Second Sand biobarrier EISB operation.

- Phase 4: Shell Horizon Biobarrier SHB-1 and SHB-3, which are shown in Figure 1.2. These biobarriers intercept the plume within the transmissive portion of the Shell Horizon. The Shell Horizon Biobarrier groundwater monitoring program will be implemented in Phase 1. The schedule shows the baseline, MNA, POC, and performance monitoring events for the Shell Horizon Biobarrier EISB operation.

The schedule includes preparatory; pre-remediation field construction activities; and remediation operations, groundwater monitoring (baseline, performance, MNA, and POC), and reporting activities. Construction and remediation activities have been planned to start after approval of the Work Plan, SAP, HASP, and procurement of the necessary equipment, materials, and subcontracting services.

Five main activities will be followed during the course of this project:

- **Stage 1 – Project Startup.** This stage includes updating the project submittals that include the Work Plan, SAP, HASP, and SOP.

- **Stage 2 – Preparatory Activities.** This stage includes notifications, dig permit review and submittal, traffic control plans as needed, procurement, and mobilization of equipment, materials, fencing staging area, setting up each site layout in accordance with the plan, mobilizing storage tanks, connex box, laydown area for equipment, preparing containment and moving in generator for power at remote locations, and acquiring appropriate station passes for project personnel.

- **Stage 3 – Pre-remediation Construction Activities.** This stage includes a preliminary marking of the injection wells, soil vapor probe locations, and POC monitoring well locations (co-ordinate with surveyors to verify correct location), uitility clearance surveys (geophysical survey of all well locations and public works utility document review), air knifing (or hand augering) to 8 to 10 ft for each drilling location, drilling, well installation, well development, installation of dedicated well head equipment, installation of temporary piping, installation of dedicated monitoring well pumps, installation of temporary extraction pumps, land survey (post-construction) to verify the well locations, and construction of the EVO and KB-1® dosing and manifold distribution system.

- **Stage 4 – Remediation Operations, Performance Monitoring, and Reporting Activities.** The first stage of this task will be to conduct a baseline sampling effort of all monitoring wells including POC wells as presented in Table 6.2. Once these data are collected and samples have been accepted at the lab for analysis, the initial EVO injection will be implemented. This will be done in accordance with the specifications in Section 7 and the SOP. Prior to and during the EVO injection a pre-defined set of extraction wells will be pumped to provide the blend water for injection and to maintain a hydraulic balance during the injection phase. Bioaugmentation will be implemented mid-way through electron donor amendment to minimize mobilizations to IR Site 70, enhance the *Dhc/VCr* distribution around the injection well, and reduce labor costs. A slug of anoxic water will be pumped into the injection wells followed by injection of KB-1®, a subsequent slug of anoxic water, and then continuation of the remainder of the EVO injection. The KB-1® introduces non-indigenous microorganisms to the groundwater (bioaugmentation to complete the dechlorination process). After EVO and KB-1® injection, the performance groundwater monitoring program will be implemented. The monitored natural attenuation monitoring program will be conducted on an annual basis initially. The EISB sequence will be documented in a report for each phase (area) of EVO/KB-1® injection. Annual status reports will be provided over the first 3-year period.

10.2 Project Responsibilities

The DON Remedial Project Manager (RPM) for this project is Mr. Si T. Le (P.E.). Mr. Le is responsible for project management, budget control, schedule maintenance, and contacting regulatory agencies. Ms. Pei-Fen Tamashiro (P.G.) is the NAVWPNSTA IR Program Coordinator. Ms. Tamashiro will be responsible for community relations activities and ensuring that the field and remedial activities are in compliance with the applicable rules and regulations. Mr. David Crawley is the Resident Officer in Charge of Construction (ROICC) and is responsible for the technical oversight of field activities, coordination of field activities with different NAVWPNSTA departments and personnel, base access for equipment, contractors and subcontractors, and project personnel, and Quality Control (QC). Mr. Chris Leadon is the DON Remedial Technical Manager, responsible for the technical oversight and review of the project documents. Mr. Narcisco Ancog is the Navy Quality Assurance Officer (QAO) and will provide review and acceptance of the SAP prior to any field work commencing.

Project personnel and responsibilities are outlined in Figure 10.2. The following is a list of key project personnel contacts:

Agency	Contact	Project Title
Naval Facilities Engineering Command Southwest 1220 Pacific Highway San Diego, CA 92132-5190	Mr. Si Le, P.E. (619) 532-2295	DON RPM
NAVWPNSTA Seal Beach 800 Seal Beach Boulevard Building 110 Seal Beach, CA 90740-5000	Ms. Pei-Fen Tamashiro, P.G. (562) 626-7897	NAVWPNSTA IR Program Coordinator
ROICC Los Angeles NAVWPNSTA Seal Beach Building 230 Seal Beach, CA 90740-5000	Mr. David Crawley (562) 626-7964	ROICC
Naval Facilities Engineering Command Southwest 1220 Pacific Highway San Diego, CA 92132-5190	Mr. Chris Leadon (619) 532-3878	Remedial Technical Manager
California Environmental Protection Agency Department of Toxic Substances Control Office of Military Facilities 5796 Corporate Way Cypress, CA 90630	Ms. Katherine Leibel (714) 484-5446	DTSC-RPM
California Regional Water Quality Control Board, Santa Ana Region 3737 Main Street, Suite 500 Riverside, CA 92501-3348	Ms. Patricia Hannon (951) 782-4498	RWQCB-RPM

10.2.1 Project and Personnel Requirements

Project personnel training requirements and inspection programs applicable to the remedial action at IR Site 70 are described below. Protocols for inspections by regulatory agencies and third parties are also addressed below.

10.2.2 Personnel Training/Certification Requirements

Personnel training and certification requirements include the following:

- Site personnel must have Occupational Safety and Health Administration (OSHA) 40-hour Health and Safety/Emergency Response Hazard Communication (1910.120) and Resource Conservation and Recovery Act (RCRA) training.

- Site personnel performing Department of Transportation (DOT) functions (including selecting, packaging, marking, labeling, preparing shipping papers, and loading) must be trained in accordance with the requirements of DOT 49 CFR, Part 172, Subpart H (aka DOT/HM-126F). Subcontractors performing DOT functions must supply proof of training.

- All project personnel (contractor and subcontractors) will be trained according to the project quality assurance compliance policies and procedures. The project QAO (or the on site designate) will verify the project personnel and subcontractors have the proper training prior to beginning project activities.

- All project personnel performing waste management will be certified for in accordance with 40 CFR, Part 265.16 for waste management activities.

10.2.3 Inspection and Audit Procedures

Site inspections and audits may occur during the remedial activities to assure compliance with this Work Plan, applicable state and federal regulations, and the HASP. Internal audits by the contractor QAO will be made to document compliance with sampling procedures, quality assurance sampling, and proper implementation of field procedures. These audits will be documented and provided to the NAVFAC SW QAO or his representative.

10.3 Data Management

The following is a summary of the data management tools that will be employed for the duration of this project:

- Microsoft Project® software will be used for all schedule tracking.

- Project cost tracking will be done using Microsoft Excel® spreadsheets.

- Home and field office staff for technical data management will use Microsoft Excel® spreadsheets and a geographic information systems (GIS) data base system. Microsoft Word® will be employed for word processing.

- Data management and manipulation will be done using GIS data base management and environmental visualization systems (EVS) software.

10.4 Document Control Procedures

Internal document control procedures will be followed for the duration of the project. Additional guidance provided by the DON will be used for document control, particularly for matters relating to regulatory compliance. Management of internal and external correspondence will be administered at the contractor's home office. Complete project files will be maintained in a secure, dry area at the field office.

Particular attention will be paid to documents related to sampling to obtain data in support of the design and for performance monitoring. In particular, a daily sampling log in a permanent binder will be completed in the field by the sampler(s). The daily log form will list each sample and QC sample taken that day and will specify the required frequency of duplicate, matrix spike and matrix spike duplicate, and other quality assurance (QA) samples. All QA and QC samples will be documented on a check list for sample submittals on each day. A copy of the sampling logs from the preceding day will be reviewed daily by a field chemist at the office to coordinate QA samples and sample batches with the laboratory. Audits of this procedure will be completed by the project manager (or his designate).

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USEPA-See United States Environmental Protection Agency

TABLES

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TABLE 3.1

TARGET CLEANUP GOALS[1] (TCGs)
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

Constituent of Concern	Exposure Route	Receptor(s)	Target Cleanup Goal* (µg/L)
1,1-Dichloroethene	Ingestion	Future residential groundwater users	6
cis-1,2-Dichloroethene	Ingestion	Future residential groundwater users	6
trans-1,2-Dichloroethene	Ingestion	Future residential groundwater users	10
Trichloroethene	Ingestion	Future residential groundwater users	5
Vinyl Chloride	Ingestion	Future residential groundwater users	0.5
Chloroform	Ingestion	Future residential groundwater users	100

Note:
[1] The EISB performance and MNA monitoring results will be periodically reviewed, including a trend analysis of the remediation performance to evaluate progress towards meeting the target cleanup goals (TCGs). The site numerical model will be periodically updated and recalibrated to evaluate whether TCGs can be met and the time required to achieve the TCGs. Reevaluation of the TCGs may be required at a future date, depending on the trends in remedial performance.
* Target Cleanup Goals (TCGs) based on ARARs

Acronyms/Abbreviations:
ARAR – applicable or relevant and appropriate requirement
EISB – enhanced *in situ* bioremediation
IR – Installation Restoration (Program)
µg/L - micrograms per liter
MNA – monitored natural attenuation
TCG – Target Cleanup Goal

TABLE 4.1

SOURCE TREATMENT DESIGN BASIS
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

Treatment Area	Aquifer Unit Targeted	Well Spacing (ft)	Total Porosity [a]	Effective Porosity [b]	Well Screen Length [c] (ft)	Proposed Screen Interval (depth bgs)	Target ROI [d] (ft)	Target Oil Dose[e] (%)
Source Grid Treatment	Upper Fines Unit	20	0.40	0.33	30	25-55	10	0.5%
Source Biobarrier	First Sand Unit	24	0.34	0.28	45	60-105	12	0.5%

Notes

[a] Estimated from soil collected during RDO activities (Geosyntec, 2006).

[b] Effective porosity is assumed to be 83 percent of total porosity, based on grain size evaluation (Technical Memorandum No. 5, Table I 2, BNI, 1999b).

[c] Based on estimated thickness of these units in this region of the aquifer.

[d] Estimated from pilot EVO injections conducted during RDO activities (Geosyntec, 2006).

[e] Based on theoretical stoichiometric demand. Reported as % oil. (*i.e* ., EVO dose is ~twice the oil dose).

Acronyms/Abbreviations

% - percent

ft - feet

bgs - below ground surface

EVO - emulsified vegetable oil

RDO - remedial design optimization

ROI - radius of influence

TABLE 4.2

Geosyntec consultants

SUMMARY OF BIOBARRIER AND SOURCE AREA DESIGN DETAILS

Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

a) Selected Remedial Design

Treatment Zone	Area	Aquifer Unit Targeted	Biobarrier Length (ft)	Total No. of Injection Wells	Estimated Duration of Biobarrier Operation (years)[a]	Well Screen Length (ft)	Target ROI (ft)	Target Oil Dose (%)	Target EVO Volume per Well (gal)[b]	Target Water Volume per Well (gal)	Target Amendment Volume per Well (gal)[b]	Minimum KB-1™ Dose per Well (L)	Total EVO Volume (gal)	Total Water Volume (gal)	Total KB-1™ Volume (L)	Anticipated Reinjection Frequency (years)
Source	Source Grid Treatment	Upper Fines Unit	--	57	U	30	10	0.5%	234	23,032	23,266	3	13,338	1,326,162	171	U[c]
	Source Biobarrier	First Sand Unit	325	14	U	45	12	0.5%	476	46,851	47,327	3	6,664	662,578	42	6
Plume Base Case Scenario	Biobarrier FS-1	First Sand Unit	820	35	14	45	12	0.5%	476	46,851	47,327	3	16,660	1,656,445	105	6
	Biobarrier FS-2	First Sand Unit	685	29	16	35	12	0.5%	370	36,440	36,810	3	10,730	1,067,490	87	5
	Biobarrier SH-1	Shell Horizon	725	16	8	25	10	0.5%	194	19,110	19,304	3	3,104	308,864	48	10
				20	8	20	10	0.5%	155	15,288	15,443	3	3,100	308,860	60	10
				1	8	15	10	0.5%	117	11,466	11,583	3	117	11,583	3	10
	Biobarrier SH-3	Shell Horizon	465	19	18	40	12	0.5%	545	53,601	54,146	3	10,355	1,028,774	57	15
				1	18	35	12	0.5%	477	46,901	47,378	3	477	47,378	3	15
	Biobarrier SS-1	Second Sand Unit	510	22	11.5	40.0	12	0.5%	423	41,645	42,068	3	9,306	925,496	66	15

b) Other Design Alternatives Evaluated

Treatment Zone	Area	Aquifer Unit Targeted	Biobarrier Length (ft)	Total No. of Injection Wells	Estimated Duration of Biobarrier Operation (years)[a]	Well Screen Length (ft)	Target ROI (ft)	Target Oil Dose (%)	Target EVO Volume per Well (gal)[b]	Target Water Volume per Well (gal)	Target Amendment Volume per Well (gal)[b]	Target KB-1™ Dose per Well (L)	Total EVO Volume (gal)	Total Water Volume (gal)	Total KB-1™ Volume (L)	Anticipated Reinjection Frequency (years)
Plume Design Alternative 1	Biobarrier FS-1	First Sand Unit	625	27	8	45	12	0.5%	476	46,851	47,327	3	12,852	1,277,829	81	6
	Biobarrier FS-2	First Sand Unit	675	29	8	45	12	0.5%	476	46,851	47,327	3	13,804	1,372,483	87	6
	Biobarrier FS-3	First Sand Unit	685	29	8	35	12	0.5%	370	36,440	36,810	3	10,730	1,067,490	87	5
	Biobarrier SH-1	Shell Horizon	725	37	8	25	10	0.5%	194	19,110	19,304	3	7,178	714,248	111	10
	Biobarrier SH-2	Shell Horizon	690	35	8	25	10	0.5%	194	19,110	19,304	3	6,790	675,640	105	10
	Biobarrier SH-3	Shell Horizon	630	32	10	25	10	0.5%	194	19,110	19,304	3	6,208	617,728	96	10
	Biobarrier SS-1	Second Sand Unit	525	22	11	40	12	0.5%	423	41,645	42,068	3	9,306	925,496	66	15
Plume Design Alternative 2	Biobarrier FS-1	First Sand Unit	625	27	8	45	12	0.5%	476	46,851	47,327	3	12,852	1,277,829	81	6
	Biobarrier FS-2	First Sand Unit	675	29	8	45	12	0.5%	476	46,851	47,327	3	13,804	1,372,483	87	6
	Biobarrier FS-3	First Sand Unit	685	29	8	35	12	0.5%	370	36,440	36,810	3	10,730	1,067,490	87	5
	Biobarrier SH-1	Shell Horizon	725	37	8	25	10	0.5%	194	19,110	19,304	3	7,178	714,248	111	10
	Biobarrier SH-2	Shell Horizon	465	24	8	25	10	0.5%	194	19,110	19,304	3	4,656	463,296	72	10
	Biobarrier SS-1	Second Sand Unit	525	22	11	40	12	0.5%	423	41,645	42,068	3	9,306	925,496	66	15

Notes

[a] Treatment duration was estimated as the time required to achieve a maximum trichloroethene concentration of 200 µg/L upgradient of each biobarrier as determined from numerical modeling (see Appendix A).

[b] Amendment volumes were calculated assuming a cylindrical distribution of fluid around each injection point, and accounting for the effective porosity of the soil, the targeted saturation of the oil, and the oil distribution efficiency around each injection point as quantified during RDO activities (Geosyntec, 2006).

[c] Longevity is dependent upon rate of TCE degradation and TCE DNAPL mass in the subsurface, which is currently unknown.

Acronyms/Abbreviations

% - percent
bgs - below ground surface
DNAPL - dense non-aqueous phase liquid
EVO - emulsified vegetable oil
FS - First Sand
ft - feet
gal - gallons
KB-1 - mixed consortia of dehalorespiring bacteria
L - liters
µg/L - micrograms per liter
RDO - remedial design optimization
ROI - radius of injection
SH - Shell Horizon
SS - Second Sand
TCE - trichloroethene
U- Unknown

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TABLE 6.1

SUMMARY OF ANALYTES

Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

ANALYTE	INFORMATION OBTAINED FROM ANALYTE	MONITORING PROGRAM
Volatile Organic Compounds	• Quantify degradation of target chlorinated volatile compounds	PMW, MNA, POC
Dissolved Hydrocarbon Gases (ethene, ethane, methane)	• Ethene and ethane are complete degradation products; secondary indicators of degradation of target compounds • Methane indicator of reducing conditions; health and safety issue	PMW, MNA, POC
Dissolved Iron/Manganese/Arsenic	• Secondary groundwater quality parameters; may be mobilized due to inducement of reducing conditions in groundwater	PMW, POC
Inorganic Anions	• Declining nitrate/nitrite and sulfate concentrations indicative of reducing conditions • Bromide used for tracer testing • Increasing chloride concentrations is an indicator of reduction of chlorinated VOCs	PMW, POC
Total Dissolved Solids (TDS)	• Bioremediation performance indicator	PMW, POC
Alkalinity	• Water quality indicator	PMW, POC
Dissolved Hydrogen Sulfide	• Indicator of sulfate reduction; health and safety issue if it forms hydrogen sulfide	PMW, POC
Total Organic Compounds (TOC)	• Qualitative indicator of presence of electron donor	PMW, POC
Volatile Fatty Acids (acetic, butyric, lactic, propionic)	• Breakdown products of the electron donor; qualitative indicator of presence of electron donor	PMW, POC
Dehalococcoides (*Dhc/VCr*)	• Measures levels of *Dehalococcoides Vinyl Chloride Reductase Gene* group of bacteria responsible for degradation of cDCE and VC to ethane • Indicator of bioaugmented culture growth and persistence	PMW, MNA
Depth to Water	• Monitor fluctuations of the water table to track groundwater flow direction	PMW, MNA, POC
Field Parameters (pH, DO, ORP, spc, turbidity, temperature)	• DO and ORP are measures of anaerobic conditions; other parameters are monitored to ensure there is no negative effect on secondary groundwater chemistry	PMW, MNA, POC
Soil Vapor - Methane	• Health and Safety	SV
Soil Vapor - Hydrogen Sulfide	• Health and Safety	SV

Acronyms/Abbreviations
cDCE- cis-1,2-dichloroethene
Dhc/VCr- Dehalococcoides Vinyl Chloride Reductase Gene
DO- dissolved oxygen
MNA- monitored natural attenuation
ORP- oxidation reduction potential
PMW - performance monitoring well
POC - point of compliance
spc - specific conductancee
SV - soil vapor
TDS - total dissolved solids
TOC - total organic compounds
VC - vinyl chloride
VOC - volatile organic compounds

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TABLE 6.2

TENTATIVE SAMPLING SCHEDULE FOR FIRST THREE YEARS OF OPERATION

Remedial Action Sampling and Analysis Plan - Installation Restoration Site 70 Naval Weapons Station Seal Beach - Seal Beach, California

Geosyntec consultants

ZONE	TREATMENT AREA	MONITORING WELL	EVENT	BASELINE										QUARTERLY (Year One Only)							SEMI-ANNUALLY										ANNUALLY				
			Well Function	FP [1]	VOCs [2]	DHGs [3]	Anions/TDS/Alk [4]	VFAs [5]	TOC [6]	Dhc/VCr [7]	SV [8]	Sulfide [9]	Dissolved Metals [10]	FP [1]	VOCs [2]	DHGs [3]	Anions/TDS/Alk [4]	VFAs [5]	TOC [6]	SV [8]	FP [1]	VOCs [2]	DHGs [3]	Anions/TDS/Alk [4]	VFAs [5]	TOC [6]	Dhc/VCr [7]	SV [8]	Sulfide [9]	Dissolved Metals [10]	FP [1]	VOCs [2]	DHGs [3]	Dhc/VCr [7]	SV [8]
Source Area	Grid Treatment	MW-70-PMW01A	PMW	√	√	√	√	√	√					√	√	√	√	√	√		√	√	√	√	√	√									
		MW-70-PMW01B	PMW	√	√	√	√	√	√					√	√	√	√	√	√		√	√	√	√	√	√									
		MW-70-27	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-28	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-MNA01	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA02	MNA	√	√	√																									√	√	√		
		MW-70-MNA03	MNA	√	√	√																									√	√	√		
		MW-70-MNA04	MNA	√	√	√																									√	√	√		
	Soil Vapor Probes	SV-70-01	SV								√									√															√
		SV-70-02	SV								√									√															√
		SV-70-03	SV								√									√															√
		SV-70-04	SV								√									√															√
		SV-70-05	SV								√									√															√
		SV-70-06	SV								√									√															√
		SV-70-07	SV								√									√															√
		SV-70-08	SV								√									√															√
		SV-70-09	SV								√									√															√
		SV-70-10	SV								√									√															√
		SV-70-11	SV								√									√															√
		SV-70-12	SV								√									√															√
	Source Biobarrier	MW-70-PMW02A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW02B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-SAB06	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-MNA05	MNA	√	√	√																									√	√	√		
		MW-70-PMW03A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW03B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
Plume	Biobarrier FS-1	MW-70-38	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-FSB118	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW06A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW06B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW04A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW04B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-FSB108	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW05A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW05B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		RDO-5	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA08	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA06	MNA	√	√	√																									√	√	√		
		MW-70-MNA11	MNA	√	√	√																									√	√	√		
		MW-70-MNA07	MNA	√	√	√																									√	√	√	√	
	Biobarrier FS-2	MW-70-PMW07A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW07B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-FSB216	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW08A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW08B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-MNA09	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA10	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA12	MNA	√	√	√																									√	√	√	√	
	Biobarrier SH-1	MW-70-PMW09	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-SHB113	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW10	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-SHB217	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA13	MNA	√	√	√																									√	√	√		

TABLE 6.2

TENTATIVE SAMPLING SCHEDULE FOR FIRST THREE YEARS OF OPERATION

Geosyntec consultants

ZONE	TREATMENT AREA	MONITORING WELL	EVENT	BASELINE										QUARTERLY (Year One Only)							SEMI-ANNUALLY										ANNUALLY				
			Well Function	FP [1]	VOCs [2]	DHGs [3]	Anions//TDS/Alk [4]	VFAs [5]	TOC [6]	Dhc/VCr [7]	SV [8]	Sulfide [9]	Dissolved Metals [10]	FP [1]	VOCs [2]	DHGs [3]	Anions//TDS/Alk [4]	VFAs [5]	TOC [6]	SV [8]	FP [1]	VOCs [2]	DHGs [3]	Anions//TDS/Alk [4]	VFAs [5]	TOC [6]	Dhc/VCr [7]	SV [8]	Sulfide [9]	Dissolved Metals [10]	FP [1]	VOCs [2]	DHGs [3]	Dhc/VCr [7]	SV [8]
Plume	Biobarrier SH-3	MW-70-PMW11A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW11B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-SHB310	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW12A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW12B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-MNA14	MNA	√	√	√																									√	√	√	√	
	Biobarrier SS-1	MW-70-PMW13A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW13B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-SSB109	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW14A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW14B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-MNA16	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA17	MNA	√	√	√																									√	√	√		
		MW-70-MNA15	MNA	√	√	√																									√	√	√	√	
		MW-70-15	MNA	√	√	√																									√	√	√		
Point of Compliance Wells	Upper Fines	MW-70-02	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-10	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-17	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-22	POC	√	√	√	√	√	√			√	√																		√	√			
	First Sand	MW-70-POC01	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-11	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-35	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-16	POC	√	√	√	√	√	√			√	√																		√	√			
	Second Sand	MW-70-23	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-36	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-21	POC	√	√	√	√	√	√			√	√																		√	√			
	Deep Sand	MW-70-POC02	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-POC03	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-POC04	POC	√	√	√	√	√	√			√	√																		√	√			

Notes

[1] FP - Field Parameters - pH, dissolved oxygen, oxidation-reduction potential, specific conductance, temperature, turbidity, and depth to water.

[2] VOCs are Chlorinated Volatile Organic Compounds (EPA Method 8260B).

[3] DHGs are Dissolved Hydrocarbon Gases (i.e. methane, ethene and ethane).

[4] Anions to be analyzed for are chloride, sulfate, nitrate and nitrite.

[5] Volatile Fatty Acids (VFAs).

[6] Total Organic Carbon (TOC).

[7] DNA Assay for *Dehalococcoides* Vinyl Chloride Reductase Gene (*Dhc/VCr*).

[8] Soil vapor analyzed for hydrogen sulfide and methane

[9] Total dissolved sulfide.

[10] Dissolved Metals include iron, manganese and arsenic.

√ indicates that indicates that a sample is to be collected.

FS - First Sand
FSB - First Sand Biobarrier
MNA - Monitoring Natural Attenuation Well
MW - Monitoring Well
PMW - Performance Monitoring Well
POC - Point of Compliance Well
TDS - Total dissolved solids
SAB - Source Area Biobarrier
SH - Shell Horizon
SHB - Shell Horizon Biobarrier
SS - Second Sand
SSB - Second Sand Biobarrier
SV - Soil Vapor

TABLE 6.3

SUMMARY OF MONITORING PROGRAM - Source Area and Dissolved-Phase Plume
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

Zone	Targeted Unit	Treatment Area	Monitoring Locations [a]	Screened Intervals [b]	Function of Well in Monitoring Program				Rationale for Well Selection
					PMW [c]	MNA	POC	Baseline	
Source	Upper Fines	Grid Treatment	MW-70-PMW01A	25 to 35 ft bgs	✓			✓	Located in area of elevated [TCE] (4 mg/L), possible DNAPL
			MW-70-PMW01B	45 to 55 ft bgs	✓			✓	
			MW-70-27	25 to 35 ft bgs	✓			✓	Located in very high concentration zone, likely DNAPL present
			MW-70-28	50 to 60 ft bgs	✓			✓	High Concentration Area
			MW-70-MNA01	40 to 50 ft bgs		✓		✓	Monitor MNA of higher [TCE] to assess need for contingency, sentinel well for monitoring plume migration
			MW-70-MNA02	35 to 45 ft bgs		✓		✓	Sentinel wells for monitoring plume migration and evaluate MNA
			MW-70-MNA03	35 to 45 ft bgs		✓		✓	
			MW-70-MNA04	35 to 45 ft bgs		✓		✓	
		Soil Vapor Probes	SV-70-01	5 to 6 ft bgs	✓			✓	Monitor methane and hydrogen sulfide production levels
			SV-70-02	5 to 6 ft bgs	✓			✓	
			SV-70-03	5 to 6 ft bgs	✓			✓	
			SV-70-04	5 to 6 ft bgs	✓			✓	
			SV-70-05	5 to 6 ft bgs	✓			✓	
			SV-70-06	5 to 6 ft bgs	✓			✓	
			SV-70-07	5 to 6 ft bgs	✓			✓	
			SV-70-08	5 to 6 ft bgs	✓			✓	
			SV-70-09	5 to 6 ft bgs	✓			✓	
			SV-70-10	5 to 6 ft bgs	✓			✓	
			SV-70-11	5 to 6 ft bgs	✓			✓	
			SV-70-12	5 to 6 ft bgs	✓			✓	
		Point of Compliance	MW-70-02	20 to 30 ft bgs			✓	✓	Upgradient Point of Compliance
			MW-70-10	30 to 40 ft bgs			✓	✓	Crossgradient Point of Compliance
			MW-70-17	30 to 40 ft bgs			✓	✓	
			MW-70-22	20 to 30 ft bgs			✓	✓	Downgradient Point of Compliance

TABLE 6.3

SUMMARY OF MONITORING PROGRAM - Source Area and Dissolved-Phase Plume
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

Zone	Targeted Unit	Treatment Area	Monitoring Locations [a]	Screened Intervals [b]	Function of Well in Monitoring Program				Rationale for Well Selection
					PMW [c]	MNA	POC	Baseline	
Source	First Sand	Biobarrier SAB-1	MW-70-PMW02A	70 to 80 ft bgs	✓			✓	Upgradient wells for monitoring concentration influx into biobarrier
			MW-70-PMW02B	90 to 100 ft bgs	✓			✓	
			MW-70-PMW03A	70 to 80 ft bgs	✓			✓	Downgradient from biobarrier, to evaluate concentrations leaving biobarrier
			MW-70-PMW03B	90 to 100 ft bgs	✓			✓	
			MW-70-MNA05	70 to 80 ft bgs		✓		✓	Sentinel well for monitoring plume migration and evaluate MNA
			IW-70-SAB06	60 to 105 ft bgs	✓			✓	Within biobarrier, provides EISB performance data
Plume	First Sand	Biobarrier FSB-1	MW-70-38	80 to 100 ft bgs	✓			✓	Upgradient well for monitoring concentration influx into biobarrier
			IW-70-FSB118	60 to 105 ft bgs	✓			✓	Within biobarrier, provides performance data along plume core
			MW-70-PMW06A	70 to 80 ft bgs	✓			✓	Downgradient from biobarrier, to evaluate concentrations leaving biobarrier in plume core
			MW-70-PMW06B	90 to 100 ft bgs	✓			✓	
			MW-70-PMW04A	70 to 80 ft bgs	✓			✓	Upgradient well for monitoring concentration influx into biobarrier
			MW-70-PMW04B	90 to 100 ft bgs	✓			✓	
			IW-70-FSB108	60 to 105 ft bgs	✓			✓	Within biobarrier, provides performance data in lower [TCE] area
			MW-70-PMW05A	70 to 80 ft bgs	✓			✓	Downgradient from biobarrier, to evaluate concentrations leaving biobarrier in plume
			MW-70-PMW05B	90 to 100 ft bgs	✓			✓	
			RDO-5	65 to 105 ft bgs		✓		✓	Evaluate MNA of plume
			MW-70-MNA08	80 to 90 ft bgs		✓		✓	
			MW-70-MNA07	80 to 90 ft bgs		✓		✓	
			MW-70-MNA06	80 to 90 ft bgs		✓		✓	Sentinel wells for monitoring plume migration and evaluate MNA
			MW-70-MNA11	80 to 90 ft bgs		✓		✓	
		Biobarrier FSB-2	MW-70-PMW07A	65 to 75 ft bgs	✓			✓	Upgradient wells for monitoring concentration influx into biobarrier
			MW-70-PMW07B	85 to 95 ft bgs	✓			✓	
			IW-70-FSB216	65 to 100 ft bgs	✓			✓	Within biobarrier, provides performance data along plume core
			MW-70-PMW08A	65 to 75 ft bgs	✓			✓	Downgradient wells for monitoring concentrations leaving biobarrier
			MW-70-PMW08B	85 to 95 ft bgs	✓			✓	
			MW-70-MNA09	75 to 85 ft bgs		✓		✓	Sentinel well for monitoring plume migration and monitor MNA
			MW-70-MNA10	75 to 85 ft bgs		✓		✓	Evaluate MNA of plume
			MW-70-MNA12	75 to 85 ft bgs		✓		✓	
		Point of Compliance	MW-70-POC01	80 to 90 ft bgs			✓	✓	Upgradient point of compliance
			MW-70-11	80 to 100 ft bgs			✓	✓	Crossgradient point of compliance
			MW-70-35	90 to 100 ft bgs			✓	✓	
			MW-70-16	95 to 105 ft bgs			✓	✓	Downgradient point of compliance

TABLE 6.3

SUMMARY OF MONITORING PROGRAM - Source Area and Dissolved-Phase Plume
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

Zone	Targeted Unit	Treatment Area	Monitoring Locations [a]	Screened Intervals [b]	Function of Well in Monitoring Program				Rationale for Well Selection
					PMW [c]	MNA	POC	Baseline	
Plume	Shell Horizon	Biobarrier SHB-1	MW-70-PMW09	115 to 125 ft bgs	✓			✓	Upgradient well for monitoring concentration influx into biobarrier
			IW-70-SHB113	105 to 130 ft bgs	✓			✓	Within biobarrier, provides performance data along plume core
			MW-70-PMW10	115 to 125 ft bgs	✓			✓	Downgradient from biobarrier, to evaluate concentrations leaving biobarrier
			IW-70-SHB-217	115 to 125 ft bgs		✓		✓	Evaluate MNA of plume
			MW-70-MNA13	115 to 125 ft bgs		✓		✓	Sentinel well for monitoring plume migration and evaluate MNA
		Biobarrier SHB-3	MW-70-PMW11A	85 to 95 ft bgs	✓			✓	Upgradient wells for monitoring concentration influx into biobarrier
			MW-70-PMW11B	115 to 125 ft bgs	✓			✓	
			IW-70-SHB310	80-95, 105 to 130 ft bgs	✓			✓	Within biobarrier, provides performance data along plume core
			MW-70-PMW12A	85 to 95 ft bgs	✓			✓	Downgradient from biobarrier, to evaluate concentrations leaving biobarrier
			MW-70-PMW12B	115 to 125 ft bgs	✓			✓	
			MW-70-MNA14	115 to 125 ft bgs		✓		✓	Evaluate MNA of plume
	Second Sand	Biobarrier SSB-1	MW-70-PMW13A	130 to 140 ft bgs	✓			✓	Upgradient wells for monitoring concentration influx into biobarrier
			MW-70-PMW13B	150 to 160 ft bgs	✓			✓	
			IW-70-SSB109	125 to 165 ft bgs	✓			✓	Within biobarrier, provides performance data along plume core
			MW-70-PMW14A	130 to 140 ft bgs	✓			✓	Downgradient from biobarrier, to evaluate concentrations leaving biobarrier
			MW-70-PMW14B	150 to 160 ft bgs	✓			✓	
			MW-70-MNA15	140 to 150 ft bgs		✓		✓	Evaluate MNA of plume
			MW-70-MNA16	140 to 150 ft bgs		✓		✓	
			MW-70-MNA17	140 to 150 ft bgs		✓		✓	Sentinel wells for monitoring plume migration and evaluate MNA
			MW-70-15	160 to 170 ft bgs		✓		✓	
	Second Sand	Point of Compliance	MW-70-23	110 to 130 ft bgs			✓	✓	Crossgradient point of compliance
			MW-70-36	150 to 160 ft bgs			✓	✓	
			MW-70-21	150 to 170 ft bgs			✓	✓	Downgradient point of compliance
	Deep Sand	Point of Compliance	MW-70-POC02	190 to 200 ft bgs			✓	✓	Crossgradient point of compliance
			MW-70-POC03	190 to 200 ft bgs			✓	✓	
			MW-70-POC04	190 to 200 ft bgs			✓	✓	Downgradient point of compliance

Notes:
[a] Monitoring well locations may be found on Figure B1.3 (SA Source Area), B1.4 (FS First Sand Unit), B1.5 (SH Shell Horizon), and B1.6 (SS Second Sand Unit). Point of compliance well locations may be found on Figure B2.2.
[b] Screen intervals are based on as built/proposed well constructions completed/proposed September 2007 consistent with injection well screens, and may be modified as necessary in the field.
[c] PMW wells will be used to evaluate the ongoing effectiveness of the EISB program and evaluate the need for biobarrier maintenance, including EVO reinjections, rebioaugmentation, etc.

Acronyms/Abbreviations:
DNAPL- dense non-aqeous phase liquid
EISB – enhanced in situ bioremediation
EVO – emulsified vegetable oil
ft bgs – feet below ground surface
FSB - first sand biobarrier
IW - injection well
mg/l - milligrams per liter
MNA – monitored natural attenuation
MW - monitoring well
PMW – performance monitoring well
POC – point of compliance
RDO - Remedial Design Optimization
SAB - source area biobarrier
SHB - shell horizon biobarrier
SSB - second sand biobarrier
SV - soil vapor
TCE – trichloroethene concentrations

TABLE 6.4

MONITORING WELL CONSTRUCTION DETAILS
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

Well Function	Well Location	Well Depth[1]	Aquifer Unit	Well Total Depth[2]	Total Feet of Screen[2]	Top of Screen (ft bgs)[2]	Bottom of Screen (ft bgs)[2]
PMW	Source Grid Treatment Area	A	Upper Fines	40	10	25	35
		B	Upper Fines	60	10	45	55
	Source Containment Biobarrier	A	First Sand Unit	85	10	70	80
		B	First Sand Unit	105	10	90	100
	Biobarrier FS-1	A	First Sand Unit	85	10	70	80
		B	First Sand Unit	105	10	90	100
	Biobarrier FS-2	A	First Sand Unit	80	10	65	75
		B	First Sand Unit	100	10	85	95
	Biobarrier SH-1	--	Shell Horizon	130	10	115	125
	Biobarrier SH-3	A	Shell Horizon	100	10	85	95
		B	Shell Horizon	130	10	115	125
	Biobarrier SS-1	A	Second Sand Unit	145	10	130	140
		B	Second Sand Unit	165	10	150	160
MNA	Source Grid Treatment Area	--	Upper Fines	50/55[3]	10	35/40[3]	45/50[3]
	Source Containment Biobarrier	--	First Sand Unit	85	10	70	80
	Biobarrier FS-1	--	First Sand Unit	95	10	80	90
	Biobarrier FS-2	--	First Sand Unit	90	10	75	85
	Biobarrier SH-1	--	Shell Horizon	130	10	115	125
	Biobarrier SH-3	--	Shell Horizon	130	10	115	125
	Biobarrier SS-1	--	Second Sand Unit	155	10	140	150
POC	First Sand Crossgradient	--	First Sand	95	10	80	90
	Deep Sand Crossgradient	--	Deep Sand	205	10	190	200
	Deep Sand Downgradient	--	Deep Sand	205	10	190	200

Notes
[1] Well depth "A" corresponds to shallower wells denoted as "PMW-#A", and well depth "B" corresponds to deeper wells denoted as "PMW-#B" installed in the same location (i.e., well nest).
[2] All construction details are subject to changes in the field due to lithology.
[3] MNA-1 will be screened between 40 and 50 ft bgs. The remainder of the MNA wells within the Source Grid Treatment Area will be screened from 35 to 45 ft bgs.

Acronyms/Abbreviations
FS - First Sand
ft bgs - feet below ground surface
IR - Installation Restoration
MNA - Monitored Natural Attenuation Wells
PMW - Performance Monitoring Wells
POC - Point of Compliance
SH - Shell Horizon
SS - Second Sand

TABLE 6.5

INJECTION WELL CONSTRUCTION DETAILS
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

Well Location	Aquifer Unit	Well Total Depth[1]	Total Feet of Screen[1]	Top of Screen (ft bgs)[1]	Bottom of Screen (ft bgs)[1]
Source Area Grid Treatment	Upper Fines	60	30	25	55
Source Area Biobarrier	First Sand Unit	110	45	60	105
Biobarrier FS-1	First Sand Unit	110	45	60	105
Biobarrier FS-2	First Sand Unit	105	35	65	100
Biobarrier SH-1	Shell Horizon	135	25	105	130
Biobarrier SH-3	Shell Horizon	135	25	105	130
Biobarrier SS-1	Second Sand Unit	170	40	125	165

Notes
[1] All construction details are subject to changes in the field due to lithology.

Acronyms/Abbreviations
FS-First Sand
ft bgs-feet below ground surface
IR-Installation Restoration
SH-Shell Horizon
SS-Second Sand

TABLE 7.1

SUMMARY OF INJECTION STAGES, AMENDMENT VOLUMES, AND ESTIMATED INJECTION DURATION - SOURCE AREA AND SOURCE BIOBARRIER
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

SOURCE AREA

Injection Stage	Injection Well Group[a]	Extraction Well Group[a]	Number IW Wells In Each Group	Target Oil Dose (%)[b]	Target EVO Volume Per Well (gal)[b]	Total EVO Volume (gal)[b]	Total Water Volume (gal)[b]	Total Amendment Volume (gal)[b]	Anticipated Injection Rate Per Well (gpm)[c]	Total Anticipated Injection Rate (gpm)	Total Target KB-1™ Dose (L)[b]	Total Volume Anoxic Water (gal)[d]
1	Group 1	Group 2	9	0.5%	234	2,106	207,288	209,394	10	90	27	3,600
2	Group 2	Group 3	9	0.5%	234	2,106	207,288	209,394	10	90	27	3,600
3	Group 3	Group4	10	0.5%	234	2,340	230,320	232,660	10	100	30	4,000
4	Group 4	Group 5	10	0.5%	234	2,340	230,320	232,660	10	100	30	4,000
5	Group 5	Group 6/ Group 2	10	0.5%	234	2,340	230,320	232,660	10	100	30	4,000
6	Group 6	Group 5	4	0.5%	234	936	92,128	93,064	5	20	12	1,600
7	Group 7	Group 2	5	0.5%	234	1,170	115,160	116,330	5	25	15	2,000
TOTAL			**57**			**13,338**					**171**	

SOURCE BIOBARRIER

Injection Stage	Injection Well Group[a]	Extraction Well Group[a]	Number IW Wells In Each Group	Target Oil Dose (%)[b]	Target EVO Volume Per Well (gal)[b]	Total EVO Volume (gal)[b]	Total Water Volume (gal)[b]	Total Amendment Volume (gal)[b]	Anticipated Injection Rate Per Well (gpm)[c]	Total Anticipated Injection Rate (gpm)	Total Target KB-1™ Dose (L)[b]	Total Volume Anoxic Water (gal)[d]
1	Group 1	Group 2	7	0.5%	476	3,332	327,957	331,289	10	70	21	4,480
2	Group 2	Group 2	3	0.5%	476	1,428	140,553	141,981	10	30	9	1,920
3	Group 2	Group 1	4	0.5%	476	1,904	187,404	189,308	5	20	12	2,560
TOTAL			**14**			**6,664**					**42**	

Notes:

[a] See Figure 7.1 for locations of wells.

[b] See Table 4.2 for a summary of design details and assumptions.

[c] Based on acheivable injection rates during RDO activities (Geosyntec, 2006) and accounting for longer screened interval.

[d] Anoxic water required for KB-1 injections.

[e] EVO injection based on 10 hour days.

[f] Total estimated time for injection includes 3 days for equipment setup, testing, and decommissioning. For injections that will require more than 5 working days, one extra day is included for cleaning of the equipment after every five days for weekend storage.

Acronyms/Abbreviations

% - percent
EVO - emulsified vegetable oil
gal - gallons
gpm - gallons per minute
IW - injection well
KB-1 - mixed consortia of dehalorespiring bacteria
L - liters
RDO - Remedial Design Optimization

TABLE 7.2

SUMMARY OF INJECTION STAGES, AMENDMENT VOLUMES, AND ESTIMATED INJECTION DURATION - BIOBARRIERS FSB-1 AND FSB-2
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

BIOBARRIER FS-1

Injection Stage	Injection Well Group[a]	Extraction Well Group[a]	Number IW Wells In Each Group	Target Oil Dose (%)[b]	Target EVO Volume Per Well (gal)[b]	Total EVO Volume (gal)[b]	Total Water Volume (gal)[b]	Total Amendment Volume (gal)[b]	Anticipated Injection Rate Per Well (gpm)[c]	Total Anticipated Injection Rate (gpm)	Total Target KB-1™ Dose (L)[b]	Total Volume Anoxic Water (gal)[d]
1	Group 1	Group 4/Group 2	9	0.5%	476	4,284	421,659	425,943	10	90	27	5,760
2	Group 2	Group 3	9	0.5%	476	4,284	421,659	425,943	10	90	27	5,760
3	Group 3	Group 2	9	0.5%	476	4,284	421,659	425,943	5	45	27	5,760
4	Group 4	Group 1	8	0.5%	476	3,808	374,808	378,616	5	40	24	5,120
TOTAL			**35**			**16,660**					**105**	

BIOBARRIER FS-2

Injection Stage	Injection Well Group[a]	Extraction Well Group[a]	Number IW Wells In Each Group	Target Oil Dose (%)[b]	Target EVO Volume Per Well (gal)[b]	Total EVO Volume (gal)[b]	Total Water Volume (gal)[b]	Total Amendment Volume (gal)[b]	Anticipated Injection Rate Per Well (gpm)[c]	Total Anticipated Injection Rate (gpm)	Total Target KB-1™ Dose (L)[b]	Total Volume Anoxic Water (gal)[d]
1	Group 1	Group 2	10	0.5%	370	3,700	364,400	368,100	10	100	30	5,000
2	Group 2	Group 3	10	0.5%	370	3,700	364,400	368,100	9	90	30	5,000
3	Group 3	Group 2	9	0.5%	370	3,330	327,960	331,290	5	45	27	4,500
TOTAL			**29**			**10,730**					**87**	

Notes:

[a] See Figure 7.2 for locations of wells.

[b] See Table 4.2 for a summary of design details and assumptions.

[c] Based on acheivable injection rates during RDO activities (Geosyntec, 2006) and accounting for longer screened interval.

[d] Anoxic water required for KB-1 injections.

[e] EVO injection based on 10 hour days.

[f] Total estimated time for injection includes 3 days for equipment setup, testing, and decommissioning. For injections that will require more than 5 working days, one extra day is included for cleaning of the equipment after every five days for weekend storage.

Acronyms/Abbreviations

% - percent
EVO - emulsified vegetable oil
FS - First Sand
FSB - First Sand Biobarrier
gal - gallons
gpm - gallons per minute
IW - injection well
KB-1 - mixed consortia of dehalorespiring bacteria
L - liters
RDO - Remedial Design Optimization

TABLE 7.3

SUMMARY OF INJECTION STAGES, AMENDMENT VOLUMES, AND ESTIMATED INJECTION DURATION - BIOBARRIERES SHB-1, SHB-3 AND SSB-1
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

BIOBARRIER SHB-1

Injection Stage	Injection Well Group[a]	Extraction Well Group[a]	Number IW Wells In Each Group	Target Oil Dose (%)[b]	Target EVO Volume Per Well (gal)[b]	Total EVO Volume (gal)[b]	Total Water Volume (gal)[b]	Total Amendment Volume (gal)[b]	Anticipated Injection Rate Per Well (gpm)[c]	Total Anticipated Injection Rate (gpm)	Total Target KB-1™ Dose (L)[b]	Total Volume Anoxic Water (gal)[d]
1	Group 1	Group 2/Group 3	10	0.5%	194 (5 wells); 155 (5 wells)	1,745	171,990	173,735	5	50	30	3,500
2	Group 2	Group 3	9	0.5%	194 (5 wells); 155 (4 wells)	1,590	156,702	158,292	5	45	27	3,150
3	Group 3	Group 4	9	0.5%	194 (4 wells); 155 (4 wells); 117 (1 well)	1,513	149,058	150,571	5	45	27	3,150
4	Group 4	Group 3	9	0.5%	194 (3 wells); 155 (5 wells); 117 (1 well)	1,474	145,236	146,710	2.5	23	27	3,150
TOTAL			**37**			**6,322**					**111**	

BIOBARRIER SHB-3

Injection Stage	Injection Well Group[a]	Extraction Well Group[a]	Number IW Wells In Each Group	Target Oil Dose (%)[b]	Target EVO Volume Per Well (gal)[b]	Total EVO Volume (gal)[b]	Total Water Volume (gal)[b]	Total Amendment Volume (gal)[b]	Anticipated Injection Rate Per Well (gpm)[c]	Total Anticipated Injection Rate (gpm)	Total Target KB-1™ Dose (L)[b]	Total Volume Anoxic Water (gal)[d]
1	Group 1	Group 2	10	0.5%	545	5,450	536,010	541,460	5	50	30	3,500
2	Group 2	Group 1	10	0.5%	545 (9 wells); 477 (1 well)	5,382	529,310	534,692	2.5	25	30	3,500
TOTAL			**20**			**10,832**					**60**	

BIOBARRIER SSB-1

Injection Stage	Injection Well Group[a]	Extraction Well Group[a]	Number IW Wells In Each Group	Target Oil Dose (%)[b]	Target EVO Volume Per Well (gal)[b]	Total EVO Volume (gal)[b]	Total Water Volume (gal)[b]	Total Amendment Volume (gal)[b]	Anticipated Injection Rate Per Well (gpm)[c]	Total Anticipated Injection Rate (gpm)	Total Target KB-1™ Dose (L)[b]	Total Volume Anoxic Water (gal)[d]
1	Group 1	Group 2/Group 3	8	0.5%	423	3,384	333,160	336,544	25	200	24	4,480
2	Group 2	Group 3	7	0.5%	423	2,961	291,515	294,476	25	175	21	3,920
3	Group 3	Group 2	7	0.5%	423	2,961	291,515	294,476	12.5	88	21	3,920
TOTAL			**22**			**9,306**					**66**	

Notes:
[a] See Figures 7.3 and 7.4 for locations of wells.
[b] See Table 4.2 for a summary of design details and assumptions.
[c] Based on acheivable injection rates during RDO activities (Geosyntec, 2006) and accounting for longer screened interval.
[d] Anoxic water required for KB-1 injections.
[e] EVO injection based on 10 hour days.
[f] Total estimated time for injection includes 3 days for equipment setup, testing, and decommissioning. For injections that will require more than 5 working days, one extra day is included for cleaning of the equipment after every five days for weekend storage.

Acronyms/Abbreviations

% - percent
EVO - emulsified vegetable oil
gal - gallons
gpm - gallons per minute
IW - injection well
KB-1 - mixed consortia of dehalorespiring bacteria
L - liters
RDO- Remedial Design Optimization
SHB - Shell Horizon Biobarrier
SSB - Second Sand Biobarrier

FIGURES

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Figure 1.2

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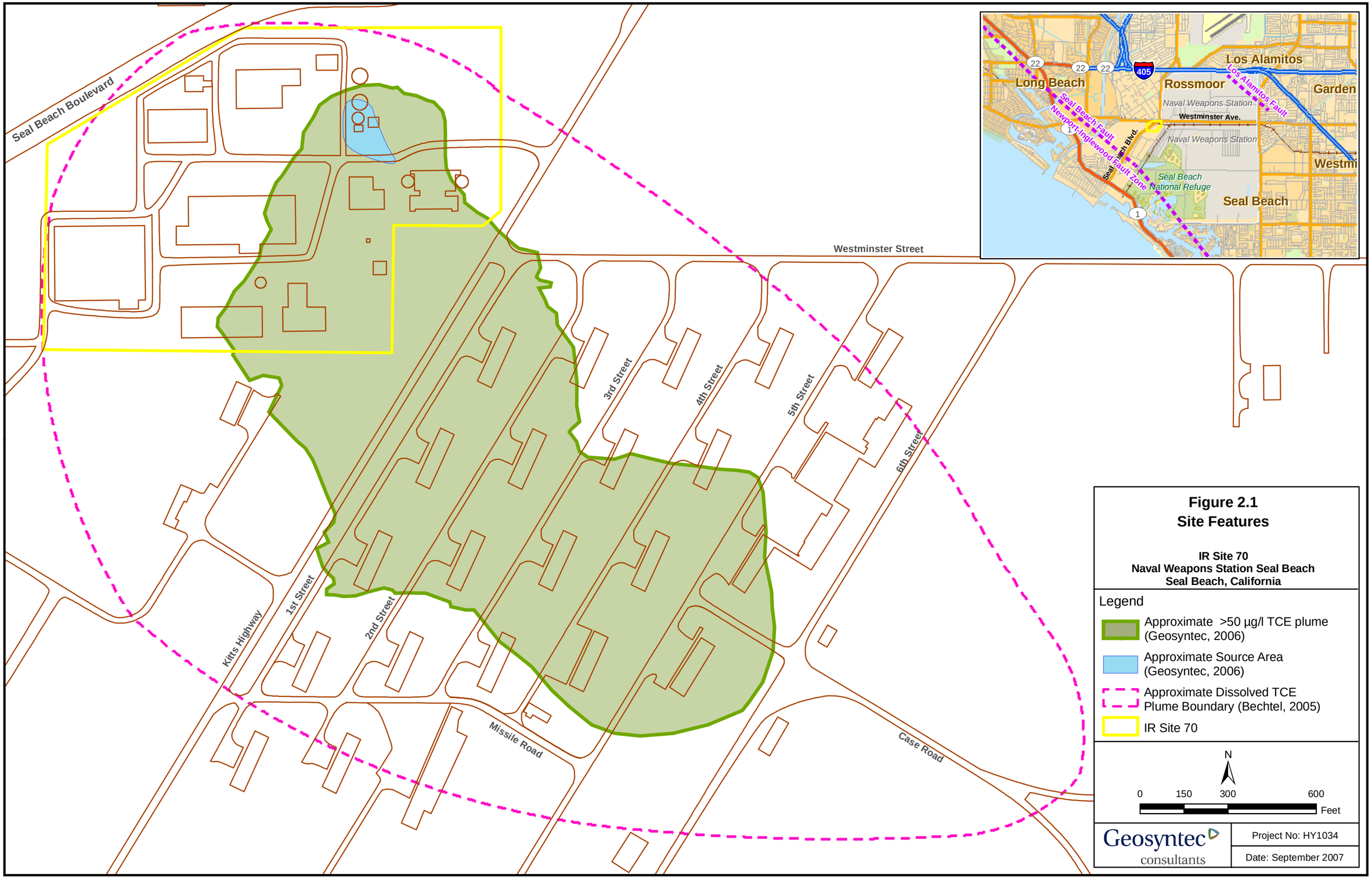

Figure 2.1
Site Features

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

Legend

- Approximate >50 µg/l TCE plume (Geosyntec, 2006)
- Approximate Source Area (Geosyntec, 2006)
- Approximate Dissolved TCE Plume Boundary (Bechtel, 2005)
- IR Site 70

Geosyntec consultants

Project No: HY1034

Date: September 2007

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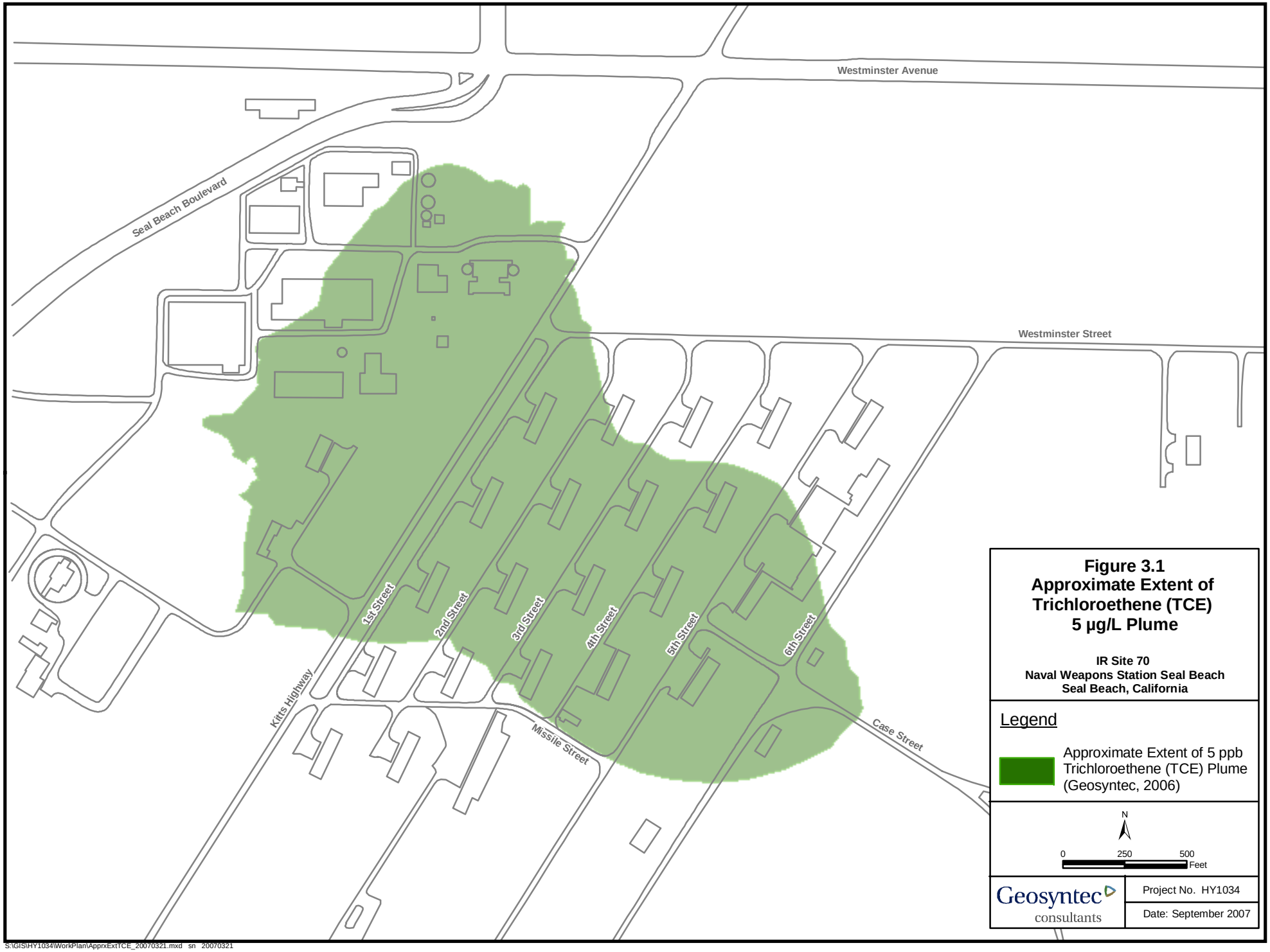

Figure 3.1
Approximate Extent of Trichloroethene (TCE) 5 µg/L Plume

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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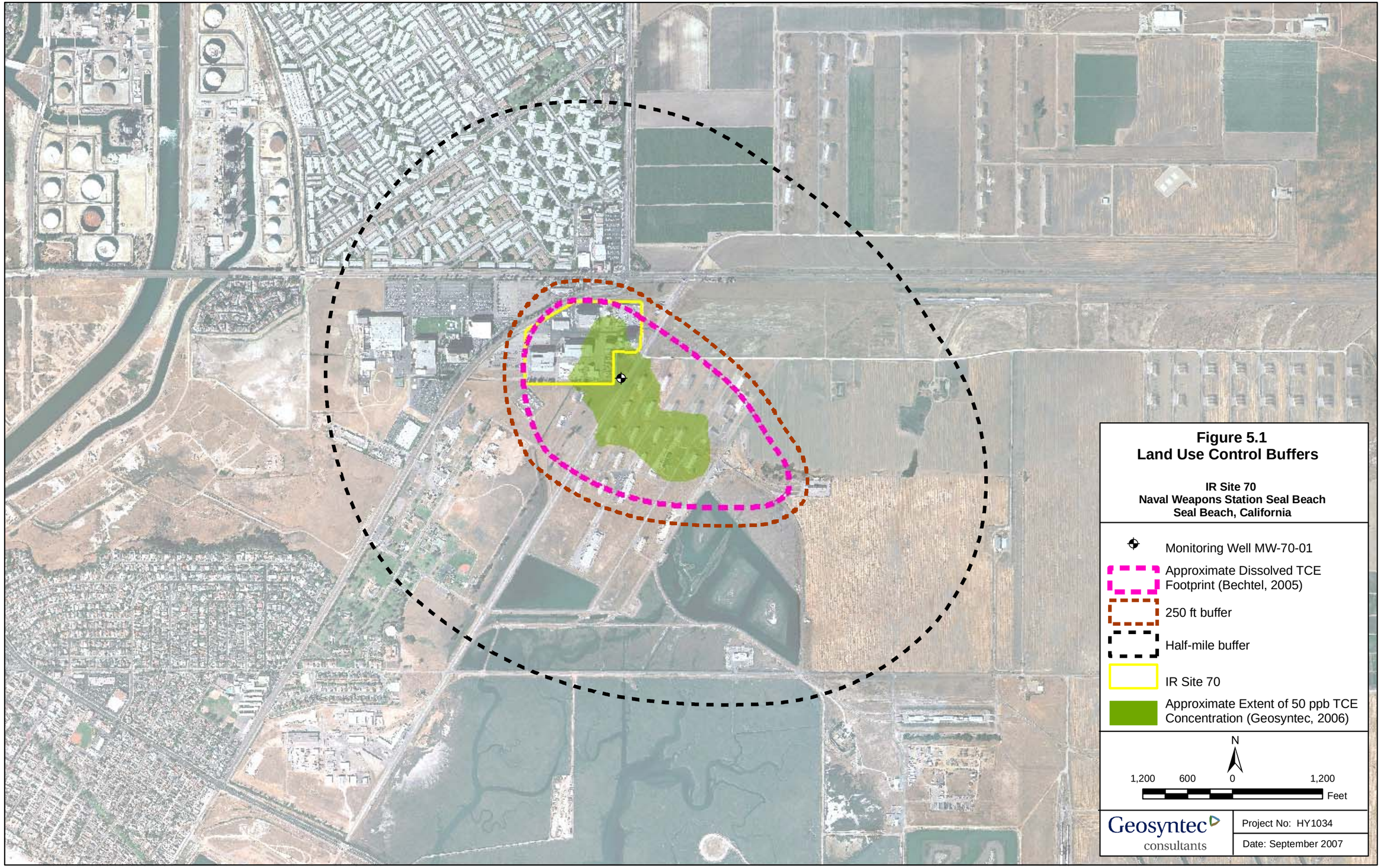

Figure 5.1
Land Use Control Buffers

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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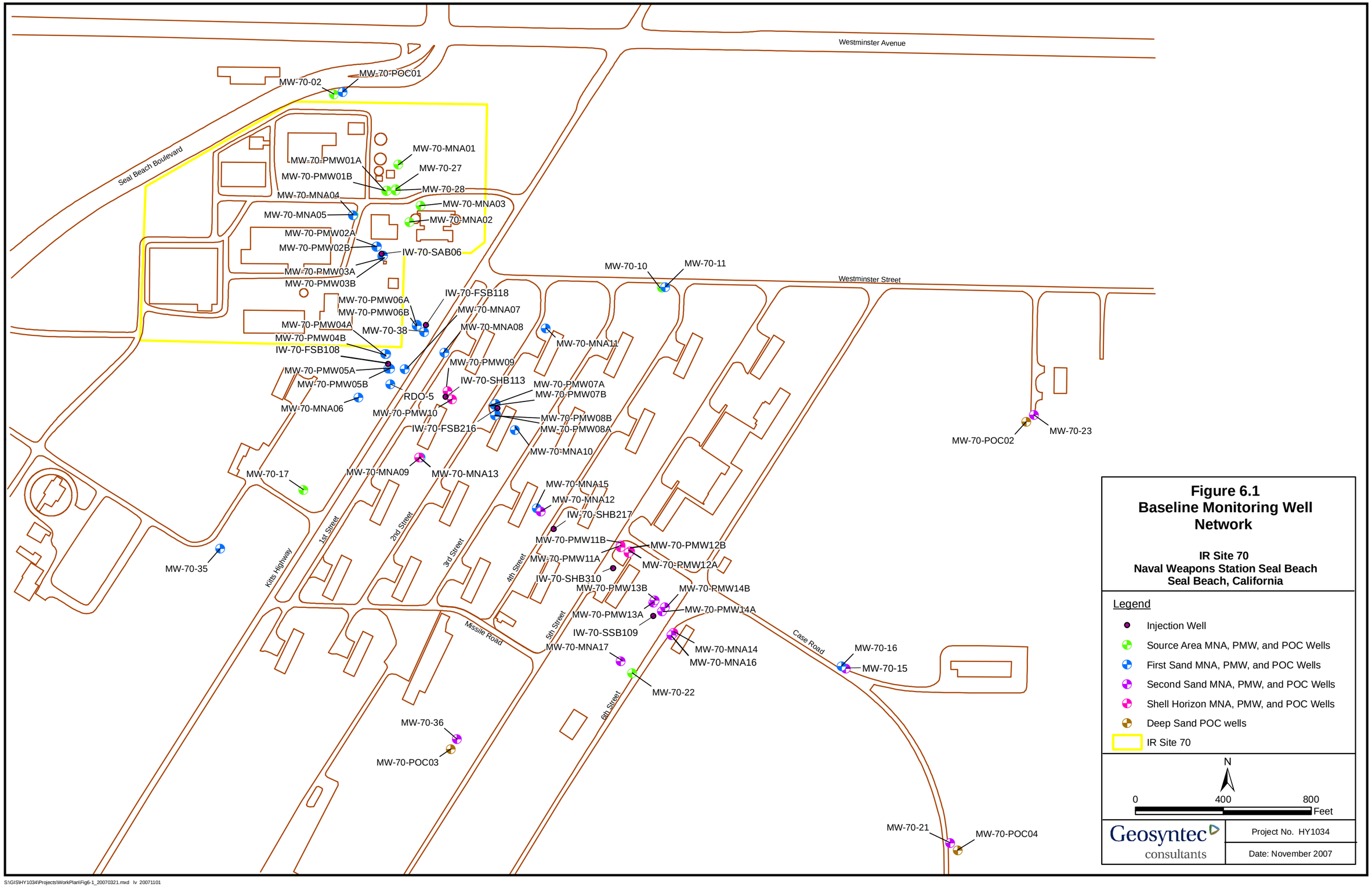

Figure 6.1
Baseline Monitoring Well Network

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

Legend

- Injection Well
- Source Area MNA, PMW, and POC Wells
- First Sand MNA, PMW, and POC Wells
- Second Sand MNA, PMW, and POC Wells
- Shell Horizon MNA, PMW, and POC Wells
- Deep Sand POC wells
- IR Site 70

N

0 400 800 Feet

Geosyntec consultants

Project No. HY1034

Date: November 2007

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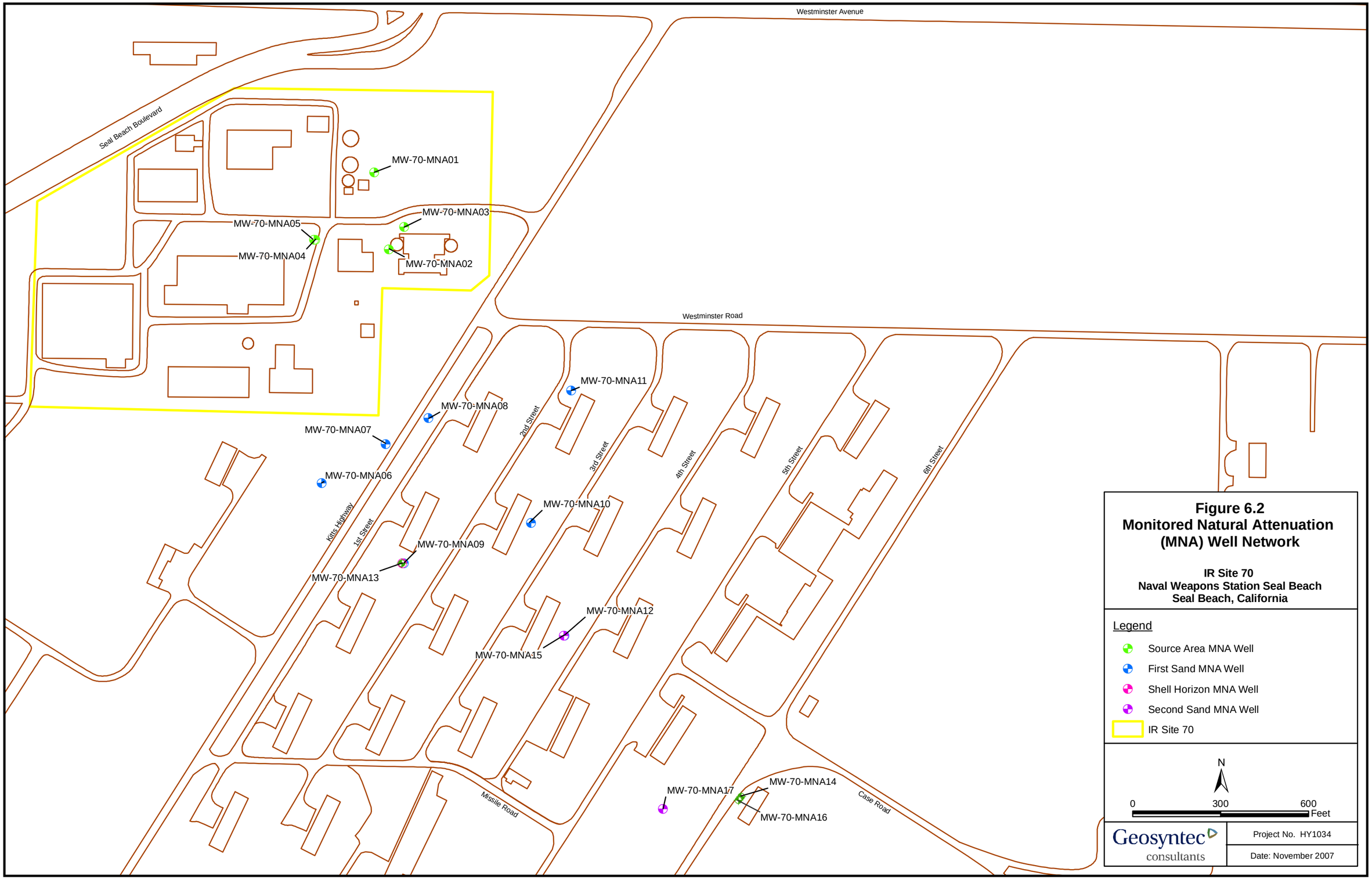

Figure 6.2
Monitored Natural Attenuation (MNA) Well Network

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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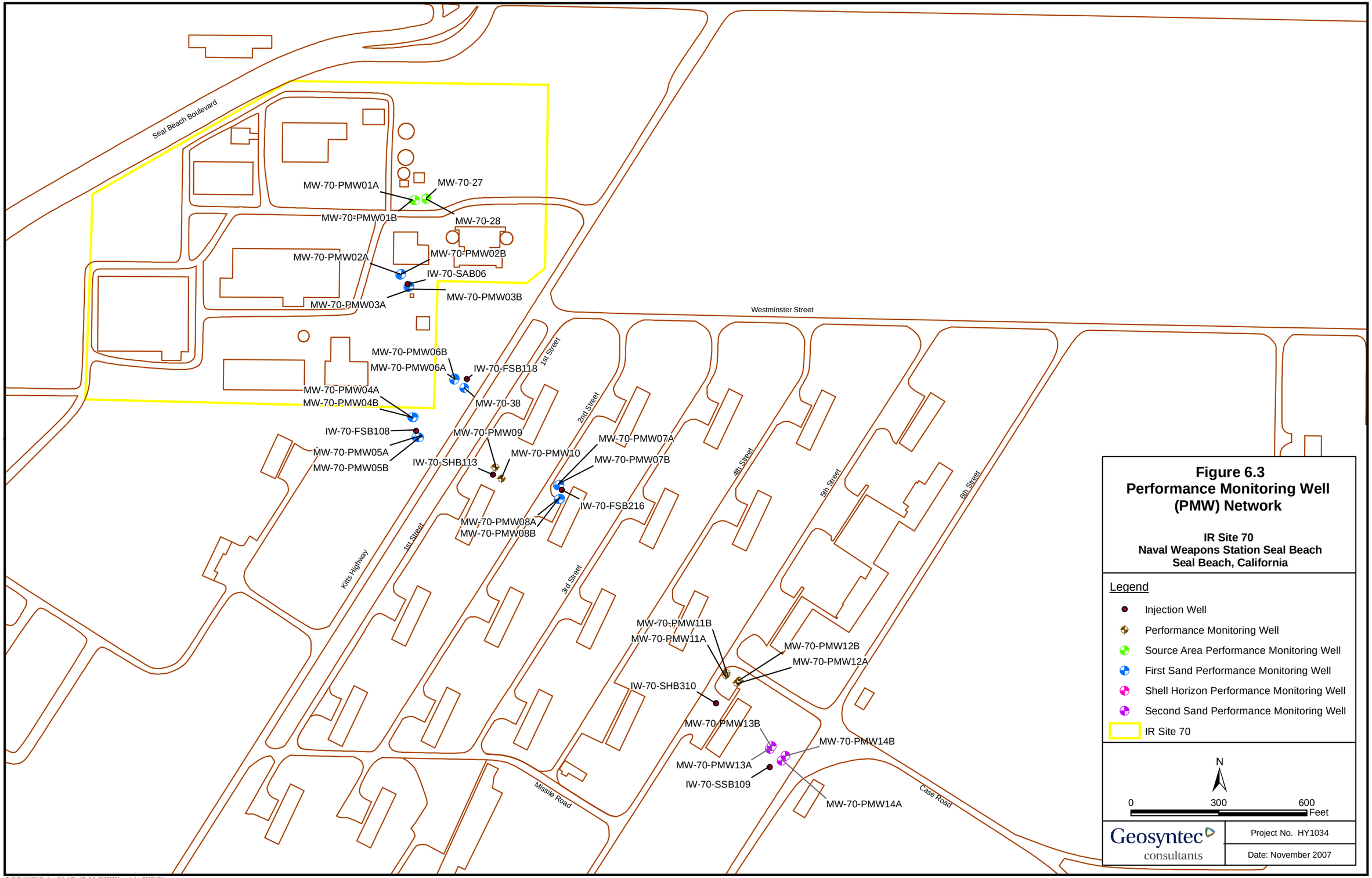

Figure 6.3
Performance Monitoring Well (PMW) Network

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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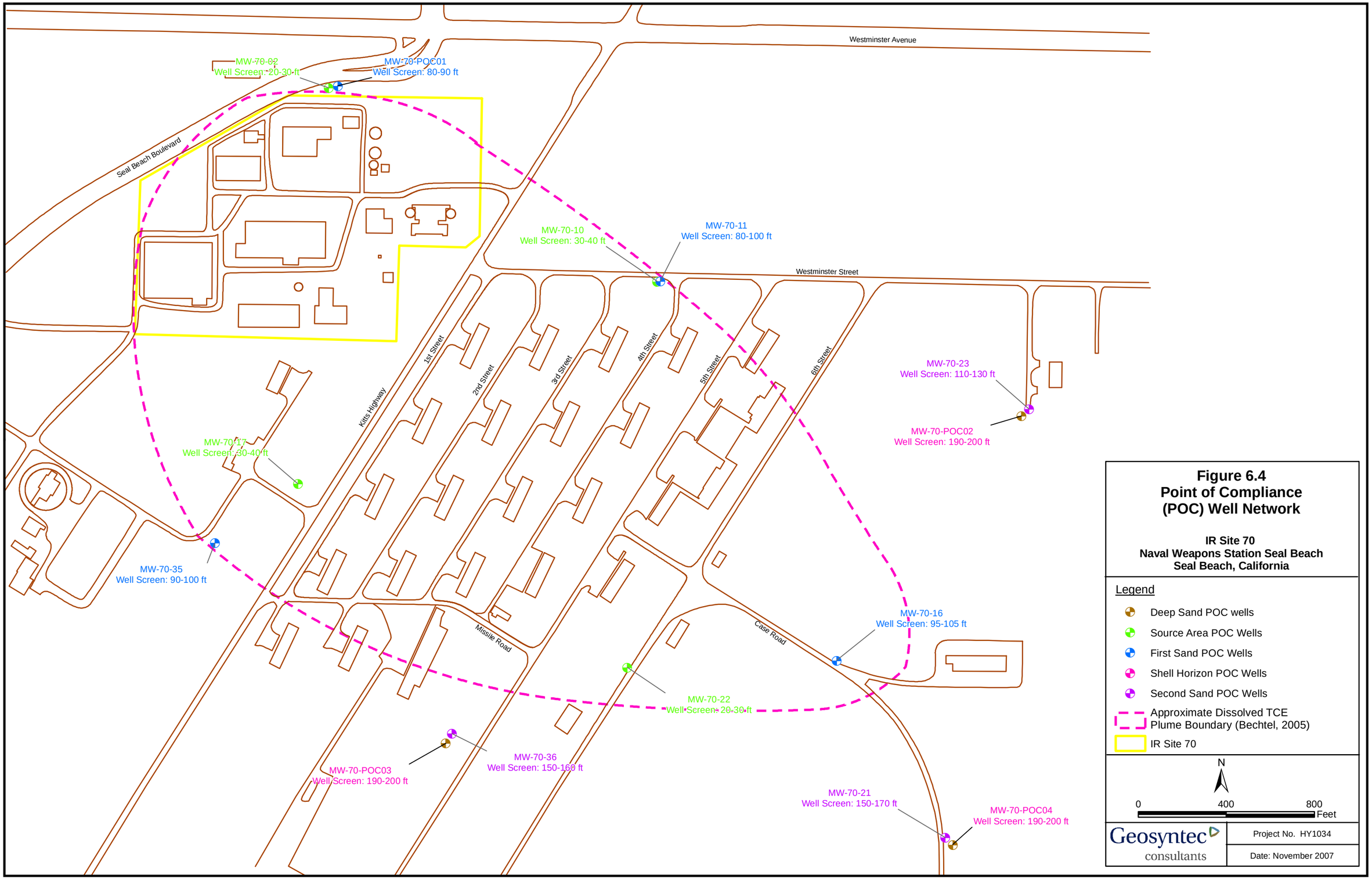

Figure 6.4
Point of Compliance (POC) Well Network

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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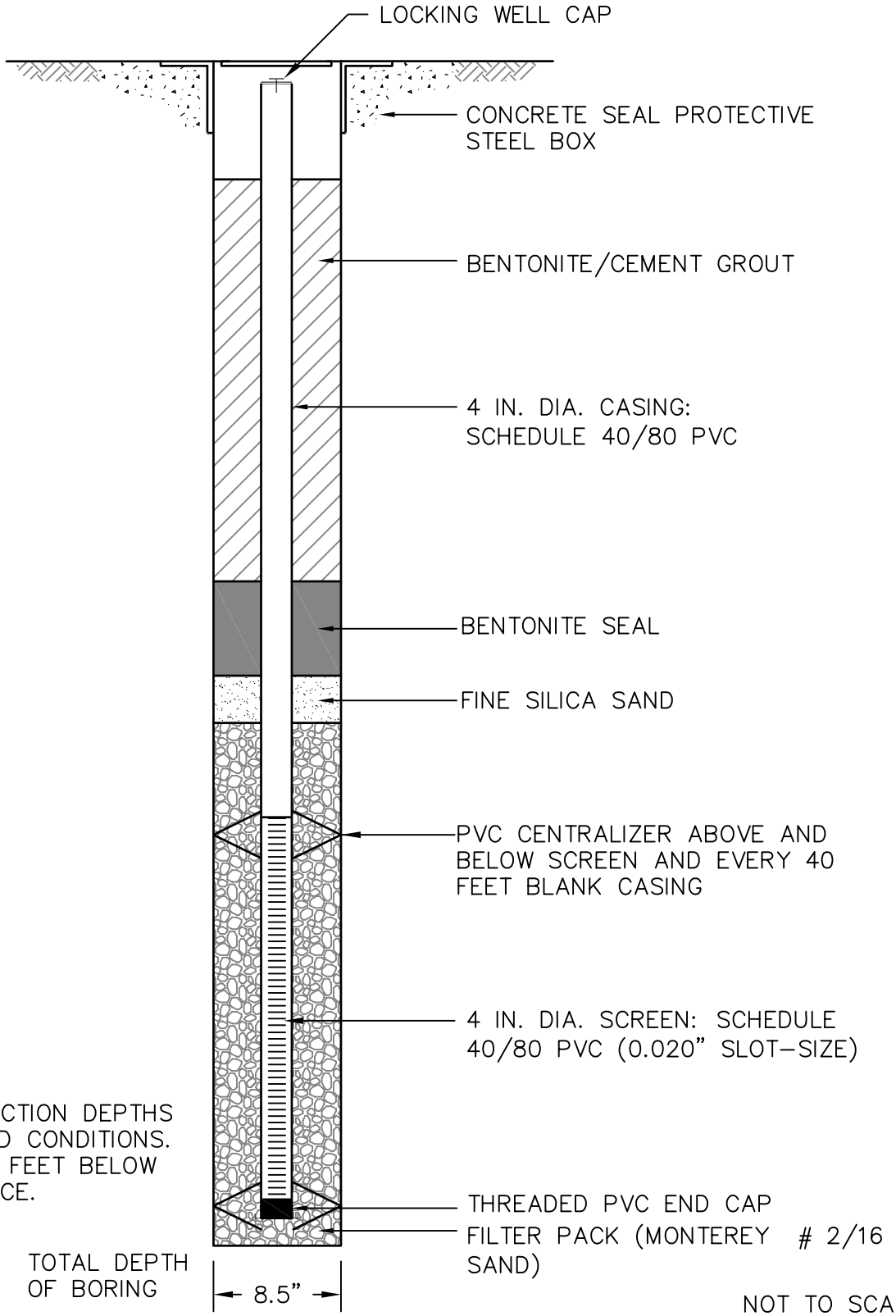

NOTES:

1. FINAL CONSTRUCTION DEPTHS BASED ON FIELD CONDITIONS. ALL DEPTHS IN FEET BELOW GROUND SURFACE.

NOT TO SCALE

Geosyntec consultants

WELL CONSTRUCTION DIAGRAM – MONITORING WELLS
IR SITE 70
NAVAL WEAPONS STATION SEAL BEACH, CALIFORNIA

FIGURE NO.	6.5
PROJECT NO.	HY1034-01
DOCUMENT NO.	
DATE:	SEPTEMBER 2007

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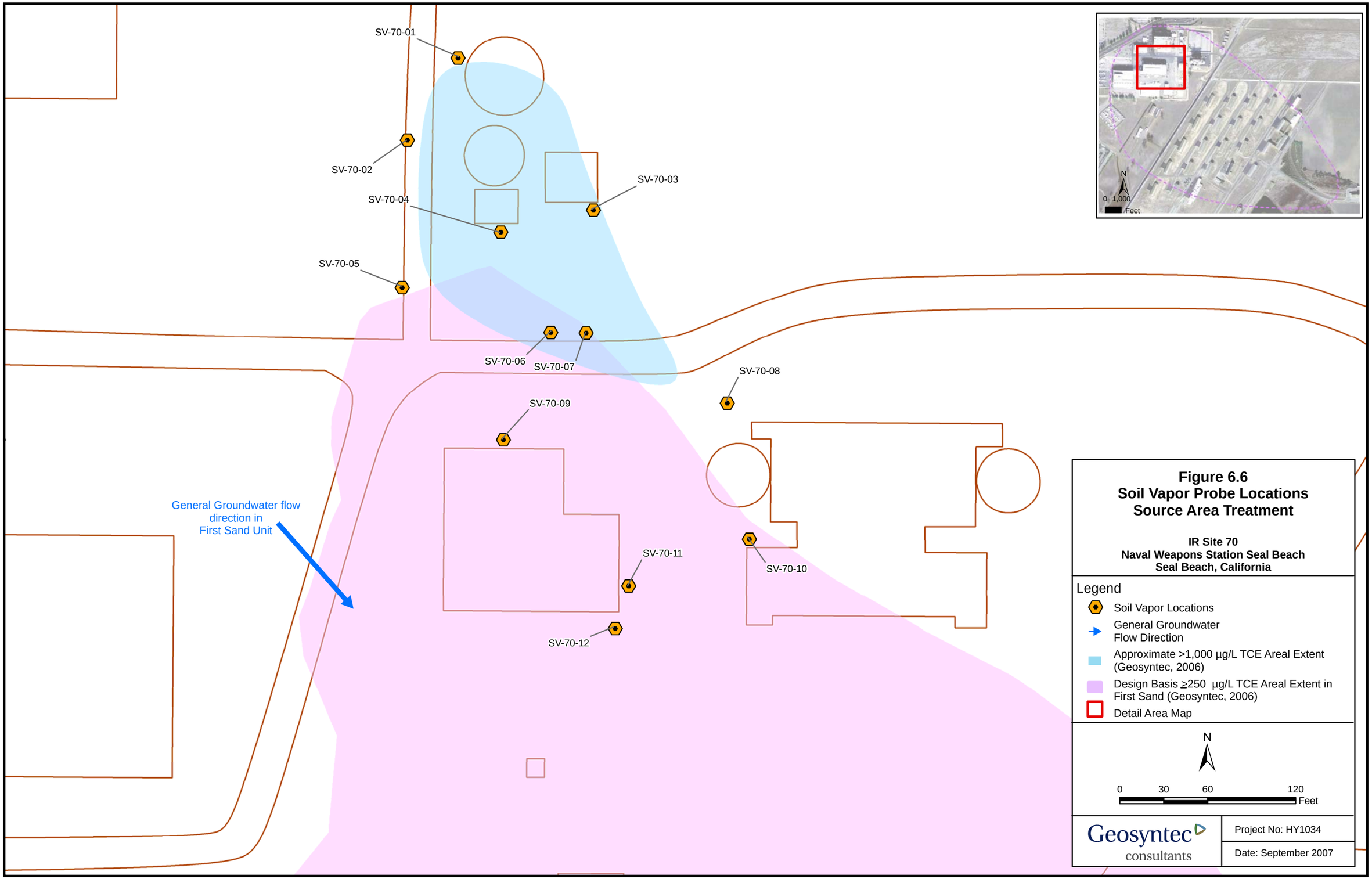

Figure 6.6
Soil Vapor Probe Locations
Source Area Treatment

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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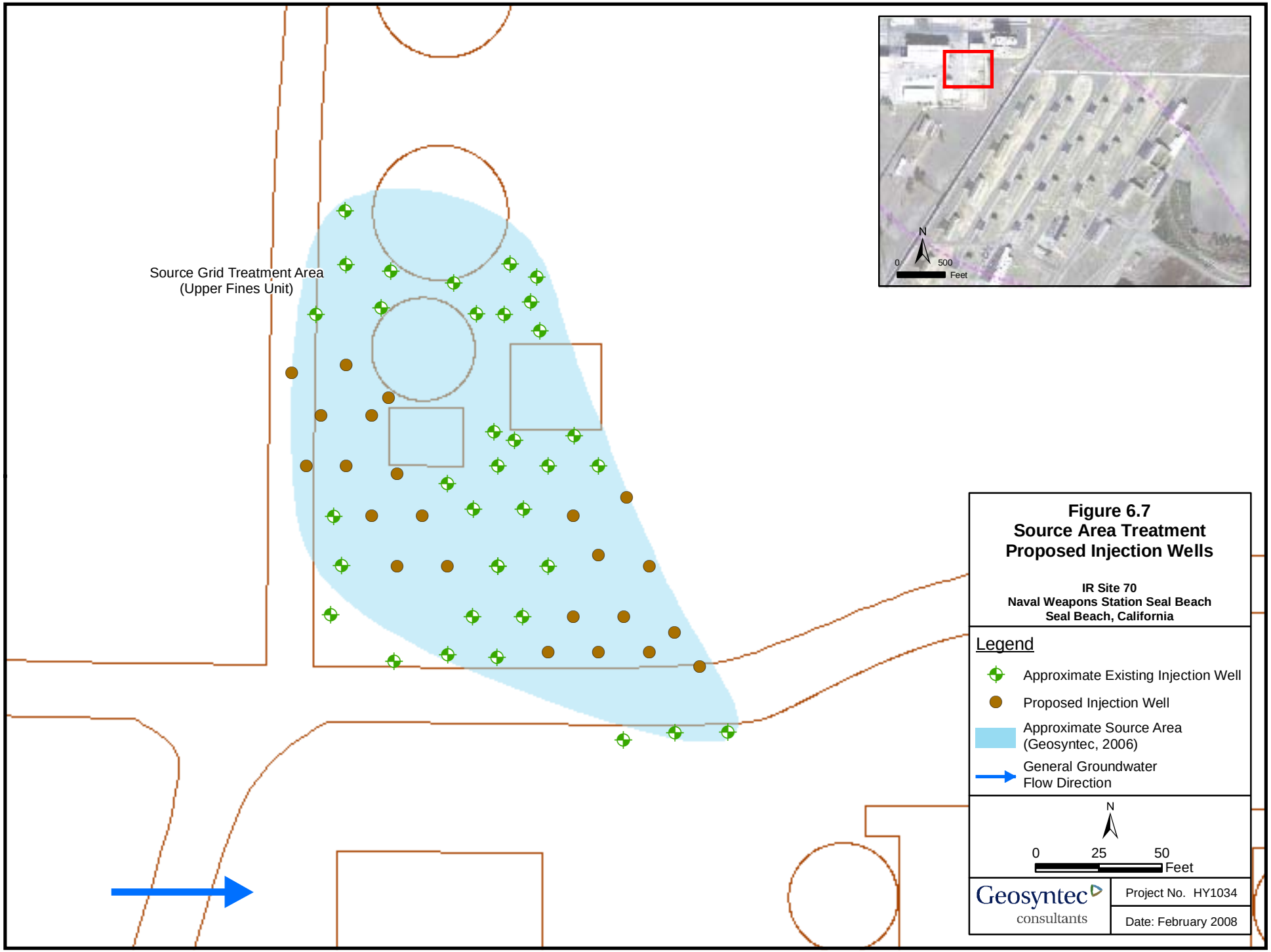

Figure 6.7
Source Area Treatment
Proposed Injection Wells

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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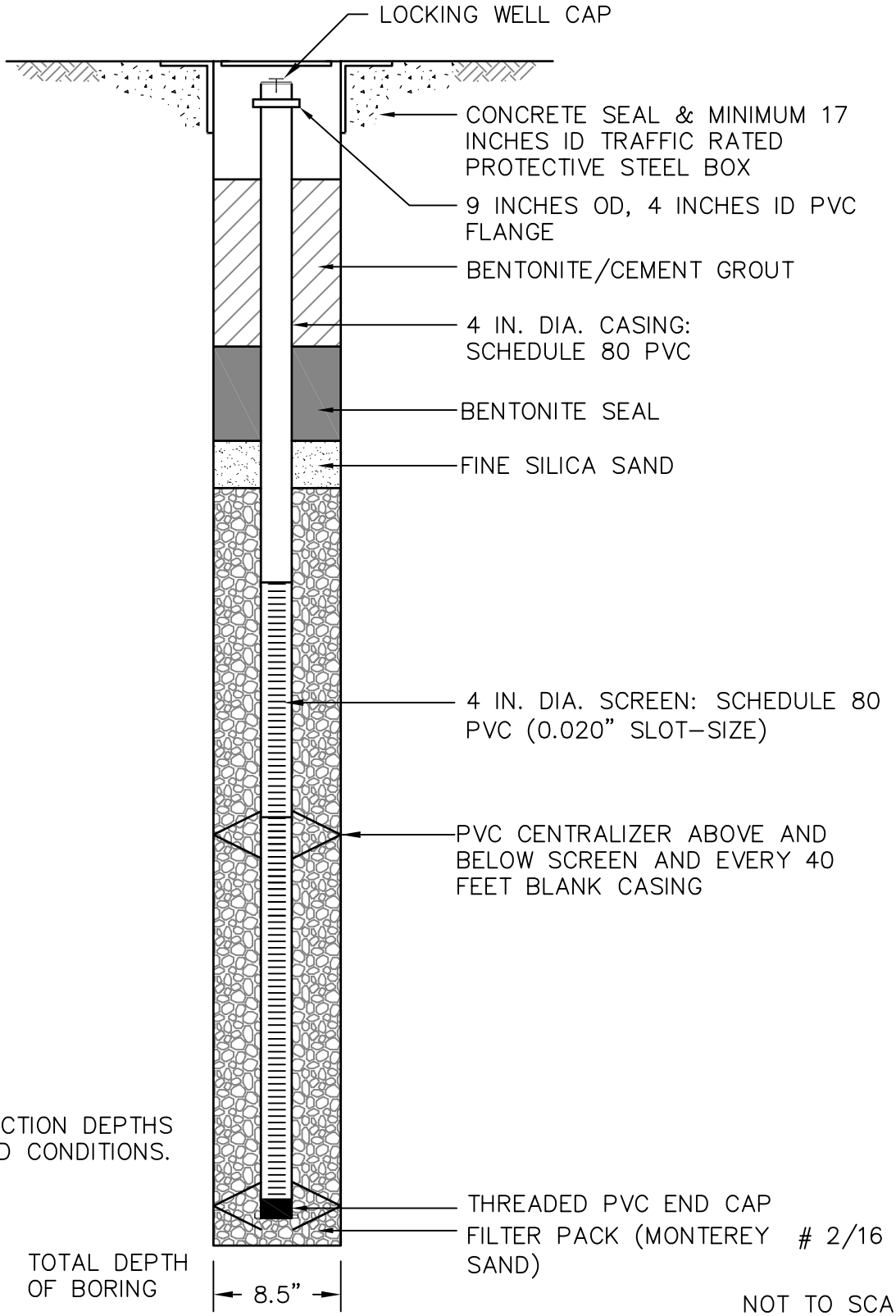

NOTE:

1. FINAL CONSTRUCTION DEPTHS BASED ON FIELD CONDITIONS.

NOT TO SCALE

Geosyntec consultants

WELL CONSTRUCTION DIAGRAM – INJECTION WELLS
IR SITE 70
NAVAL WEAPONS STATION SEAL BEACH, CALIFORNIA

FIGURE NO.	6.8
PROJECT NO.	HY1034-01
DOCUMENT NO.	
DATE:	SEPTEMBER 2007

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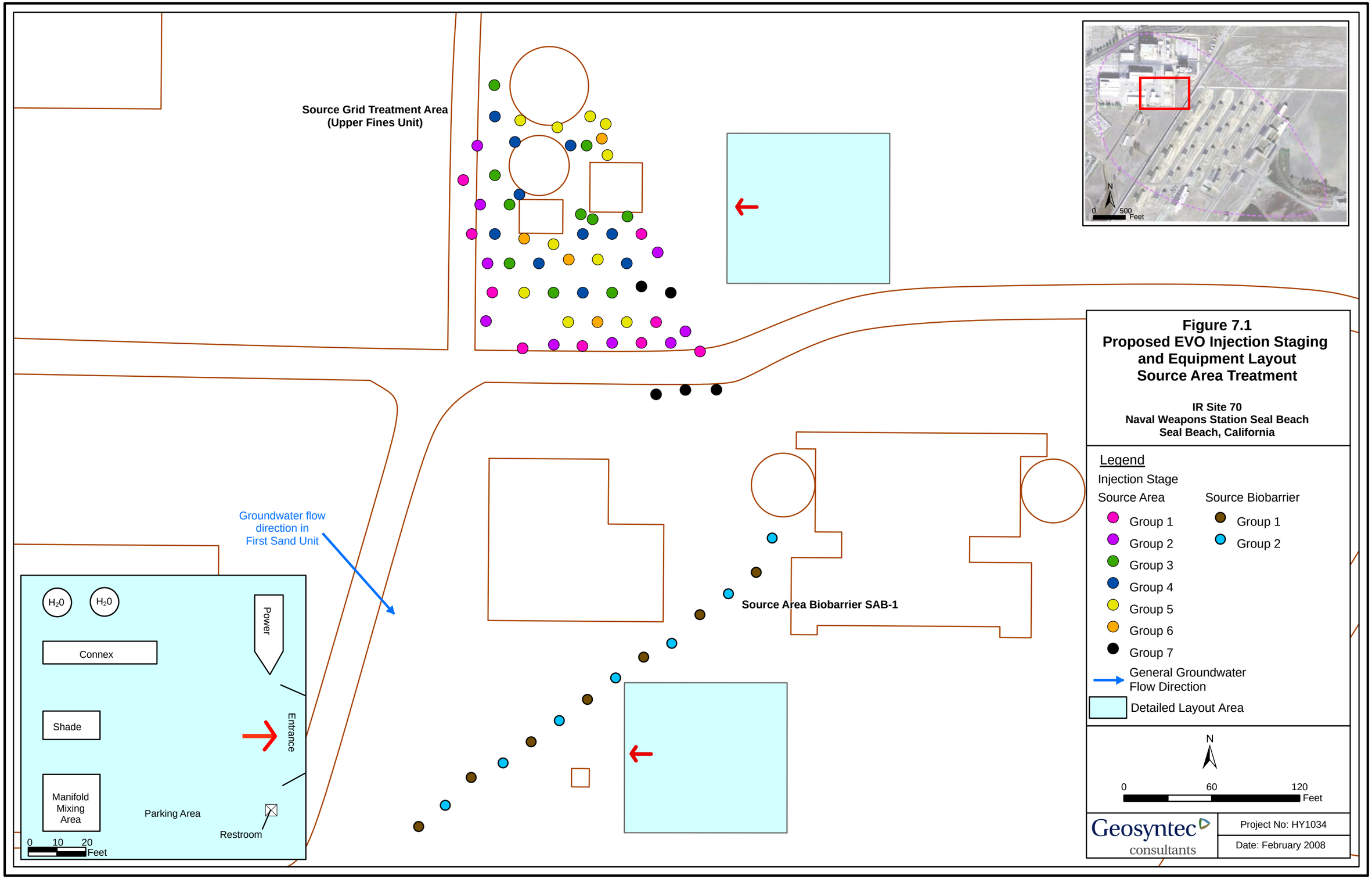

Figure 7.1
Proposed EVO Injection Staging and Equipment Layout
Source Area Treatment

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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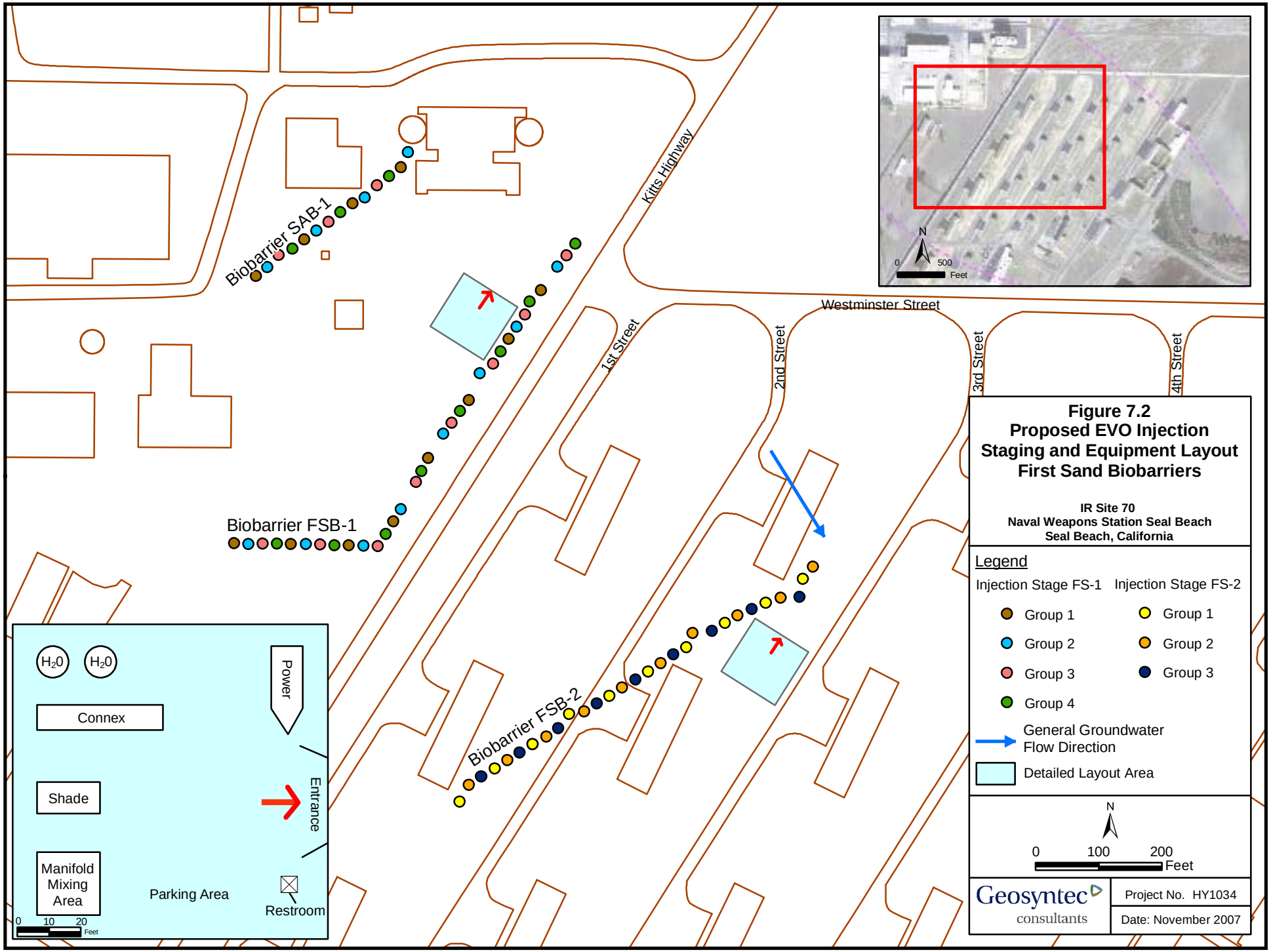

Figure 7.2
Proposed EVO Injection Staging and Equipment Layout First Sand Biobarriers

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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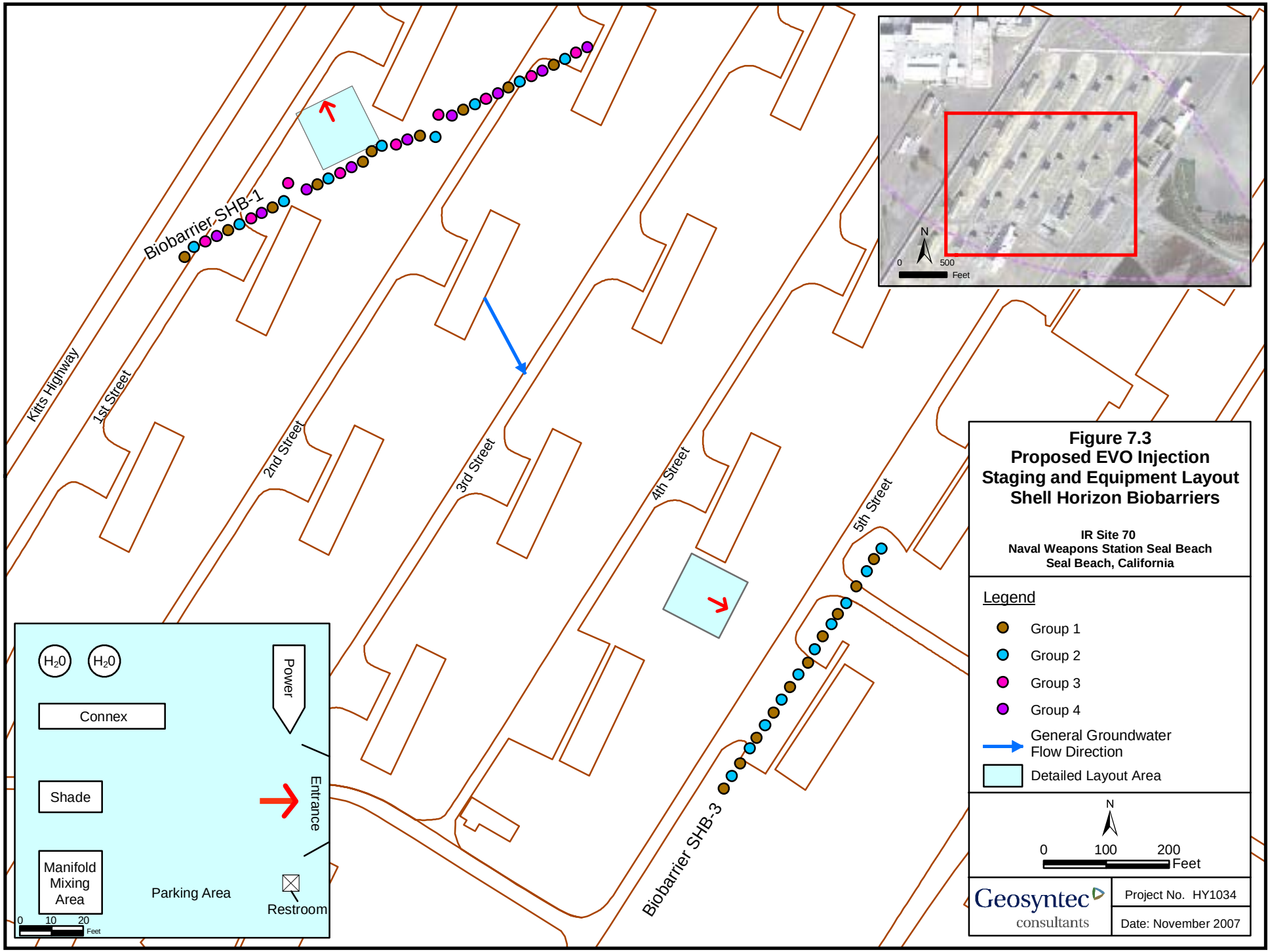

Figure 7.3
Proposed EVO Injection Staging and Equipment Layout
Shell Horizon Biobarriers

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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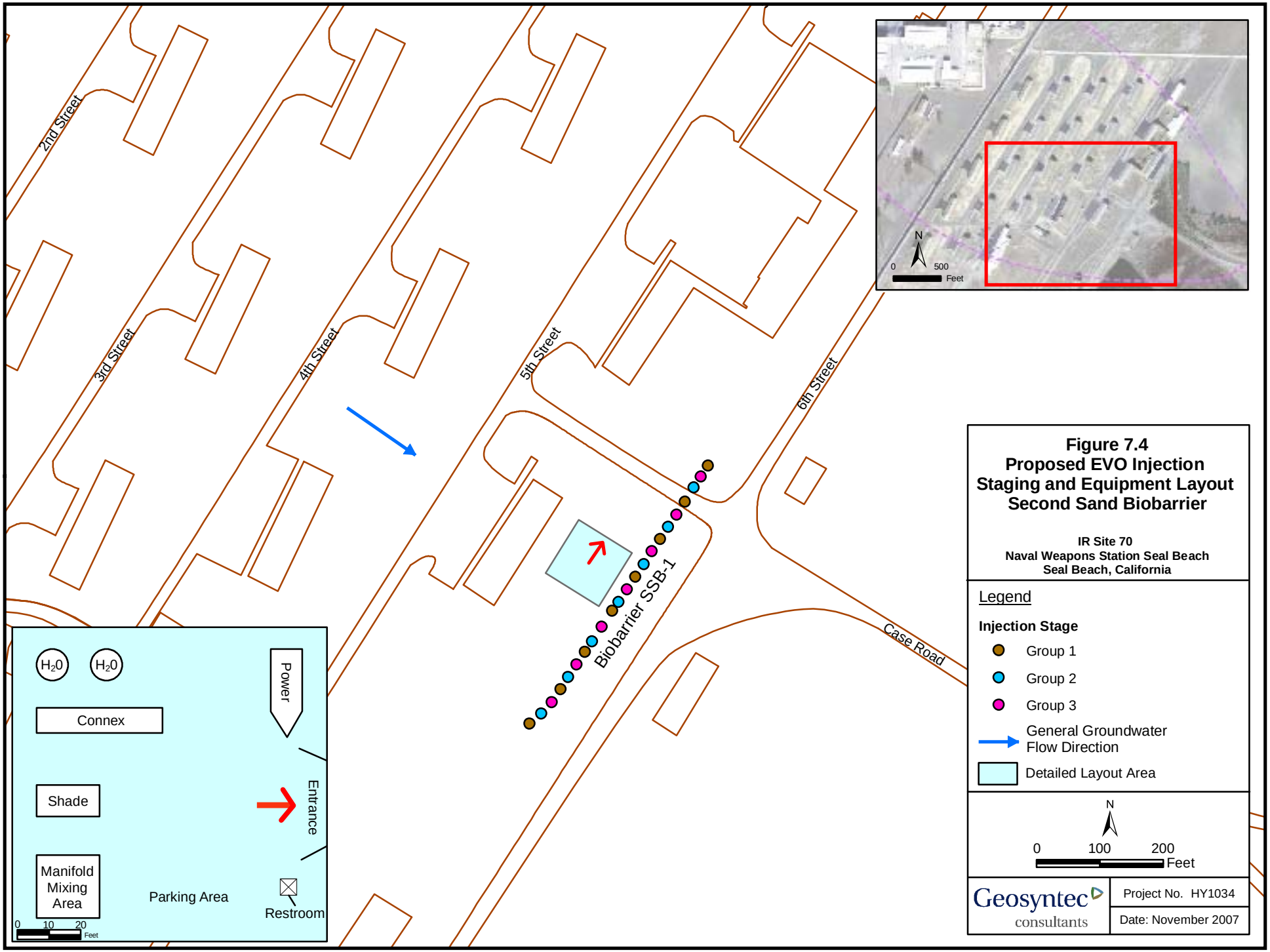

Figure 7.4
Proposed EVO Injection Staging and Equipment Layout
Second Sand Biobarrier

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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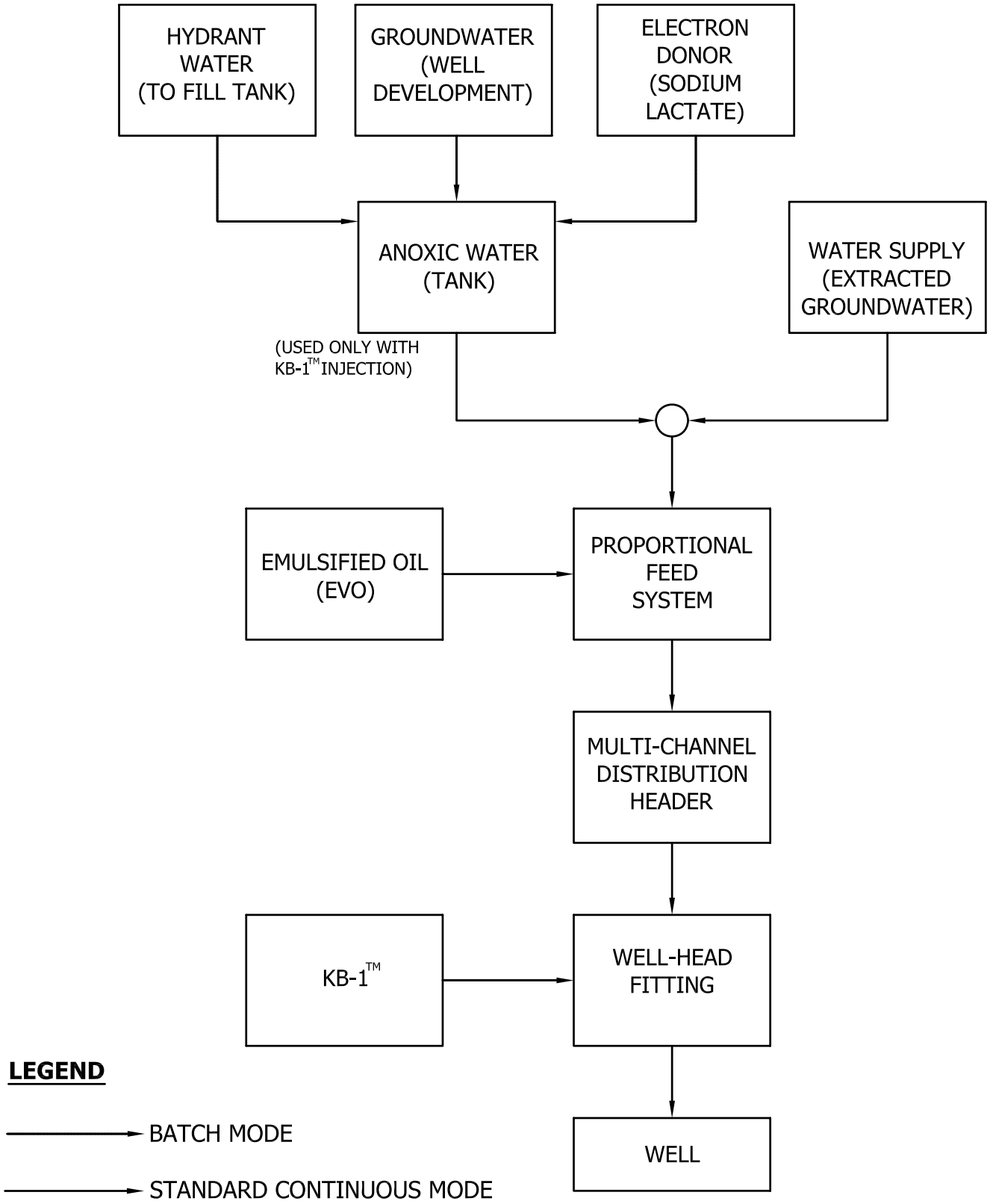

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PROCESS FLOW SCHEMATIC FOR EMULSIFIED OIL INJECTION IR SITE 70 NAVAL WEAPONS STATION SEAL BEACH, CALIFORNIA	FIGURE NO. 7.5
	PROJECT NO. HY1034-01
	DOCUMENT NO.
	DATE: SEPTEMBER 2007

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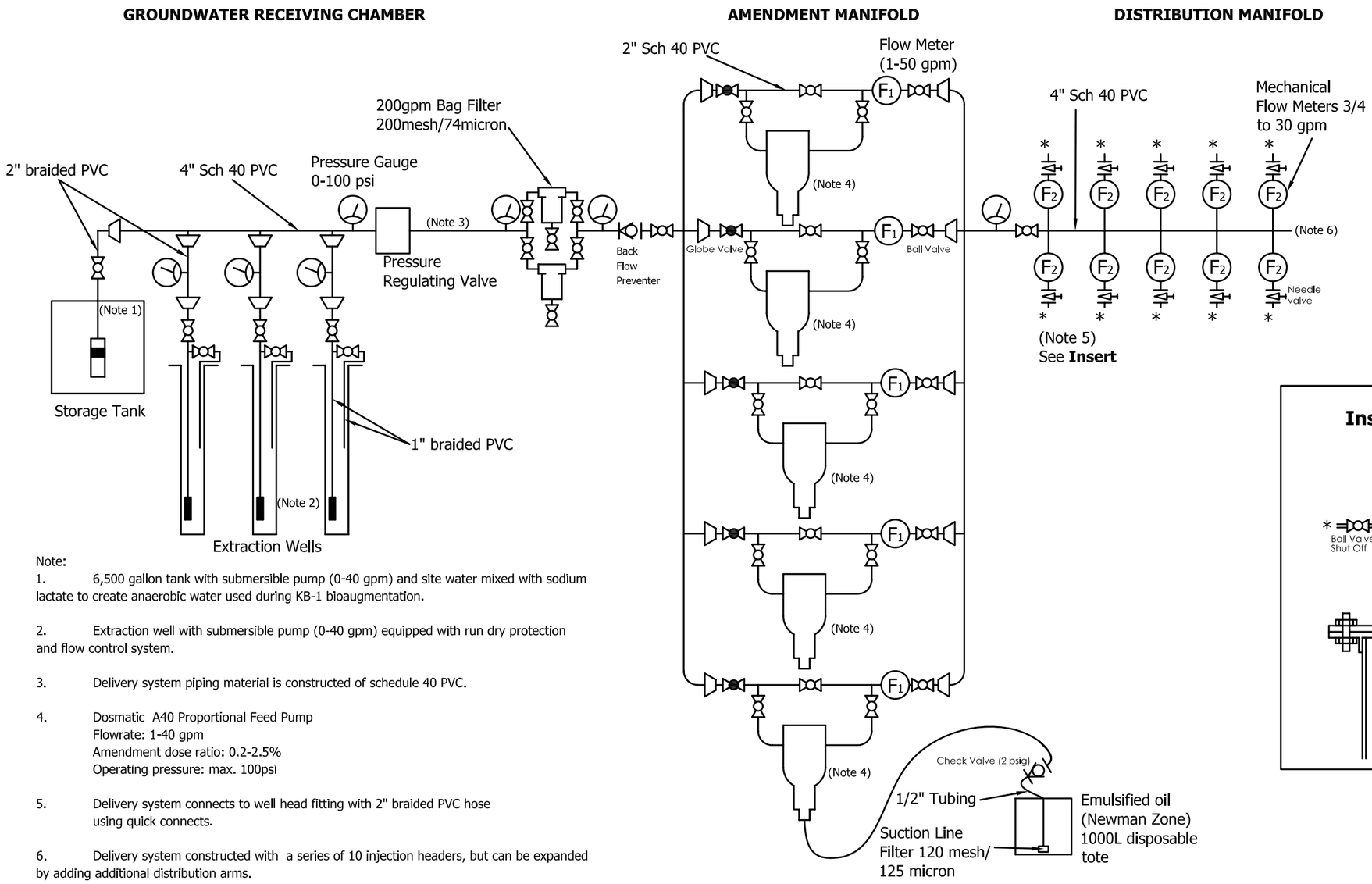
TABLE 6.2

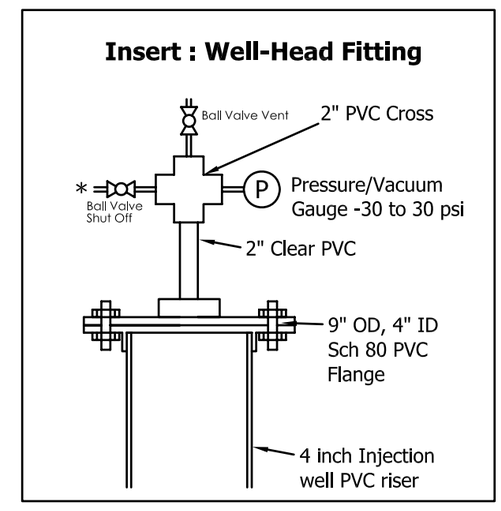
TENTATIVE SAMPLING SCHEDULE FOR FIRST THREE YEARS OF OPERATION

Remedial Action Sampling and Analysis Plan - Installation Restoration Site 70 Naval Weapons Station Seal Beach - Seal Beach, California

Geosyntec consultants

ZONE	TREATMENT AREA	MONITORING WELL	EVENT	BASELINE										QUARTERLY (Year One Only)							SEMI-ANNUALLY										ANNUALLY				
			Well Function	FP [1]	VOCs [2]	DHGs [3]	Anions/TDS/Alk [4]	VFAs [5]	TOC [6]	Dhc/VCr [7]	SV [8]	Sulfide [9]	Dissolved Metals [10]	FP [1]	VOCs [2]	DHGs [3]	Anions/TDS/Alk [4]	VFAs [5]	TOC [6]	SV [8]	FP [1]	VOCs [2]	DHGs [3]	Anions/TDS/Alk [4]	VFAs [5]	TOC [6]	Dhc/VCr [7]	SV [8]	Sulfide [9]	Dissolved Metals [10]	FP [1]	VOCs [2]	DHGs [3]	Dhc/VCr [7]	SV [8]
Source Area	Grid Treatment	MW-70-PMW01A	PMW	√	√	√	√	√	√					√	√	√	√	√	√		√	√	√	√	√	√									
		MW-70-PMW01B	PMW	√	√	√	√	√	√					√	√	√	√	√	√		√	√	√	√	√	√									
		MW-70-27	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-28	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-MNA01	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA02	MNA	√	√	√																									√	√	√		
		MW-70-MNA03	MNA	√	√	√																									√	√	√		
		MW-70-MNA04	MNA	√	√	√																									√	√	√		
	Soil Vapor Probes	SV-70-01	SV								√									√															√
		SV-70-02	SV								√									√															√
		SV-70-03	SV								√									√															√
		SV-70-04	SV								√									√															√
		SV-70-05	SV								√									√															√
		SV-70-06	SV								√									√															√
		SV-70-07	SV								√									√															√
		SV-70-08	SV								√									√															√
		SV-70-09	SV								√									√															√
		SV-70-10	SV								√									√															√
		SV-70-11	SV								√									√															√
		SV-70-12	SV								√									√															√
	Source Biobarrier	MW-70-PMW02A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW02B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-SAB06	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-MNA05	MNA	√	√	√																									√	√	√		
		MW-70-PMW03A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW03B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
Plume	Biobarrier FS-1	MW-70-38	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-FSB118	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW06A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW06B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW04A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW04B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-FSB108	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW05A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW05B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		RDO-5	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA08	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA06	MNA	√	√	√																									√	√	√		
		MW-70-MNA11	MNA	√	√	√																									√	√	√		
		MW-70-MNA07	MNA	√	√	√																									√	√	√	√	
	Biobarrier FS-2	MW-70-PMW07A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW07B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-FSB216	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW08A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW08B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-MNA09	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA10	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA12	MNA	√	√	√																									√	√	√	√	
	Biobarrier SH-1	MW-70-PMW09	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-SHB113	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW10	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-SHB217	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA13	MNA	√	√	√																									√	√	√		





Note:

1. 6,500 gallon tank with submersible pump (0-40 gpm) and site water mixed with sodium lactate to create anaerobic water used during KB-1 bioaugmentation.

2. Extraction well with submersible pump (0-40 gpm) equipped with run dry protection and flow control system.

3. Delivery system piping material is constructed of schedule 40 PVC.

4. Dosmatic A40 Proportional Feed Pump
   Flowrate: 1-40 gpm
   Amendment dose ratio: 0.2-2.5%
   Operating pressure: max. 100psi

5. Delivery system connects to well head fitting with 2" braided PVC hose using quick connects.

6. Delivery system constructed with a series of 10 injection headers, but can be expanded by adding additional distribution arms.

Geosyntec consultants	EMULSIFIED OIL PROPORTIONAL DELIVERY SYSTEM IR SITE 70 NAVAL WEAPONS STATION SEAL BEACH, CALIFORNIA	FIGURE NO. 7.6 PROJECT NO. HY1034-01 DATE: SEPTEMBER 2007

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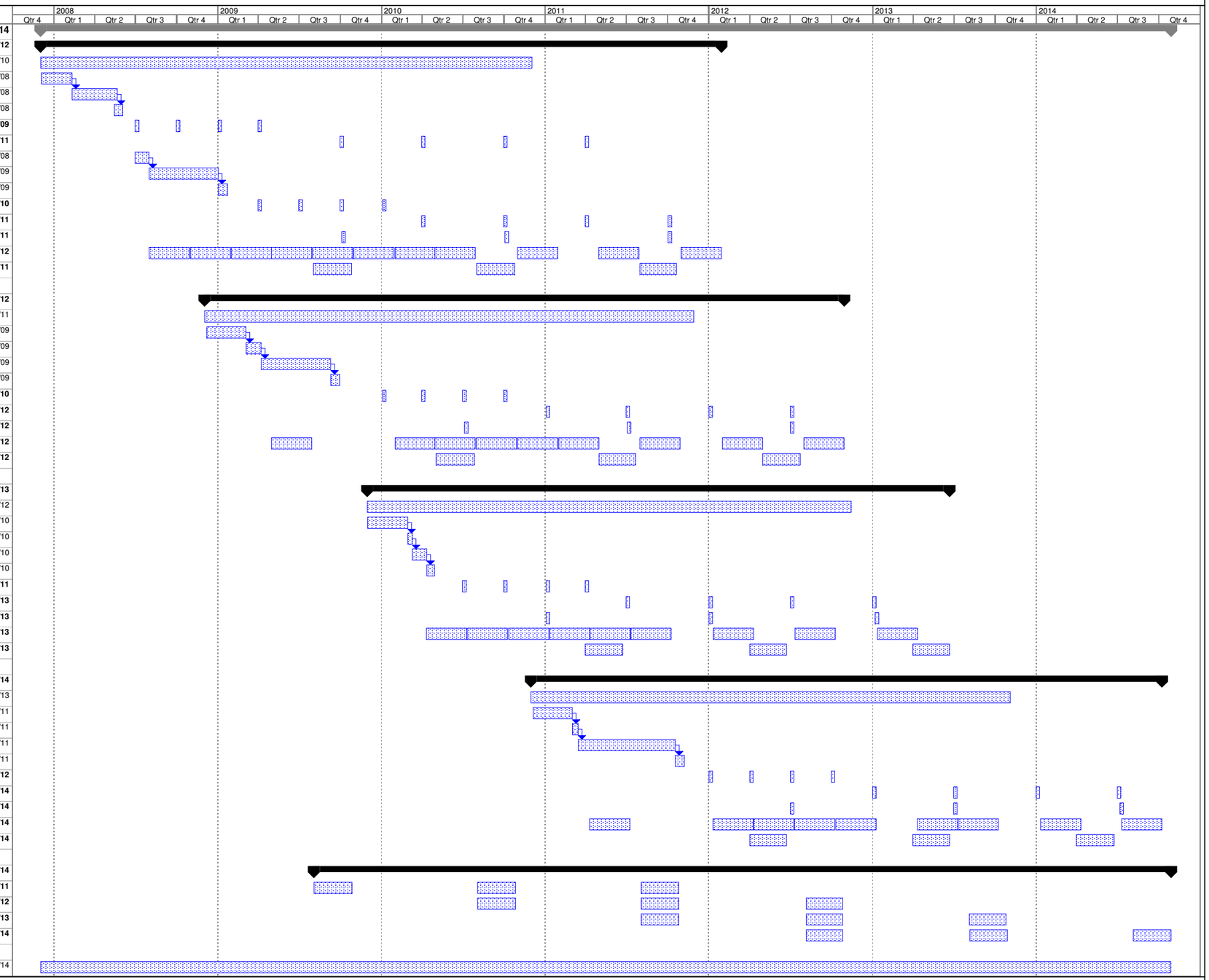
Figure 10.1 - Proposed Project Schedule
IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

ID	Task Name	Duration	Start	Finish
0	**Figure 10.1**	**1774.2 days**	**Mon 12/3/07**	**Tue 10/28/14**
1	**Phase 1-Source Area**	**1057.2 days**	**Mon 12/3/07**	**Mon 1/30/12**
2	Task 1-Meetings	760 days	Mon 12/3/07	Fri 12/3/10
3	Task 2-Pre-Field Activities	45 days	Wed 12/5/07	Mon 2/11/08
4	Task 3-Well Construction	73 days	Mon 2/11/08	Thu 5/22/08
5	Task 4-Soil Vapor Probe Construction	12 days	Thu 5/15/08	Tue 6/3/08
6	**Task 5-Soil Vapor Monitoring (Quarterly)**	**194.8 days**	**Tue 7/1/08**	**Wed 4/8/09**
11	**Task 5-Soil Vapor Monitoring (Semi-Annual)**	**383.6 days**	**Thu 10/1/09**	**Fri 4/8/11**
16	Task 6-Baselline Monitoring	22 days	Tue 7/1/08	Thu 7/31/08
17	Task 7-EVO/KB-1 Injection	104 days	Fri 8/1/08	Fri 1/2/09
18	Task 8-Demobilization	15 days	Fri 1/2/09	Fri 1/23/09
19	**Task 9-Groundwater Monitoring (PMW - Quarterly)**	**195.8 days**	**Wed 4/1/09**	**Mon 1/11/10**
24	**Task 9-Groundwater Monitoring (PMW - Semi-Annual)**	**389.8 days**	**Thu 4/1/10**	**Mon 10/10/11**
29	**Task 9-Groundwater Monitoring (MNA - Annual)**	**512.6 days**	**Mon 10/5/09**	**Mon 10/10/11**
33	**Task 10-Data Evaluation**	**888.4 days**	**Fri 8/1/08**	**Mon 1/30/12**
45	**Task 11-Reporting**	**565.6 days**	**Mon 8/3/09**	**Fri 10/21/11**
49				
50	**Phase 2-First Sand**	**999.4 days**	**Wed 12/3/08**	**Tue 10/30/12**
51	Task 1-Meetings	760 days	Wed 12/3/08	Tue 11/29/11
52	Task 2-Pre-Field Activities	60 days	Mon 12/8/08	Thu 3/5/09
53	Task 3-Baseline Monitoring	24 days	Thu 3/5/09	Wed 4/8/09
54	Task 4-EVO/KB-1 Injection	108 days	Wed 4/8/09	Thu 9/10/09
55	Task 5-Demobilization	14 days	Thu 9/10/09	Wed 9/30/09
56	**Task 6-Groundwater Monitoring (PMW - Quarterly)**	**197 days**	**Mon 1/4/10**	**Fri 10/8/10**
61	**Task 6-Groundwater Monitoring (PMW - Semi-Annual)**	**395 days**	**Tue 1/4/11**	**Mon 7/9/12**
66	**Task 6-Groundwater Monitoring (MNA - Annual)**	**518.8 days**	**Tue 7/6/10**	**Mon 7/9/12**
70	**Task 7-Data Evaluation**	**895.6 days**	**Fri 5/1/09**	**Tue 10/30/12**
80	**Task 8-Reporting**	**572.8 days**	**Mon 5/3/10**	**Mon 7/23/12**
84				
85	**Phase 3-Second Sand**	**917.6 days**	**Tue 12/1/09**	**Fri 6/21/13**
86	Task 1-Meetings	760 days	Tue 12/1/09	Wed 11/14/12
87	Task 2-Pre-Field Activities	60 days	Wed 12/2/09	Mon 3/1/10
88	Task 3-Baseline Monitoring	8 days	Mon 3/1/10	Thu 3/11/10
89	Task 4-EVO/KB-1 Injection	22 days	Thu 3/11/10	Mon 4/12/10
90	Task 5-Demobilization	14 days	Mon 4/12/10	Fri 4/30/10
91	**Task 6-Groundwater Monitoring (PMW - Quarterly)**	**194.8 days**	**Thu 7/1/10**	**Fri 4/8/11**
96	**Task 6-Groundwater Monitoring (PMW - Semi-Annual)**	**398 days**	**Fri 7/1/11**	**Tue 1/8/13**
101	**Task 6-Groundwater Monitoring (MNA - Annual)**	**530 days**	**Tue 1/4/11**	**Mon 1/14/13**
105	**Task 7-Data Evaluation**	**775.8 days**	**Mon 4/12/10**	**Fri 4/12/13**
115	**Task 8-Reporting**	**581 days**	**Fri 4/1/11**	**Fri 6/21/13**
119				
120	**Phase 4-Shell Horizon**	**1002.8 days**	**Wed 12/1/10**	**Thu 10/9/14**
121	Task 1-Meetings	760 days	Wed 12/1/10	Mon 11/4/13
122	Task 2-Pre-Field Activities	60 days	Mon 12/6/10	Thu 3/3/11
123	Task 3-Baseline Monitoring	9 days	Thu 3/3/11	Wed 3/16/11
124	Task 4-EVO/KB-1 Injection	155 days	Wed 3/16/11	Wed 10/19/11
125	Task 5-Demobilization	14 days	Wed 10/19/11	Tue 11/8/11
126	**Task 6-Groundwater Monitoring (PMW - Quarterly)**	**201 days**	**Mon 1/2/12**	**Mon 10/8/12**
131	**Task 6-Groundwater Monitoring (PMW - Semi-Annual)**	**396 days**	**Tue 1/1/13**	**Tue 7/8/14**
136	**Task 6-Groundwater Monitoring (MNA - Annual)**	**531 days**	**Mon 7/2/12**	**Mon 7/14/14**
140	**Task 7-Data Evaluation**	**913 days**	**Mon 4/11/11**	**Thu 10/9/14**
150	**Task 8-Reporting**	**581 days**	**Mon 4/2/12**	**Mon 6/23/14**
154				
155	**Phase 5-Longterm POC Monitoring**	**1351.6 days**	**Tue 8/4/09**	**Tue 10/28/14**
156	**Task 1-Source Area Monitoring**	**567.6 days**	**Tue 8/4/09**	**Wed 10/26/11**
160	**Task 2-First Sand Monitoring**	**576.8 days**	**Wed 8/4/10**	**Fri 10/26/12**
164	**Task 3-Second Sand Monitoring**	**582 days**	**Thu 8/4/11**	**Fri 10/25/13**
168	**Task 4-Shell Horizon Monitoring**	**582 days**	**Mon 8/6/12**	**Tue 10/28/14**
172				
173	**Project Management**	1774 days	Mon 12/3/07	Tue 10/28/14



Project: Figure 10.1
Date: Tue 9/18/07

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

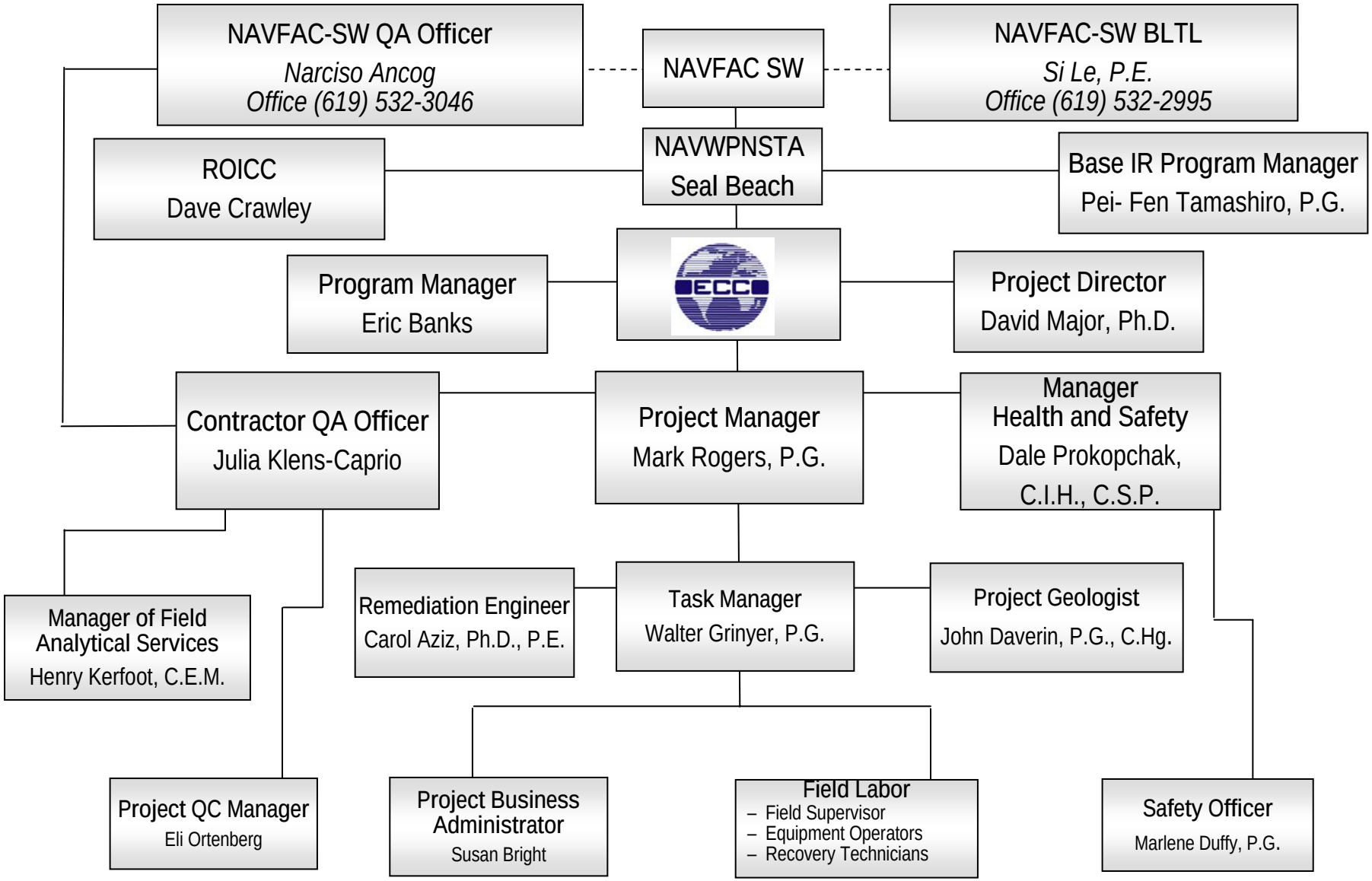


FIGURE 10.2

Project Organization Chart

IR Site 70

Naval Weapons Station Seal Beach, California

Date: September 2007	Project No. HY1034

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APPENDIX A
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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APPENDIX A
Final Applicable or Relevant and Appropriate Requirements

INSTALLATION RESTORATION PROGRAM SITE 70
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

March 2008

Department of the Navy
Naval Facilities Engineering Command Southwest
San Diego, CA 92132

Environmental Multiple Award Contract
Contract Number N68711-04-D-1106, CTO 003
Document Control Number ECC-1106-0003-0002

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APPENDIX A

Final Applicable or Relevant and Appropriate Requirements

INSTALLATION RESTORATION PROGRAM SITE 70
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

March 2008

Prepared for:

Department of the Navy
Naval Facilities Engineering Command Southwest
San Diego, CA 92132

Prepared by:

ECC
1240 Bayshore Highway
Burlingame, CA 94010

In association with:

2100 Main Street, Suite 150
Huntington Beach, CA 92648

Prepared under:
Environmental Multiple Award Contract
Contract Number N68711-04-D-1106, CTO 003
Document Control Number ECC-1106-0003-0002

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ACRONYMS AND ABBREVIATIONS

ARARs	applicable or relevant and appropriate requirements
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DON	Department of the Navy
EVO	emulsified vegetable oil
HWCA	Hazardous Waste Control Act
IR	Installation Restoration
KB-1™	mixed consortia of dehalorespiring bacteria
MCLs	maximum contaminant levels
MCLGs	maximum contaminant level goals
NAVWPNSTA	Naval Weapons Station
POC	Point of Compliance
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RFS	Revised Feasibility Study
RT&E	Research, Testing, and Evaluation
SDWA	Safe Drinking Water Act
SWRCB	California State Water Resources Control Board
TBC	To Be Considered
USC	United States Code
U.S. EPA	United States Environmental Protection Agency
VOCs	volatile organic compounds
WQCP	water quality control plan
WQOs	water quality objectives

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1. INTRODUCTION

A full review of applicable or relevant and appropriate requirements (ARARs) was completed as part of the remedial design (RD) (Geosyntec, 2006). The following was excerpted from the RD (Geosyntec, 2006)

1.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

A full review of ARARs was completed as part of the RD (Geosyntec, 2006) and is included below.

1.1.1 Chemical Specific ARARs

ARARs are used to develop remediation goals for the groundwater affected by volatile organic compounds (VOCs) at Installation Restoration (IR) Site 70.

Chemical-specific ARARs are generally health- or risk-based numerical values or methodologies applied to site-specific conditions that result in the establishment of numerical values. Many potential ARARs associated with particular remedial alternatives (such as closure or discharge) can be characterized as action-specific ARARs, but include numerical values or methodologies to establish them so they fit in both categories of ARARs. To simplify the comparison of numerical values, some action-specific ARARs with numerical values are discussed in this section.

The substantive provisions of the following requirements are the most stringent of the potential federal and state groundwater ARARs and to be considered values (TBCs) for the action:

- Water Quality Control Plan (WQCP) for the Santa Ana River Basin (8) (RWQCB 1995) (water quality objectives [WQOs], beneficial uses, waste discharge limitations);
- federal maximum contaminant levels (MCLs) and nonzero maximum contaminant level goals (MCLGs) for organic compounds;
- state primary MCLs for organic compounds in Title 22 California Code of Regulations (CCR); and
- Resource Conservation and Recovery Act (RCRA) groundwater protection standards in Title 22 CCR Section 66264.94(a)(1),(a)(3), (c), (d), and (e).

It is not technically or economically feasible to achieve background (i.e., nondetect) levels of VOCs in the contaminant plume as required under the RCRA groundwater protection standards. Therefore, as provided for in 22 CCR 66294.94(c), concentration limits based on MCLs, nonzero MCLGs, and health-based criteria have been set as the remedial goals for IR Site 70.

The Point of Compliance (POC) for MCLGs and MCLs under the Safe Drinking Water Act (SDWA) is at the tap. For Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedies, however, the United States Environmental Protection Agency (U.S. EPA) indicates that nonzero MCLGs or MCLs should be attained throughout the contaminated plume, or at and beyond the edge of the waste management area when the waste is left in place *(55 Federal Register* 8753). The CERCLA POC is consistent with that specified under the RCRA groundwater protection standards, which state that the POC at which the protection standards apply is a vertical surface, located at the hydraulically downgradient limit of the waste management area that extends throughout the uppermost aquifer underlying the regulated unit (22 CCR 66264.95). The POC for IR Site 70 will be the Naval

Weapons Station (NAVWPNSTA) Seal Beach site boundary or the existing groundwater point of use, whichever is hydraulically most upgradient.

The California State Water Resources Control Board (SWRCB) Resolution No 68-16 establishes the policy that high-quality waters of the state "shall be maintained to the maximum extent possible" consistent with the "maximum benefit to the people of the state." This has been interpreted by the SWRCB to include a prohibition on the continued migration of existing groundwater contaminant plumes at levels that exceed background for the aquifer (SWRCB, 1994). The Department of Navy (DON) has considered this position and determined that further migration of already contaminated groundwater is not a discharge governed by the language in SWRCB Resolution No. 68-16. More specifically, the language indicates that it is prospective in intent, applying to new discharges in order to maintain existing high-quality waters. It is not intended to apply to restoration of waters that have already degraded.

For construction of monitoring and emulsified vegetable oil (EVO) injection wells, federal and state requirements for characterizing wastes will be applicable to the drill cuttings and contaminated personal protective equipment generated from the implementation of the remedial action.

1.1.2 Location Specific ARARs

Pertinent and substantive provisions of the following potential ARARs were reviewed to determine whether they are potential federal ARARs for the IR Site 70 groundwater Revised Feasibility Study (RFS):

- Title 22 CCR 66264.18 (a), (b), and (c) (Hazardous Waste Control Act [HWCA])
- 40 Code of Federal Regulations (CFR) Part 6, 6.302 and Appendix B, excluding Sections 6(a)(2), 6(a)(4), and 6(a)(6); Executive Order 11988, Protection of Floodplains; and Executive Order 11990, Protection of Wetlands
- 36 CFR Part 65 (National Archeological and Historical Preservation Act)
- 36 CFR Part 800 (National Historic Preservation Act, Section 106)
- 16 United States Code (USC) Section 1536(a) (Endangered Species Act of 1973)
- 40 CFR 230.10, 231, 231.1, 231.2, 231.7, and 231.8 (Clean Water Act Section 404)
- 50 CFR Section 35.1 et seq. (Wilderness Act)
- 50 CFR Part 27 (National Wildlife Refuge System)
- 16 USC Section 662 (Fish and Wildlife Coordination Act)
- 16 USC 1271 et seq. and Section 7(a) (Wild and Scenic Rivers Act)
- 16 USC Section 307(c) and Section 1456(c); 15 CFR part 930 and Section 723.45 (Coastal Zone Management Act)
- 16 USC 3504 (Coastal Barrier Resource System)
- 16 USC 461-467 (Historic Sites, Buildings, and Antiquities Act)
- 16 USC 403 (Rivers and Harbors Act of 1890)
- 16 USC Section 703 (Migratory Bird Treaty Act of 1972)

- 16 USC Section 1372(2) (Marine Mammal Protection Act)
- 16 USC Section 1801 et seq. (Magnuson Fishery Conservation and Management Act)

Requirements that are determined to be ARARs or TBCs are identified in Table A-1 in the column denoted by the heading ARAR Determination. Determinations of status for location-specific ARARs were generally based upon consultation of maps or lists included in the regulation or prepared by the administering agency. References to the document or agency consulted are provided in the Comments column and in footnotes to the table. Specific issues concerning some of the requirements are discussed in the following sections.

1.1.2.1 FLOODPLAINS

The requirements of actions taken within a floodplain (40 CFR Part 6[b], 6.302, and Appendix B) address the potential impacts on floodplain beneficial use (flood control, water quality, and habitat) that could be affected by site remediation.

NAVWPNSTA Seal Beach is outside the study area and is designated "Area Not Included." Therefore, the areas are in a location for which flood hazards are undetermined. However, it is noted that areas directly adjacent to NAVWPNSTA Seal Beach IR Site 70 within the Seal Beach city boundary are mapped as "Zone X" – areas lying outside the 500-year floodplain.

1.1.2.2 HISTORIC AND CULTURAL RESOURCES

The National Historic Preservation Act requires federally funded projects to identify and mitigate impacts of project activities on properties included in or eligible for the National Register of Historic Places.

The National Archeological and Historical Preservation Act requires federally funded projects to identify and mitigate the impacts of project activities on significant scientific, prehistoric, historic, or archeological data. An archeological survey was conducted for portions of NAVWPNSTA Seal Beach (Ogden, 1995). As indicated, a total of 186 of the 250 structures addressed in the survey (including IR Site 70) were eligible for nomination to the National Register of Historic Places as contributing elements to a historic district. Structures included at IR Site 70 were designated as eligible.

1.1.2.3 CRITICAL HABITATS AND ENDANGERED OR THREATENED SPECIES

Biological resources and sensitive habitats at NAVWPNSTA Seal Beach were identified through field reconnaissance surveys performed in May 1992 and 1994. Personnel from the California Department of Fish and Game and the U.S. Fish and Wildlife Service were also contacted. Two published databases were consulted: the California Natural Diversity Data Base and the California Wildlife Habitat Relationships System. Based on these surveys, none of the IR Site 70 areas were identified to contain habitat that may support special-status species. However, five species of birds and one species of salt marsh habitat plant (classified as endangered either by federal or state agencies) are known to inhabit NAVWPNSTA Seal Beach (BNI, 1999).

Owl and/or hawk nests are known to exist in the research, testing and evaluation (RT&E) buildings; however, remedial activities are unlikely to impact these birds, as industrial activities already exist in the area. No federal- or state-listed species or species proposed as rare, threatened, or endangered are known to live in the immediate project area. The requirements pertaining to biological resources are therefore not ARARs.

1.1.3 State ARARs

Potential state location-specific ARARs are presented in Table A-2. Potential location-specific ARARs identified from the state include the WQCP (RWQCB 1995), the Ocean Plan (SWRCB 1997), the Coastal Act of 1976, and the Endangered Species Act. These have been discussed in previous sections.

1.1.4 Action Specific ARARs

Federal and State ARARs are addressed above. The South Coast Air Quality Management District mandates that no VOCs should be discharged from the groundwater, EVO, and a mixed consortia of dehalorespiring bacteria (KB-1™) blending operation. The blending operation treatment approach is intended to develop an anaerobic condition, and thus groundwater will not be exposed to the atmosphere.

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TABLES

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Table A-1
Potential Federal Location-Specific ARARs
IR Site 70, Naval Weapons Station Seal Beach, California

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Hazardous Waste Control Act					
Within 61 meters (200 feet) of a fault displaced in Holocene time.	New treatment, storage, or disposal of hazardous waste prohibited.	RCRA hazardous waste; treatment, storage, or disposal of hazardous waste.	22 CCR 66264.18(a)	Not an ARAR	The nearest active fault with Holocene movement is the Newport-Inglewood Fault, approximately 8 miles southwest of NAVWPNSTA Seal Beach.
Within 100-year floodplain	Facility must be designed, constructed, operated, and maintained to avoid washout.	RCRA hazardous waste; treatment, storage, or disposal of hazardous waste.	22 CCR 66264.18(b)	Not an ARAR	Potential groundwater treatment plant site locations and extraction wells are not within the 100-year floodplain (as defined by FEMA).
Within salt dome formation, underground mine, or cave.	Placement of noncontainerized or bulk liquid hazardous waste prohibited.	RCRA hazardous waste, placement.	22 CCR 66264.18 (c)	Not an ARAR	Based on geologic information presented in ERSE, salt domes, mines, or caves do not exist at or in the vicinity of NAVWPNSTA Seal Beach.
Executive Order 11988, Protection of Floodplains					
Within floodplain.	Actions taken should avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values.	Action that will occur in a floodplain (i.e., lowlands) and relatively flat areas adjoining inland and coastal waters and other flood-prone areas.	40 CFR 6, Appendix A; excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	Not an ARAR	Although not surveyed, areas directly adjacent to NAVWPNSTA Seal Beach IR Site 70 within the Seal Beach city boundary are mapped as “Zone X” - areas lying outside of the 500-year floodplain. None of the proposed extraction wells or on-site treatment facilities is within the FEMA-delineated floodplain.
National Archeological and Historical Preservation Act					
Within area where action may cause irreparable harm, loss, or destruction of significant artifacts.	Construction on previously undisturbed land would require an archeological survey of the area.	Alteration of terrain that threatens significant scientific, prehistoric, historic, or archeological data.	Substantive requirements of 36 CFR 65, 40 CFR 6.301(3), 16 USC Section 469	ARAR	An archeological survey for NAVWPNSTA Seal Beach indicates the presence of 186 out of the 250 structures surveyed as eligible for contributing to a historic district. Buildings at IR Site 70 are listed.
National Historic Preservation Act, Section 106					
Historic property owned or controlled by federal agency.	Action to preserve historic properties; planning of action to minimize harm to properties listed on or eligible for listing on the National Register of Historic Places.	Property included in or eligible for the National Register of Historic Places.	Substantive requirements of 36 CFR 800, 40 CFR 6.301(b), 16 USC, Section 470	ARAR	An archaeological survey of NAVWPNSTA Seal Beach indicates the presence of 186 out of 250 structures that are eligible as elements contributing to a historic district. Buildings at IR Site 70 are included.

Table A-1 (continued)
Potential Federal Location-Specific ARARs
IR Site 70, Naval Weapons Station Seal Beach, California

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Endangered Species Act of 1973					
Critical habitat upon which endangered species or threatened species depend.	Action to conserve endangered species or threatened species, including consultation with the Department of the interior.	Determination of effect upon endangered or threatened species or its habitat.	16 USC 1536(a), 50 CFR 402	ARAR	IR Site 70 remedial activities may affect the Seal Beach NWR, which supports special status species or habitat.
Executive Order 11990, Protection of Wetlands					
Wetland.	Action to minimize the destruction, loss, or degradation of wetlands.	Wetland as defined by EO 11990 Section 7.	40 CFR 6, Appendix A; excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	TBC	Jurisdictional wetlands at NAVWPNSTA Seal Beach, identified by U.S. Army Corps of Engineers, are in close proximity to the sites. IR Site 70 remedial actions will include measures to prevent or mitigate any expected impacts on wetlands.
Clean Water Act, Section 404					
Wetland.	Action to prohibit discharge of dredged or fill material into wetland without permit.	Wetland as defined by EO 11990 Section 7.	40 CFR 230.10; 40 CFR 231 (231.1, 231.2,231.7, 231.8)	Not an ARAR	Discharge of dredged or fill material to a wetland is not planned as part of the response action.
Wilderness Act					
Wilderness area.	Area must be administered in such a manner as will leave it unimpaired as wilderness and preserve its wilderness character.	Federally owned area designated as wilderness area.	50 CFR 35.1 et seq. 16 USC, Section 1131	Not an ARAR	NAVWPNSTA Seal Beach is not in a federally owned wilderness area.
National Wildlife Refuge System					
Wildlife	Only actions allowed under the provisions of 16 USC Section 668 dd(c) may be undertaken in areas that are part of the NWR System.	Area designated as part of NWR System.	50 CFR 27; 16 USC, Section 668dd	ARAR	NAVWPNSTA Seal Beach includes the Seal Beach NWR and Bolsa Chica Ecological Reserve. NAVWPNSTA Seal Beach is part of the NWR System.
Fish and Wildlife Coordination Act, Section 662					
Area affecting stream or other water body.	Action taken should protect fish or wildlife.	Diversion, channeling, or other activity that modifies a stream or other water body and affects fish or wildlife.	16 USC 662	Not an ARAR	Response actions are not anticipated to modify a stream or other water body.

Table A-1 (continued)
Potential Federal Location-Specific ARARs
IR Site 70, Naval Weapons Station Seal Beach, California

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Wild and Scenic Rivers Act					
Within area affecting national wild, scenic, or recreational river.	Avoid taking or assisting in action that will have direct adverse effect on scenic river.	Activities that affect or may affect any of the rivers specified in Section 1276.	16 USC 1271 et seq. and Section 7(a), 40 CFR 6.302(e)	Not an ARAR	No wild, scenic, or recreational rivers are at or in the vicinity of NAVWPNSTA Seal Beach.
Coastal Zone Management Act					
Within coastal zone.	Conduct activities in a manner consistent with approved state management programs.	Activities affecting the coastal zone, including lands hereunder and adjacent shore land.	Section 307(c) of 16 USC 1456(c); also see 15 CFR 930 and 923.45	TBC	NAVWPNSTA Seal Beach is within the Coastal Barrier Resource System.
National Recommended Water Quality Criteria - Correction 1999					
Habitat including freshwater and saltwater environments.	Establishes water quality standards for freshwater, saltwater, and human-health criteria.	Discharge potentially affecting water quality.	40 CFR 131 Section 304(a)(1) of the Clean Water Act	TBC	Establishes water quality standards for freshwater and saltwater that are based on current toxicity information. Where discharges occur to freshwater and saltwater, these criteria provide guidance.
Historic Sites, Buildings, and Antiquities Act					
Historic sites.	Avoid undesirable impacts on landmarks.	Areas designated as historic sites.	16 USC 461-467, 40 CFR 6.301(a)	Not an ARAR	See comments under National Historic Preservation Act.
Rivers and Harbors Act of 1890					
Navigable waters.	Requires permits for structures or work in or affecting navigable waters.	Activities affecting navigable waters.	33 USC 403	Not an ARAR	NAVWPNSTA Seal Beach is in the vicinity of navigable waters. However, remedial actions should have no adverse effect on navigable waters.
Migratory Bird Treaty Act of 1972					
Migratory bird area.	Protects almost all species of native birds in the U.S. from unregulated "take" that can include poisoning at hazardous waste sites.	Presence of migratory birds.	16 USC Section 703	TBC	IR Site 70 remedial action addresses contaminated groundwater. Migratory birds are not likely to be exposed to VOC-affected groundwater or affected by remedial activities.
Marine Mammal Protection Act					
Marine mammal area.	Protects any marine mammal in the U.S., except as provided by international treaties from unregulated "take."	Presence of marine mammals.	16 USC 13722)	TBC	The project site is in a coastal zone or area that might be habitat for marine mammals.

Table A-1 (continued)
Potential Federal Location-Specific ARARs
IR Site 70, Naval Weapons Station Seal Beach, California

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Magnuson Fishery Conservation and Management Act					
Fishery under management.	Provides for conservation and management of specified fisheries within specified fishery conservation zones.	Presence of managed fisheries.	16 USC 1801 et seq.	Not an ARAR	The project site is not near areas of managed fisheries.

Notes:

Statutes and policies and their citations are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate the DON accepts the entire statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading: only substantive requirements of the specific citations are considered potential ARARs.

Acronyms/Abbreviations:

ARAR – applicable or relevant and appropriate requirement
CCR –*California Code of Regulations*
CFR – *Code of Federal Regulations*
DON – U.S. Department of the Navy
EO – Executive Order
ERSE – Extended Removal Site Evaluation
FEMA – Federal Emergency Management Agency
IR – Installation Restoration
NAVWPNSTA Seal Beach – Naval Weapons Station Seal Beach
NWR – National Wildlife Refuge
RCRA – Resource Conservation and Recovery Act
TBC – to be considered
USC – *United States Code*

Table A-2
Potential State Location-Specific ARARs
IR Site 70, Naval Weapons Station Seal Beach, California

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Hazardous California Endangered Species Act					
Habitat	No person shall import, export, take, possess, or less any endangered or threatened species or part or product thereof.		Fish and Game Code Sections 2050-2098	TBC	IR Site 70 remedial actions might affect areas that support California-listed endangered species or habitat. The NAVWPNSTA Seal Beach NWR supports endangered species.
California Coastal Act of 1976					
Coastal Zone	Regulates activities associated with development to control direct significant impacts on coastal waters and to protect state and national interests in California coastal resources.		Public Resources Code Sections 30000-30900; 14 CCR 13001-13666.4	TBC	The project site is not in an area governed by this statute.
State Water Resources Control Board and California Regional Water Quality Control Board, Santa Ana Region					
Describes water basins in Santa Ana Region. Establishes beneficial uses of groundwater and surface water. Establishes water quality objectives, including narrative and numerical standards. Establishes implementation plans to meet water quality objectives and protect beneficial uses, and incorporates statewide water quality control plans and policies.	Public Water System.		Water Quality Control Plan for the Santa Ana Basin (Basin Plan).	ARAR	Substantive provisions in Chapters 2 through 4 of the Basin plan are ARARs. The beneficial uses for the Santa Ana Pressure Subbasin are municipal/domestic use (potential drinking water), agricultural supply, industrial service supply, and industrial process supply. These uses also apply to the shallow groundwater system at NAVWPNSTA Seal Beach.
California Ocean Plan of 1997					
Ocean and Coastal Waters.	Provides for the protection of the quality of the ocean waters for use and enjoyment by the people of the State, requiring the control of discharge of waste into the ocean waters.	Discharge potentially affecting water quality.	California Ocean Plan, SWRCB Resolution No. 97-026	ARAR	The remedial actions to be conducted at IR Site 70 may result in discharge of treated groundwater to surface waters terminating in the ocean.

Table A-2 (continued)
Potential State Location-Specific ARARs
IR Site 70, Naval Weapons Station Seal Beach, California

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Aquatic Habitat/ Species	Action must be taken if toxic materials are placed where they can enter waters of the State. There can be no release that would have a deleterious effect on species or habitat.		Fish and Game Code 5650(a), (b), and (f)	TBC	These code sections prohibit the deposition into state waters of, *inter alia*, petroleum products (Section 5650(a)), factory refuse (Section 5650(b)), and any substance deleterious to fish, plants or birds (Section 5650(f)). These are substantive, promulgated environmental protection requirements. These requirements impose strict criminal liability on violators. (*People v. Chevron Chemical Company (1983) 143 Cal. App. 3d 50).* This imposition of strict criminal liability imposes a standard that is more stringent than federal law. The extent to which each subdivision of Section 5650 is relevant and appropriate depends on the site characterization. Section 5650 makes it unlawful "to deposit in, permit to pass into, or place where it can pass into the waters of this state," enumerated substances as petroleum products, sawdust, wood shavings, factory refuse, or any other substances or materials that are deleterious to fish, plant life, or bird life.
Wildlife Species	Action must be taken to prohibit the taking of birds and mammals, including the taking by poison		Fish and Game Code Section 3005 (Stats. 1957, c. 456, p. 1353, Section 3005)	ARAR	This code section prohibits the taking of birds and mammals, including taking by poison. "Take" is defined by Fish and Game Code Section 86 to include killing. "Poison" is not defined in the code. Although there is no state authority on this point, federal law recognizes that poison, such as Strychnine, may effect incidental taking. (*Defenders of Wildlife v. Administrator, Environmental Protection Agency (1989) 882. F. 2d. 1295).* This code section imposes a substantive, promulgated environmental protection requirement. Because the remediation of this site involves treatment of contaminants, this section appears to be applicable and relevant.
Rare Native Plants	Action must be taken to conserve native plants, there can be no releases and/or actions that would have a deleterious effect on species or habitat		Fish and Game Code Section 1908 (Added by Stats. 1977, c. 1181, p. 3869, Section 8)	TBC	Section 1908 imposes a substantive requirement by forbidding any "person" to take rare or endangered native plants. California Code of Regulations Title 14, Section 670.2 provides a listing of the plants of California that have been declared to be Endangered, Threatened or Rare. Fish and Game Code Section 67 provides the definition of "person" as any natural person or partnership, corporation, limited liability company, trust, or other type of association. Whether the federal government or contractors acting on behalf of the federal government would fall within the definition is a potential issue. To the extent that there are rare or endangered plants on site, Section 1908 would be an ARAR

Table A-2 (continued)
Potential State Location-Specific ARARs
IR Site 70, Naval Weapons Station Seal Beach, California

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Endangered Species	Action must be taken to conserve endangered species, there can be no releases and/or actions that would have a deleterious effect on species or habitat.		Fish and Game Code Section 2080 (Added by Stats. 1984, c. 1240, Section 2).	ARAR	This section prohibits the take, possession, purchase or sell within the state, any species (including rare native plant species), or any product thereof, that the commission determines to be an endangered or threatened species, or the attempt of any of these acts. This section is applicable and relevant to the extent that there are endangered or threatened species in the area which have the potential of being affected if actions are not taken to conserve the species. This section prohibits releases and/or actions that would have a deleterious effect on species or their habitat. This section and applicable Title 14 regulations should be considered applicable, relevant, and appropriate due to the presence of the California least tern, the peregrine falcon, the California brown pelican, and the double-crested cormorant. California Code of Regulations Title 14 Section 670.2 provides a listing of the plants of California declared to be Endangered, Threatened or Rare. California Code of Regulations Title 145 Section 670.5 provides a listing of Animals of California declared to be endangered or threatened. California Code of Regulations Title 14 Section 783 et. seq., provides the implementation regulations for the California Endangered Species Act.
Wildlife / Domestic Species	Action must be taken to prohibit the use of steel-jawed leghold traps		Fish and Game Code Section 3003.1 (Prop. 4, Section 1 approved Nov. 3, 1998, eff. Nov. 4, 1998)	TBC	This section prohibits the use of any body gripping trap and provides that it is unlawful for any person, including an employee of the federal government, to use or authorize the use of such device to capture any game mammal, fur-bearing mammal, non-game mammal, protected mammal, or any dog or cat. This prohibition will not apply in the extraordinary case where the use of such a device is the only method available to protect human health and safety.

Table A-2 (continued)
Potential State Location-Specific ARARs
IR Site 70, Naval Weapons Station Seal Beach, California

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Fully Protected Bird Species / Habitat	Action must be taken to prevent the taking of fully protected birds		Fish and Game Code Section 3511 (Added by Stats. 1970, c. 1036, p. 1848 Section 4)	ARAR	This section provides that it is unlawful to take or possess any of the following fully protected birds: a. American peregrine falcon b. Brown pelican c. California black rail d. California clapper rail e. California condor f. California least tern g. Golden eagle h. Greater sandhill crane i. Light footed clapper rail j. Southern bald eagle k. Trumpeter swan l. White-tailed kite m. Yuma clapper rail Although some of the fully protected birds are not typically found in Site 70, this statute will be considered Applicable and Relevant if any of the above mentioned fully protected birds or their habitat are found on or near the site.
Wetlands	Actions must be taken to assure that there is "no net loss" of wetlands acreage or habitat value. Action must be taken to preserve, protect, restore, and enhance California's wetland acreage and habitat values.		Fish and Game Commission Wetlands Policy (adopted 1987) included in Fish and Game Code Addenda	TBC	This policy seeks to provide for the protection, preservation, restoration, enhancement, and expansion of wetland habitat in California. Further, it opposes any development or conversion of wetland that would result in a reduction of wetland acreage or habitat value. It adopts the USFWS definition of a wetland which utilizes hydric soils, saturation or inundation, and vegetable criteria, and requires the presence of at least one of these criteria (rather than all three) in order to classify an area as a wetland. This policy is not a regulatory program and should be included as a TBC.

Table A-2 (continued)
Potential State Location-Specific ARARs
IR Site 70, Naval Weapons Station Seal Beach, California

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Fully Protected Mammals	Action must be taken to ensure that no fully protected mammals are taken or possessed at any time		Fish and Game Code section 4700 (Added by Stats. 1970, c. 1036, p. 1848 Section 6)	TBC	This section prohibits the take or possession of any of the fully protected mammals or their parts. The following are fully protected mammals: a. Morro Bay kangaroo rat b. Bighorn sheep except Nelson bighorn sheep c. Northern elephant seal d. Guadalupe fur seal e. Ring-tailed cat f. Pacific right whale g. Salt-marsh harvest mouse h. Southern sea otter i. Wolverine Although some fully protected mammals are not typically found in Site 70, this statute will be considered Applicable and Relevant if any of the above mentioned fully protected mammals or their habitat are found on or near the site.
Fully Protected Reptiles and Amphibians	Actions must be taken to prevent the take or possession of any fully protected reptile or amphibian		Fish and Game Code Section 5050 (Added by Stats. 1970, c. 1036, p. 1849 Section 7)	TBC	This section prohibits the take or possession of fully protected reptiles and amphibians or parts thereof. The following are fully protected reptiles and amphibians: a. Blunt-nosed leopard lizard b. San Francisco garter snake c. Santa Cruz long-toed salamander d. Limestone salamander e. Black toad Although some fully protected reptiles and amphibians are not typically found in Site 70, this statute will be considered Applicable and Relevant if any of the above mentioned fully protected reptiles or amphibians or their habitat are found on or near the site.
Birds	Action must be taken to avoid the take or destruction of the nest or eggs of any bird		Fish and Game Code Section 3503	ARAR	This section prohibits the take, possession, or needless destruction of the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto.

Table A-2 (continued)
Potential State Location-Specific ARARs
IR Site 70, Naval Weapons Station Seal Beach, California

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Birds of Prey	Action must be taken to prevent the take, possession, or destruction of any birds-of-prey or their eggs		Fish and Game Code Section 3503.5 (Added by Stats. 1985, c. 1334, Section 6)	TBC	This section prohibits the take, possession, or destruction of any birds in the orders of Falconifromes or Strigifromes (birds-of-prey) or to take, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto. This section will be applicable and relevant if such species or their eggs are located on or near the site.
Non-Game Birds	Actions must be taken to prevent the take of non-game birds		Fish and Game Code Section 3800 (Added by Stats. 1971, c. 1470, p. 2906, Section 13)	TBC	This section prohibits the take of non-game birds, except in accordance with regulations of the commission, or when related to mining operations with a mitigation plan approved by the department. This section further provides requirements concerning mitigation plans related to mining. This section is applicable and relevant if non-game birds or their eggs are located on or near the site and such species have not been included in the Fish and Wildlife Conservation Plan filed pursuant to the Federal Fish and Wildlife Conservation Act. Species included in the plan will be protected at the federal standard making this section an ARAR to the extent that it is more stringent than the federal standard of protection.
Fur-Bearing Mammals	Provides manners under which fur-bearing mammals may be taken		Fish and Game Code Section 4000 et. Seq. (Stats. 1957, c. 456, p. 1380, Section 4000)	TBC	This section provides that a fur-bearing mammal may be taken only with a trap, a firearm, bow and arrow, poison under a proper permit, or with the use of dogs
Non-Game Mammals	Action must be taken to avoid the take or possession of non-game animals		Fish and Game Code Section 4150 (Added by Stats. 1971, c. 1470, p. 2907, Section 21)	TBC	Non-game mammals are those occurring naturally in California which are not game mammals, fully protected mammals, or fur-bearing mammals. These mammals, or their parts, may not be taken or possessed except as provided in this code or in accordance with regulations adopted by the commission.

Table A-2 (continued)
Potential State Location-Specific ARARs
IR Site 70, Naval Weapons Station Seal Beach, California

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Non-Game Animals	Action must be taken to avoid the take of non-game mammals except as provided in applicable regulations		Title 14 California Code of Regulations (CCR) Section 472, Effective 07/01/74	TBC	This Regulation provides that non-game birds and mammals may not be taken. a. The following non-game birds and mammals may be taken except as provided in Chapter 6: English sparrow, starling, coyote, weasels, skunks, opossum, moles and rodents (excludes tree and flying squirrels, and those listed as furbearers, endangered, or threatened species); b. Fallow, sambar, sika, and axis deer may be taken concurrently with the general deer season; c. Aoudad, mouflon, tahr, and feral goats may be taken all year; and d. American crows may be taken only under provisions of Section 485 and by landowners or tenants, or person authorized by landowners or tenants, when American crows are committing or about to commit depredations upon ornamental shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance. If required by Federal regulations, landowners or tenants shall obtain a Federal migratory bird depredation permit before taking any American crows or authorizing any other person to take them. Although some of the non-game birds and mammals are not typically found in Site 70, this statute will be Applicable and Relevant if any of the above mentioned non-game birds and mammals or their habitat are found on or near the site.
Tidal Invertebrates	Action must be taken to avoid the take or possession of mollusks, crustaceans, or other invertebrates		Fish and Game Code Section 8500 (Added by Stats. 1972, c. 1248, p. 2436, Section 2, eff. Dec. 13, 1972)	ARAR	It is unlawful to possess or take, unless otherwise expressly permitted in this chapter, mollusks, crustaceans, or other invertebrates, unless a valid tidal invertebrate permit has been issued. The taking, possessing, or landing of such invertebrates pursuant to this section shall be subject to regulations adopted by the commission.
Protected Amphibians	Action must be taken to avoid the take or possession of protected amphibians		Title 14 CCR Sections 40 (Section 40 designated effective 03/01/74)	ARAR	This regulation makes it unlawful to capture, collect, intentionally kill or injure, possess, purchase, propagate, sell, transport, import, or export any native reptile or amphibian, or parts thereof unless under special permit from the department issued pursuant to Title 14 CCR, Sections 650, 670.7, or 783 of these regulations, or as otherwise provided in the Fish and Game Code or these regulations.

Table A-2 (continued)
Potential State Location-Specific ARARs
IR Site 70, Naval Weapons Station Seal Beach, California

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Furbearing Mammals	Action must be taken to avoid take		Title 14 CCR, Section 460 (effective 07/01/59)	ARAR	Regulation makes it unlawful to take fisher, marten, river otter, desert kit fox, and red fox. Although some of the mammals are not typically found in Site 70, to the extent that the red fox, which is highly possible to occur in the area, or its habitat is found on or near Seal Beach NWS, this section will be an ARAR.
Furbearing Mammals	Provides methods of take for other forbearing mammals not listed in Title 14 CCR, Section 460		Title 14 CCR, Section 465 (effective 07/01/69)	TBC	Furbearing mammals not listed specifically in Title 14 CCR Section 460 and listed in 14 CCR, Section 461, 462, 463, and Section 464 may be taken only with a firearm, bow and arrow, or with the use of dogs, or traps in accordance with the provisions of Section 465.5 of Title 14 and Section 3003.1 of the Fish and Game Code. Although these mammals may not be currently present in Site 70, if one is found on or near Site 70 at some future date, this section will become applicable and relevant.

Notes:

Statutes and policies and their citations are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate the DON accepts the entire statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading: only substantive requirements of the specific citations are considered potential ARARs.

Acronyms/Abbreviations:

ARAR – applicable or relevant and appropriate requirement
CCR – *California Code of Regulations*
DON – U.S. Department of the Navy
IR – Installation Restoration
NAVWPNSTA Seal Beach – Naval Weapons Station Seal Beach
NWR – National Wildlife Refuge
SWRCB – State Water Resources Control Board
TBC – to be considered

APPENDIX B
FINAL SAMPLING AND ANALYSIS PLAN
FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN

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APPENDIX B

Final Sampling and Analysis Plan Field Sampling Plan and Quality Assurance Project Plan

INSTALLATION RESTORATION PROGRAM SITE 70
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

October 2007

Department of the Navy
Naval Facilities Engineering Command Southwest
San Diego, CA 92132

Environmental Multiple Award Contract
Contract Number N68711-04-D-1106, CTO 003
Document Control Number ECC-1106-0003-0002

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APPENDIX B

Final Sampling and Analysis Plan Field Sampling Plan and Quality Assurance Project Plan

INSTALLATION RESTORATION PROGRAM SITE 70
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

October 2007

Prepared for:

Department of the Navy
Naval Facilities Engineering Command Southwest
San Diego, CA 92132

Prepared by:

ECC
1240 Bayshore Highway
Burlingame, CA 94010

In association with:

2100 Main Street, Suite 150
Huntington Beach, CA 92648

Prepared under:
Environmental Multiple Award Contract
Contract Number N68711-04-D-1106, CTO 003
Document Control Number ECC-1106-0003-0002

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Final

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

Installation Restoration Program IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

October 2007

Prepared by: _____ Date: 2 Oct, 2007
David Major, Ph.D.
Geosyntec Consultants – Project Director

and _____ Date: October 2, 2007
Mark Rogers, P.G.
BCC – Project Manager

Approved by: _____ Date: 10/3/07
Julia Klenz Caprio
Geosyntec Quality Assurance Office

and _____ Date: 10/9/2007
Narciso A. Ancog
U.S. Navy Quality Assurance Office

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ELEMENTS OF THE UFP-QAPP AND EPA QA/R-5 IN RELATION TO THIS SAP

UFP-QAPP Worksheet	EPA QA/R-5	Geosyntec IR Site 70 WP SAP	Variance from UFP-QAPP
#1 Title and Approval Page	A1 Title and Approval Sheet	Title Page	
#2 QAPP Identifying Information		Table of Contents and Section 1.1	
#3 Distribution List	A3 Distribution List	Distribution List	
#4 Project Personnel Sign-Off Sheet		Project Personnel Sign-Off Sheet	
#5 Project Organization Chart	A4 Project/Task Organization	Figure B2.1	
#6 Communication Pathways		Figure B2.1 Sections 2.5, 3.2.1.5.2, 3.2.1.5.3, and 4.9	
#7 Personnel Responsibilities and Qualifications Table		Table B2.1 Section 2.5	
#8 Special Personnel Training Requirements Table	A8 Special Training/Certification	Sections 2.10, 3.4, 4.4.4, and 4.6.2	
#9 Project Scoping Sessions Participants Sheet		Section 5.3	
#10 Problem Definition	A5 Problem Definition/Background	Figures B1.3, B1.4, B1.5, and B1.6 Sections 1.2 and 2.4.4	
#11 Project Quality Objectives/Systematic Planning Process Statements	A7 Quality Objectives and Criteria	Section 2.8	
#12 Measurement Performance Criteria Table		Table B3.4	
#13 Secondary Data Criteria and Limitations Table			No secondary data used
#14 Summary of Project Tasks	A6 Project/Task Description	Section 2.6	
#15 Reference Limits and Evaluation Table		Table B2.1	
#16 Project Schedule/Timeline Table		Table B2.6 and Section 10 of the RA Work Plan	
#17 Sampling Design and Rationale	B1 Sampling Process Design (Experimental Design)	Tables B2.5 and B2.6 Section 2.7, 2.8.2 and 2.8.3	
#18 Sampling Locations and Methods/SOP Requirement Table	B2 Sampling Methods	Table B2.4	
#19 Analytical SOP Requirement Table		Table B3.1	
#20 Field Quality Control Sample Summary Table	B5 Quality Control	Table B3.3	
#21 Project Sampling SOP Reference Table		Section 2.8.3, 2.9.3, and 3.4.1	

UFP-QAPP Worksheet	EPA QA/R-5	Geosyntec IR Site 70 WP SAP	Variance from UFP-QAPP
#22 Field Equipment Calibration, Maintenance, Testing, and Inspection Table	B6 Instrument/Equipment Testing, Inspection, and Maintenance B7 Instrument/Equipment Calibration and Frequency	TableB3.2 and Section 3.2	
#23 Analytical SOP Reference Table		Section 2.2 Attachment B-1 and Attachment B-2	
#24 Analytical Instrument Calibration Table	B7 Instrument/Equipment Calibration and Frequency	Tables B2.7 and B2.8 and Section 3.4.1	
#25 Analytical Instrument and Equipment, Maintenance, Testing, and Inspection Table	B6 Instrument/Equipment Testing, Inspection, and Maintenance	Tables B2.7 and B2.8 and Section 3.8	
#26 Sampling Handling System	B3 Sample Handling and Custody	Section 3.4.1	
#27 Sample Custody Requirements	B3 Sample Handling and Custody	Section 3.4.1	
#28 QC Samples Table	B5 Quality Control	Tables B2.7 and B2.8 and Section 3.5	
#29 Project Documents and Records Table	A9 Documents and Records	Table B5.2	
#30 Analytical Services Table		Tables B5.3 and B5.4 Sections 3.6, 3.7 and 4.1 Attachments B-1 and B-3	
#31 Planned Project Assessment Table		Section 4.6	
#32 Assessment Findings and Response Actions	C1 Assessments and Response Actions	TablesB2.7 and B2.8 Section 4.5	
#33 QA Management Reports Table	C2 Reports to Management	Sections 5	
#34 Sampling and Analysis Verification (Step 1) Process Table		Table B5.1	
#35 Sampling and Analysis Validation (Steps 2a and 2b) Process Table		Sections 5.1	
#36 Sampling and Analysis Validation (Steps 2a and 2b) Summary Table		Sections 5.1	
#37 Data Usability Assessment	D3 Reconciliation with User Requirements	Section 5.1.3	

I certify that this SAP complies with the latest version of the UFP-QAPP and the EPA QA/R-5

PRINT NAME (Contractor QA Representative)	SIGNATURE	DATE

DISTRIBUTION LIST

QAPP WORKSHEET #3 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 2.3.1)

QAPP Recipients	Title	Organization	Telephone Number	E-mail Address
Mr. Si Le, P.E.	Environmental Business Line Team Lead	Naval Facilities Engineering Command Southwest (NFEC- SW)	(619) 532-2295	si.t.le@navy.mil
Ms. Pei-Fen Tamashiro, P.G.	NAVWPNSTA IR Program Manager	NAVWPNSTA Seal Beach	(562) 626-7897	pei-fen.tamashiro@navy.mil
Mr. David Crawley	ROICC	ROICC Los Angeles	(562) 626-7964	david.crawley@navy.mil
Mr. Chris Leadon	Remedial Technical Manager	NFEC-SW	(619) 532-3878	christopher.leadon@navy.mil
Mr. Nars Ancog	Quality Assurance Officer	NFEC SW	(619) 532-3046	narciso.ancog@navy.mil
Mrs. Katherine Leibel	Project Manager	Department of Toxic Substances Control	(714) 484-5446	KLeibel@dtsc.ca.gov
Ms. Patricia Hannon	Project Manager	California RWQCB, Santa Ana Region	(951) 782-4498	phannon@waterboards.ca.gov
Ms. Laurie Sullivan	Federal Coastal Resource Coordinator	National Oceanic and Atmospheric Administration	(415) 972-3210	laurie.sullivan@noaa.gov
Mr. Charlie Huang	Ecological Toxicologist	California Department of Fish and Game, Office of Spill Prevention and Response	(916) 324-9805	chuang@ospr.dfg.ca.gov
TBN	Environmental Contaminant Biologist	U.S. Fish and Wildlife Service, Division of Environmental Contaminants		
Mr. John Locke	Installation Restoration Coordinator	Environmental Department, Office of the Deputy Assistant Chief of Staff	(619) 524-6405	locke.john.b@asw.cnrsw.navy.mil
Mr. Steve Tsai, Ph.D., P.E.	Program Manager	Environmental Chemical Corporation	(858) 592-2698	Stsai@ecc.net
Mr. Dave Major, Ph.D.	Project Director	Geosyntec Consultants	(519) 822-2230	dmajor@geosyntec.com
Ms. Julia Klens Caprio	Contractor Quality Assurance Officer	Geosyntec Consultants	(865) 330-0037	jklenscaprio@geosyntec.com
Mr. Mark Rogers, P.G.	Project Manager	Environmental Chemical Corporation	(808) 620-4891	mrogers@ecc.net
Mr. Walter Grinyer, P.G.	Task Manager	Geosyntec Consultants	(951) 682-8576	wgrinyer@geosyntec.com

Notes:
NFEC-SW = Naval Facilities Engineering Command Southwest
QAPP = Quality Assurance Project Plan
RAB = Restoration Advisory Board
RWQCB = Regional Water Quality Control Board

PROJECT PERSONNEL SIGN-OFF SHEET

QAPP WORKSHEET #4 NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 3.1.1)

Project Personnel	Organization	Title	Signature	Date QAPP Read
John Daverin, C.Hg.	Geosyntec Consultants	Project Geologist		
Joseph Cronk	ECC	Site Health and Safety Officer		
Brian Gober	ECC	Site Superintendent		
Henry Kerfoot, C.E.M.	Geosyntec Consultants	Manager of Field Analytical Services		
Marlene Duffy, P.G.	Geosyntec Consultants	Safety Officer		
Alison Sloat	Geosyntec Consultants	Project QC manager		
Eli Ortenberg	Geosyntec Consultants	Field Personnel		
		Laboratory Quality Control Manager		
		Data Validation Manager		
		Field Team Manager		

Project Personnel	Organization	Title	Signature	Date QAPP Read

Notes: The project personnel sign-off sheet will be signed by the field team managers, field sampling team, laboratory quality control manager, and data validation manager and will be included in the final project report.

Acronyms/Abbreviations

CEM – Certified Environmental Manager, Nevada
CIH – Certified Industrial Hygienist
C.Hg – Certified Hydrogeologist
CSP – Certified Safety Professional
ECC – Environmental Chemical Corporation
QA – Quality Assurance
QAPP – Quality Assurance Project Plan
QC – Quality Control
PE – Professional Engineer
PG – Professional Geologist
Ph.D – Doctorate

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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
%	percent
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
3D	Three Dimensional
ARARs	applicable, relevant and appropriate requirements
AOCs	Areas of Concern
Bgs	below ground surface
BNI	Bechtel National Inc.
BGM	Baseline Groundwater Monitoring
CADD	Computer Aided Digital Design
$CaMg(CO_3)_2$	dolomite
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
CLP	Contract Laboratory Program
cm/sec	centimeters per second
COC	Chain of Custody
COPCs	Chemicals of Potential Concern
CTR	California Toxics Rule
CVOC	chlorinated Volatile Organic Compounds
DHGs	Dissolved Hydrocarbon Gases
Dhc	*Dehalococcoides*
Dhc/VCr	*Dhc* with the vinyl chloride reductase gene
DHS	Department of Health Services
DNAPL	Dense Non-Aqueous Phase Liquid
DO	dissolved oxygen
DON	Department of Navy
DOT	Department of Transportation
DQAR	Data Quality Assessment Report
DQO	Data Quality Objectives
DTSC	Department of Toxic Substance Control
ECC	Environmental Chemical Corporation
EDD	Electronic Data Deliverable
e.g.	for example
EISB	Enhanced *In Situ* Bioremediation
ELAP	Environmental Laboratory Accreditation Program
EPA	Environmental Protection Agency
ERSE	Extended Removal Site Evaluation
Etc.	etcetera
EVO	Emulsified Vegetable Oil
EVS	Environmental Visualization Software
Fe^{2+}	dissolved iron
FeS	iron sulfide
Freon TF	trichlorotrifluoroethane
FS	Feasibility Study
FSB	First Sand Biobarrier
FSP	Field Sampling Plan

ft	feet
ft bgs	feet below ground surface
ft/ft	feet per foot
GC/MS	Gas Chromatograph/Mass Spectrometer
GIS	Geographic Information Systems
HASP	Health and Safety Plan
ICP	Inductively Coupled Plasma
IDQTF	Intergovernmental Data Quality Task Force
IDW	Investigation Derived Waste
IR	Installation Restoration
JEG	Jacobs Engineering Group
KB-1®	Mixed dehalorespiring bacterial culture
L	liter
LCS	Laboratory Control Standard
LCSD	Laboratory Control Spike Duplicate
LDC	Laboratory Data Consultants
µg	micrograms
µg/L	micrograms/liter
µm	micrometer
MCL	Maximum Contaminant Levels
MDL	Method Detection Limit
mg/L	milligrams/liter
mL	milliliter
MNA	Monitored Natural Attenuation
MS	Matrix Spike
MSA	Method Standard Addition
mS/cm	micro Siemens per centimeter
MSD	Matrix Spike Duplicate
mV	millivolts
MW	Monitor Well
NASA	National Aeronautics and Space Administration
NAVFAC SW	Naval Facilities Engineering Command Southwest
NAVWPNSTA	Naval Weapons Station
NCR	Nonconformance Report
NEDD	Naval Electronic Data Deliverable
NFEC-SW	Naval Facilities Engineering Command Southwest
NFESC	Naval Facilities Engineering Service Center
NIRIS	Naval Installation Restoration Information Solution
NIST	National Institute for Standards and Testing
NTR	National Toxics Rule
NTU	Nephelometric turbidity units
O&M	operation and maintenance
OCHCA	Orange County Health Care Agency
OCWD	Orange County Water District
OMM	Operation, Maintenance and Monitoring
ORP	oxidation reduction potential
PA	Preliminary Assessment
PARCCS	Precision, accuracy, representativeness, comparability, completeness and sensitivity
PCR	polymerase chain reaction
PDA	Personal Digital Assistant

PDF	Portable Document Format
PE	Performance Evaluation
PMW	Performance Monitoring Well
POC	Point-of-Compliance
PQL	Practical Quantitation Limit
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QL	Quantitation Limit
RA	Remedial Action
RD	Remedial Design
RFS	Revised Feasibility Study
RI/FS	Remedial Investigation/Feasibility Study
ROI	Radius of Injection
ROICC	U.S. Navy Resident Officer in Charge of Construction
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RRSEM	Relative Risk Site Evaluation Model
RSE	Removal Site Evaluation
RT&E	Research, Testing and Evaluation
RWQCB	Regional Water Quality Control Board
SAB	Source Area Biobarrier
SAP	Sampling and Analysis Plan
SBNWR	Seal Beach National Wildlife Refuge
SDG	Sample Delivery Group
SHB	Shell Horizon Biobarrier
SWDIV	Southwest Division
SOP	Standard Operating Procedures
SSB	Second Sand Biobarrier
TCE	Trichloroethene
TCG	Target Cleanup Goal
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
trans-1,2-DCE	trans-1,2-dichloroethene
UFP	Uniform Federal Policy
USTs	Underground Storage Tanks
VC	Vinyl Chloride
VCr	VC reductase gene
VFA	Volatile Fatty Acid
VOA	Volatile Organic Analysis
VOCs	Volatile Organic Compounds
WRD	Water Replenishment District

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1. INTRODUCTION

1.1 TERMS OF REFERENCE

This Sampling and Analysis Plan (SAP) was prepared by Environmental Chemical Corporation (ECC) in association with Geosyntec Consultants (Geosyntec) on behalf of the Naval Facilities Engineering Command Southwest (NAVFAC SW). The SAP describes data collection methods and procedures that will be followed during the installation and operation of the Enhanced *In Situ* Bioremediation (EISB) system for the remediation of groundwater contaminated with chlorinated solvents at Naval Weapons Station (NAVWPNSTA) Seal Beach Installation Restoration (IR) Site 70, Seal Beach, California (Site).

This SAP is a combination of a field sampling plan (FSP) and a quality assurance project plan (QAPP) that meets the requirements of the following documents:

- U.S. Environmental Protection Agency (EPA), Requirements for Quality Assurance Project Plans (QAPPs), EPA Quality Assurance (QA)/R-5 (EPA, 2001)
- EPA, Guidance for the Data Quality Objectives Process, EPA QA/G-4 (EPA, 2006)
- Naval Facilities Engineering Service Center (NFESC), Navy Installation Restoration Chemical Data Quality Manual (NFESC, 1999)
- Southwest Division (SWDIV), Environmental Work Instruction 3EN2.1 - Chemical Data Validation (SWDIV, 2001a)
- SWDIV, Environmental Work Instruction 3EN2.2 - Review, Approval, Revision, and Amendment of Field Sampling Plans and Quality Assurance Project Plans (SWDIV, 2006)
- SWDIV, Environmental Work Instruction 3EN2.3 - Laboratory Quality Assurance Program (SWDIV, 2001c)
- SWDIV, Environmental Work Instruction EVR.4 – Implementing and Maintaining the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Administrative Record and Compendium at NAVFAC Southwest (NAFVAC SW, 2007)
- SWDIV, Environmental Work Instruction EVR.6 – Environmental Data Management and Required Electronic Delivery Standards (SWDIV, 2005).

This plan also incorporates the requirements of the Intergovernmental Data Quality Task Force (IDQTF) Uniform Federal Policy (UFP) for Quality Assurance Project Plans (IDQTF, 2005a). Applicable UFP worksheets are provided as tables within this SAP, as indicated by the crosswalk table located at the front of this document.

This plan provides direction for the data collection and analysis components of the Remedial Action (RA) field activities, which will consist of the start-up, operation, and project completion of a full-scale EISB system to treat chlorinated volatile organic compound (CVOC)-impacted groundwater at IR Site 70. The predominant CVOC is trichloroethene (TCE); therefore TCE is used as an indicator of CVOC contamination. TCE will be used for the purposes of defining plume boundaries with the understanding that its daughter products may be co-located within the same plume. The goal of the RA is to reach Target Cleanup Goals (TCGs) for TCE and its associated daughter products cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethene (1,1-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), and vinyl chloride (VC) using a combination of bioremediation/bioagumentation and monitored natural attenuation (MNA).

Additional compounds of concern as identified by the Record of Decision are chloroform and 1,1-dichloroethane (1,1-DCA). Table B2.1 lists the compounds of concern as well as the applicable TCGs.

This SAP will be required reading for all members of the project team participating in sample collection and EISB system operation, will be in the possession of all field teams, and will be distributed to laboratories performing analytical work for the RA. A project personnel sign-off sheet is included at the beginning of this SAP to document that the key personnel responsible for implementing SAP activities (e.g., sample collection, sample package/shipment, sample analysis, quality assurance/quality control (QA/QC), data review, etc.) have read the SAP prior to performing their duties. This SAP has been developed to provide guidance so that data acquired over the course of the RA are thoroughly documented, verifiable, and defensible, and that the quality of the data meets requirements for its intended use. The data quality objectives (DQOs) described in this SAP (Section 2.8) have been used to develop project QA objectives and QC requirements for acquiring valid usable data. Criteria for data quality were established in terms of the precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS) parameters. This SAP outlines the sampling strategy and design for the RA and establishes field procedure requirements. If necessary, this SAP may be modified as the project progresses based on information collected during field activities. The modification process will be based on EPA guidelines and direction specified in Navy Environmental Work Instruction 3EN2.2 (SWDIV, 2006).

1.2 OVERVIEW OF REMEDIAL ACTION

IR Site 70 is located just south of Westminster Boulevard and east of Seal Beach Boulevard (Figure B1.1). Site 70 encompasses approximately 40 acres, but the groundwater plume extends beyond the site boundaries (Figure B1.2). Groundwater contamination at IR Site 70 exists in two distinct areas: (i) a suspected source area which may contain residual dense, non-aqueous phase liquid (DNAPL) with dissolved TCE concentrations exceeding 1,000 micrograms per liter (µg/L) at shallow depths (within 60 feet below ground surface [bgs]); and (ii) a dissolved-phase plume extending downgradient in a south-southeasterly direction from the source. The areal extent of the TCE plume in groundwater is approximately 4,000 feet (ft) by 1,500 ft, with vertical migration to depths of approximately 150 ft below the water table. The water table is approximately 13 feet below ground surface (ft bgs). A Site conceptual model was generated from the remedial investigation data and presented in the Feasibility Study (FS) (BNI, 2002a).

The remedial approach for the Site is EISB followed by MNA, as discussed in the Revised Feasibility Study (RFS; Geosyntec, 2005). EISB involves the addition of electron donor and a dechlorinating culture to stimulate reductive dechlorination of TCE, the primary CVOC found at the site, through cis-1,2-DCE and VC to ethene. Details regarding this process and evidence supporting the efficacy of EISB at the Site are provided in the pilot study (Geosyntec, 2006). The source area will be treated with a combination of active *in situ* biostimulation/bioaugmentation and a passive Source Area Biobarrier (SAB-1), while the dissolved-phase plume will be treated with five passive biobarriers installed in targeted hydrogeologic units, transecting the dissolved-phase plume at a number of locations along the long axis of the plume (Figures B1.3 through B1.6). Two (2) biobarriers installed in each of the First Sand (FSB-1 and FSB-2) and Shell Horizon (SHB-1 and SHB-3) hydrogeologic units and a single biobarrier installed in the Second Sand (SSB-1) hydrogeologic unit (Figures B1.4 through B1.6) will be utilized to treat TCE in their respective units. The design of the remediation system was based on the vertical and lateral extent of the 250 µg/L TCE plume (in order to avoid confusion in the remainder of the document, the 250 µg/L TCE plume will be referred to as the design basis plume). Each biobarrier consists of a number of injection

wells spanning the width of the design basis plume. Emulsified vegetable oil (EVO) and a dechlorinating culture (KB-1®) will be injected into the aquifer through these wells to facilitate reductive dechlorination of the TCE and associated CVOCs as the plume migrates through each biobarrier under ambient groundwater flow.

Active remediation will be conducted within areas of TCE concentrations exceeding 200 µg/L. Active treatment consists of continued re-injection of EVO within the treatment areas (i.e., within the biobarriers and source zone). Active treatment will be terminated once the TCE concentrations in groundwater are reduced to below 200 µg/L. Monitored natural attenuation will be employed throughout the remainder of the plume not actively treated (i.e., where TCE concentrations are below 200 µg/L) and after the active treatment phase in the active treatment area until TCGs are achieved. It is estimated that active treatment of the plume will be required for a maximum of 16 years (with shorter operation times for some biobarriers), followed by 35 years of MNA to achieve the TCG. The TCGs are based on Federal surface water quality criteria (40 C.F.R. § 131.36), referred to as the National Toxics Rule (NTR) criteria; consistent with California Toxics Rule (CTR); consistent with project applicable, relevant and appropriate requirements (ARARs).

The duration of source treatment cannot be predicted due to the lack of information regarding the mass of DNAPL phase TCE present in the source area.

Site remedial activities will involve the following major components:

- Initial injections of EVO to accelerate natural biodegradation of CVOCs in groundwater.
- Injection of a commercially available *Dehalococcoides* (Dhc) culture (KB-1®) to stimulate complete dechlorination of TCE to ethene.
- Comprehensive performance monitoring throughout the EISB process to monitor remedial performance and assess the need for biobarrier maintenance.
- Periodic maintenance of the biobarriers in the form of EVO re-injections, additional bioaugmentations, well rehabilitation, etc. as needed.
- Monitoring of contaminant concentrations and natural attenuation parameters until remediation goals are achieved. Monitoring will consist of baseline sampling, bioremediation system performance monitoring, MNA monitoring, and point of compliance monitoring.
- Installation of soil vapor monitoring points (Figure B1.7) in the source area and monitoring of methane and hydrogen sulfide generated as a by product of the bioremediation process.

Annual reviews of monitoring data will be conducted to assess biobarrier performance and the need for maintenance; in addition plume migration, dechlorination activity, and extent of microbial migration will be documented. These annual reviews may recommend changes to the monitoring program based on trend analysis of monitoring data to increase remedial performance, and the adequacy of the remedial action to meet target cleanup goals (TCGs) will be assessed. Annual reviews will be documented in a summary report issued to appropriate regulatory agencies.

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2. SITE CONDITIONS AND BACKGROUND

2.1 FACILITY AND SITE CONDITIONS

IR Site 70, also known as the Research, Testing, and Evaluation (RT&E) area, consists of multistory office and production buildings, asphalt-paved parking areas, an assortment of aboveground tanks and attendant above- and below-ground piping distribution systems, several concrete-lined sumps, and underground storage tanks (USTs). From 1962 to 1973, the National Aeronautics and Space Administration (NASA) utilized the area for the design and manufacture of the Saturn II launch vehicle for the Apollo Program. Subsequent to NASA leaving the area, the United States Department of Energy and Garrett Engineering (Allied Signal) conducted pilot test assembly operations for a classified uranium enrichment process in portions of one Building 112 (S-03). These tests were conducted from 1980 to 1985 but did not include either the manufacture or enrichment of uranium. Currently, the building is used for storage, communications research, and office space.

The Removal Site Evaluation (RSE) Report from Bechtel National, Inc. (BNI 1996a) for the IR Site 70 area addressed potential waste sources from:

- Bulkhead Fabrication Building 128 (S-02);
- Vertical Assembly and Hydrotest Building 112 (S-03);
- Pneumatic Test, Paint, and Packaging Building 122 (S-04);
- Tool and Maintenance Building 130 (S-05);
- Structural Test Tower (S-06); and
- Water Conditioning Plant (S-07).

Operations at these facilities included the use of dilute acids, Volatile Organic Compounds (VOCs) including chlorinated solvents such as TCE, phenolic compounds, petroleum oils, sodium dichromate containing hexavalent chromium, detergents, metals containing paint wastes, and machine lubricating oil. Discharged wastewater contained high total dissolved solids (TDS), sodium, chloride, and had high or low pH.

2.2 PREVIOUS INVESTIGATIONS

In 1993, Jacobs Engineering Group (JEG) conducted a Preliminary Assessment (PA) of IR Site 70 (JEG, 1994). Ten Areas of Concern (AOCs) were identified for further evaluation to assess the presence or absence of chemicals of potential concern (COPCs). These ten AOCs were identified based on historical activities, use of chemicals, and the likelihood of a potential threat to human health and the environment. The PA identified major COPCs as hexavalent chromium, TCE, phenolic compounds, trichlorotrifluoroethane (Freon TF), and heavy metals.

BNI conducted an RSE for the RT&E area (BNI 1996a) to address potential waste sources from IR Site 70. The RSE report recommended that process piping systems and facilities be decommissioned and that soil and groundwater in the area be investigated further (BNI 1996a). The report also recommended soil investigations for the presence of hexavalent chromium, VC, and heavy metals. Groundwater investigations were recommended to delineate the TCE plume and to determine a potential vadose zone source, as well as the nature and extent of hexavalent chromium, phenolic compounds, and heavy metals.

In 1996, soil and groundwater samples were collected at IR Site 70 to obtain analytical data necessary to populate a Relative Risk Site Evaluation Model (RRSEM, BNI 1996b). (By using data collected at

NAVWPNSTA Seal Beach and 14 other bases, the RRSEM was used to assist in prioritizing funding for sites in the IR Program.) The samples indicated the presence of VOCs, semi-volatile organic compounds, polychlorinated biphenyls, pesticides, and metals. Based on this and subsequent studies, including the Extended Removal Site Evaluation (ERSE) of IR Sites 40 and 70 (BNI, 1999), the Navy determined that there was no immediate threat to the environment from groundwater at Site 70. The remedial investigation / feasibility study (RI/FS) (BNI, 2002a) determined that groundwater at IR Site 70 was impacted and a remedial action was required to address the source area and dissolved phase plume, based on a human health risk evaluation.

2.3 PHYSICAL SETTING

NAVWPNSTA Seal Beach is situated at latitude 33° 45' 27" N and longitude 118° 4' 22" W, San Bernardino Baseline and Meridian. NAVWPNSTA Seal Beach is located within the Los Angeles-Orange County coastal plain. This northwest-trending structural basin is approximately 50 miles long and 20 miles wide with deposits as much as 20,000 feet thick. Basin morphology was developed through the mechanisms of folding, faulting, erosion, and fluctuating sea levels (JEG, 1994).

Most of the NAVWPNSTA Seal Beach lies on predominantly flat alluvial deposits in the southeastern portion of the Los Angeles Basin. The Los Angeles Basin is bounded on the north by the Santa Monica Mountains; on the northeast by the Repetto and Puente Hills; on the east and southeast by the Santa Ana Mountains and the San Joaquin Hills; and on the south, southwest, and west by the Palos Verdes Hills and the Pacific Ocean. The land at NAVWPNSTA Seal Beach slopes evenly from approximately 20 feet above sea level in the northwestern part of the NAVWPNSTA Seal Beach to sea level in the tidal flats of the Seal Beach National Wildlife Refuge (SBNWR) in the southeast. The most pronounced topographic feature at the NAVWPNSTA is part of Landing Hill on the southwest. Landing Hill reaches a maximum elevation of about 50 feet (JEG, 1994).

The area climate is classified as a marine-influenced southern California coastal region with mild winters that average 52 degrees Fahrenheit (°F) and summers that average 68 °F. Temperature ranges from winter lows in the 30s °F to summer highs in the 90s °F. Annual precipitation averages 12.5 inches, with approximately 90 percent occurring between the months of November and April. Although precipitation is low, a high humidity level is sustained because of the proximity of the Pacific Ocean (JEG, 1994). Prevailing winds average 3.8 miles per hour from the west. Occasional strong, dry winds from the northeast, known as the "Santa Anas," occur in the fall, winter, and early spring (JEG, 1994). Periodically, the region is subjected to a phenomenon called "El Nino," which brings unusually high precipitation, flooding, high winds, and temperatures outside the expected range. The NAVWPNSTA was subjected to this El Nino weather pattern in 1997 and 1998, resulting in extremely high winds, higher than normal tidal cycles, a rise in groundwater level, flooding, and ponding in otherwise dry areas.

2.4 SITE CONDITIONS

Two faults, the Seal Beach Fault and the Los Alamitos Fault, traverse portions of the station. These two faults are part of the Newport-Inglewood Fault zone. The Seal Beach Fault is located in the southern portion of the Newport-Inglewood Fault zone. It is a right lateral oblique fault with the south side displaced upward relative to the north side. Vertical displacement is approximately 5 feet in the upper Pleistocene units (Ebersold, 1997). Movement along the fault since or during recent alluvium deposition has not displaced recent sediments. On the station, the Seal Beach Fault has uplifted Upper Pleistocene deposits at Landing Hill and Hog Island, cutting diagonally across the station and parallel to the coast

(JEG 1995a). Apparent movement is nearly vertical with the south side displaced upward relative to the north side. There is also evidence of apparent right lateral motion (Ebersold, 1997). The Los Alamitos Fault lies parallel to the Seal Beach Fault and about 2.25 miles northeast of the Alamitos Gap. The Los Alamitos Fault has little effect on the movement and quality of groundwater in the Lower Pleistocene San Pedro Formation and is older than the active Seal Beach Fault (JEG 1995a).

Soils at the station contain abundant clay and silt and are poorly drained. Six soil types have been identified. The Bolsa series (JEG, 1995b) covers approximately two-thirds of NAVWPNSTA Seal Beach including IR Site 70. These soils are moderately alkaline and calcareous and have developed from largely flat alluvial and coastal deposits. The soils extend to approximately 49 inches bgs and have moderate to slow permeability.

The sequence of the stratigraphy underlying NAVWPNSTA Seal Beach, from youngest to oldest, is:

- Recent Alluvium;
- Upper Pleistocene Lakewood Formation;
- Lower Pleistocene San Pedro Formation; and
- Pliocene Pico Formation.

The maximum thickness of Recent Alluvium deposits in the region is approximately 80 to 100 feet. The upper 50 feet consists of fine sands, silty clays, and clays, while the lower unit consists of sands and gravels, silty sands, silty clays, and clays.

Transitional, shallow marine and fluvial deposits of great variability are part of the Upper Pleistocene sand and clay deposits, starting at approximately 80 to 100 feet and continuing to depths beyond the scope of investigations at IR Site 70. Units are discontinuous and contain zones of high and low permeability. The maximum thickness of the Lakewood Formation is approximately 350 feet in the city of Lakewood (DWR, 1961).

NAVWPNSTA Seal Beach is located at the southwestern corner of the Orange County Basin. The Orange County Basin contains the Artesia, Gage, Hollydale, Jefferson, Lynwood, and Silverado aquifers. The Lynwood and Silverado aquifers are merged across most of the station (JEG, 1995a). There are four general aquifer zones at the station (JEG, 1995a):

- a semiperched, unconfined zone within the upper Recent Alluvium deposits;
- a confined fresh groundwater zone contained in lower Recent Alluvium deposits;
- Late and Early Pleistocene deposits of the Lakewood and San Pedro Formations, respectively, and in some parts, deposits of the Late Pliocene Pico Formation; and
- a confined zone of saline water underlying the freshwater zone.

Shallow groundwater underlying the station (upper Recent Alluvium deposits) is within the Lower Santa Ana River Basin (Orange County management zone) as defined by the Regional Water Quality Control Board (RWQCB) Santa Ana Basin Plan with amendments (RWQCB, 1995, with Amendment R8-2004-0001). Beneficial uses of groundwater within the Orange County management zone include municipal and domestic supply, agriculture, industrial service supply, and industrial process supply. Shallow groundwater underlying IR Site 70 currently does not serve as a water source for any of the beneficial uses designated in the Water Quality Control Plan, Santa Ana River Basin (Basin Plan) (RWQCB, 1995).

The principal freshwater body (lower Recent Alluvium deposits and Upper Pleistocene Lakewood Formation) is a large confined aquifer occupying two zones. The first zone is approximately 75 to 200 feet deep and saline. The second zone is approximately 250 to 1,000 feet deep and freshwater. This aquifer is the primary water supply source for neighboring cities. Groundwater levels in the principal freshwater zone fluctuate from year to year due to variations in pumping, infiltration, and recharge. Recharge to this aquifer is primarily from unconfined areas upgradient and from unlined rivers that are hydraulically connected to the aquifer. Seasonal variations occur with highs in the wet winter months and lows in the dry summer months when large quantities of water are used for irrigation (JEG, 1995a).

2.4.1 Site Specific Hydrogeology

A Site conceptual model was generated from the remedial investigation data and presented in the FS (BNI, 2002a). The conceptual Site model was refined based on further review of the remedial investigation and pilot study data and is presented in the Final Remedial Design (RD); (Geosyntec, 2006). This conceptual Site model consists of six separate hydrostratigraphic units. Working down from ground surface, these are:

- **Upper Fines Unit (ground surface to approximately 60 ft bgs).** Comprises three zones: a shallow zone of surficial soils and recent clayey sediments; an intermediate zone of interbedded silts, clays, and sandy silts and clays that include the semi-perched zone; and a lower zone of interbedded silts, clays, and fine to coarse-grained, silty to clayey sands. A zone of organic material, mainly wood chips, was encountered in a number of boreholes at a depth of approximately 45 to 50 ft bgs.
- **First Sand (approximately 60 to 105 ft bgs).** Poorly-graded fine-grained sands and silty sands. A coarse sand/fine gravel layer was encountered in several borings between 80 and 95 ft bgs. This coarse layer lies just above or slightly within the Shell Horizon. The First Sand varies in thickness from approximately 30 to 50 feet.
- **Shell Horizon (approximately 105 to 135 ft bgs).** Characterized by a sequence of interbedded clays, silts, sands, and gravels below the source area grading to predominantly fine-grained sand in the vicinity of RDO-6A/B. This Unit has been subdivided into the Shell Horizon (Interbedded Clays) and Shell Horizon (Fine-grained Sands) to reflect differences in the plume migration behavior and hydrogeologic characteristics. Shell and gravel layers were encountered in some but not all borings, comprising interbeds within the Shell Horizon that do not appear to be spatially extensive. Wood chips were encountered in several borings at a depth of about 110 feet.
- **Second Sand (approximately 135 to 170 ft bgs).** Similar in character to the First Sand; however, this lower unit appears to be slightly coarser in its upper section.
- **Deep Clay (approximately 170–190 ft bgs).** An apparently continuous unit consisting mainly of clay to silty clay is encountered at depths between 164 to 176 feet bgs. The unit grades to clayey silt, silt, sandy silt, or sandy clay in some areas. It is 3 to 20 feet thick, extending to between 175 and 188 feet bgs. The unit is underlain by up to 6 feet of silty sand and sand to the maximum depth of the ERSE borings, which were 191 feet bgs.
- **Deep Sand (approximately 190 ft bgs and below).** Appears to be similar in character to the First and Second Sand Units; however, it has been logged in only a few sample points on Site (BNI, 2002a)

2.4.2 Site Specific Hydraulic Conductivity, Heterogeneity

The hydraulic conductivities of screened intervals in selected groundwater monitoring wells were determined on the basis of aquifer (slug and continuous discharge pumping) tests (BEI, 2003). Local relative vertical variability in hydraulic conductivities (indicating degree of soil heterogeneity) was evaluated using electromagnetic borehole flowmeter surveys in selected groundwater monitoring wells installed as part of the Pilot Study activities documented in the RD (Geosyntec, 2006). Results of the tests may be summarized as follows:

- **Upper Fines Unit:** Relatively low horizontal hydraulic conductivity based on limited lateral migration of dissolved phase contaminants within this Unit. Vertical variability of hydraulic conductivities an order of magnitude or higher within a distance of a few feet was observed during Pilot Study activities, indicating significant heterogeneity in this Unit (Geosyntec, 2006).
- **First Sand Unit:** Represented by a horizontal hydraulic conductivity of 2.4×10^{-2} centimeter per second (cm/sec) based on a slug test (BNI, 2003a) this unit varies dramatically across the transect wells. The zone of highest relative permeability within this unit (at minimum an order of magnitude higher) in the area of the transect of wells installed during Pilot Study activities (RDO-1 to RDO-5) appears to be between 65 to 80 ft bgs (Geosyntec, 2006).
- **Shell Horizon:** Estimated hydraulic conductivities range from 1×10^{-7} cm/sec horizontal and 1×10^{-7} cm/sec vertical near the source area where the Shell Horizon is predominantly interbedded clays, to 1×10^{-2} cm/sec horizontal and 8×10^{-4} cm/sec vertical for the area where the Shell Horizon is predominantly fine-grained sand (BNI, 2003a). Localized variability in hydraulic conductivity in the region of the Shell Horizon where it grades to predominantly fine-grained sand ranges by an order of magnitude between layers with thicknesses typically on the order of one to two feet (Geosyntec 2006).
- **Second Sand Unit:** The bulk hydraulic conductivity of the Second Sand Unit is approximately 2.3×10^{-2} cm/sec horizontally and 1.5×10^{-3} cm/sec vertically based on the 2003 pump test (BNI, 2003a). Vertical characterization of hydraulic conductivity variability in the upper coarser area of this Unit, showed a smaller degree of heterogeneity than the Shell Horizon (Geosyntec, 2006).

The hydraulic conductivities of the Deep Sand range from 10 to 100 feet per day based on information from the Geologists Report Alamitos Barrier Improvement Project Construction Unit 12, Los Angeles and Orange Counties, California (December 30, 1997, Section 2.2, page 13). This is based on correlation of the Deep Sand Unit to the B aquifer. The hydraulic conductivities of the Deep Clay Unit are unknown (Geosyntec, 2006).

2.4.3 Site-Specific Groundwater Flow and General Chemistry

The First and Second Sands are laterally continuous and are both of sufficient horizontal and vertical conductivities to allow both vertical and horizontal migration to occur. The Upper Fines, Shell Horizon (Interbedded Clays) Units and the Deep Clay exhibit geologic layers that significantly hamper the migration of contaminants, likely due to their predominantly fine-grained character and a lack of connected layers of high permeability. However as the Shell Horizon grades to a slightly coarser unit to the southeast, it provides vertical continuity between the First and Second Sands allowing for vertical migration of contaminants. The Deep Sand appears separated from the Second Sand in the study area by the Deep Clay.

Groundwater flow in the First Sand Unit is nearly south near the source area (averaging approximately 170° from north), which is the direction of plume migration in the upgradient portion of the plume where it is primarily confined to this unit. Groundwater flow in the Second Sand Unit is more southeasterly, resulting in a shift in the plume migration direction where the plume migrates vertically into this Unit. Downgradient of this location, the groundwater flow direction within the First Sand Unit also appears to shift to a more southeasterly direction, although limited data is available in this area. The vertical head difference between hydrogeologic units indicates consistent downward migration of groundwater throughout the plume and source area, with some localized areas (primarily near the RDO-6 well nest) demonstrating slight head differences that imply at least transient localized areas of upward migration of groundwater between the Second and First Sand Units.

The general groundwater flow direction in each hydrogeologic unit is consistent over time, with little seasonal variation. The magnitude of the average horizontal hydraulic gradients in each of the units also appears to remain consistent with time, although seasonal variations between summer and winter months are observed along with seasonal fluctuations in the water elevations ranging up to 7 ft in all layers. The gradients in the winter months are generally a factor of two to three lower than those in the summer months. The horizontal gradients are highest in the First Sand Unit, by approximately a factor of three in comparison to those in the Upper Fines Unit and the Second Sand. The average horizontal hydraulic gradient in each unit ranges from 0.0006 feet per foot (ft/ft) in the Upper Fines Unit, 0.0007 ft/ft in the Second Sand, up to 0.002 ft/ft in the First Sand/Shell Horizon (Fine-Grained Sands).

Potential external factors that may influence local gradients and vertical migration of groundwater include groundwater pumping (regional water supply wells) and aquifer recharge (e.g., Alamitos Injection Barrier) activities. Groundwater pumping and aquifer recharge in the Orange County Groundwater Basin cause significant temporal fluctuations in the local groundwater elevations; however, the temporal consistency in the gradients and groundwater flow direction indicate that the overall impact to local groundwater flow migration is minimal. Tidal influences appear negligible in areas within the Site that will be impacted by remediation activities (BNI, 2003a).

In the long term, variability in the groundwater migration behavior on Site may be caused by changes in operation of the Alamitos Injection Barrier. The Alamitos Injection Barrier, to the Northwest of IR Site 70, is operated jointly by Los Angeles County, Department of Public Works, the Water Replenishment District of Southern California (WRD) and the Orange County Water District (OCWD) as a seawater barrier. This Barrier includes the injection of fresh water at depths as shallow as 27 ft bgs. The shallowest injection may affect the southeasterly gradient in the Second Sand Unit as well as the vertical gradient. The injection barrier may affect the direction of flow in the First Sand Unit to a lesser extent, due to lower injection rates. WRD does not currently anticipate any substantial changes to the Alamitos Barrier over the next 30 years; however, OCWD has long-term plans to expand the barrier farther into Orange County. OCWD will follow the required permitting procedures outlined by the Orange County Health Care Agency (OCHCA) within the Department of the Navy's (DON) proposed IR Site 70 buffer zone, which include consultation with relevant stakeholders. In the event that OCWD does submit a permit request, the DON will review potential conflicts with the remediation system and take appropriate actions. Future changes will be monitored and evaluated under the long-term evaluation monitoring program

General groundwater chemistry data (BNI, 1999) indicate:

- Groundwater at IR Site 70 appears to vary from fresh to brackish, based upon TDS data;

- Chloride appears to be the major anion present in groundwater;
- Major cations include sodium, calcium, and magnesium;
- Minor amounts of dissolved gases (methane and ethene) are present;
- Based on alkalinity values, groundwater appears to be generally hard to very hard;
- Dissolved iron is locally present up to about 6 milligrams per liter (mg/L);
- Total organic carbon (TOC) is present locally; the highest concentrations were reported in a center-of-plume location within the defined boundary of the CVOC plume;
- Specific conductance indicates that shallow groundwater underlying the site ranges from fresh to brackish to slightly saline;
- pH values suggest that the groundwater is slightly basic;
- Dissolved oxygen (DO) and oxidation reduction potential (ORP) data indicate moderately reduced to reduced conditions; and
- X-ray diffraction mineralogical data obtained from eight IR Site 70 soil samples during the Pilot Study showed calcite to be present at 1% to 5% by weight in all of the samples and dolomite ($CaMg[CO_3]_2$) in over 50% of the samples.

2.4.4 Nature and Extent of Contamination

The spatial distribution of contaminants within these units at IR Site 70 reported in the RD (Geosyntec, 2006) is based on groundwater sampling data collected during the 3rd quarter 2005 groundwater sampling event and the Pilot Study activities. The primary CVOC detected was TCE. High TCE concentrations (>1,000 µg/L) are present within the source area, suggesting the presence of TCE in the form of residual DNAPL, with a dissolved phase plume extending to the south-southeast. The ERSE (BNI, 1999) data represented in the three dimensional (3D) Revised Feasibility Study (RFS) data set (Geosyntec, 2005) suggest the presence of a localized high concentration (>10,000 µg/L) area down plume near monitoring well (MW) MW-70-40; however, the 3rd quarter 2005 groundwater monitoring data do not (BEI, 2006). The Remedial Design field investigation did detect TCE concentrations above 5,000 µg/L in the same vicinity (Geosyntec, 2006). Given the more complete coverage (i.e., more depth discrete data points) in the ERSE (BNI, 1999) data set, the potential for the existence of localized higher concentrations in this area should be considered.

The lateral migration of contaminants within the Upper Fines Unit is mostly confined to the source area, due to the downward hydraulic gradients and the low horizontal hydraulic conductivity. Further downward migration of the dissolved phase is prevented in areas of the Site where the Shell Horizon predominantly consists of interbedded clay layers (i.e., beneath the source area and the upgradient portion of the plume). The plume migrates in a horizontal south-southeasterly direction within the First Sand Unit. Further downgradient where the Shell Horizon grades to predominantly fine-grained sands, downward migration of the plume is observed into the Second Sand Unit.

The areal extent of the dissolved phase plume in groundwater is approximately 4,000 feet (ft) by 1,500 ft, with vertical migration to depths of approximately 150 ft below the water table. The water table is approximately 13 feet below ground surface (ft bgs). Of the total plume mass, 50% is confined to the upgradient portion of the plume within the source area and the First Sand Unit. The area comprising 90%

of the total plume mass extends to the toe of the plume into the Second Sand Unit. See Figures 2.6 through 2.22 in the RD (Geosyntec, 2006) for visualizations of the plume.

Cis-1,2-DCE is detected at low concentrations (few hundred µg/L) throughout the plume, indicating a low level of natural biological attenuation. Similarly, VC is primarily detected at low concentrations (<100 µg/L) within the source area, with sporadic detections further downgradient in the dissolved-phase plume at concentrations just above the detection limit. Preliminary results from the natural attenuation microcosm study (provided in Geosyntec, 2006) confirm that biological attenuation of the plume is minimal. An analysis of natural attenuation of TCE within the plume, based on concentration trends with distance along the axis of the plume, is presented in Appendix A of the RD (Geosyntec, 2006). This analysis suggests that the natural attenuation rate of TCE is on the order of 5 years at this site.

2.5 PROJECT ORGANIZATION

As shown in Figure B2.1, the project organization includes DON staff, who are providing technical direction and QA oversight, and the contractor project team. The following are the project roles:

- Environmental Business Line Team Lead, –NAVFAC SW
- U.S. Navy Quality Assurance Officer (QAO), NAVFAC SW
- Program Manager, ECC
- Project Director, Geosyntec
- Project Manager, ECC
- Contractor QAO, Geosyntec
- Health & Safety Manager, Geosyntec
- Manager of Field Analytical Services, Geosyntec
- Project QC Manager, Geosyntec
- Task Manager, Geosyntec
- Remediation Engineer, Geosyntec
- Project Geologist, Geosyntec
- Safety Officer, Geosyntec
- Project Business Administrator, Geosyntec
- Field Labor – Team Supervisor, ECC – Equipment Operators, ECC/Geosyntec – Recovery Technicians, ECC/Geosyntec

Responsibilities of team members associated with data acquisition activities are presented in Table B2.2. All field activities will be coordinated with the Contractor Project Manager. Decisions regarding work to be done during the implementation will be made by the DON. The lead agency for remedial investigation and remedial action at this station is the DON. Regulatory agencies providing support and oversight include the Department of Toxic Substance Control (DTSC) and the RWQCB Santa Ana Region. The distribution list for this SAP is provided in the foreword to this SAP.

2.6 SCOPE AND OBJECTIVES

The RA will consist of the start-up, operation, and shutdown of full-scale passive and semi-passive EISB systems, combined with MNA to treat the CVOC-impacted groundwater at IR Site 70. It will also include operational and performance monitoring necessary to assess the systems' progress toward the objectives of the RA.

The overall performance objective of the RA is to reduce CVOCs in groundwater at the Site to TCGs. Based on the results of the modeling studies (Geosyntec, 2006), it appears that TCE concentrations on the order of 200 µg/L may be successfully attenuated below the TCGs 35 years after termination of the active treatment phase. Therefore, the RA calls for active treatment of dissolved TCE in groundwater to 200 µg/L *via* EISB, followed by MNA to reduce concentrations of TCE and daughter products to TCGs. The initial criteria for switching from active EISB treatment to MNA will be based upon achievement of 200 µg/L throughout upgradient areas (i.e., for termination of operation of each biobarrier, the region of the aquifer that is upgradient of that biobarrier and downgradient of the next biobarrier should have maximum TCE concentrations of 200 µg/L prior to termination of active treatment). This evaluation will be made from the upgradient monitoring well for each biobarrier. Ongoing monitoring and evaluation of natural attenuation rates and plume migration behavior will provide data to allow for a periodic reevaluation of this active treatment goal, as changing conditions and/or model refinement may require either a lower or higher target active treatment goal to achieve TCGs in the timeframe suggested by the modeling studies (Geosyntec, 2006).

The initial criteria (TCGs) for termination of MNA are State (California) MCLs. Final Site MNA TCGs will be determined through an iterative process, taking into account site-specific factors such as aquifer classification and designated use, MNA performance, equal application of TCGs for remedial sites, and the site- and chemical-specific nature of the groundwater requiring remedial action.

Source Area

The source area treatment system was developed following the design process outlined in Section 4.2.2.1 of the RD (Geosyntec, 2006). The source treatment consists of a grid of EVO injection wells, used to directly target high concentration zones, combined with a downgradient source area biobarrier, which will intercept untreated mass flux from the source area and address continuing mass contribution to the dissolved-phase plume (see Figure B1.3 for source area treatment configuration). Both the grid injection and the biobarrier will include a one-time injection of KB-1® to allow for the complete dechlorination of the primary CVOC, TCE, to ethene. The source area treatment EVO injection wells are screened within the Upper Fines Unit and distributed within the estimated 1,000 µg/L TCE contour on approximate 20 ft spacings, as shown in Figure B1.3. The area directly beneath this targeted treatment zone contains a large number of buried utilities, which may require modification of the locations of the wells to avoid interference with these utilities during drilling activities. Source area biobarrier wells are screened within the First Sand Unit, as shown in Figure B1.3, and will consist of 14 wells spaced approximately 24 ft apart transecting the width of the design basis plume.

The operational objectives of the source area EISB system are as follows:

- to amend groundwater with soluble electron donor (EVO), to achieve a concentration of 0.5% volume in the source area and, if necessary, with pH-adjusting chemical(s) to maintain a neutral pH (6<pH<8);

- to bioaugment the injection wells with a volume of KB-1® sufficient to establish growth of *Dehalococcoides* with the vinyl chloride reductase gene *(Dhc/*VCr) in the source zone (after an initial pre-conditioning period in which electron donor alone will delivered to the treatment zone to achieve reducing conditions [described in the RD; Geosyntec, 2006]);
- to reduce concentrations in the source area (defined by groundwater concentrations greater than 1,000 µg/L TCE; Figure B1.3) to levels consistent with treatment *via* MNA (i.e., < 200 µg/L);
- to monitor MNA trends and evaluate the need for more aggressive treatment outside of the 1,000 µg/L source treatment zone;
- to intercept groundwater emanating from untreated portions of the source area with the source area biobarrier transecting the width of the design basis plume to address the flux of contaminated groundwater to the downgradient dissolved-phase plume; and
- to monitor the source area system until performance objectives in the source area are met.

Dissolved-phase Plume

The dissolved-phase plume treatment system was developed following the design process outlined in Section 4.2.2.2 of the RD (Geosyntec, 2006). The selected plume treatment approach consists of a total of five biobarriers transecting the plume at various depth intervals (two biobarriers in the First Sand Unit, two biobarriers in the Shell Horizon, and one biobarrier in the Second Sand Unit) in addition to the source area biobarrier. The length of each biobarrier was chosen to effectively intercept the design basis plume.

The operational objectives of the dissolved-phase plume EISB system are as follows:

- to amend groundwater with electron donor (EVO) to achieve a concentration of 0.5% volume and, if necessary, with pH-adjusting chemical(s) to maintain a neutral pH (6<pH<8);
- to bioaugment the injection wells with a volume of KB-1® sufficient to establish growth of *Dhc/*VCr (after an initial pre-conditioning period in which electron donor alone will be delivered to the treatment zone to achieve reducing conditions [described in the RD; Geosyntec, 2006]);
- to intercept groundwater across the width of the design basis plume;
- to treat intercepted groundwater until upgradient TCE concentrations are reduced below a concentration of 200 µg/L; and
- to maintain the presence of the treatment zone at each biobarrier transect, reinjecting EVO as necessary, until performance objectives in the dissolved-phase plume are met.

MNA will also be utilized to treat groundwater laterally and vertically outside the extent of the biobarriers and following termination of the operation of the biobarriers to monitor CVOC concentrations to their respective TCGs.

2.7 PROJECT MEASUREMENTS

As stated above, the objective of the RA at IR Site 70 is to reduce the concentration of the primary CVOC, TCE, in groundwater within the source area and dissolved-phase plume of IR Site 70 to less than 200 µg/L, followed by MNA to further reduce CVOC concentrations to TCGs to achieve a no further action status for the Site. The RA at the Site consists of the following stages: 1) mobilization; 2)

installation: 3) start-up: 4) operation: 5) confirmation; and 6) project closure. Performance monitoring will be conducted at the Site during the mobilization, operation, and confirmation phases of the RA to assess overall progress toward and achievement of this performance objective in both the source area and the dissolved-phase plume. Additional monitoring and measurements will be conducted during the mobilization, installation, startup, treatment, and confirmation phases of the RA to evaluate continued achievement of operational objectives and to determine when contingency measures should be implemented. In general, monitoring and measurements to be made during the RA consist of the following:

- **Groundwater Sampling** – Collection of groundwater samples from the baseline groundwater monitoring (BGM) wells, performance monitoring wells (PMW), MNA wells and point-of-compliance (POC) wells and analyzing the samples for VOCs, anions (e.g., chloride, nitrate, nitrite, bromide, and sulfate), TOC, dissolved hydrocarbon gases (DHG; innocuous end products of the dechlorination reaction, including ethene and ethane, and methane), volatile fatty acids (VFAs – acetic, butyric, lactic and propionic acids which are breakdown products of EVO fermentation), dissolved metals (e.g., iron, manganese, arsenic), dissolved hydrogen sulfide, TDS, alkalinity, and field parameters (pH, temperature, specific conductivity, turbidity, DO, and ORP);
- **Molecular Analysis for *Dhc*/VCr** – Conducting additional analysis of groundwater samples to determine the growth and proliferation of *Dhc*/VCr from KB-1®;
- **Operational Parameter Data** – Measuring operational parameters from the EISB system, including injection rates and injection pressures;
- **Water Level Measurements** – Measuring water level elevations in the performance monitoring network; and
- **Soil Vapor Sampling** – Collection of soil vapor samples to assess the potential for vadose zone impacts from methane and hydrogen sulfide generated from the operation of the EISB system.
- **Field Parameters** – Logs will be generated describing lithology encountered in drilling operations, field measurements during well development and/or well rehabilitation activities, and cone penetrometer logs generated during installation of push points.

Each of these project measurements will be made at monitoring points within the monitoring well network. These monitoring wells are described by category (i.e., observation objective) in the subsection to follow.

2.7.1 Baseline Groundwater Monitoring (BGM) Network

The baseline groundwater monitoring program will be a one time sampling event for each treatment zone to establish the starting conditions within each respective treatment area. The baseline sampling event will be conducted prior to any injection activities in each zone. The baseline event will include the PMW wells, MNA wells, and POC wells for each respective zone. The baseline samples will be analyzed for the analytical suite listed in Table B2.3. Future sampling for MNA, PMW, and POC will be compared and evaluated against the initial data provided in the Baseline Sampling. Table B2.4 describes the sampling locations and analytical tests. There will be four baseline sampling events, one each for the following zones:

- Source area, including the SAB-1, within the first sand (Figure B1.3);

- First Sand zone, including the First Sand biobarriers FSB-1, FSB-2, and SAB-1 (Figure B1.4);
- Shell Horizon zone, which includes the Shell Horizon SHB-1 and SHB-3 biobarriers (Figure B1.5); and
- Second Sand zone, which includes biobarrier SSB-1 (Figure B1.6).

2.7.2 Performance Monitoring Well (PMW) Network

The EISB performance monitoring program was developed with the primary objectives of collecting sufficient data to assess long-term EISB performance and the need for EISB maintenance and/or implementation of contingency measures while minimizing long-term monitoring costs.

The wells to be used for performance monitoring in the Source area treatment are outlined in Table B2.5. The locations of these wells are shown in Figure B1.3. For the source grid treatment area, EISB performance will be monitored at two key locations using two well nests (proposed new well installations MW-70-PMW01A/B and existing well nest MW-70-27 and MW-70-28). These locations were selected as they represent locations where both the electron donor demand and the EVO consumption rate are likely to be highest, due to the presence of elevated TCE concentrations and suspected DNAPL. For the Source Area Biobarrier, EISB performance will be monitored at a location within the core of the plume along a transect of three well nests through the biobarrier. The transect of wells will consist of MW-70-PMW02A/B (upgradient wells), EVO injection well IW-70-SAB06, and MW-70-PMW03A/B (downgradient wells). The location of this transect was chosen to approximately coincide with the higher concentration core of the plume, where the EVO is likely to be consumed first.

The wells to be used for monitoring system performance in the dissolved-phase plume are outlined in Table B2.5. The locations of these wells are shown in Figures B1.4, B1.5, and B1.6 for the First Sand Unit, Shell Horizon, and Second Sand Unit, respectively. For each biobarrier, EISB performance will be monitored at a location within the core of the plume along a transect of three well nests through the biobarrier. The transect of wells will consist of upgradient, EVO injection, and downgradient wells. The location of each transect was chosen to approximately coincide with the higher concentration core of the plume, where the EVO is likely to be consumed first. The only exception to this is the second transect through Biobarrier FSB-1 situated to the southwest end of the biobarrier (i.e., transect of MW-70-PMW04A/B, IW-70-FSB108, and MW-70-PMW05A/B). This second transect was included in the monitoring program due to the extended length of this biobarrier and to provide one monitoring location with a lower influx of TCE to provide a secondary measure of EVO longevity in areas with a lower electron donor demand.

2.7.3 Monitored Natural Attenuation (MNA) Network

The MNA monitoring program for the source area was developed with the following objectives:

- Monitor MNA trends and evaluate the need for more aggressive treatment outside of the 1,000 µg/L TCE source treatment zone; and
- Collect sufficient data for evaluating the need for implementation of contingency measures.

The critical areas for evaluating MNA performance in the source area are: (i) within the Upper Fines Unit outside of the grid treatment area and within the area of elevated (>100 µg/L) TCE concentrations; (ii) within the Upper Fines Unit at a location downgradient of the grid treatment area and within an area of

lower (<100 µg/L) TCE concentrations; and (iii) within the First Sand Unit and upgradient of the source area biobarrier but downgradient of the area in which mass flux from the Upper Fines Unit is expected to enter the First Sand Unit. Figure B1.3 illustrates the proposed sampling locations in relation to the TCE concentrations within the Upper Fines Unit and the proposed grid treatment area and downgradient source area biobarrier location.

The critical areas for evaluating MNA performance in the dissolved-phase plume are: (i) at the outer edges of each biobarrier to evaluate plume bypass related to decreased permeability in the biobarrier, as well as evaluate impacts to the plume due to EVO injection activities; (ii) at the toe of the plume to evaluate dissolved-phase plume migration rate during the treatment duration; and (iii) between biobarriers to evaluate plume attenuation rate between the treatment zones. Figures B1.4, B1.5, and B1.6 illustrate the proposed sampling locations in relation to the primary CVOC, TCE, concentrations within the First Sand, Shell Horizon, and Second Sand Units, respectively, and the proposed biobarrier locations. The evaluation frequency of the MNA data during the initial three-year active treatment phase may be continued, reduced, or increased based on the results of the concentration trend analyses.

2.7.4 Point-of-Compliance (POC) Network

The POC for Site 70 will be the boundary of Naval Weapons Station Seal Beach. To determine if the plume is migrating off-site, a monitoring well network will be established. This network will be comprised of existing wells that have no or very low previous detections of CVOCs. Wells will be selected such that each contaminated groundwater zone will have a POC well network. Additionally, POC wells will be installed into the Deep Sand. The proposed POC network is shown in Figure B2.2. Since no CVOCs have been detected in the deeper aquifers immediately upgradient of the source zone and there is a consistent southeasterly gradient supported by the Alamitos barrier injection to the northwest, only the Upper Fines and First Sand units will be monitored for POC along the northwestern base boundary. The POC wells will be monitored for groundwater gradient in addition to groundwater chemistry according to the schedule in Table B2.6; should the groundwater flow direction change significantly in the lower aquifers, additional wells may be installed. Should a CVOC be detected in POC wells above its MCL (confirmed by two subsequent samples), the DON will consider additional remedial actions and/or new POC wells.

2.8 DATA QUALITY OBJECTIVES (DQOS)

DQOs 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. 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 site investigation and remediation (EPA, 2000):

- Problem Statement;
- Decision Questions;
- Information Inputs;
- Site Boundaries;
- Decision Rules;
- Closeout Criteria; and,

- Detailed Plan for Obtaining Data.

This section of the SAP describes the outcome of the seven-step DQO process for data collection activities to be conducted as part of the RA at the Site

2.8.1 Problem Statement

Site investigations at IR Site 70 have indicated the need for a RA to address groundwater contamination. Contaminants in the groundwater at IR Site 70 consist of CVOCs, primarily TCE, but also chloroform, 1,1-DCE, 1,1-DCA, cis-1,2-DCE, trans-1,2-DCE, and VC. Concentrations of TCE in excess of the TCG persist in each of the four primary aquifer zones: the Upper Fines Unit, the First Sand Unit, the Shell Horizon, and Second Sand Unit. While natural attenuation of TCE appears to be taking place, past investigations have concluded that natural attenuation is not occurring at a rate sufficient to reduce TCE to its TCG within a reasonable timeframe (Geosyntec, 2006).

The overall objective of the RA at IR Site 70 is to reduce CVOCs in groundwater at the Site to TCGs. The RA will consist of the installation, start-up, operation, and project completion of full-scale passive and semi-passive EISB systems, combined with MNA to treat the CVOC-impacted groundwater at IR Site 70. It will also include operational and performance monitoring necessary to assess the systems' progress toward the objectives of the RA.

2.8.2 Goal Identification

The data obtained during the RA at IR Site 70 will be used to measure progress toward and attainment of the following overall performance goal. The data will be obtained by posing the following decision questions:

Does the data confirm a permanent reduction in the concentration of CVOCs, primarily TCE, in the source area to the 200 ug/L concentration?

Does the data confirm a permanent reduction in the concentration of CVOCs, primarily TCE, in the dissolved-phase plume groundwater towards the TCG and confirm that concentrations continue to meet this criterion post-treatment?

Does the data confirm that site groundwater outside of the design basis plume has also been reduced to TCGs through MNA only?

Does the data indicate that TCGs have been achieved such that no further action status for each zone is warranted?

This performance goal will be used to evaluate the overall performance of the RA at the Site. However, if the progress toward this goal does not proceed as anticipated, additional data may be required to diagnose system issues and support system optimization decisions.

These data will be required to answer the following decision questions pertaining to the RA:

1. Is a sufficient quantity of electron donor distributed to maintain reducing conditions suitable for bioaugmentation ?;
2. Is point injection of amendments capable of achieving the desired radius of influence (ROI)?
3. Does the treatment zone at each biobarrier remain effective until TCE concentrations in the dissolved-phase plume are reduced to below 200 µg/L?
4. After bioaugmentation, are the microorganisms capable of degrading site CVOCs (i.e., *Dhc*/VCr) present and maintained at a sufficient cell density until overall performance goals are met?
5. For the dissolved-phase plume EISB system and the source area biobarrier, is groundwater across the width of the design basis plume intercepted?
6. Has the installation of the EISB systems adversely affected the groundwater flow regime in the dissolved-phase plume?
7. Are the natural attenuation rates sufficient to treat groundwater laterally and vertically outside the extent of the biobarriers and following termination of the operation of the biobarriers to TCGs?
8. For the dissolved-phase plume EISB system, are the injection wells operating efficiently and properly maintained? and
9. Are methane and hydrogen sulfide generated from the EISB system adversely impacting the vadose zone or posing a potential vapor intrusion hazard at the Site?

As described below, data will be obtained during the various phases of the RA to evaluate the above decision questions and to provide a basis for designing and implementing contingency measures to optimize system operation, if necessary.

2.8.3 Information Inputs

The monitoring activities associated with each phase of the RA are summarized in Section 1.5 and Table B2.5. The data generated by these activities will serve as information inputs toward the goals identified in Section 1.6.2. Each of these monitoring activities is described below in more detail.

Groundwater Sampling

The RD (Geosyntec, 2006) provides details regarding the proposed EISB base line / performance / MNA and POC monitoring programs. These groundwater monitoring programs have been developed for the first three years of monitoring, at which point the sampling locations, frequency, and analytes monitored will be optimized for the long-term monitoring program. The sampling program may be refined as necessary within this timeframe and/or extended as appropriate, based on the data collected.

In general, the number of EISB performance monitoring sampling locations per treatment area will be confined to one or two locations selected from those areas that will provide early indications of EVO consumption (and thus the need to reinject) and/or locations where biobarrier performance is most likely to be lowest (e.g., due to insufficient residence time, higher initial TCE concentrations requiring more degradation half-lives to meet the TCG, etc.). In this way, the sampling and analytical costs may be minimized while continuing to collect critical information. Vertical monitoring intervals will be confined

to 10 ft intervals, per U.S. EPA guidance (U.S. EPA, 1986), and nested wells will be used to monitor treatment zones that exceed 25 ft in vertical depth. If at any time decreasing EISB performance is detected at these wells indicating the need for biobarrier maintenance, then selected other locations will be sampled to evaluate the extent of the region within the treatment area that requires maintenance and appropriate corrective action will be taken.

Table B2.3 summarizes the parameters that will be monitored during the initial five-year monitoring program and the information that may be obtained from each analyte. Groundwater samples will be obtained *via* low-flow sampling methods as described in Attachment B-2. A number of parameters will be sampled from wells located within active treatment zones on a quarterly basis for the first year of operation (to confirm the successful stimulation of desired bioactivity levels), followed by semi-annual monitoring (to assess ongoing treatment levels and the need for biobarrier maintenance) for the remainder of the three-year period. Targeted analytes include CVOCs, DHGs (innocuous end products of the dechlorination reaction, including ethene and ethane, and methane), inorganic anions (particularly chloride), TDS, alkalinity, depth to water (to monitor groundwater flow direction) and field parameters (particularly pH, ORP and DO, which are measures of geochemical conditions required for anaerobic microbial activity).

To assess the continuing presence of EVO within the treatment zone, qualitative measures of EVO presence will also be monitored in these locations on a semi-annual basis, including TOC and VFAs. Typical concentration trends for these analytes are an initial increase shortly after EVO injection, then slow decreases to an asymptotic level as the biomass grows. Depending on the sustained level of bioactivity, the asymptotic TOC and VFA concentrations may or may not be above background levels, and thus the usefulness of these parameters in providing a surrogate indicator of EVO presence may be limited. The information gained from these analytes will be evaluated on an ongoing basis and modifications to the sampling program may be made as appropriate.

To evaluate the potential impact on secondary groundwater quality and the contaminant distribution in the plume, samples will be obtained from targeted locations downgradient of the biobarriers on a semi-annual basis. To provide a baseline comparison, samples will also be obtained from upgradient locations at similar sampling intervals. Targeted analytes include all of the bioremediation performance indicators listed above (i.e., CVOCs; DHGs; inorganic anions; alkalinity; depth to water; and field parameters, including TDS and specific conductance), as well as secondary groundwater quality parameters including dissolved metals (e.g., iron, manganese, and arsenic), and sulfide.

Molecular Analysis for Dhc/VCr

In addition to the above-described parameters, additional groundwater samples will be obtained during certain monitoring events for polymerase chain reaction (PCR) assays specific to *Dhc*/VCr; the microorganisms responsible for complete dechlorination of TCE to ethene. These samples will be obtained according to the methods described in Attachment B-1. The planned schedule for *Dhc*/VCr analysis is shown in Table B2.6.

Operational Parameter Measurement

The operational parameters of the EISB system will be monitored during the start-up and operational phases. During all injections, EVO injection rates, pressures, total EVO and water volumes will be tracked for each injection well. EVO injection monitoring forms listing the parameters to be monitored

(e.g., injection flow rates, injection well water levels, system pressures, etc.) are presented in the Standard Operation Procedures (SOP); (Geosyntec, 2006).

Water Level Measurements

During each groundwater-monitoring event, a round of groundwater level measurements will be obtained from each BGM, PMW, MNA and POC monitoring well (Figures B1.3 through B1.6 and B2.2). The location and reference point elevations for each of the new wells was surveyed during the installation phase of the RA. The measured groundwater levels will be used to calculate groundwater piezometric head elevations in each of the wells and thereby support evaluation of changes in the groundwater flow field consequent to implementation of the EISB systems.

Performance Testing

Performance testing will be conducted, as needed, to assess proper functioning of the passive biobarriers. If well recovery performance during sampling suggests reduction in flow, aquifer and other testing will be conducted in EVO injection wells to determine if there has been a loss of permeability. Chemical and biological testing may aid in identifying the mechanism impacting aquifer permeability and sampling in downgradient wells may provide indirect evidence of biobarrier by-pass. Additional testing may include downhole video-logging, pumping, and/or slug tests in the wells. If significant declines in hydraulic conductivity are confirmed, the well(s) will be rehabilitated if subsequent EVO injections are planned.

Tracer tests may also be performed using the closely spaced injection wells to evaluate preferred flow and transport pathways in the heterogeneous aquifer system. A more completely discretized flow system may illuminate unforeseen transport and delivery anomalies. If insufficient biodegradation occurs, then testing will be conducted to evaluate microbial activity, groundwater ORP conditions, and the presence of sufficient electron donor and nutrients. A mitigation plan to enhance the performance of the EISB approach will be formulated and implemented.

Soil Vapor Testing

Permanent soil vapor probes will be located within the source area EISB active treatment zone (i.e., within the zone of oil injection). The proposed locations are shown in Figure B1.3 and were selected to obtain soil vapor data within the source EISB treatment area, particularly in locations in close proximity to occupied buildings. These samples will be obtained according to the methods described in Attachment B-2. Soil gas will be analyzed for methane and hydrogen sulfide. The planned schedule for soil vapor analysis is shown in Table B2.6.

2.8.4 Site Boundaries

The physical, temporal, and sample population boundaries for the RA are summarized below.

- IR Site 70 is located just south of Westminster Boulevard and east of Seal Beach Boulevard (Figure B1.2). Site 70 encompasses approximately 40 acres within NAVWPNSTA, but the groundwater plume extends beyond the site boundaries. NAVWPNSTA is bounded to the south by the Seal Beach National Wildlife Refuge and to the south / southwest by the Pacific Ocean.
- The areal extent of the TCE plume in groundwater is approximately 4,000 ft by 1,500 ft, with vertical migration to depths of approximately 150 ft from the water table (approximately

13 ft bgs). Contaminated groundwater exists in each of the four primary aquifer zones: the Upper Fines Unit, the First Sand Unit, the Shell Horizon, and Second Sand Unit within this area. The target area for active treatment is all the groundwater at the Site with concentrations of TCE greater than 1,000 µg/L in the source area and greater than 200 µg/L TCE in the dissolved phase plume. The target area for MNA following active treatment is all groundwater at concentrations greater than TCGs. Figure B1.2 shows the target treatment area and the locations of the source area and dissolved-phase plume treatment zones.

- Groundwater data that will be used to measure the overall attainment of the project objectives and will be obtained from the monitoring network shown on Figures B1.3 through B1.6 and B2.2. Data concerning the characteristics of the wells in the network are provided in Table B2.5.

The duration of the RA field activities is anticipated to last approximately 50 years (including MNA until attainment of TCGs), but field activities will be conducted until the project objective is met or a decision is made to otherwise modify the RA for the Site. The overall estimated project schedule is described in Section 10 of the RA Work Plan.

2.8.5 Analytical Approach

The principal performance goal of the RA is to permanently reduce the concentration of CVOCs in the source area and dissolved-phase plume groundwater towards their TCGs and confirm that concentrations continue to meet this criterion post-treatment. More specifically, the data obtained during the RA will be used to confirm a reduction in the concentration of TCE, the primary CVOC, in the source area and dissolved-phase plume groundwater to 200 µg/L during active remediation (active remediation is defined as the time when additional EVO injections will be made as needed to sustain the in situ bioremediation), followed by a further reduction of all CVOCs to their TCGs *via* MNA. The attainment of this overall performance goal will be evaluated based on the following decision rules:

- The objective of the source area treatment is to reduce TCE concentrations within the area defined by groundwater concentrations greater than 1000 µg/L TCE (Figure B1.3) to levels consistent with treatment *via* MNA (i.e., < 200 µg/L). MNA trends will be monitored to evaluate the need for more aggressive treatment outside of the 1,000 µg/L source treatment zone. *If natural attenuation rates are determined to be 25% higher or lower from those previously identified, (Geosyntec, 2006), then their impact on the overall performance goal for the Site will be evaluated.* Potential modifications of the RA design (such as either a lower or higher target active treatment goal) will be evaluated and implemented, if necessary relative to the overall performance goal for the Site.
- The criteria for the active EISB remediation system is ≥200 µg/L for the primary CVOC, TCE, for the dissolved-phase plume. Based on the results of the groundwater flow and transport modeling studies (Geosyntec, 2006), it appears that TCE concentrations on the order of 200 µg/L may be successfully attenuated below the TCG 35 years after termination of the active treatment phase. *Therefore, if the active EISB system reduces TCE concentrations in groundwater throughout upgradient areas below 200 µg/L then the remedy will be switched to MNA to meet the TCG.* That is, for termination of operation of each biobarrier, the region of the aquifer that is upgradient of that biobarrier and downgradient of the previous upgradient biobarrier should have maximum TCE concentrations of 200 µg/L prior to termination of active treatment. This evaluation will be made from upgradient and downgradient monitoring wells for each biobarrier. Ongoing monitoring and evaluation of natural attenuation rates and plume migration behavior

will provide data to allow for a periodic reevaluation of this active treatment goal, as changing conditions and/or model refinement may require either a lower or higher target active treatment goal to achieve similar results.

- The RA calls for active treatment of dissolved TCE in groundwater to 200 µg/L via EISB followed by MNA to reduce concentrations of all CVOCs to their respective TCGs. Site groundwater located outside of the design basis plume will also be remediated to TCGs *via* MNA only. Ongoing monitoring and evaluation of natural attenuation rates and plume migration behavior will provide data to allow for a periodic reevaluation (annual report) of this active treatment goal and the ability of MNA to attain TCGs in the desired timeframe. *If natural attenuation rates are determined to be either lower or higher from those previously identified (Geosyntec, 2006) to the extent that the site groundwater model predicts timeframes to reach TCGs will increase or decrease by more than 5 years, then potential modifications of the RA design (such as a lower or higher target active treatment goal) will be evaluated and implemented.*
- Similarly, the initial criteria (TCG) for termination of MNA are State MCLs. Final Site MNA TCGs for CVOCs will be determined through an iterative process, taking into account site-specific factors such as aquifer classification and designated use, MNA performance, equal application of TCGs for remedial sites, and the site- and chemical-specific nature of the groundwater requiring remedial action. *If final site MNA TCGs for CVOCs are achieved, then MNA will be terminated resulting in a no further action required status for each zone.*

In addition to the above approach for evaluating achievement of the performance goal for the RA, the following decision rules may be applied to diagnose system issues and optimize system operation:

1. During the operational phase, groundwater monitoring will be used to evaluate whether electron donor is sufficiently distributed to maintain reducing conditions suitable for bioaugmentation in the source area. The distribution of electron donor will be monitored using TOC and VFAs as surrogate parameters. In addition, sulfate concentrations and field parameter measurements (i.e., DO and ORP) in groundwater samples collected from performance monitoring wells and extracted groundwater will serve as a quantitative measure of the reducing conditions in the source area treatment zone. It is expected that, DO concentrations will drop below approximately 0.5 mg/L, and ORP measurements will drop below -75 millivolts (mV) if sufficient electron donor is being distributed to the treatment area. *If these parameters (DO and ORP) are measured below these levels in the performance monitoring wells in the source area and dissolved-phase plume during operation, then it will be concluded that sufficiently reducing conditions are being maintained. If measurements of one or more of these parameters increases above these criteria in one or more performance monitoring well, then potential process modifications will be evaluated relative to the overall performance goal for the Site and implemented, if necessary.* However, the first course of action will be to assess that accuracy of the field instrument giving an anomalous result and to re-calibrate if necessary. Such process modifications could include increasing electron donor injection rates or modifying extraction and/or injection rates.

2. During the source grid and biobarrier installation phase, the effective ROI of amendment injection will be tested. The biobarrier design in the RD assumes the injection will be able to achieve a ROI of approximately 12 ft in the First and Second Sand Units and 10 ft in the Shell Horizon (Fine-Grained Sands) and the Upper Fines Unit. These test injections will be conducted within both the source area and the dissolved-phase plume. The injections will be conducted

within approximately 10 to 20 feet of at least two other injection points / monitoring wells to evaluate the horizontal component of the ROI in aquifer material at the Site. Monitoring for EVO / tracer breakthrough will involve visual monitoring (i.e., emulsified donor will cause the water to become cloudy), the collection of groundwater samples for bromide analysis and by measuring field parameters including turbidity. *If the testing shows that the designed horizontal distribution of amendments cannot be achieved, then potential design modifications will be evaluated relative to the overall performance goal for the Site and implemented, if necessary. Such design modifications could include increasing the number of injection wells or increasing the volume of amendments injected at each point.*

3. The design life of the treatment zone between EVO injections is expected to range from approximately 6 to 15 years, depending on the specific biobarrier (Geosyntec, 2006). However, during the operational phase, groundwater data will be used to evaluate whether the treatment zone at each biobarrier within the source area and dissolved-phase plume remains effective until overall performance goals are met. Performance monitoring wells are located upgradient and downgradient of each of the biobarriers. Groundwater samples from these wells will be obtained during periodic monitoring rounds (Table B2.6) and the samples will be analyzed for, among other parameters, TOC and VFAs (as surrogates for the electron donor), sulfate, and field parameters (specifically DO and ORP). It is expected that once groundwater from the nearest upgradient biobarrier reaches a downgradient performance monitoring well, DO concentrations will decrease below approximately 0.5 mg/L, and ORP measurements will decrease below -75 mV. *If these parameters (DO and ORP) decrease and are maintained below these levels, then it will be concluded that the biobarrier continues to be generating reducing conditions amenable to reductive dechlorination. If measurements of one or more of these parameters do not decrease below these levels, or decrease then increase again, then the persistence of the biobarrier will be investigated further. This investigation may include the collection of additional groundwater samples from existing monitoring wells. However, the first course of action will be to assess that accuracy of the field instrument giving an anomalous result and to re-calibrate if necessary. If it is determined that a biobarrier is no longer maintaining sufficiently reducing conditions and additional treatment of the dissolved-phase plume in the given area is required to meet performance goals for the Site, then the biobarrier in that location will be reinjected with EVO.*

4. During the mobilization and operation phases of the RA, molecular analyses will be used to evaluate whether sufficient quantities of *Dhc*/VCr are present in the source area and dissolved-phase plume biobarriers to mediate effective reductive dechlorination of site contaminants. Based on previous experience, significant dechlorination to ethene typically occurs when cell density of *Dhc*/VCr is on the order of 10^7 gene copies/liter (L). Analysis of *Dhc*/VCr will be conducted on samples from performance monitoring wells in the source area and within the dissolved-phase plume according to the schedule presented in Table B2.6. *If the growth and proliferation of Dhc/*VCr *cells and ethene generation are not observed after 6 months in the source area and after 12 months within or immediately downgradient of the biobarriers, then the need for supplemental bioaugmentation and/or increased donor supply (as the growth of Dhc/VCr is related, in part, to donor availability) will be evaluated and conducted, if necessary, relative to the overall performance goal for the Site.*

5. The length of each biobarrier was chosen to effectively intercept the design basis plume. During the operational phase, groundwater monitoring will be used to evaluate TCE concentrations

outside the biobarrier groundwater intercept zone to determine that the lateral and vertical extents of each biobarrier are sufficient to intercept the plume. Samples will be analyzed for VOCs and will be collected from the monitoring network described in Table B2.5 according to the schedule in Table B2.6. *If TCE concentrations in groundwater outside a biobarrier interception zone greater than 250 ug/L are detected, the design basis plume will be revised and input in the numerical model (Geosyntec, 2006) to evaluate the implications of the revised distribution relative to the overall performance goal. Should the evaluation indicate that the performance goal will not be attained with the current biobarrier configuratio,then the lateral or vertical extent of the biobarrier may be increased.*

6. Water level measurements will be made in all performance monitoring wells (Figures B1.3 through B1.6) during the baseline, performance, and monitored natural attenuation groundwater monitoring phases of the EISB. These measurements will be used to describe the groundwater flow regime at the time of each round of measurements. It is possible that injection of EVO for the dissolved-phase EISB system and the growth of *Dhc*/VCr could affect groundwater flow through the creation of a lower permeability zone. In addition, water level measurements will serve to evaluate whether other unintended effects on the flow regime at the Site, such as the migration of impacted groundwater in an undesired direction, have resulted from the EISB systems in the source area or in the dissolved-phase plume. After each round of water level measurements, the calculated flow regime will be compared to those previously calculated based on prior rounds of data. *If significant changes to the groundwater flow regime at the Site are identified, then their effect on the overall performance goal for the Site will be evaluated. If the changes are determined to be detrimental, then potential modifications to the RA design will be evaluated and implemented, if necessary relative to the overall performance goal for the Site. If further mitigation measures be required then the DON and other stakeholders will be consulted to develop a strategy going forward.*

7. Natural or intrinsic biodegradation of the TCE is an integral component of the remedy affecting the duration of active remediation and the duration of MNA. During the RD, only a biodegradation half-life of 5 years for TCE was estimated using field data as insufficient data were available to estimate half-lives for cis-1-2-DCE and VC. MNA monitoring wells within the plume will be monitored for VOCs throughout the RA. These data will be used to refine MNA half-lives or rates for TCE, cis-1-2-DCE, and VC, which can be used in the groundwater model to modify timeframe predictions for active remediation and for MNA to reach TCGs. *If TCE, cis-1,2-DCE, and/or VC half-lives decrease, then TCGs may be reached sooner than expected. Conversely if half-lives increase then attainment of TCGs may take longer and a decision may be made as to whether the duration of active remediation should be extended. Actual TCE concentrations will be used to make this assessment.*

8. As discussed in the RD, routine monitoring and maintenance of the EISB system in the dissolved-phase plume area will be conducted to promote effective operation of the injection wells. Fouling (biological and mineral) of the injection wells and injection apparatus will be monitored by tracking injection and withdrawal rates over time. Because the groundwater at the site has been characterized as hard to very hard, mineral precipitation during injection is of concern. *If during operation injection pressures increase by more than 25 percent, then the system performance will be evaluated relative to the overall performance goal for the Site and maintenance activities will be implemented, if necessary. Such maintenance activities may include physical brushing,*

chemical wash, jetting, surging, and pumping of wells and will only be applied if the aquifer conditions for optimum performance of the KB-1® microbial consortium can be maintained.

9. Because of the possibility of generating both methane and hydrogen sulfide, soil-gas probes will be installed near source area EVO injection wells, particularly in the vicinity of buildings or utility corridors. For the source remedial target area, soil vapor samples will be collected and analyzed for oxygen, carbon dioxide, methane and hydrogen sulfide. The generation of methane and hydrogen sulfide may indicate the potential of future vapor intrusion issues at the Site. However, methanogenesis can be inhibited in the presence of high chlorinated solvent concentrations, methane degrades under aerobic conditions, and hydrogen sulfide can precipitate out as iron sulfide (FeS) if sufficient ferrous iron is present. The objectives of the soil vapor sampling program is to collect Site data to accurately characterize the soil vapor and quantify the rate of methane and hydrogen sulfide gas generation by the remedial activities and use the collected data to estimate potential rate of gas emissions at ground surface. *If during system operation analysis of soil vapor data indicates that concentrations of methane and hydrogen sulfide may pose a future vapor intrusion issue at the Site, then the system performance will be evaluated relative to the overall performance goal for the Site and maintenance activities will be implemented, if necessary. Such maintenance activities may include the installation of a vapor mitigation system in impacted areas or installation of a more complete soil vapor monitoring system to evaluate the impacts to potential receptors and pathways.*

2.8.6 Closeout Criteria

The overall performance goal for the RA will be evaluated with the following acceptance criterion: if the average TCE concentration obtained for the performance monitoring wells in either the source area or the respective portions of the dissolved-phase plume (i.e., first sand, shell horizon, and second sand) meets the 200 µg/L project action limit within the projected 16 year time period, then the EISB treatment in the source area or respective portion of the dissolved-phase plume can be ended. Following active treatment, if the average CVOC concentration obtained for the performance monitoring wells in either the source area or dissolved-phase plume meets TCGs, then MNA treatment in the source area or dissolved-phase plume can be ended and confirmation sampling can begin. Groundwater sampling results will be examined for the presence of hot spots (i.e., wells with TCE concentrations greater than the project action limit). Any hot spots that persist will be further analyzed and considered for additional remediation. The same approach will be employed for evaluating CVOCs data during the confirmation phase, which will be used to confirm the completion of the RA. When both the source area and dissolved-phase plume have achieved this objective, the overall performance goal for the RA will be achieved and official site closure will be requested.

The data collection methodology and analytical approach for evaluating the operational goals of the RA are based on Geosyntec's professional experience.

2.8.7 Detailed Plan for Obtaining Data

Professional judgment was used to design the BGM, PMW, MNA and POC monitoring well networks for this RA, based on previously collected data from past Site investigations, including the Pilot Study (Appendix D; Geosyntec, 2006). To provide a cost-effective performance monitoring design, groundwater samples and water level elevations will be obtained using existing monitoring wells to the maximum extent practical (Table B2.5 and Figures B1.3 through B1.6 and B2.2) and the frequency of sampling will be reduced over time as the effective performance of the system is demonstrated. The

sampling scheme has been designed to emphasize the measurement of the primary CVOC, TCE, in groundwater samples, as the primary indication of progress toward the overall performance goal. Other measurements will provide information about factors that will affect the ability of the treatment systems to achieve this goal and will enable adjustments to be made to optimize the operation of the systems. Table B2.3 presents a list of analysis types that will be performed.

2.9 PROJECT QUALITY ASSURANCE/QUALITY CONTROL OBJECTIVES

The results of water sample analysis will be obtained from a certified laboratory using standard methods and will be assess through measurement of PARCCS parameters. The QC criteria are defined in this section, along with analytical methods and project-required reference limits.

2.9.1 Precision

Precision measures the reproducibility of measurements under a given set of conditions. Analytical precision is the measurement of the variability associated with duplicate or replicate analyses. Total precision is the measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate field samples and measures variability introduced by both the laboratory and field operations. Field duplicate and matrix spike duplicate samples will be used to assess field and analytical precision. The precision measurement expressed as the relative percent difference (RPD) between the duplicate sample results. The following equation illustrates the method for calculating RPD to assess a method's precision:

Precision as RPD = (Result-Duplicate Result) / ((Result +Duplicate Result)/2)× 100%

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

The laboratory uses Laboratory Control Spike/Laboratory Control Spike Duplicate (LCS/LCSD) pairs when a MS/MSD pair is not practical because of the nature of the sample or analytical method used. The LCS/LCSD pair is prepared and analyzed with each batch of samples instead of a MS/MSD. A LCS/ LCSD pair may also be prepared in place of a MS/MSD pair 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 laboratory sample duplicate results. Laboratory duplicates may also be used for organic analysis as a measure of precision.

The analytical laboratory will have statistically based acceptability limits for RPD established for each method of analysis and sample matrix. The laboratory will review the QC samples to test that internal QC data are within the limits of acceptability. Any suspect trends will be investigated and corrective actions taken. If the laboratory does not have statistically derived control limits, the analytical precision acceptability limits for this project will be as follows:

- **Water:** 20 percent for all analyses
- **Soil Vapor:** 30 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 1 for every 20 samples. Sampling precision will be evaluated based on the RPD for field duplicate samples. The field precision acceptability limits will be as follows:

- **Water:** 30 percent for all analyses
- **Soil Vapor:** 40 percent for all analyses

Field precision will be monitored for evaluating the sampling techniques and sample-handling procedures.

2.9.2 Accuracy

Accuracy is the nearness of a result or the mean of a set of results to the true or accepted value and 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 quantitative 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:

Accuracy as percent recovery = ((Spiked Sample Result-Sample Result)/ Spike True Value) × 100%

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

EPA SW-846 mandates the recovery acceptance limits for organic analysis in the LCS at 75 to 125 percent until control limits are established. Control limits are defined as the mean recovery, plus or minus three standard deviations, of a minimum of 20 data points, with the warning limits set as the mean plus or minus two standard deviations. Additionally, surrogate recoveries for organic analysis must be within the specified method criteria. EPA SW-846 mandates the recovery limits for metals analysis in the LCS as 80 to 120 percent and for the MS/MSD, 75 to 125 percent.

The laboratory will review the QC samples and surrogate standard recoveries for each analysis to test that internal QC data are within the limits of acceptability. The laboratory will investigate any suspect trends and take appropriate corrective actions.

2.9.3 Representativeness

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

Field personnel will be responsible for ensuring that samples are representative of field conditions by collecting and handling samples according to the approved SAP and SOP. Errors in sample collection,

packaging, preservation, or chain-of custody procedures may result in samples being judged nonrepresentative and may form a basis for rejecting the data.

Data generated by the laboratory must be representative of the laboratory database of accuracy and precision measurements for analytes in different matrices. Laboratory procedures for sample preparation will allow 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.

2.9.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another, whether it was generated by a single laboratory or during inter-laboratory studies. Sample data should be comparable with other measurements for similar samples and sample conditions. The objective for the QA/QC program is to produce data with the greatest possible degree of comparability. The number of matrices sampled and the range of field conditions encountered are considered in determining comparability. The use of standardized field and analytical procedures allows 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.

2.9.5 Completeness

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

Completeness is evaluated using the following equation:

$$\text{Completeness} = (\text{Acceptable Results}/\text{Total Results}) \times 100\%$$

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 nonconformance will be evaluated to determine whether resampling and reanalysis is necessary.

2.9.6 Sensitivity and Reference Limits

Sensitivity is the capability of a test or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) or a variable interest. Examples of QC measures for determining sensitivity include laboratory fortified blanks, a method detection limit (MDL) study, and calibration standards at the quantitation limit (QL). Reference limits for analyses conducted by the certified laboratory, including MDLs, QLs, Project Action Limits, and Project Quantitation Limit Goals, are presented in Table B2.1.

MDL is a statistically determined concentration. It is the minimum concentration of a substance (analyte) that can be measured and reported with 99 % confidence that the analyte concentration is greater than zero as determined from the analysis of a sample in a given matrix containing the analyte. The MDL is

lower than the concentration at which the laboratory can quantitatively report. Accordingly, sample results greater than the MDL but less than the QL will be laboratory qualified as "estimated." MDL is defined as follows for all measurements:

$$MDL = (t_{n-1,1-\alpha=0.99}) \times (s)$$

where:

MDL = method detection limit

$t_{n-1,1-\alpha=0.99}$ = students t-value for a one-sided 99 percent confidence level and a standard deviation estimate with n-1 degrees of freedom

s = standard deviation of the replicate analyses

n = number of replicate samples analyzed

QL is the minimum concentration of an analyte or category of analytes in a specific matrix that can be identified and quantified above the MDL and within specified limits of precision and bias during routine analytical operating conditions. The laboratory will select the QL for all analytes at concentration levels that exceed the calculated MDLs by a factor of 3 to 10. Frequently, QLs for specific samples are adjusted for dilution, changes to sample volume/size and extract/digestate volumes, percentage solids, and cleanup procedures.

Project Action Limit is defined as the numerical value that causes a decision maker to choose or accept one of the alternate actions for the project site. The Project Action Limit may be a regulatory threshold standard, such as a maximum contaminant level for drinking water; a risk-based concentration level; a technology limitation; or a reference-based standard.

Project Quantitation Limit is defined as the lowest concentration or amount of the target analyte required to be reported from the data collected. Because of uncertainty at the QL, Project Quantitation Limits should be no greater than one-third of the action limit and ideally one-tenth of the action limit.

2.9.7 Analytical Methods

Analytical methods will include standard EPA methods. The methods that will be used include:

- VOCs by EPA Method 8260B;
- dissolved metals (iron, manganese, arsenic) by EPA Method 6010B;
- anions (nitrate, nitrite, bromide, chloride, and sulfate) by EPA Method 300.0;
- TOC by EPA Method 415.1;
- VFAs (acetic, butyric, lactic, propionic) by EPA Method 300M;
- DHGs (ethene, ethane, and methane) by RSK 175;
- *Dhc*/VCr by SiREM's Gene-Trac-VC Assay method (non-EPA, described in Attachment B-1);
- dissolved hydrogen sulfide by EPA Method 376.2; and

- TDS by Method 160.1.
- Alkalinity by Method 310.0
- Methane in soil vapor by Method ASTM 1946
- Hydrogen sulfide in soil vapor by Method 307-91

2.9.8 Project-Required Control Limits

Advisory precision and accuracy QC limits for analyses conducted by the certified laboratory are identified in Tables B2.7 and B2.8. Specific precision and accuracy limits will be provided by the laboratory upon submission of the analytical results.

2.10 SPECIAL TRAINING AND CERTIFICATION

2.11 HEALTH AND SAFETY TRAINING

All field activities will be performed by individuals with appropriate training (Code of Federal Regulations [CFR] 1910.120), in accordance with the site-specific Health and Safety Plan (HASP, Appendix C). Before field activities commence, the site-specific HASP shall be reviewed and signed by all Contractor personnel conducting field work. The HASP shall be available in the field for personnel in the event of a potentially hazardous situation.

2.11.1 Subcontractor Training

All subcontractors performing work during the RA will be required to conduct all activities in accordance with applicable health and safety regulations (e.g., CFR 1910.120) and site-specific requirements. A copy of the HASP will be provided to each subcontractor. However, subcontractors will be responsible for the health and safety of their personnel while working at the Site. Each day before work commences, a tailgate health and safety meeting shall be conducted by the contractor field team lead.

2.11.2 Technical Skills Training

Contractor staff working on the site will have a minimum of 24 hours of on–the-job training for each activity they complete. In addition, the Contractor will provide in-house training on soil and groundwater sampling. Training will be documented and kept in the project file. All drilling activities will be overseen by a California Professional Geologist or Engineer.

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3. DATA GENERATION AND ACQUISITION

3.1 OVERVIEW

This section describes the sampling strategies and field procedures that will be implemented to support the EISB activities at IR Site 70 in order to provide the data required to meet the DQOs described in Section 1.6. Environmental measurements to be obtained during the EISB include the following:

- groundwater sampling from existing and new monitoring wells to evaluate performance goals and operational parameters;
- measuring water levels in Site monitoring wells;
- molecular analysis for *Dhc*/VCr;
- operational parameters;
- soil vapor monitoring and
- biobarrier performance testing, as needed.

In addition, the following activities will be conducted in support of the EISB:

- conducting land surveying to obtain location coordinates and elevation for existing and new EISB wells;
- decontaminating of field equipment;
- sampling and managing investigation-derived waste (IDW).

The methodology and procedure for each of these items is addressed in the remainder of this section. In addition, analytical parameters; field and laboratory QC strategies; equipment testing, inspection, and maintenance; inspection and acceptance of supplies and consumables; and non-direct measurements pertaining to the EISB are discussed in this section.

3.2 FIELD METHODS AND PROCEDURES FOR ENVIRONMENTAL MEASUREMENTS

This section describes the procedures that will be implemented by the contractor and its field subcontractor to complete environmental measurements during the EISB. It includes a description of the procedures for field collection, analysis, and handling of water samples. All field activities will be carried out in accordance with this SAP and the project HASP (Appendix D). Field personnel will be required to read the SAP and HASP and sign the sheets included in the front of each document. In addition to the requirement of reading this SAP and the HASP, all workers will have the appropriate environmental, health, and safety training as documented in the HASP.

3.2.1 Groundwater Sampling and Analysis

Groundwater samples in the area of the TCE plume will be obtained during the mobilization, operation, and confirmation phases of implementation from monitoring wells installed at IR Site 70. In general, samples will be collected in accordance with guidelines described in the SOPs in Attachment B-2. Sample locations are shown in Figures B1.3 through B1.6 and B2.2 and described in Table B2.5.

Groundwater monitoring wells at the Site will be sampled via low-flow sampling techniques using bladder pumps. Purging of the groundwater will be performed at relatively low flow rates (between 0.1 and 0.5 liters per minute) in order to minimize drawdown of the surrounding water table and minimize stress on the formation. Water purged from the wells will be monitored for the following water quality: temperature, pH, conductivity, DO, ORP, and turbidity to document changes in water quality. These parameters will be recorded every three minutes or each time the internal volume of the flow cell is replaced with water during purging. Additionally, color and any noticeable odors will be documented. Water will continue to be purged from the wells until the drawdown of water level has stabilized and three consecutive measurements have stabilized according to the following criteria:

- temperature ± 1°C;
- pH ± 0.1;
- specific conductivity within 3 percent;
- DO ± 0.3 mg/L;
- ORP ± 10 millivolts; and
- Turbidity within ± 10 percent.

Immediately following purging activities (after the groundwater has reached stabilization), laboratory-provided sample containers (with the appropriate type and volume of preservative) will be filled directly from the sample pump discharge tube while maintaining the flow rate established during purging to minimize any potential agitation of the groundwater. Samples collected for dissolved iron, arsenic and manganese analysis will be filtered in the field using a 0.45 micometer (µm) filter placed at the end of the pump discharge tube, immediately prior to the discharge point at the sample bottle. Dissolved iron will also be tested in the field using a field test kit (e.g., Hach Color Disk) following the manufactures SOPs.

During each phase of the implementation, groundwater samples from monitoring wells will be submitted for analysis by some or all of the following methods:

- VOCs by EPA Method 8260B;
- dissolved metals (iron, manganese, arsenic) by EPA Method 6010B;
- anions (nitrate, nitrite, bromide, chloride, and sulfate) by EPA Method 300.0;
- TOC by EPA Method 415.1;
- VFAs (acetic, butyric, lactic, propionic) by EPA Method 300M;
- DHGs (ethene, ethane, and methane) by RSK 175;
- *Dhc*/VCr by SiREM's Gene-Trac-VC Assay method (non-EPA, described in Attachment B-1);
- dissolved hydrogen sulfide by EPA Method 376.2;
- alkalinity by Method 310.0; and
- TDS by Method 160.1.

Specific information pertaining to sample collection requirements for the analytical methods to be used during the implementation phase of IR Site 70 are included in Table B3.1.

3.2.1.1 Special Considerations for VOC Sample Collection

Collection of samples for VOC requires use of procedures that minimize or prevent loss of dissolved volatile constituents during sample collection. Therefore, field procedures for VOC sampling will be performed consistent with the following guidelines:

- field sampling must be performed in a manner that prevents aeration or mixing of the sampling material;
- handling and storage of samples must be performed in a manner that prevents exposure of the sample to elevated temperatures at any point during the process; and
- exposure of samples to air must be minimized.

VOA samples will be collected as follows.

1. Carefully collect the water samples in preserved 40-mL (milliliter) volatile organic analysis (VOA) vials, minimizing aeration. Samples will be collected via bladder pump prior to the collection of other samples.
2. Fill the vial to the lid until a positive meniscus is formed.
3. Cap the vial immediately and slowly.
4. Check the sample for the presence of air bubbles.
5. If any air bubbles are present, discard the collected sample and resample using a new vial.
6. Repeat the previous steps until an air bubble-free sample is collected.
7. Preserve VOA samples by promptly chilling on site (minimize volatilization) to an average temperature of 4 ± 2°C.

3.2.1.2 GROUNDWATER QUALITY FIELD MEASUREMENT PROCEDURES

Field water quality measurements will be obtained using calibrated portable instruments capable of measuring DO, ORP, pH, temperature, turbidity, and specific conductance. Field samples will be analyzed after instrument calibration is performed according to the manufacturer's instruction manual for the instrument. Results will be recorded as follows: DO to the nearest 0.1 mg/L, ORP to the nearest 0.1 mV, specific conductance to the nearest 0.1 milliSiemens per centimeter (mS/cm), turbidity to the nearest 0.1 nephelometric turbidity units (NTU), pH to the nearest 0.1 pH unit, and temperature to the nearest 1°C. The membrane on the DO probe will be periodically checked for integrity and will be replaced according to manufacturer's specifications if it is found to be torn or if air bubbles are distinguishable under the membrane. Results of manufacturer-recommended calibration checks and any maintenance conducted on the field measurement instrument will be recorded in the field logbook or on a field data sheet. The criteria for calibration checks for the field instruments are shown in Table B3.2.

3.2.1.3 SAMPLE HANDLING

This section describes the requirements for sample numbering and labeling as well as packaging and shipment.

3.2.1.3.1 Sample Numbering

All samples submitted to an off-site laboratory will be uniquely numbered according to the following format:

XXXXXX-YY-ZZZZ

In this format, "*XXXXXX*" is the six-digit contractor project number (i.e., *MR0437*), "*YY*" is the initials of the sampler, and "*ZZZZ*" is a sequential number generated at the time of sample collection. The number sequence to be used during each sampling event will be assigned by the Project Manager, or his designee, based on sequences used during previous rounds. The sample number must be recorded on the chain of custody (COC) record and in a field logbook at the time of sample collection. A complete description of the sample and sampling circumstances will be recorded in the field logbook and referenced to the unique sample identification number.

3.2.1.3.2 Sample Labeling

Sample labels are used to prevent misidentification of samples. Labels will be filled out and affixed to sample containers at the time of sample collection. Sample labels will be completed using indelible black ink and will be affixed to each sample container. Sample containers will be placed in resealable plastic bags to protect the sample labels from moisture during transportation to the laboratory. Each sample container will be labeled with the following, at a minimum:

- sample identification number;
- sample collection date (month/day/year);
- time of collection (24-hour clock); and
- analyses to be performed.

3.2.1.3.3 Sample Packaging and Shipment

Packaging of the sample containers will be based on the level of protection a sample will require during handling, shipping, and storage. Packaging 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);
- method of overpack sealing (e.g., strapping tape, custody seals); and
- marking and labeling of overpacks (e.g., laboratory address, any appropriate Department of Transportation (DOT) Hazard Class Labels, and handling instructions).

Sufficient space between sample containers will be provided for placement of ice. Cooler lids will be secured with packing tape on both ends of the cooler. Signed and dated custody seals will be placed over opposite ends of the cooler lid and secured with clear tape. All glass sample containers will be protected with plastic bubble wrap material.

Samples to be shipped by commercial carrier will be packed in a sample cooler. Ice that has been double bagged in resealable bags or an ice substitute will be added to the cooler in sufficient quantity to keep the samples cooled to 4 ± 2 °C for the duration of the shipment to the laboratory. Sample cooler drain spouts will be taped closed from the inside and outside of the cooler to prevent leakage. Saturday deliveries will be coordinated with the laboratory. If the samples are picked up by a laboratory courier service, the COC record 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 record will include

the air bill number in the "transfers accepted by" column and will be sealed in a resealable bag. The COC record will then be taped to the inside of the sample cooler lid. The cooler will be taped shut with packing 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 air bill will be retained for documentation.

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

3.2.1.4 SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

The volume and type of containers and the preservatives to be used for field and laboratory analyses must comply with EPA protocols and laboratory-specific requirements. Certified pre-cleaned containers will be provided by the subcontract laboratory. Table B3.1 lists container, preservative, matrix, and holding time requirements by analysis.

3.2.1.5 SAMPLE CUSTODY AND DOCUMENTATION

An overriding consideration for data resulting from laboratory analyses is the ability to demonstrate that the data are legally defensible (i.e., 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 COC record. A sample is considered to be in custody if the following applies to the sample:

- it is in actual possession or in view of the person who collected the samples;
- it is locked in a secure area;
- it is placed in an area restricted to authorized personnel; or
- it is placed in a container and secured with an official custody seal, such that the sample cannot be reached without breaking the seal.

This section describes sample custody and field documentation procedures that will be followed at the Site. Samples will be stored in iced coolers while on site. Sample custody will be the responsibility of the Field Team Manager or 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.

3.2.1.5.1 Chain-of-Custody (COC)

COC records will be filled out for all samples to establish the documentation necessary to trace sample possession from the time of collection. The COC record lists each sample and the individuals performing the sample collection, shipment, and receipt. The following information will be recorded on the COC

record (if information does not apply to the collected samples, then NA for not applicable should be entered):

- project name;
- project location;
- Geosyntec project number;
- Geosyntec project manager name;
- client representative (DON);
- sample numbers;
- date of sample collection;
- time of sample collection to the nearest minute in military time;
- sample type (composite or grab);
- sample description (location and matrix);
- number of sample containers;
- analysis required;
- remarks;
- data reporting level for samples (i.e., EPA Level III or IV);
- MS/MSD samples;
- observations specific to sample;
- item numbers (to be relinquished);
- courier/laboratory representative's signature for commercial carrier (record waybill number);
- date and time of custody transfer;
- transportation method;
- laboratory name;
- compositing instructions (if applicable);
- turnaround time required; and
- sampler's signature.

3.2.1.5.2 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 will be retained by the sample coordinator for inclusion in the project files; and
- the original will be sent to the analytical laboratory with the sample shipment.

The sample custodian will inventory each shipment after the laboratory receives the samples and, before signing for the shipment, the custodian will note on the original COC record any discrepancy in the number of samples, temperature of the cooler, or broken samples. The contractor QAO will be notified immediately of any problems identified with shipped samples. The contractor QAO will, in turn, notify the Project Manager; together they will determine the appropriate course of action. The contractor QAO will also 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 contractor QAO, at which time the samples will either be returned to the project for disposal or disposed of by the laboratory.

3.2.1.5.3 Field Sample Custody

The COC record will be the controlling document to demonstrate that sample custody is maintained. The COC record will be initiated in the field by sampling personnel when they collect a sample. Each individual who has the sample in his or 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 shipping personnel until receipt by the laboratory.

If the laboratory sample custodian judges sample custody to be invalid (e.g., custody seals have been broken), the laboratory will initiate a nonconformance report (NCR). The contractor QAO will be immediately notified. The contractor QAO will, in turn, notify the Project Manager. The Project Manager will make a decision, in consultation with the client, as to the fate of the sample in question on a case-by-case basis. The sample 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 narrative.

3.2.1.5.4 Custody Seals

Custody seals are used to prevent unauthorized tampering with samples from the time of sample collection through the time of laboratory analysis. The seals will be signed and dated by sampling personnel and then placed on the shipping containers in such a way that they must be broken to open the containers. Seals will be affixed to the sample containers before the samples leave the custody of the sampling personnel.

3.2.1.5.5 Laboratory Sample Custody and Documentation

Samples will be delivered to laboratory personnel authorized to receive samples, also referred to as the "sample custodian". The custodian, upon receipt of a sample, will inspect the condition of the sample (including temperature of the cooler) and the custody seal, reconcile the information on the sample label against that on the COC record, assign a laboratory number, log the sample into the sample tracking system, and store the sample in a secured sample storage room. The custodian will record all pertinent observations and measurements on the COC record, and sign the COC record.

The contractor QAO will be informed immediately of any inconsistencies between the COC record and the sample containers received. Any deviation from accepted sample-handling procedures will be documented by the laboratory and reported to the contractor QAO.

3.2.1.5.6 Field Logbooks

All information pertinent to field sampling will be recorded in a permanently bound and pre-paginated field logbook and, in addition, on a field data sheet or personal digital assistant (PDA) electronic database

to maintain the integrity and traceability of samples. All hard entries will be recorded in black indelible ink. Corrections will be made by crossing out erroneous data with a single line, and then dating and initialing the entry. At a minimum, the following information will be recorded:

- project name and location (on the front page of the logbook);
- date and time of collection for each sample (upper right-hand corner of each page);
- sample number;
- sample location (sampling point);
- sample type (water);
- composite or grab sample;
- composite type (the number of grab samples);
- depth of sample;
- weather (rain, sunny, approximate temperature, etc.);
- containers used (metal liners, glass bottles, etc.);
- requested analysis;
- if prudent, a drawing of or a copy of a map with the sample locations;
- each sample location must be clearly identified on the map;
- field analyses performed, including results, instrument checks, problems, and calibration records for field instruments;
- descriptions of deviations from this SAP;
- problems encountered and corrective action taken;
- identification of field QC samples;
- list of QC activities;
- verbal or written instructions from the Navy and contractor QAO Manager; and
- any other events that may affect the samples.

3.2.1.5.7 Electronic Data

Electronic data management will be coordinated by the contractor or a designated subcontractor (i.e., LDC). All electronic data will be organized in the format of the most recent Naval Electronic Data Deliverable (NEDD) so that it can be readily uploaded into the Naval Installation Restoration Information Solution (NIRIS) database. Field information (e.g., date and time collected, sample identification, etc.) will be entered directly into NEDD format from the COC record or uploaded from field-generated electronic files. Upon receipt, electronic data from the certified laboratory will be processed to compare the fields against a list of required values. If any errors are identified, the file will be manually edited or regenerated by the laboratory. If no errors are identified, the data will be uploaded into NIRIS. The laboratory database will be merged with the field database, and reports will be generated from the merged database. The NEDD should be submitted to NIRIS 30 days after validation is completed.

3.2.1.5.8 Document Corrections

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

3.2.2 Water-Level Measurements

Water levels will be measured using a water-level indicator with a pre-calibrated measuring tape attached directly to the probe. The meter will come fully calibrated by the manufacturer, with graduations in English units. The tape will be inspected before use for missing or defective graduation marks. Water levels will be recorded to the nearest 0.01 foot. The probe and tape in contact with water will be decontaminated with a Alconox wash and deionized rinse water between wells.

3.2.3 Soil Vapor Sampling and Analysis

Soil vapor samples will be obtained from soil vapor probes installed at IR Site 70. In general, samples will be collected in accordance with guidelines described in the SOPs in Attachment B-2. Probe locations are shown in Figures B1.7 and described in Table B2.4. Soil vapor samples with be collected with the same frequency as groundwater samples collected from performance monitoring wells and analyzed for methane and hydrogen sulfide.

3.3 FIELD METHODS AND PROCEDURES FOR SUPPORT ACTIVITIES

3.3.1 Equipment

Decontamination of groundwater sampling equipment will occur during all field activities. Groundwater sampling equipment to be used at more than one monitoring point (i.e., non-dedicated) and which will come in contact either with the groundwater directly, or indirectly through contact with other equipment, shall be new or decontaminated prior to use.

The purpose of decontamination is to eliminate the transfer of contaminants from one monitoring well to another, and to protect the health and safety of personnel who may come in contact with contaminated equipment. Decontamination procedures described in this section shall be performed at the beginning of each day of field work, between each monitoring point, at the end of each day of field work, and whenever the equipment is suspected of having been contaminated.

The laboratory is responsible for providing clean, contaminant-free containers for use during sampling events. Site field personnel shall be responsible for the decontamination of field equipment.

Field sampling equipment can generally be decontaminated manually. The following procedure is given as a sequence, which should be modified to be consistent with site conditions or depending on the equipment manufacturer's specific instructions for decontamination:

1. Wash with potable water and/or hot pressurized potable water to remove particles and residue.
2. Wash with decontamination solution (Alconox and water), using a soft-bristled or hard-bristled brush made of inert materials.

3. For equipment that cannot be adequately cleaned with a brush because of internal mechanisms or tubing, the decontamination solutions shall be circulated through the equipment.
4. Rinse thoroughly with deionized water. A double rinsing system, consisting of an initial rinse followed by a second final rinse in a separate container shall be used.

Allow to air dry or use clean towels to dry, if necessary.

Package or wrap decontaminated items to reduce the potential for recontamination.

3.3.2 Management of Investigation Derived Waste (IDW)

Project-generated wastes from IR Site 70 field activities may consist of groundwater from well purging, decontamination water, discarded inline sampling materials, soil cuttings, amendment injection waste and personal protective clothing. The management and disposal of this waste will be coordinated and conducted by the Navy in accordance with the IDW management plan presented in the RA Work Plan. Well purge water will be transported to an onsite holding tank or 55-gallon DOT-approved drums for subsequent transportation to an appropriate disposal facility. Similarly, solids will be containerized in 55-gallon DOT-approved drums or roll-off bins pending characterization. The Project Manager, in consultation with the disposal facility, will determine whether any analytical testing is required. Otherwise, analytical results from groundwater sampling will be used to characterize the water for disposal.

Liquid Waste

If required, liquid waste samples will be collected as described below:

- use new disposable bailers and wear new, clean, chemical-resistant gloves during sample collection;
- retrieve the bailer and fill appropriate bottles for the analyses being requested;
- cap the bottles and wipe any moisture from the outside of the bottle;
- place a sample label, completed with the information described in Appendix E of the RA Work Plan, on each bottle;
- place each bottle in a resealable bag;
- immediately place the resealable bag in a cooler with bagged ice; and
- record the sample number, date, time, and description on the COC record and in the field logbook. Write all entries in indelible black ink.

Solid Waste

Groundwater sampling tubes, bailers, and contaminated personal protective equipment will be drummed as they are generated and stored in a waste storage area at the end of each day. Drums containing IDW will be properly sealed, labeled, and temporarily stored on-site pending transport and final disposition by the Navy. Additional waste management information is presented in the IDW Management Plan (Appendix E of the RA Work Plan).

Discarded protective clothing will not be directly profiled for hazardous characteristics. Instead, the analytical results from the groundwater sampling events associated with the discarded clothing will be used to classify the materials.

3.4 ANALYTICAL METHODS

3.4.1 Selection of Laboratory

Bid requests will be sent to a minimum of six California Certified Laboratories chosen based on previous experience with the contractor and the Department of Defense as well as local presence. Of these six laboratories, a minimum of three returned bids will be considered. The laboratory bids received for the analytical work will be evaluated on prior experience with the contractor, qualifications, completeness of bid, and cost. The contract lab will be selected based on previous work for the DON, qualifications, and cost. To standardize the cost comparison, only the standard analyses will be used in the side-by-side comparison of costs. The procurement of the contract lab will be completed in compliance with the Federal acquisition guidelines.

This contract lab will be a California State Certified full service environmental laboratory, which is also an approved Navy laboratory. All analytical test procedures utilized by the laboratory will be California Department of Health Services (DHS) and EPA approved test methods. Additional test methods such as standard methods for the examination of water and wastewater will also be used when applicable. For analyses that are not performed by the contract lab, the samples will be subcontracted to an outside State certifiedand Navy approved lab. Note that SiREM, who will be conducting the analysis of groundwater samples to determine the growth and proliferation of *Dhc*/VCr from KB-1®, is not a State certified or NAVY approved laboratory and will not perform any tests requiring a certified laboratory.

3.4.2 Project Analytical Requirements

Project analytical requirements are outlined in Tables B3.1, B2.1, B2.7, and B2.8.

3.5 QUALITY CONTROL

3.5.1 Field Quality Control Samples

Field QC samples will be collected and analyzed to assess the consistency and performance of the groundwater sampling activities. The field QC samples will be collected and provided for groundwater samples submitted to SiREM and the certified laboratory. Field QC samples for this project will include field duplicates, MS/MSD samples, equipment rinsates and source blanks when necessary, and trip blanks. A summary of the field QC samples to be obtained during the implementation of the EISB is included in Table B3.3. Performance criteria for field QC samples that are collected during implementation phase of EISB are summarized in Table B3.4

3.5.1.1 FIELD DUPLICATES

Field duplicates are two samples (an original and a duplicate) of the same matrix, to the extent practicable, collected at the same time and location and using the same sampling techniques. Field duplicate samples are used to evaluate the precision of the overall sample collection and analysis process. Field duplicates will be collected at a frequency of 1 per 10 regular samples and will be analyzed for the full set of analyses used for the regular sample collected. Field duplicates receive unique sample identification numbers; therefore, the identities of the duplicate samples are “blind” to the analytical

laboratory. Exact locations of duplicate samples and sample identifications will be recorded in the field logbook.

3.5.1.2 MATRIX SPIKES/MATRIX SPIKE DUPLICATES

Matrix spikes are QC samples that measure matrix-specific method performance. A matrix spike sample is prepared by adding a known quantity of target analytes to a sample before sample digestion, extraction, or analysis. The laboratory will analyze an MS/MSD for every 20 samples analyzed or for every analytical batch prepared, whichever is more frequent. Field personnel will collect triple the amount of the volume of the sample matrix for the designated MS/MSD sample at a frequency of one set per every 20 samples. The results for the MS/MSD pair will be used to determine the precision and accuracy of the sample preparation and analytical method from the site specific matrices.

3.5.1.3 EQUIPMENT RINSATES AND SOURCE (FIELD) BLANKS

Equipment rinsate samples will be collected at a frequency of one per day for each day that non-disposable or non-dedicated sampling equipment is used. If more than one sampling team is using non-disposable or non-dedicated sampling equipment, then each of these teams must collect equipment rinsate samples to demonstrate adequate decontamination technique. Rinsate samples are laboratory-certified clean water collected from the final rinse of the decontamination process. Rinsate samples will be collected from the sampling equipment, placed in appropriate containers supplied by the analytical laboratory, and analyzed for the full set of analyses used for the samples collected that day. Equipment rinsate samples are used to evaluate the effectiveness of the decontamination procedure and the potential for cross-contamination during sampling events. One source blank will be collected per event or per lot of source water (if applicable) whichever is more frequent, by pouring laboratory-certified clean water directly into the appropriate sample containers while at a site. A source blank will be collected to verify that the water used for the rinsate samples is free of organic contaminants, but will only be tested if significant concentrations of contaminants are detected in the rinsate sample.

3.5.1.4 TRIP BLANKS

Trip blanks will be prepared by the laboratory in 40-mL vials with analyte-free water. The trip blanks will be carried into the field, stored, and shipped to the laboratory along with the water samples. One trip blank will be shipped with each cooler that contains samples to be analyzed for VOCs. Trip blanks are evaluated to determine whether VOC cross-contamination between samples has occurred during storage and transportation. Trip blanks apply only to volatile organics and must be free of headspace.

3.5.1.5 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. If samples are received at the laboratory less than 8 hours after collection, they may not have had sufficient time to cool to the required 4 $\pm$2 ºC.

3.5.2 Laboratory Quality Control Samples

Laboratory QC samples are used to evaluate the performance and reliability of each laboratory measurement parameter. QC samples such as method blanks, MS/MSDs, sample duplicates, and LCS/LCSDs are used to measure the accuracy and precision of the analytical methods and to evaluate

matrix interference. The recovery of known additions is a part of laboratory analytical protocol. The use of additives at known concentrations allows detection of the matrix interferences and estimation of the impact of these interferences when present. It also permits assessment of the efficiency of extraction procedures and overall accuracy of analysis. Laboratory internal QC checks conducted by the certified laboratory will include the following as applicable:

- laboratory control samples;
- laboratory duplicates;
- matrix spikes;
- surrogate standards;
- internal standards;
- method and instrument blanks;
- serial dilutions; and
- post-digestion spikes.

3.5.2.1 LABORATORY CONTROL SAMPLES

An LCS is a sample containing known concentrations of specific target analytes. It can be purchased or prepared by spiking known amounts of target analytes into a well-characterized blank matrix. The matrix will be laboratory reagent water for water samples. The spiking solution used for the LCS/LCSD preparation is of a source different from the stock that was used to prepare calibration standards. The LCS is prepared and analyzed with the associated samples, using the same reagents and under the same conditions. All analytes in the LCS must meet recovery criteria, as specified in SW-846. If the criteria are not met, the entire batch of samples must be re-prepared, together with a new LCS, and re-analyzed.

3.5.2.2 LABORATORY DUPLICATES

The laboratory duplicate is created by the laboratory; two aliquots are intentionally taken from the same sample, prepared, and analyzed in parallel. This analysis serves to measure the precision of laboratory operations. Laboratory duplicates will be prepared as required by analytical the method and laboratory QA protocol.

3.5.2.3 MATRIX SPIKES

In general, for organic analyses, an MS/MSD pair is prepared and analyzed with each preparation batch or for every 20 field samples. For inorganic compound analysis, a single MS and a laboratory sample duplicate are often prepared and analyzed with each batch. The matrix spike results allow verification of the presence of matrix effects.

3.5.2.4 SURROGATE STANDARDS

Surrogates are measured amounts of certain compounds added before sample preparation or extraction. 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; and

- 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. Surrogates are added to all samples analyzed for chlorinated pesticides, Gas Chromatograph/Mass Spectrometer (GC/MS) extractables, volatiles, and GC volatiles. 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.

3.5.2.5 INTERNAL STANDARDS

Some compound analyses (organic and inorganic) include the addition, quantitation, and recovery calculation of internal standards. Internal standards are usually synthetic compounds that 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 quantify results through internal standard calculation procedures. Internal standard recoveries are used to correct for injection and detector variability. Gas chromatography/mass spectroscopy (GC/MS) must use internal standards and have method dependent acceptability limits. Inductively coupled plasma (ICP) metals analysis also uses an internal standard calculation procedure.

3.5.2.6 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.

The method blank must not contain analytes at concentrations greater than the required QLs. If contaminants are found that either contribute to the apparent concentration of a particular target analyte or interfere with the analysis, the analysis sequence must be stopped, the source of contamination identified and corrected, and the analysis must be repeated. Contamination in the method blank could mean that the entire associated batch of extracts or digestates must be re-prepared. Therefore, it is very important to make sure that no such contamination is present.

A method blank is carried through the entire sample preparation process and is included with each batch of samples. Some analytical methods 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.

3.5.2.7 INSTRUMENT BLANKS

An instrument blank is used to monitor the cleanliness of the instrument portion of a sample analysis process.

Instrument blanks must be analyzed following calibration runs, before sample analyses are initiated, and after analysis of samples that contain high concentrations of target analytes at concentrations greater than the required reporting limits. If the laboratory consistently observes contaminants in the instrument blanks, the source of the contamination must be investigated and eliminated, if possible.

Instrument blanks are usually just the solvent or acid solution of the standard used to calibrate the instrument. During metal analyses one instrument blank is usually analyzed for every ten samples.

3.5.2.8 POST DIGESTION SPIKES AND 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 the interferences.

If a post-digestion spike recovery fails to meet acceptance criteria, the method 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 samples, 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.

3.6 EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

3.6.1 Field Equipment

The field geologist or technician will inspect the drill rig and other equipment upon arrival at the site and will document in the field notebook that all equipment to be provided by the driller is in good condition, and free of residual dirt, grease, or other possible sources of contamination. Field work will not proceed until the field geologist or technician has verified the good working condition of the equipment.

All downhole equipment will be decontaminated prior to commencing operations and between locations (Section 2.3.1). All rinse waters will be stored and properly disposed as IDW (Section 2.3.2).

Field instruments that will be used for this work include a water-quality meter and a water-level measurement instrument. Readings will be recorded in a field logbook and on field data sheets or a PDA. These instruments will be calibrated at least once daily in accordance with the manufacturer's specifications. The operation of monitoring equipment required for health and safety monitoring is included in the project HASP (Appendix D).

Appropriate corrective actions will be taken if a field instrument fails the instrument-specific calibration QC criteria. Corrective action steps will be as follows:

- check the instrument;
- investigate the cause of failure;
- recalibrate the instrument;
- if the instrument recalibration still fails, call the instrument manufacturer for assistance;
- if the problem persists, send the instrument for service;
- if the instrument is a rental, contact the rental office for immediate replacement of the instrument; and
- if practicable, keep a backup instrument on site.

The field geologist or technician will inspect all equipment used for groundwater sampling prior to and after sampling each well in order to evaluate proper working condition.

3.6.2 Laboratory Equipment

Instruments are maintained according to the manufacturer's specifications. Major maintenance/repair is performed by or under the direction of the manufacturer's service personnel. Records of instrument checks and maintenance are kept in logbooks. The maintenance log contains the date, analyst, instrument fault (if any), and corrective or preventive maintenance performed.

All laboratory equipment 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 method 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 will be less than or equal to the QL based on the final volume of extract or sample; or
- 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.

Initial calibration will be verified before samples are analyzed with a second source standard prepared at the mid-point of the calibration curve. Initial calibration verification will meet the acceptance criteria that 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 quantization 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 will therefore be traceable to the standard preparation records.

3.7 INSPECTION AND ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Supplies and consumables will be inspected and approved by the Contractor on-site manager to ensure products meet project requirements.

3.8 NON-DIRECT MEASUREMENTS

Data from previous investigations have been incorporated into the project database and will be used to further develop the site conceptual model and to serve as a comparison for data generated during the EISB implementation. This data consists of the lithologic data, soil and groundwater analytical data, and well construction information. The primary source of historical data includes the following documents:

- Final Groundwater Feasibility Study Report for IR Sites 40 and 70 (BNI, 2002a);
- Final Revised Groundwater Feasibility Study Report, Installation Restoration Site Program Site 70, (Geosyntec, 2005)

- Final Removal Site Evaluation Report for the Research, Testing, and Evaluation Area, (BNI, 1996a);
- Extended Removal Site Evaluation (ERSE) of IR Sites 40 and 70 (BNI 1999);
- Final IR Site 70 Aquifer Test Report (BEI, 2003);
- Final Pilot-Test Report for In Situ Chemical Oxidation at IR Site 70 (BNI, 2002b);
- Final Annual Groundwater Monitoring Report, IR Sites 40 and 70 (BNI, 2002c);
- Final Second Annual Groundwater Monitoring Report IR Sites 40 and70 (BNI, 2003a);
- Final Third Annual Groundwater Monitoring Report IR Sites 40 and70 (BNI, 2003b);
- Final Fourth Annual Groundwater Monitoring Report IR Sites 40 and70 (BNI, 2004);
- Final Fifth Annual Groundwater Monitoring Report IR Sites 40 and 70 (BEI, 2006); and
- Final Remedial Design (RD) for IR Site 70 Enhanced In Situ Bioremediation (Geosyntec, 2006).

The project will use commercially available software for geographic information systems (GIS) and Environmental Visualization Software (EVS) to update and evaluate the conceptual site model. A groundwater flow and transport model developed for RD activities will be updated and used as needed to evaluate plume migration.

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4. ASSESSMENT AND OVERSIGHT

Assessment activities will be performed in compliance with at least the minimum QA/QC requirements as outlined in UFP-QAPP Part 2B (IDQTF, 2005b).

4.1 PROJECT REQUIRED QL'S

According to the Navy requirements (NFESC, 1999) the laboratory will determine the MDL for each method, instrument, analyte, and matrix by using the procedure describe in 40 CFR Part 136 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 matrix spiked with target analytes at concentrations two to five times greater than the estimated MDL. At a minimum, the laboratory will conduct annual MDL studies. The laboratory will select the practical quantitation limits (PQLs) for all analytes at concentration levels that exceed the calculated MDLs by a factor of two to ten.

Reporting limits for the project are presented in Table B2.1. These limits may be elevated for individual sample if matrix interferences are encountered. Precision and accuracy QC limits are summarized in Tables B2.7 and B2.8.

4.2 LABORATORY QUALITY ASSURANCE

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

4.2.1 Laboratory Qualifications

The certified analytical laboratory selected for this project will be certified by the California DHS through the Environmental Laboratory Accreditation Program (ELAP) for all of the analytical methods required for the project. In addition, the laboratory will successfully complete the NFESC Laboratory Evaluation Program before sampling activities begin and will maintain that status throughout the project. The laboratory must be capable of providing the required turnaround times, project QC, and data deliverables required by this SAP.

4.2.2 Calibration

All instruments will be calibrated and the calibration acceptance criteria met before samples are analyzed. Calibration standards will be prepared with NIST-traceable standards and analyzed according to method 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 will be less than or equal to the QL based on the final volume of extract or sample; or
- 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.

Initial calibration will be verified before samples are analyzed with a second source standard prepared at the mid-point of the calibration curve. Initial calibration verification will meet the acceptance criteria that 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 will therefore be traceable to the standard preparation records.

4.2.3 Preventive Maintenance

The primary objective of a preventive maintenance program is to allow for the timely and effective completion of a measurement effort by minimizing the downtime of crucial analytical equipment caused by 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. The manufacturer's recommendations or sample throughput provide the basis for the established maintenance schedules, and the manufacturers' service contracts provide primary maintenance for many major instruments (e.g., GC 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 downtime. 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 laboratory manager is responsible for maintaining an adequate inventory of necessary spare parts. Sufficient equipment will 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 fittings, septa, atomic absorption lamps, mirrors, diaphragms, graphite furnace tubes, and other ancillary equipment, will be maintained.

4.2.4 Training

The laboratory will have an established policy and procedure on training and documenting of the analyst's competency. Each staff member that performs sample preparation and analysis will demonstrate their proficiency through preparation and analysis of four LCSs as described in SW-846. 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.

4.2.5 Laboratory 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 allow for use before manufacturers' expiration dates and storage under safe and chemically compatible conditions.

4.2.6 Software Quality Assurance

The generation, compilation, and reporting of electronic data are critical components of laboratory operations. The laboratory, to produce defensible data of known quality, will develop a software QA plan or an SOP that will describe 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.

4.2.6.1 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 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; and/or
- 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. The correctness of results will be checked by one manual calculation per QC batch during data review to eliminate data entry errors during analytical sequence set-up, as part of data package review. This verification will be documented in the QA/QC checklist for each data file.

4.2.6.2 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 will have a password that allows access to these areas.

4.2.6.3 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.

If a need for manual integration arises, the analysts performing analysis will select a proper approach based on their professional judgment. Manual integration then will be 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. A laboratory supervisor will review and approve all manual integrations performed by analysts. Although manual integrations typically are not directly approved by the laboratory manager, it is the laboratory manager who has the authority to justify manual integration and is responsible for training supervisors on QC procedures.

4.3 LABORATORY CORRECTIVE ACTION

The laboratory will implement corrective action when a circumstance or procedural error is detected that has a negative impact on the quality of the analytical data generated during sample analysis. Awareness of a problem must exist for a corrective action to be initiated. 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 that can then be corrected, thus, preventing a major breakdown in the QA system, which is in place. If major problems arise, laboratory personnel 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 the prime responsibility for recognizing a nonconformance and the need for implementing and documenting the corrective action.

The following closed-loop corrective action process will be used if a situation arises that requires corrective action.

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:

- identify the individual discovering or originating the nonconformance;
- describe the nonconformance;
- obtain required approval signatures;
- identify method for corrective action or describe the variance granted; and
- prepare a schedule for completing corrective action.

All impacted project samples will be listed on the nonconformance/corrective action report. The laboratory project manager will notify the contractor Project Manager or QAO of any laboratory

nonconformance impacting the samples. Nonconformance/corrective action reports will be submitted to the contractor as part of data packages. Corrective action procedures are presented in Tables B2.7 and B2.8.

4.3.1 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:

1. preparation batch;
2. instrument batch; and
3. 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., liquid waste, water), are treated in a similar manner, and are processed with the same lots of reagents. Each batch will contain a method blank, an LCS, an MS, MSD, and/or a sample duplicate. These QC check samples are not counted into 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 by each particular method.

Method QC 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 QC 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. MS, MSD, laboratory sample duplicates, surrogates, and post digestion spikes measure the matrix component of method performance.

A SDG is a group of samples received collectively by the laboratory on the same day, which will be assigned the same unique laboratory project or report number.

4.3.2 Method Blank

The method blank measures laboratory-introduced contamination for the sample batch, which is a group of samples that undergoes the same preparation procedure at the same time along with a method blank. Batch corrective action is initiated when contamination is found. Although it is the goal to have no detected target analytes in the method blanks, analytes may be periodically detected in blanks because of the nature of the analysis or the QL for the analyte.

If the following conditions are met, a method blank will be considered acceptable:

- target analytes are present at concentrations less than one half of the QLs;
- target analytes are present at concentrations less than 5 percent of the regulatory limits for these analytes; and
- 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.

4.3.3 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 re-analysis of the whole batch, including method blank, samples, and QC check samples.

If a MS/MSD pair is not analyzed, an LCS/LCSD pair will be analyzed with each batch of samples. If the LCS/LCSDs are outside method acceptance criteria for accuracy and precision, the whole batch will be re-extracted and re-analyzed, including method blank, samples, and QC check samples.

4.3.4 Matrix Spikes

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

MS data evaluation is more complex than blank or LCS data evaluation since the MS measures matrix effects in addition to sample preparation and analysis effects. Sample heterogeneity and the 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 sample 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 impacted samples and associated QC samples will be re-prepared and re-analyzed. If the MS/MSD or sample/sample duplicate pair fails in precision because of observed matrix interferences, sample variability, or the nature of the contaminant, corrective action will not be required, and the laboratory will make an appropriate notation in the case narrative.

In addition to batch corrective action, individual samples within a batch may also require corrective action. Re-extraction and re-analysis of individual samples will take place if errors have been made during sample preparation and results of analysis are inconclusive.

4.4 LABORATORY ASSESSMENT AND OVERSIGHT

Systems and performance audits will be conducted 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 to identify any areas requiring corrective action.

4.4.1 Navy Laboratory Audits

The certified laboratory will successfully complete an NFESC laboratory audit. An NFESC audit conducted in the past for a different project is an acceptable qualification provided it is still current.

4.4.2 Technical Laboratory Audits

A technical systems audit is an on-site, qualitative review of the sampling or analytical system to assess 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 prequalification (or periodic) systems audit performed by the contractor, 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 the 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 prequalification provided that prequalification has been within the past year and the work performed has been acceptable. A technical audit will include a review of the following elements of the laboratory operations:

- 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; and

- 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 assess that corrective actions have been taken.

4.4.3 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, the contractor will administer PE samples for the target analytes. Reviews of PE results include the following elements:

1. correct identification and quantification of the PE sample analytes;
2. accurate and complete reporting of the results; and
3. 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.

The off-site laboratory will participate in the EPA PE Water Supply and Water Pollution Studies program or equivalent program 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.

4.4.4 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. Magnetic tape audits of the off-site laboratory may be performed when warranted by project PE samples results, or by other circumstances.

4.5 FIELD AUDITS

The Contractor QAO and Navy QAO may schedule audits of field activities at any time to evaluate the execution of sample collection, identification, and control in the field. The audit may also include observations of COC procedures, field documentation, instrument calibrations, and field measurements.

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

Sampling operations will be reviewed and compared with the SAP, 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 by the contractor QAO and the Project Manager. Corrective action will be implemented as needed.

4.6 SAMPLING AND ANALYSIS PLAN REVISIONS OR AMENDMENTS

When circumstances arise that impact the original project DQOs, such as a significant change in work scope, the SAP document will be revised or amended. The modification process will be based on EPA guidelines and direction specified in Navy Environmental Work Instruction 3EN2.2 (SWDIV, 2006).

4.7 REPORTS TO MANAGEMENT

4.7.1 Daily Progress Reports

Daily field logs will be kept during all field activities. The author of the field log shall maintain a copy of all field logs generated and ensure that the field supervisor is given a copy as well.

4.7.2 Project Monthly Status Reports

The field supervisor will provide the Project Manager with weekly updates of progress in the field. This will allow the Project Manager to submit monthly status reports to the Navy.

4.7.3 Quality Control Summary Reports

The project QAO will review, edit, and approve the final quality control summary report as provided by the site supervisor or other designated personnel.

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5. DATA MANAGEMENT

This section describes data management procedures to be employed during EISB implementation, including procedures for reduction, verification, reporting, and validation of data results from the certified fixed-base laboratory, as well as management of other data generated during the implementation phase of the EISB. A summary of data verification processes is provided in Table B5.1. A summary of project documents and records is provided in Table B5.2.

5.1 CERTIFIED FIXED-LABORATORY DATA

This section describes the management procedures for review, verification, reporting and validation of data generated by the certified fixed-laboratory.

5.1.1 Data Reduction, Validation, and Reporting

All analytical data generated by the laboratory in support of the project will be reviewed before reporting to assess the validity of the 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, which will be signed and dated by the reviewer.

5.1.1.1 DATA REDUCTION

Data reduction involves the mathematical or statistical calculations used by the laboratory to convert raw data to the reported data. The laboratory will perform reduction of analytical data as specified in each of the appropriate analytical methods and laboratory SOPs. All raw data results will be recorded, for each method, 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 the calculations. All raw and electronic data, notebook references, supporting documentation, and correspondence will be assembled, packaged, and stored for a minimum of 7 years for future use. All reports will be held to ensure strict client confidentiality. If the laboratory is unable to store project-related data for seven years, then it is the responsibility of the laboratory to contact the contractor to make alternative arrangements.

5.1.1.2 LABORATORY DATA VERIFICATION AND REPORTING

After data reduction has occurred, draft reports of the analytical results are submitted to the project manager for review. The raw data and calculations are reviewed to assess that the chemists correctly interpreted the data and did not make errors in the calculation of the reported analytical results. The project manager also reviews the data to assess that the all QA/QC requirements are met. For each analytical method the analytical batch is checked to assess that all QA/QC elements were performed. The QA/QC results are checked to identify potential deviations from the method QA/QC acceptance criteria. If deviations are found, the appropriate corrective action must be taken before the results can be released.

Upon delivery of data to the contractor, data will be reviewed by project staff for internal and external consistency. Each data package will be reviewed against a deliverables requirements checklist prepared based on project-specific DQOs. Field and laboratory data will be managed using manual and electronic systems. Data stored, evaluated, and reported electronically will be subject to 100 percent manual verification against hard dopy data reports. Discrepancies will be corrected and documented.

5.1.1.3 DATA REPORTING

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

The contractor will maintain copies of all COC records 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 from the certified laboratory will be prepared to meet the requirements for data package contents, which are presented in Tables B5.3 and B5.4. Data packages for waste characterization samples will require a standard laboratory package.

The laboratory will provide an electronic deliverable that complies with Naval Facilities Engineering Command, 2005, *Navy Electronic Data Deliverable Standard Operating Procedure 1.0* as identified in Environmental Work Instruction EVR. 6 for that portion of the data deliverable which contains laboratory derived data.

5.1.1.4 ELECTRONIC DELIVERABLES

The contractor will provide an electronic deliverable that complies with Naval Facilities Engineering Command, 2005, *Navy Electronic Data Deliverable Standard Operating Procedure 1.0* as identified in Environmental Work Instruction EVR. 6. This Work Instruction requires data deliverables to meet the standardized formats compatible with the NEDD. To facilitate this, the project team will request the Navy provide the database format and deliverable format for analytical results, borehole information, and groundwater data. Geosyntec currently maintains the Site 70 data in a GIS data base. Data submittals will conform with the NIRIS standardized data structure which is non-proprietary in nature.

5.1.1.5 NEDD-NIRIS

The electronic data deliverable (EDD) from the certified laboratory will be in the NEDD format. The laboratory will certify that the EDD and the hard copy reports are identical. Both the EDD, portable document format (PDF) copies, and the hard copy reports will present results at two or three significant figures depending on the analysis type. The EDD for each sample delivery group will be due at the same time as the hard copy.

Electronic data management will be coordinated by the contractor or a designated subcontractor (i.e., LDC). All electronic data will be organized in the format of the most recent NEDD so that it can be readily uploaded into the NIRIS. Field information (e.g., date and time collected, sample identification, etc.) will be entered directly into NEDD format from the COC record or uploaded from field-generated electronic files. Upon receipt, electronic data from the certified laboratory will be processed to compare the fields against a list of required values. If any errors are identified, the file will be manually edited or regenerated by the laboratory. If no errors are identified, the data will be uploaded into NIRIS. The NEDD should be submitted to NIRIS 30 days after validation is complete.

5.1.2 Data Validation

An independent validator will perform data validation on the analyses of the groundwater samples conducted by the certified laboratory according to Navy Environmental Work Instruction 3EN2.1

(SWDIV, 2001a). For the selected data packages, 90 percent will be validated by Level III protocols, and 10 percent will be validated by Level IV protocols. Data used for waste characterization do not require independent data validation. At a minimum, waste characterization data will be reviewed by the contractor Project Manager.

The validation will be according to the guidelines of the EPA Contract Laboratory Program (CLP) National Functional Guidelines for Inorganic Data Review (EPA, 1994) and the EPA CLP National Functional Guidelines for Organic Data Review (EPA, 1999) and the QC criteria specified in these documents. Data will be validated and flagged with the following data qualifiers:

- J qualifier means that the analyte was positively identified, the quantitation is an estimate;
- U qualifier means that the analyte was analyzed for, but not detected. The associated numerical value is the QL;
- UJ qualifier means that the analyte was analyzed for but not detected. The associated numerical value is an estimated QL; and
- R qualifier means that the data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.

Additional details related to data validation procedures and criteria requirements are provided in the Section 5.2.2 of the UFP-QAPP Manual (IDQTF, 2005a).

5.1.3 Data Usability Assessment

Once the data have been verified and validated by a third party, the contractor QAO will review the data and determine whether the data meet project quality objectives as they related to the project decisions to be made. The contractor QAO will prepare a data quality assessment report (DQAR) based on their assessment of data usability. The DQAR will discuss the following topics:

- Deviations and their impact on usability, including:
  - Sampling location;
  - Chain-of-custody documentation or procedures;
  - Sample holding times;
  - Damaged samples, if applicable; and
  - Sampling methods and procedures provided in this SAP;
- Data quality indicators (PARCCS parameters), including:
  - Precision - field duplicates, laboratory duplicates, matrix spike duplicates;
  - Accuracy - matrix spikes, trip blanks, equipment blanks;
  - Representativeness - sampling design, sampling methods, analysis audits;
  - Comparability, if appropriate (e.g., when two or more sampling teams collect samples);
  - Completeness - proper frequency of field QC samples; and
  - Sensitivity - method detection limits, calibration standards at quantitation limits; and
- Overall data usability for project decisions.

Criteria for acceptability of the data quality indicators are provided in Section 2.9. These criteria will be evaluated and included in each performance monitoring report, along with supporting tables, so that any necessary modifications to methods or procedures can be made for subsequent sampling events. Any

limitations on the use of project data will be described and individual data qualifiers will be modified, if necessary, in the DQAR, which will be included in the final project report.

5.2 OTHER DATA

In addition to fixed laboratory data, other data consisting of direct-measured field data, SiREM laboratory data, and logged system operational parameter data will be obtained during the EISB remedial implementation of IR Site 70. These types of data will not be subject to the same management procedures for data review, verification, reporting, and validation as fixed-laboratory data. Instead, the following management procedures for this data will be employed.

5.2.1 Direct Measured Field Data

All field data will be documented in a dedicated field logbook or on field data sheets, as follows.

5.2.1.1 FIELD LOGBOOK

A dedicated field logbook will be retained on-site during all EISB Implementation activities. The project name and contact information for the person responsible for maintaining the logbook will be entered on the inside of the front cover of the logbook. Each page in the logbook will be numbered and dated. All entries will be legible and contain accurate and inclusive documentation of project activities and field measurements. At the end of each daily entry or at the end of a particular event, the person recording the entry will draw a diagonal line and initial indicating the conclusion of the entry. Since field records are the basis for later written reports, language shall be objective, factual, and free of personal feelings or other terminology that might prove inappropriate. Once completed, the logbooks will be transmitted to the Project Manager for incorporation into the project file. All aspects of field data collection and sample handling shall be documented in the field logbook. If information is to be recorded on a field data sheet and/or a PDA in addition to in the logbook, the relevant data sheet should be referenced in the logbook entry.

5.2.1.2 FIELD DATA SHEETS

Electronic or paper field data sheets may also be employed to record field data. Field data sheets for this project likely are to include:

- Daily Field Reports;
- Well Boring Logs;
- Well Records (Construction Diagram);
- Well Development Logs;
- Purge and Sample Field Reports;
- Chain-of-Custody Reports;
- Amendment Injection Logs; and
- Well Inspection/Gauging Logs.

Field data sheets shall be filled out completely, either electronically or by hand, for each task by the field personnel performing the task during the course of the activity. The field data sheets completed by hand shall be filled out in indelible ink with entry errors crossed out with a single line. All corrections shall be dated and initialed. All field data sheets shall be reviewed for completeness and legibility upon completion of field activities and shall be transmitted to the Project Manager for incorporation into the

project file. Copies of all relevant field data sheets will be included in the reports generated during the EISB implementation.

5.2.2 SiREM Data

Data resulting from the Gene-Trac-VC Assay for determining the cell density of *Dhc*/VCr will be reported by SiREM as described in Attachment B-1. Upon receipt from SiREM, the data will be compiled and then reviewed by the contractor QAO. SiREM will be notified of any analytical or reporting inadequacies and any such issues will be addressed by SiREM prior to reporting of the data. Upon approval by the contractor QAO, the SiREM data will be provided in NEDD format for inclusion in the NIRIS database.

5.2.3 Remotely Logged

All remotely logged data from the EISB system will be compiled and maintained in a Microsoft Access™ database or in a similar format. From this database, the remotely logged data will be reviewed by a member of the project team relative to project DQOs. Any trigger issues pertaining to the DQOs that are observed in the operational data will be referred to the contractor Project Manager so that the appropriate action, if any, can be evaluated.

5.3 REPORTS GENERATED

The data obtained from the IR Site 70 field activities will be tabulated, reviewed, interpreted, and compiled in a series of reports. Sign-in sheets and meeting minutes of scoping sessions, including field activity kick-off meetings, will be maintained in the Navy project file. After the start-up phase of the remedial action implementation, an Operation, Maintenance, and Monitoring (OMM) Manual will be prepared. The OMM Manual will document the installation of the EISB systems at the Site and provide additional details on the procedures that will be followed during the performance phase of the implementation. Upon completion of the confirmation phase of the work, a Remedial Action Closeout Report will be prepared to document the completion of the IR Site 70 remedial action for the Site.

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TABLES

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TABLE B2.1

REFERENCE LIMITS TABLE – GROUNDWATER/ SOIL VAPOR

QAPP WORKSHEET #15 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 2.8.1)

Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70 Naval Weapons Station Seal Beach
Seal Beach, California

ANALYTICAL GROUP	ANALYTE	CAS NUMBER	TARGET CLEANUP GOAL[1]	PROJECT QUANTITATION LIMIT GOAL	ANALYTICAL METHOD MDLs[2]	ANALYTICAL METHOD QLs[2]
VOCs/8260B	1,1,1-Trichloroethane	71-55-6	—	1 µg/L	0.2 µg/L	1 µg/L
	1,1,1,2-Tetrachloroethane	630-20-6	—	1 µg/L	0.2 µg/L	1 µg/L
	1,1,2,2-Tetrachloroethane	79-34-5	—	1 µg/L	0.2 µg/L	1 µg/L
	1,1,2-Trichloroethane	79-00-5	—	1 µg/L	0.2 µg/L	1 µg/L
	1,1,2-Trichlorotrifluoroethane	76-13-1	—	1 µg/L	0.2 µg/L	1 µg/L
	1,1-Dichloroethane	75-34-3	6 µg/L	1 µg/L	0.2 µg/L	1 µg/L
	1,1-Dichloroethene	75-35-4	6 µg/L	0.5 µg/L	0.2 µg/L	0.5 µg/L
	1,1-Dichloropropene	563-58-6	—	1 µg/L	0.2 µg/L	1 µg/L
	1,2-Dibromo-3-chloro-propane	96-12-8	—	2 µg/L	0.5 µg/L	2 µg/L
	1,2-Dibromoethane	106-93-4	—	1 µg/L	0.2 µg/L	1 µg/L
	1,2-Dichlorobenzene	95-50-1	—	1 µg/L	0.2 µg/L	1 µg/L
	1,2-Dichloroethane	107-06-2	—	0.5 µg/L	0.2 µg/L	0.5 µg/L
	1,2-Dichloropropane	78-87-5	—	1 µg/L	0.2 µg/L	1 µg/L
	1,2,3-Trichlorobenzene	87-61-6	—	1 µg/L	0.2 µg/L	1 µg/L
	1,2,3-Trichloropropane	96-18-4	—	1 µg/L	0.5 µg/L	1 µg/L
	1,2,4-Trichlorobenzene	120-82-1	—	1 µg/L	0.2 µg/L	1 µg/L
	1,2,4-Trimethylbenzene	95-63-6	—	1 µg/L	0.2 µg/L	1 µg/L
	1,3-Dichlorobenzene	541-73-1	—	1 µg/L	0.2 µg/L	1 µg/L

TABLE B2.1 (Continued)

REFERENCE LIMITS TABLE – GROUNDWATER/ SOIL VAPOR
QAPP WORKSHEET #15 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 2.8.1)
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Installation Restoration Site 70 Naval Weapons Station Seal Beach
Seal Beach, California

ANALYTICAL GROUP	ANALYTE	CAS NUMBER	TARGET CLEANUP GOAL[1]	PROJECT QUANTITATION LIMIT GOAL[2]	ANALYTICAL METHOD MDLs[2]	ANALYTICAL METHOD QLs[2]
VOCs/8260B (continued)	1,3-Dichloropropene (total)	542-75-6	—	1 µg/L	0.2 µg/L	1 µg/L
	1,3,5-Trimetheylbenzene	108-67-8	—	1 µg/L	0.2 µg/L	1 µg/L
	1,4-Dichlorobenzene	106-46-7	—	1 µg/L	0.2 µg/L	1 µg/L
	2-Butanone (MEK)	78-93-3	—	5 µg/L	5 µg/L	5 µg/L
	2-Chlorotoluene	95-49-8	—	1 µg/L	0.2 µg/L	1 µg/L
	2-Hexanone	591-78-6	—	5 µg/L	5 µg/L	5 µg/L
	2,2-Dichloropropane	594-20-7	—	1 µg/L	0.2 µg/L	1 µg/L
	4-chlorotoluene	106-43-4	—	1 µg/L	0.2 µg/L	1 µg/L
	4-Methyl-2-pentanone (MIBK)	108-10-1	—	5 µg/L	5 µg/L	5 µg/L
	n-Butylbenzene	104-51-8	—	1 µg/L	0.2 µg/L	1 µg/L
	n-Propylbenzene	103-65-1	—	1 µg/L	0.2 µg/L	1 µg/L
	p-Isopropyltoluene	98-82-8	—	1 µg/L	0.2 µg/L	1 µg/L
	sec-Butylbenzene	135-98-8	—	1 µg/L	0.2 µg/L	1 µg/L
	tert-Butylbenzene	98-06-6	—	1 µg/L	0.2 µg/L	1 µg/L
	Acetone	67-64-1	—	10 µg/L	5 µg/L	10 µg/L
	Benzene	71-43-2	—	1 µg/L	0.2 µg/L	1 µg/L
	Bromobenzene	108-86-1	—	1 µg/L	0.2 µg/L	1 µg/L
	Bromodichloromethane	75-27-4	—	1 µg/L	0.2 µg/L	1 µg/L

TABLE B2.1 (Continued)

REFERENCE LIMITS TABLE – GROUNDWATER/ SOIL VAPOR
QAPP WORKSHEET #15 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 2.8.1)
Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70 Naval Weapons Station Seal Beach
Seal Beach, California

ANALYTICAL GROUP	ANALYTE	CAS NUMBER	TARGET CLEANUP GOAL[1]	PROJECT QUANTITATION LIMIT GOAL[2]	ANALYTICAL METHOD MDLs[2]	ANALYTICAL METHOD QLs[2]
VOCs/8260B (continued)	Bromomethane	74-83-9	—	2 µg/L	0.2 µg/L	2 µg/L
	Bromoform	75-25-2	—	1 µg/L	0.3 µg/L	1 µg/L
	Carbon disulfide	75-15-0	—	1 µg/L	0.2 µg/L	1 µg/L
	Carbon tetrachloride	56-23-5	—	0.5 µg/L	0.2 µg/L	0.5 µg/L
	Chlorobenzene	108-90-7	—	1 µg/L	0.2 µg/L	1 µg/L
	Chloroethane	75-00-3	—	2 µg/L	0.2 µg/L	2 µg/L
	Chloroform	67-66-3	100 µg/L	1 µg/L	0.2 µg/L	1 µg/L
	Chloromethane	74-87-3	—	2 µg/L	0.2 µg/L	2 µg/L
	cis-1,2-Dichloroethene	156-59-2	6 µg/L	1 µg/L	0.2 µg/L	1 µg/L
	Dichlorodifluoromethane	75-71-8	—	2 µg/L	0.3 µg/L	2 µg/L
	Dibromochloromethane	124-48-1	—	1 µg/L	0.2 µg/L	1 µg/L
	Dibromomethane	74-95-3	—	1 µg/L	0.2 µg/L	1 µg/L
	Ethylbenzene	100-41-4	—	1 µg/L	0.2 µg/L	1 µg/L
	Hexachlorobutadiene	87-68-3	—	1 µg/L	0.2 µg/L	1 µg/L
	Isopropylbenzene	98-82-8	—	1 µg/L	0.2 µg/L	1 µg/L
	Methylene chloride	75-09-2	—	1 µg/L	0.5 µg/L	1 µg/L
	Methyl tert-butyl ether (MTBE)	1634-04-4	—	1 µg/L	0.2 µg/L	1 µg/L
	Styrene	100-42-5	—	1 µg/L	0.2 µg/L	1 µg/L

TABLE B2.1 (Continued)

REFERENCE LIMITS TABLE – GROUNDWATER/ SOIL VAPOR
QAPP WORKSHEET #15 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 2.8.1)
Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70 Naval Weapons Station Seal Beach
Seal Beach, California

ANALYTICAL GROUP	ANALYTE	CAS NUMBER	TARGET CLEANUP GOAL[1]	PROJECT QUANTITATION LIMIT GOAL[2]	ANALYTICAL METHOD MDLs[3]	ANALYTICAL METHOD QLs[3]
VOCs/8260B (continued)	Tetrachloroethene	127-18-4	—	1 µg/L	0.2 µg/L	1 µg/L
	Toluene	108-88-3	—	1 µg/L	0.2 µg/L	1 µg/L
	trans-1,2-Dichloroethene	156-60-5	10 µg/L	1 µg/L	0.2 µg/L	1 µg/L
	Trichloroethene	79-01-6	5 µg/L	5 µg/L	0.2 µg/L	5 µg/L
	Trichlorofluoromethane	75-69-4	—	2 µg/L	0.2 µg/L	2 µg/L
	Vinyl chloride	75-01-4	0.5 µg/L	0.5 µg/L	0.2 µg/L	0.5
	Xylenes (total)	1330-20-7	—	1 µg/L	0.7 µg/L	1 µg/L
Anions/300.0	Bromide	24959-67-9	—	0.5 mg/L	0.1 mg/L	0.5 mg/L
	Chloride	16887-00-6	—	0.2 mg/L	0.1 mg/L	0.2 mg/L
	Sulfate	14808-79-8	—	0.5 mg/L	0.25 mg/L	0.5 mg/L
	Nitrate	84145-82-4	—	0.2 mg/L	0.1 mg/L	0.2 mg/L
	Nitrite	1594-56-5	—	0.2 mg/L	0.1 mg/L	0.2 mg/L
Alkalinity/310.0	Alkalinity, as $CaCO_3$	—	—	5 mg/L	1 mg/L	5 mg/L
Volatile Fatty Acids/300M	Acetic	64-19-7	—	1 mg/L	0.5 mg/L	1 mg/L
	Butyric	107-92-6	—	1 mg/L	0.5 mg/L	1 mg/L
	Lactic	79-33-4	—	1 mg/L	0.5 mg/L	1 mg/L
	Propionic	79-09-4	—	1 mg/L	0.5 mg/L	1 mg/L
Total Dissolved Solids (TDS)/160.1	Total Dissolved Solids	—	—	20 mg/L	20 mg/L	20 mgL
Total Organic Carbon/415.1	Total Organic Carbon	—	—	1 mg/L	0.5 mg/L	1 mg/L
Metals/6010B	Dissolved Iron	7439-89-6	—	0.2 mg/L	0.04 mg/L	0.2 mg/L

TABLE B2.1 (Continued)

REFERENCE LIMITS TABLE – GROUNDWATER/ SOIL VAPOR
QAPP WORKSHEET #15 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 2.8.1)
Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70 Naval Weapons Station Seal Beach
Seal Beach, California

ANALYTICAL GROUP	ANALYTE	CAS NUMBER	TARGET CLEANUP GOAL[1]	PROJECT QUANTITATION LIMIT GOAL[2]	ANALYTICAL METHOD MDLs[3]	ANALYTICAL METHOD QLs[3]
	Dissolved Manganese	7439-96-5	—	0.2 mg/L	0.04 mg/L	0.2 mg/L
	Dissolved Arsenic	7440-38-2	—	0.2 mg/L	0.04 mg/L	0.2 mg/L
DHG/RSK 175	Ethane	74-84-0	—	2 µg/L	0.6 µg/L	2 µg/L
	Ethene	74-85-1	—	2 µg/L	0.6 µg/L	2 µg/L
	Methane	74-82-8	—	2 µg/L	0.6 µg/L	2 µg/L
Sulfide/376.2	Hydrogen Sufide	18496-25-8	—	1 mg/L	0.4 mg/L	1 mg/L
Dhc/Gene-Trac-VCr[3]	*Dehalococcoides* possessing the vinyl chloride reductase enzyme	—	—	4.3×10^3 gene copies/L	10^3 gene copies/L	4.3×10^3 gene copies/L
25C	Soil Vapor – Methane	74-82-8	—	0.50 ppm	0.19 ppm	0.50 ppm
ASTM D5504	Soil Vapor – Hydrogen Sulfide	7783-06-4	—	1000 ppm	400 ppm	1000 ppm

Notes: [1] Target Cleanup Goal (TGL) based on Federal surface water quality criteria (40 C.F.R. § 131.36), referred to as the National Toxics Rule (NTR) criteria; consistent with California Toxics Rule (CTR); consistent with project ARARs
[2] The Analytical Method MDLs and QLs listed are those that can be routinely achieved by the analytical laboratory, upon laboratory selection this table will be updated to reflect the actual QLs and MDLs provided by the laboratory.
[3] Analysis of *Dhc*/VCr by molecular genetic probe method (SiREM method [non-EPA])

ASTM – American Society of Testing and Materials
$CaCO_3$ – calcium carbonate
CAS – Chemical Abstracts Service
CVOCs – chlorinated volatile organic compounds
Dhc/VCr – Dehalococcoides Vinyl Chloride Reductase Gene
DHG – dissolved hydrocarbon gases
DOC – dissolved organic carbon

TABLE B2.1 (Continued)

REFERENCE LIMITS TABLE – GROUNDWATER/ SOIL VAPOR
QAPP WORKSHEET #15 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 2.8.1)
Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70 Naval Weapons Station Seal Beach
Seal Beach, California

Fe^{2+} – ferrous iron (dissolved)
L – liter
MDL – method detection limit
mg/L – milligram per liter
ppm – parts per million
QL – quantitation limit
RSK 175 – ASTM standard method
TDS – total dissolved solids
VCr – vinyl chloride reductase enzyme
VOC – volatile organic compound (includes CVOCs)
µg/L – microgram per liter
— Not listed or not applicable

TABLE B2.2

PERSONNEL RESPONSIBILITIES ASSOCIATED WITH SAMPLING

QAPP WORKSHEET #7 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 2.4.3)

Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

POSITION	RESPONSIBILITY
NFEC-SW Quality Assurance Officer (QAO)	Provides governmental oversight of the Contractor QA Program Provides quality-related directives through Contracting Officer's Technical Representative Provides technical and administrative oversight of Contractor surveillance audit activities Serves as point-of-contact for all matters concerning QA and the Navy's Laboratory QA Program Coordinates training on matters pertaining to generation and maintenance of data quality Has the authority to suspend project execution if QA requirements are not adequately followed
NFEC-SW Environmental Business Line Team Lead	Responsible for overall project execution and coordination of all members of project team, including NFEC-SW QAO, Contractor Project Manager, Contractor QAO, and base personnel Reviews SAP Has the authority to suspend site or project activities if QA requirements are not fulfilled
Contractor QAO	Reviews and approves SAP Develops project QA process Supervises or performs audits of projects for compliance with program procedures and specifications Has the authority to suspend site or project activities if quality standards are not maintained Maintains primary contact with NFEC-SW QAO
Project Manager	Develops SAP Selects qualified subcontract laboratories Implements chemical data QC procedures and audits field performance Reviews laboratory data prior to use Coordinates independent validation of laboratory data Reviews the data validation report Prepares and supports report preparation

TABLE B2.2

PERSONNEL RESPONSIBILITIES ASSOCIATED WITH SAMPLING

QAPP WORKSHEET #7 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 2.4.3)

Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

POSITION	RESPONSIBILITY
Database/GIS/CADD	Provides oversight for management of project database
Field Team Managers	Performs all sampling in accordance with the approved SAP Ensures that field QA/QC samples are collected as specified in the SAP Completes field sampling notes, forms, and sample logs Coordinates laboratory and field sampling activities Implements corrective action as required

Notes:
CADD – computer aided digital design
GIS – geographic information system
NFEC-SW – Naval Facilities Engineering Command Southwest
QA – quality assurance
QAO – Quality Assurance Officer
QC – quality control
SAP – Sampling and Analysis Plan

TABLE B2.3

SUMMARY OF ANALYTES

Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

ANALYTE	INFORMATION OBTAINED FROM ANALYTE	MONITORING PROGRAM
Volatile Organic Compounds	• Quantify degradation of target chlorinated volatile compounds	PMW, MNA, POC
Dissolved Hydrocarbon Gases (ethene, ethane, methane)	• Ethene and ethane are complete degradation products; secondary indicators of degradation of target compounds • Methane indicator of reducing conditions; health and safety issue	PMW, MNA, POC
Dissolved Iron/Manganese/Arsenic	• Secondary groundwater quality parameters; may be mobilized due to inducement of reducing conditions in groundwater	PMW, POC
Inorganic Anions	• Declining nitrate/nitrite and sulfate concentrations indicative of reducing conditions • Bromide used for tracer testing • Increasing chloride concentrations is an indicator of reduction of chlorinated VOCs	PMW, POC
Total Dissolved Solids (TDS)	• Bioremediation performance indicator	PMW, POC
Alkalinity	• Water quality indicator	PMW, POC
Dissolved Hydrogen Sulfide	• Indicator of sulfate reduction; health and safety issue if it forms hydrogen sulfide	PMW, POC
Total Organic Compounds (TOC)	• Qualitative indicator of presence of electron donor	PMW, POC
Volatile Fatty Acids (acetic, butyric, lactic, propionic)	• Breakdown products of the electron donor; qualitative indicator of presence of electron donor	PMW, POC
Dehalococcoides (*Dhc/VCr*)	• Measures levels of *Dehalococcoides Vinyl Chloride Reductase Gene* group of bacteria responsible for degradation of cDCE and VC to ethane • Indicator of bioaugmented culture growth and persistence	PMW, MNA
Depth to Water	• Monitor fluctuations of the water table to track groundwater flow direction	PMW, MNA, POC
Field Parameters (pH, DO, ORP, spc, turbidity, temperature)	• DO and ORP are measures of anaerobic conditions; other parameters are monitored to ensure there is no negative effect on secondary groundwater chemistry	PMW, MNA, POC
Soil Vapor - Methane	• Health and Safety	SV
Soil Vapor - Hydrogen Sulfide	• Health and Safety	SV

Acronyms/Abbreviations
cDCE- cis-1,2-dichloroethene
D*hc/VCr- Dehalococcoides* Vinyl Chloride Reductase Gene
DO- dissolved oxygen
MNA- monitored natural attenuation
ORP- oxidation reduction potential
PMW- performance monitoring well
POC- point of compliance
spc- specific conductance
VC- vinyl chloride
TDS - total dissolved solids
SV - Soil vapor
TOC - total organic complounds

TABLE B2.4

SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE FOR THREE YEARS

QAPP WORKSHEET #18 - NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 3.1.1)

Installation Restoration Site 70, Naval Weapons Station Seal Beach, Seal Beach, CA

Sampling Locations	Matrix	Depth (Ft bgs)	FP[1]	VOCs[2]	DHGs[3]	Anions/TDS/ Alkalinity[4]	VFAs[5]	TOC[6]	DHC[7]	SV[8]	Sulfide[9]	Diss. Metals[10]	Number of Samples [(a)]	Sampling SOP Reference
MW-70-PMW01A	GW	25-35	√	√	√	√	√	√					9	SOP 3
MW-70-PMW01B	GW	45-55	√	√	√	√	√	√					9	SOP 3
MW-70-27	GW	25-35							√				9	SOP 3
MW-70-28	GW	50-60							√				9	SOP 3
MW-70-MNA01	GW	40-50	√	√	√				√				3	SOP 3
MW-70-MNA02	GW	35-45	√	√	√								3	SOP 3
MW-70-MNA03	GW	35-45	√	√	√								3	SOP 3
MW-70-MNA04	GW	35-45	√	√	√								3	SOP 3
SV-70-01	SV	5								√			9	SOP 3
SV-70-02	SV	5								√			9	SOP 3
SV-70-03	SV	5								√			9	SOP 3
SV-70-04	SV	5								√			9	SOP 3
SV-70-05	SV	5								√			9	SOP 3
SV-70-06	SV	5								√			9	SOP 3
SV-70-07	SV	5								√			9	SOP 3
SV-70-08	SV	5								√			9	SOP 3
SV-70-09	SV	5								√			9	SOP 3
SV-70-10	SV	5								√			9	SOP 3
SV-70-11	SV	5								√			9	SOP 3
SV-70-12	SV	5								√			9	SOP 3
MW-70-PMW02A	GW	70.5-80.5	√	√	√	√	√	√			√	√	7	SOP 3
MW-70-PMW02B	GW	90-100	√	√	√	√	√	√			√	√	7	SOP 3
IW-70-SAB06	GW	65-80, 85-105	√	√	√	√	√	√	√				9	SOP 3
MW-70-MNA05	GW	70-80	√	√	√								3	SOP 3
MW-70-PMW03A	GW	70-80	√	√	√	√	√	√			√	√	9	SOP 3
MW-70-PMW03B	GW	90-100	√	√	√	√	√	√			√	√	9	SOP 3
MW-70-38	GW	80-100	√	√	√	√	√	√			√	√	7	SOP 3
IW-70-FSB118	GW	60-105	√	√	√	√	√	√	√				9	SOP 3
MW-70-PMW04A	GW	70-80	√	√	√	√	√	√			√	√	7	SOP 3
MW-70-PMW04B	GW	90-100	√	√	√	√	√	√			√	√	7	SOP 3
MW-70-PMW05A	GW	70-80	√	√	√	√	√	√			√	√	7	SOP 3
MW-70-PMW05B	GW	90-100	√	√	√	√	√	√			√	√	7	SOP 3
MW-70-PMW06A	GW	69.5-79.5	√	√	√	√	√	√			√	√	7	SOP 3
MW-70-PMW06B	GW	91-101	√	√	√	√	√	√			√	√	7	SOP 3
IW-70-FSB108	GW	60-105	√	√	√	√	√	√	√				9	SOP 3
RDO-5	GW	65-105	√	√	√				√				3	SOP 3
MW-70-MNA06	GW	80-90	√	√	√								3	SOP 3
MW-70-MNA07	GW	90-100	√	√	√				√				3	SOP 3
MW-70-MNA08	GW	80-90	√	√	√				√				3	SOP 3
MW-70-MNA11	GW	80-90	√	√	√								3	SOP 3

TABLE B2.4

SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE FOR THREE YEARS

QAPP WORKSHEET #18 - NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 3.1.1)

Installation Restoration Site 70, Naval Weapons Station Seal Beach, Seal Beach, CA

Sampling Locations	Matrix	Depth (Ft bgs)	FP[1]	VOCs[2]	DHGs[3]	Anions/TDS/ Alkalinity[4]	VFAs[5]	TOC[6]	DHC[7]	SV[8]	Sulfide[9]	Diss. Metals[10]	Number of Samples [(a)]	Sampling SOP Reference
MW-70-PMW07A	GW	65-75	√	√	√	√	√	√			√	√	7	SOP 3
MW-70-PMW07B	GW	85-95	√	√	√	√	√	√			√	√	7	SOP 3
IW-70-FSB216	GW	65-100	√	√	√	√	√	√	√				9	SOP 3
MW-70-PMW08A	GW	65-75	√	√	√	√	√	√			√	√	9	SOP 3
MW-70-PMW08B	GW	85-95	√	√	√	√	√	√			√	√	9	SOP 3
MW-70-MNA09	GW	64.25-74.25	√	√	√				√				3	SOP 3
MW-70-MNA10	GW	74.5-84.5	√	√	√				√				3	SOP 3
MW-70-MNA12	GW	75-85	√	√	√				√				3	SOP 3
MW-70-PMW09	GW	120-130	√	√	√	√	√	√			√	√	7	SOP 3
IW-70-SHB113	GW	105-130	√	√	√	√	√	√	√				9	SOP 3
MW-70-PMW10	GW	120-130	√	√	√	√	√	√			√	√	7	SOP 3
IW-70-SHB217	GW	105-130	√	√	√				√				3	SOP 3
MW-70-MNA13	GW	115-125	√	√	√								3	SOP 3
MW-70-PMW11A	GW	85-95	√	√	√	√	√	√			√	√	7	SOP 3
MW-70-PMW11B	GW	115-125	√	√	√	√	√	√			√	√	7	SOP 3
IW-70-SHB310	GW	80-95, 105-130	√	√	√	√	√	√	√				9	SOP 3
MW-70-PMW12A	GW	85-95	√	√	√	√	√	√			√	√	7	SOP 3
MW-70-PMW12B	GW	115-125	√	√	√	√	√	√			√	√	7	SOP 3
MW-70-MNA14	GW	115-125	√	√	√				√				3	SOP 3
MW-70-PMW13A	GW	125-135	√	√	√	√	√	√			√	√	7	SOP 3
MW-70-PMW13B	GW	145-155	√	√	√	√	√	√			√	√	7	SOP 3
IW-70-SSB109	GW	125-165	√	√	√	√	√	√	√				9	SOP 3
MW-70-PMW14A	GW	128-138	√	√	√	√	√	√			√	√	9	SOP 3
MW-70-PMW14B	GW	149-159	√	√	√	√	√	√			√	√	9	SOP 3
MW-70-MNA15	GW	140-150	√	√	√				√				3	SOP 3
MW-70-MNA16	GW	140.5-150.5	√	√	√				√				3	SOP 3
MW-70-MNA17	GW	140-150	√	√	√								3	SOP 3
MW-70-15	GW	160-170	√	√	√								3	SOP 3
MW-70-02	GW	20-30	√	√	√	√	√	√			√	√	3	SOP 3
MW-70-10	GW	30-40	√	√	√	√	√	√			√	√	3	SOP 3
MW-70-17	GW	30-40	√	√	√	√	√	√			√	√	3	SOP 3
MW-70-22	GW	20-30	√	√	√	√	√	√			√	√	3	SOP 3
MW-70-POC01	GW	80-90	√	√	√	√	√	√			√	√	3	SOP 3
MW-70-11	GW	80-100	√	√	√	√	√	√			√	√	3	SOP 3
MW-70-35	GW	90-100	√	√	√	√	√	√			√	√	3	SOP 3
MW-70-16	GW	95-105	√	√	√	√	√	√			√	√	3	SOP 3
MW-70-23	GW	110-130	√	√	√	√	√	√			√	√	3	SOP 3
MW-70-36	GW	150-160	√	√	√	√	√	√			√	√	3	SOP 3
MW-70-21	GW	150-170	√	√	√	√	√	√			√	√	3	SOP 3
MW-70-POC02	GW	190-200	√	√	√	√	√	√			√	√	3	SOP 3

TABLE B2.4

SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE FOR THREE YEARS

QAPP WORKSHEET #18 - NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 3.1.1)
Installation Restoration Site 70, Naval Weapons Station Seal Beach, Seal Beach, CA

Sampling Locations	Matrix	Depth (Ft bgs)	FP[1]	VOCs[2]	DHGs[3]	Anions/TDS/ Alkalinity[4]	VFAs[5]	TOC[6]	DHC[7]	SV[8]	Sulfide[9]	Diss. Metals[10]	Number of Samples [(a)]	Sampling SOP Reference
MW-70-POC03	GW	190-200	√	√	√	√	√	√			√	√	3	SOP 3
MW-70-POC04	GW	190-200	√	√	√	√	√	√			√	√	3	SOP 3

Notes

[1] FP - Field Parameters - pH, dissolved oxygen, oxidation-reduction potential, specific conductance, temperature, turbidity, and depth to water
[2] VOCs - Volatile Organic Compounds (EPA Method 8260B)
[3] DHGs - Dissolved Hydrocarbon Gases (i.e. methane, ethene, and ethane)
[4] Anions analyzed - chloride, sulfate, nitrate, and nitrite
[5] VFAs - Volatile Fatty Acids
[6] TOC - Total Organic Carbon.
[7] DNA Assay for *Dehalococcoides* Vinyl Chloride Reductase Gene (*Dhc/VCr*)
[8] Soil vapor analyzed for hydrogen sulfide and methane
[9] Total Sulfides
[10] Dissolved Metals include iron, manganese, and arsenic

[a] Number of samples include:

9 samples = Baseline (1) + 4 qtrs the first year (4) + 2 yrs semi-annual sampling (4)
7 samples = Baseline (1) + three semi-annual sampling events (6)
3 samples = Baseline (1) sampling the first year + 2 annual sampling events (2)

√ indicates that a sample is to be collected
DHC - *Dehalococcoides*
FSB - First Sand Biobarrier
Ft bgs - feet below ground surface
GW - Groundwater
IW - Injection Well
MNA - Monitored Natural Attenuation
MW - Monitoring Well
PMW - Performance Monitoring Well
POC - Point of Compliance
SAB - Source Area Biobarrier
SHB - Shell Horizon Biobarrier
SOP - Standard Operating Procedure
SSB - Second Sand Biobarrier
SV - Soil Vapor
TOC - Total Organic Carbon
TDS - Total Dissolved Solids

TABLE B2.5

Geosyntec consultants

SUMMARY OF MONITORING PROGRAM
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

Zone	Targeted Unit	Treatment Area	Monitoring Locations [a]	Screened Intervals [b]	Function of Well in Monitoring Program				Rationale for Well Selection
					PMW [c]	MNA	POC	Baseline	
Source	Upper Fines	Grid Treatment	MW-70-PMW01A	25 to 35 ft bgs	✓			✓	Located in area of elevated [TCE] (4 mg/L), possible DNAPL
			MW-70-PMW01B	45 to 55 ft bgs	✓			✓	
			MW-70-27	25 to 35 ft bgs	✓			✓	Located in very high concentration zone, likely DNAPL present
			MW-70-28	50 to 60 ft bgs	✓			✓	High Concentration Area
			MW-70-MNA01	40 to 50 ft bgs		✓		✓	Monitor MNA of higher [TCE] to assess need for contingency, sentinel well for monitoring plume migration
			MW-70-MNA02	35 to 45 ft bgs		✓		✓	Sentinel wells for monitoring plume migration and evaluate MNA
			MW-70-MNA03	35 to 45 ft bgs		✓		✓	
			MW-70-MNA04	35 to 45 ft bgs		✓		✓	
		Soil Vapor Probes	SV-70-01	5 to 6 ft bgs	✓			✓	Monitor methane and hydrogen sulfide production levels
			SV-70-02	5 to 6 ft bgs	✓			✓	
			SV-70-03	5 to 6 ft bgs	✓			✓	
			SV-70-04	5 to 6 ft bgs	✓			✓	
			SV-70-05	5 to 6 ft bgs	✓			✓	
			SV-70-06	5 to 6 ft bgs	✓			✓	
			SV-70-07	5 to 6 ft bgs	✓			✓	
			SV-70-08	5 to 6 ft bgs	✓			✓	
			SV-70-09	5 to 6 ft bgs	✓			✓	
			SV-70-10	5 to 6 ft bgs	✓			✓	
			SV-70-11	5 to 6 ft bgs	✓			✓	
			SV-70-12	5 to 6 ft bgs	✓			✓	
		Point of Compliance	MW-70-02	20 to 30 ft bgs			✓	✓	Upgradient Point of Compliance
			MW-70-10	30 to 40 ft bgs			✓	✓	Crossgradient Point of Compliance
			MW-70-17	30 to 40 ft bgs			✓	✓	
			MW-70-22	20 to 30 ft bgs			✓	✓	Downgradient Point of Compliance

TABLE B2.5

Geosyntec consultants

SUMMARY OF MONITORING PROGRAM
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

Zone	Targeted Unit	Treatment Area	Monitoring Locations [a]	Screened Intervals [b]	Function of Well in Monitoring Program				Rationale for Well Selection
					PMW [c]	MNA	POC	Baseline	
Source	First Sand	Biobarrier SAB-1	MW-70-PMW02A	70 to 80 ft bgs	✓			✓	Upgradient wells for monitoring concentration influx into biobarrier
			MW-70-PMW02B	90 to 100 ft bgs	✓			✓	
			MW-70-PMW03A	70 to 80 ft bgs	✓			✓	Downgradient from biobarrier, to evaluate concentrations leaving biobarrier
			MW-70-PMW03B	90 to 100 ft bgs	✓			✓	
			MW-70-MNA05	70 to 80 ft bgs		✓		✓	Sentinel well for monitoring plume migration and evaluate MNA
			IW-70-SAB06	60 to 105 ft bgs	✓			✓	Within biobarrier, provides EISB performance data
Plume	First Sand	Biobarrier FSB-1	MW-70-38	80 to 100 ft bgs	✓			✓	Upgradient well for monitoring concentration influx into biobarrier
			IW-70-FSB118	60 to 105 ft bgs	✓			✓	Within biobarrier, provides performance data along plume core
			MW-70-PMW06A	70 to 80 ft bgs	✓			✓	Downgradient from biobarrier, to evaluate concentrations leaving biobarrier in plume core
			MW-70-PMW06B	90 to 100 ft bgs	✓			✓	
			MW-70-PMW04A	70 to 80 ft bgs	✓			✓	Upgradient well for monitoring concentration influx into biobarrier
			MW-70-PMW04B	90 to 100 ft bgs	✓			✓	
			IW-70-FSB108	60 to 105 ft bgs	✓			✓	Within biobarrier, provides performance data in lower [TCE] area
			MW-70-PMW05A	70 to 80 ft bgs	✓			✓	Downgradient from biobarrier, to evaluate concentrations leaving biobarrier in plume
			MW-70-PMW05B	90 to 100 ft bgs	✓			✓	
			RDO-5	65 to 105 ft bgs		✓		✓	Evaluate MNA of plume
			MW-70-MNA08	80 to 90 ft bgs		✓		✓	
			MW-70-MNA07	80 to 90 ft bgs		✓		✓	
			MW-70-MNA06	80 to 90 ft bgs		✓		✓	Sentinel wells for monitoring plume migration and evaluate MNA
			MW-70-MNA11	80 to 90 ft bgs		✓		✓	
		Biobarrier FSB-2	MW-70-PMW07A	65 to 75 ft bgs	✓			✓	Upgradient wells for monitoring concentration influx into biobarrier
			MW-70-PMW07B	85 to 95 ft bgs	✓			✓	
			IW-70-FSB216	65 to 100 ft bgs	✓			✓	Within biobarrier, provides performance data along plume core
			MW-70-PMW08A	65 to 75 ft bgs	✓			✓	Downgradient wells for monitoring concentrations leaving biobarrier
			MW-70-PMW08B	85 to 95 ft bgs	✓			✓	
			MW-70-MNA09	75 to 85 ft bgs		✓		✓	Sentinel well for monitoring plume migration and monitor MNA
			MW-70-MNA10	75 to 85 ft bgs		✓		✓	Evaluate MNA of plume
			MW-70-MNA12	75 to 85 ft bgs		✓		✓	
		Point of Compliance	MW-70-POC01	80 to 90 ft bgs			✓	✓	Upgradient point of compliance
			MW-70-11	80 to 100 ft bgs			✓	✓	Crossgradient point of compliance
			MW-70-35	90 to 100 ft bgs			✓	✓	
			MW-70-16	95 to 105 ft bgs			✓	✓	Downgradient point of compliance

TABLE B2.5

Geosyntec consultants

SUMMARY OF MONITORING PROGRAM
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

Zone	Targeted Unit	Treatment Area	Monitoring Locations [a]	Screened Intervals [b]	Function of Well in Monitoring Program				Rationale for Well Selection
					PMW [c]	MNA	POC	Baseline	
Plume	Shell Horizon	Biobarrier SHB-1	MW-70-PMW09	115 to 125 ft bgs	✓			✓	Upgradient well for monitoring concentration influx into biobarrier
			IW-70-SHB113	105 to 130 ft bgs	✓			✓	Within biobarrier, provides performance data along plume core
			MW-70-PMW10	115 to 125 ft bgs	✓			✓	Downgradient from biobarrier, to evaluate concentrations leaving biobarrier
			IW-70-SHB-217	115 to 125 ft bgs		✓		✓	Evaluate MNA of plume
			MW-70-MNA13	115 to 125 ft bgs		✓		✓	Sentinel well for monitoring plume migration and evaluate MNA
		Biobarrier SHB-3	MW-70-PMW11A	85 to 95 ft bgs	✓			✓	Upgradient wells for monitoring concentration influx into biobarrier
			MW-70-PMW11B	115 to 125 ft bgs	✓			✓	
			IW-70-SHB310	80-95, 105 to 130 ft bgs	✓			✓	Within biobarrier, provides performance data along plume core
			MW-70-PMW12A	85 to 95 ft bgs	✓			✓	Downgradient from biobarrier, to evaluate concentrations leaving biobarrier
			MW-70-PMW12B	115 to 125 ft bgs	✓			✓	
			MW-70-MNA14	115 to 125 ft bgs		✓		✓	Evaluate MNA of plume
	Second Sand	Biobarrier SSB-1	MW-70-PMW13A	130 to 140 ft bgs	✓			✓	Upgradient wells for monitoring concentration influx into biobarrier
			MW-70-PMW13B	150 to 160 ft bgs	✓			✓	
			IW-70-SSB109	125 to 165 ft bgs	✓			✓	Within biobarrier, provides performance data along plume core
			MW-70-PMW14A	130 to 140 ft bgs	✓			✓	Downgradient from biobarrier, to evaluate concentrations leaving biobarrier
			MW-70-PMW14B	150 to 160 ft bgs	✓			✓	
			MW-70-MNA15	140 to 150 ft bgs		✓		✓	Evaluate MNA of plume
			MW-70-MNA16	140 to 150 ft bgs		✓		✓	
			MW-70-MNA17	140 to 150 ft bgs		✓		✓	Sentinel wells for monitoring plume migration and evaluate MNA
			MW-70-15	160 to 170 ft bgs		✓		✓	
	Second Sand	Point of Compliance	MW-70-23	110 to 130 ft bgs			✓	✓	Crossgradient point of compliance
			MW-70-36	150 to 160 ft bgs			✓	✓	
			MW-70-21	150 to 170 ft bgs			✓	✓	Downgradient point of compliance
	Deep Sand	Point of Compliance	MW-70-POC02	190 to 200 ft bgs			✓	✓	Crossgradient point of compliance
			MW-70-POC03	190 to 200 ft bgs			✓	✓	
			MW-70-POC04	190 to 200 ft bgs			✓	✓	Downgradient point of compliance

Notes:

[a] Monitoring well locations may be found on Figure B1.3 (SA Source Area), B1.4 (FS First Sand Unit), B1.5 (SH Shell Horizon), and B1.6 (SS Second Sand Unit). Point of compliance well locations may be found on Figure B2.2.

[b] Screen intervals are based on as built/proposed well constructions completed/proposed September 2007 consistent with injection well screens, and may be modified as necessary in the field.

[c] PMW wells will be used to evaluate the ongoing effectiveness of the EISB program and evaluate the need for biobarrier maintenance, including EVO reinjections, rebioaugmentation, etc.

Acronyms/Abbreviations:

DNAPL- dense non-aqeous phase liquid
EISB – enhanced in situ bioremediation
EVO – emulsified vegetable oil
ft bgs – feet below ground surface
FSB - first sand biobarrier
IW - injection well
mg/l - milligrams per liter
MNA – monitored natural attenuation
MW - monitoring well
PMW – performance monitoring well
POC – point of compliance
SAB - source area biobarrier
SHB - shell horizon biobarrier
SSB - second sand biobarrier
SV - soil vapor
[TCE] – trichloroethene concentrations

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Geosyntec consultants

TABLE B2.6

TENTATIVE SAMPLING SCHEDULE FOR FIRST THREE YEARS OF OPERATION

Remedial Action Sampling and Analysis Plan - Installation Restoration Site 70 Naval Weapons Station Seal Beach - Seal Beach, California

ZONE	TREATMENT AREA	MONITORING WELL	EVENT	BASELINE										QUARTERLY (Year One Only)							SEMI-ANNUALLY										ANNUALLY				
			Well Function	FP [1]	VOCs [2]	DHGs [3]	Anions//TDS/Alk [4]	VFAs [5]	TOC [6]	Dhc/VCr [7]	SV [8]	Sulfide [9]	Dissolved Metals [10]	FP [1]	VOCs [2]	DHGs [3]	Anions//TDS/Alk [4]	VFAs [5]	TOC [6]	SV [8]	FP [1]	VOCs [2]	DHGs [3]	Anions//TDS/Alk [4]	VFAs [5]	TOC [6]	Dhc/VCr [7]	SV [8]	Sulfide [9]	Dissolved Metals [10]	FP [1]	VOCs [2]	DHGs [3]	Dhc/VCr [7]	SV [8]
Source Area	Grid Treatment	MW-70-PMW01A	PMW	√	√	√	√	√	√					√	√	√	√	√	√		√	√	√	√	√	√									
		MW-70-PMW01B	PMW	√	√	√	√	√	√					√	√	√	√	√	√		√	√	√	√	√	√									
		MW-70-27	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-28	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-MNA01	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA02	MNA	√	√	√																									√	√	√		
		MW-70-MNA03	MNA	√	√	√																									√	√	√		
		MW-70-MNA04	MNA	√	√	√																									√	√	√		
	Soil Vapor Probes	SV-70-01	SV								√									√															√
		SV-70-02	SV								√									√															√
		SV-70-03	SV								√									√															√
		SV-70-04	SV								√									√															√
		SV-70-05	SV								√									√															√
		SV-70-06	SV								√									√															√
		SV-70-07	SV								√									√															√
		SV-70-08	SV								√									√															√
		SV-70-09	SV								√									√															√
		SV-70-10	SV								√									√															√
		SV-70-11	SV								√									√															√
		SV-70-12	SV								√									√															√
	Source Biobarrier	MW-70-PMW02A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW02B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-SAB06	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-MNA05	MNA	√	√	√																									√	√	√		
		MW-70-PMW03A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW03B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
Plume	Biobarrier FS-1	MW-70-38	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-FSB118	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW06A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW06B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW04A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW04B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-FSB108	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW05A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW05B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		RDO-5	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA08	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA06	MNA	√	√	√																									√	√	√		
		MW-70-MNA11	MNA	√	√	√																									√	√	√		
		MW-70-MNA07	MNA	√	√	√																									√	√	√	√	
	Biobarrier FS-2	MW-70-PMW07A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW07B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-FSB216	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW08A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW08B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-MNA09	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA10	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA12	MNA	√	√	√																									√	√	√	√	
	Biobarrier SH-1	MW-70-PMW09	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-SHB113	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW10	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-SHB217	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA13	MNA	√	√	√																									√	√	√		

TABLE B2.6

Geosyntec consultants

TENTATIVE SAMPLING SCHEDULE FOR FIRST THREE YEARS OF OPERATION

ZONE	TREATMENT AREA	MONITORING WELL	EVENT	BASELINE										QUARTERLY (Year One Only)							SEMI-ANNUALLY										ANNUALLY				
			Well Function	FP [1]	VOCs [2]	DHGs [3]	Anions//TDS/Alk [4]	VFAs [5]	TOC [6]	Dhc/VCr [7]	SV [8]	Sulfide [9]	Dissolved Metals [10]	FP [1]	VOCs [2]	DHGs [3]	Anions//TDS/Alk [4]	VFAs [5]	TOC [6]	SV [8]	FP [1]	VOCs [2]	DHGs [3]	Anions//TDS/Alk [4]	VFAs [5]	TOC [6]	Dhc/VCr [7]	SV [8]	Sulfide [9]	Dissolved Metals [10]	FP [1]	VOCs [2]	DHGs [3]	Dhc/VCr [7]	SV [8]
Plume	Biobarrier SH-3	MW-70-PMW11A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW11B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-SHB310	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW12A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW12B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-MNA14	MNA	√	√	√																									√	√	√	√	
	Biobarrier SS-1	MW-70-PMW13A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW13B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		IW-70-SSB109	PMW	√	√	√	√	√	√	√				√	√	√	√	√	√		√	√	√	√	√	√	√								
		MW-70-PMW14A	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-PMW14B	PMW	√	√	√	√	√	√			√	√								√	√	√	√	√	√			√	√					
		MW-70-MNA16	MNA	√	√	√																									√	√	√	√	
		MW-70-MNA17	MNA	√	√	√																									√	√	√		
		MW-70-MNA15	MNA	√	√	√																									√	√	√	√	
		MW-70-15	MNA	√	√	√																									√	√	√		
Point of Compliance Wells	Upper Fines	MW-70-02	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-10	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-17	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-22	POC	√	√	√	√	√	√			√	√																		√	√			
	First Sand	MW-70-POC01	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-11	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-35	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-16	POC	√	√	√	√	√	√			√	√																		√	√			
	Second Sand	MW-70-23	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-36	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-21	POC	√	√	√	√	√	√			√	√																		√	√			
	Deep Sand	MW-70-POC02	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-POC03	POC	√	√	√	√	√	√			√	√																		√	√			
		MW-70-POC04	POC	√	√	√	√	√	√			√	√																		√	√			

Notes

[1] FP - Field Parameters - pH, dissolved oxygen, oxidation-reduction potential, specific conductance, temperature, turbidity, and depth to water.

[2] VOCs are Chlorinated Volatile Organic Compounds (EPA Method 8260B).

[3] DHGs are Dissolved Hydrocarbon Gases (i.e. methane, ethene and ethane).

[4] Anions to be analyzed for are chloride, sulfate, nitrate and nitrite.

[5] Volatile Fatty Acids (VFAs).

[6] Total Organic Carbon (TOC).

[7] DNA Assay for *Dehalococcoides* Vinyl Chloride Reductase Gene (*Dhc/VCr*).

[8] Soil vapor analyzed for hydrogen sulfide and methane

[9] Total dissolved sulfide.

[10] Dissolved Metals include iron, manganese and arsenic.

√ indicates that indicates that a sample is to be collected.

FS - First Sand
FSB - First Sand Biobarrier
MNA - Monitoring Natural Attenuation Well
MW - Monitoring Well
PMW - Performance Monitoring Well
POC - Point of Compliance Well
TDS - Total dissolved solids

SAB - Source Area Biobarrier
SH - Shell Horizon
SHB - Shell Horizon Biobarrier
SS - Second Sand
SSB - Second Sand Biobarrier
SV - Soil Vapor

TDS - Total Dissolved Solids

TABLE B2.7

SUMMARY OF ADVISORY QC REQUIREMENTS AND CORRECTIVE ACTION FOR GC/MS METHODS

QAPP WORKSHEET #24 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 3.2.2)

Remedial Action Sampling and Analysis Plan

Installation Restoration Site 70 Naval Weapons Station Seal Beach

Seal Beach, California

QC CHECK	MINIMUM FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Five-point initial calibration for target analytes.	Initial calibration prior to sample analysis.	The minimum average SPCC RF for Chloromethane, 1,1-Dichloroethane, and Bromoform is 0.1; for Chlorobenzene and 1,1,2,2-Tetrachloroethane is 0.30. 8260B: RSD is less than or equal to 15% for target analytes, and is less than or equal to 30% for CCC[1]. 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 analyzes of a QC check sample.	Once.	QC acceptance criteria per method's requirements.	Re-calculate results; locate and fix the problem, re-run demonstration of those analytes that did not meet acceptance criteria.
Check of mass spectral ion intensities (tuning procedure) using BFB (8260B).	Prior to initial calibration and calibration verification.	Must meet the method's requirements before samples are analyzed.	Re-tune 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.

TABLE B2.7 (Continued)

SUMMARY OF ADVISORY QC REQUIREMENTS AND CORRECTIVE ACTION FOR GC/MS METHODS

QAPP WORKSHEET #24 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 3.2.2)

Remedial Action Sampling and Analysis Plan

Installation Restoration Site 70 Naval Weapons Station Seal Beach

Seal Beach, California

Method blank.	One per analytical batch (8260B).	No analytes detected above the QL.	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 analytical/preparation batch (1 per 20 sample minimum).	Laboratory established QC acceptance criteria. Advisory recovery limits: 75-125%.	None.
LCS or LCS/LCSD pair if there is not enough sample for MS/MSD.	One LCS or LCS/LCSD per analytical/preparation batch.	Laboratory established QC acceptance criteria. Advisory recovery limits: 75-125%.	Correct problem, then re-extract and re-analyze the LCS (LCS/LCSD) and all associated batch samples.

Notes:

BFB – 4-bromofluorobenzene (GC/MS tuning standard)

CCC – continuing calibration check

GC/MS – gas chromatography/ mass spectroscopy

LCS – laboratory control sample

LCSD – laboratory control sample duplicate

MS/MSD – matrix spike/matrix spike duplicate

QC – quality control

QL – quantitation limit

RF – response factor

RSD – relative standard deviation

SPCC – system performance check compound

[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 >0.995.

TABLE B2.8

SUMMARY OF ADVISORY QC REQUIREMENTS AND CORRECTIVE ACTION FOR INORGANIC ANALYSIS

QAPP WORKSHEET #24 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 3.2.2)

Remedial Action Sampling and Analysis Plan

Installation Restoration Site 70 Naval Weapons Station Seal Beach

Seal Beach, California

QC CHECK	MINIMUM FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Initial five-point calibration (IC) and a blank.	Initial calibration prior to 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 QL.	Prepare and analyze the blank again, re-calibrate 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.	Re-calculate results; locate and fix the problem, re-run demonstration of those analytes that did not meet acceptance criteria.
MDL study (water only).	Once per 12 month period.	MDL will be below the QL.	Correct problem, repeat the MDL study.
Method blank.	One per preparation batch.	No analytes detected above the QL.	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 (1 per 20 sample minimum).	Advisory recovery limits 75-125%.	None.
Sample duplicate (SD) or MS/MSD pair	One SD or MS/MSD pair conducted on Navy samples per each preparation batch.	20% RPD for water; Advisory recovery limits 75-125%.	None.
LCS or LCS/LCSD pair if there is not enough sample for MS/MSD or SD.	One LCS or LCS/LCSD pair per each preparation batch.	20% RPD for water; Advisory recovery limits 80-120%.	Correct problem, re-prepare and re-analyze LCS/LCSD and the impacted batch.

TABLE B2.8 (Continued)

SUMMARY OF ADVISORY QC REQUIREMENTS AND CORRECTIVE ACTION FOR INORGANIC ANALYSIS

QAPP WORKSHEET #24 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 3.2.2)

Remedial Action Sampling and Analysis Plan

Installation Restoration Site 70 Naval Weapons Station Seal Beach

Seal Beach, California

Notes:

CCV – continuing calibration verification
IC – initial calibration
ICV – initial calibration verification
LCSD – laboratory control sample duplicate
LCS – laboratory control sample
MDL – method detection limit
MS/MSD – matrix spike/matrix spike duplicate
QC – quality control
QL – quantitation limit
RPD – relative percent difference
SD – sample duplicate

TABLE B3.1

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ANALYTICAL REQUIREMENTS

Remedial Action Sampling and Analysis Plan

QAPP WORKSHEET #19 - NAVFAC SW SAP (UFF-QAPP MANUAL SECTION 3.1.1)

Installation Restoration Site 70 Naval Weapons Station Seal Beach - Seal Beach, California

ANALYTE	METHOD	CONTAINER	PRESERVATION	VOLUME	HOLD TIME
Volatile Organic Compounds	8260B	VOA vial	HCL pH<2 Store at 4 °C +/- 2°	3 x 40 mL	14 days
Dissolved Hydrocarbon Gases (ethene, ethane, methane)	RSK 175	VOA vial	Store at 4 °C +/- 2 °C	2 x 40 mL	14 days
Dissolved Iron/Manganese/Arsenic	6010B	plastic	HNO_3 to pH<2	1000 mL	6 months
Inorganic Anions Nitrate/Nitrite/Chloride/Sulfate/ Bromide	300	plastic	Store at 4 °C +/- 2 °C	250 mL	NO_3^- 48 hours Cl 14 days SO_4^{2-} 28 days NO_2^- 48 hours Br^- 28 days
Dissolved Hydrogen Sulfide	376.2	plastic	Store at 4 °C +/- 2 °C, NaOH	500 mL	7 days
Total Dissolved Solids	160.1	plastic	Store at 4 °C +/- 2 °C	1 L	7 days
Alkalinity	310	plastic	Store at 4 °C +/- 2 °C	500 mL	14 days
Total Organic Carbon	415.1 single burn/9060 quadruple burn	plastic	H_2SO_4 pH<2, Store at 4 °C +/- 2 °C	500 mL	14 days
Volatile Fatty Acids (acetic, butyric, lactic, propionic)	300M	plastic	Store at 4 °C +/- 2 °C	500mL	28 days
Dehalococcoides (DHC)	PCR 16S rRNA	plastic	Store at 4 °C +/- 2 °C	1 L	7 days

TABLE B3.1

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ANALYTICAL REQUIREMENTS

Remedial Action Sampling and Analysis Plan

QAPP WORKSHEET #19 - NAVFAC SW SAP (UFF-QAPP MANUAL SECTION 3.1.1)

Installation Restoration Site 70 Naval Weapons Station Seal Beach - Seal Beach, California

ANALYTE	METHOD	CONTAINER	PRESERVATION	VOLUME	HOLD TIME
Depth to Water	water sounding tape	NA	NA	NA	NA
Field Parameters (pH, DO, ORP, spc, turbidity, temperature)	Ion Specific Electrode, thermocouple	NA	NA	NA	NA
Soil Vapor - Methane (Health and Safety)	25 C	Tedlar bag	NA	1 L	28 days
Soil Vapor - Hydrogen Sulfide (Health and Safety)	ASTM D5504	Tedlar bag	NA	1 L	24 hours

Acronyms/Abbreviations

°C – degrees Celsius
Br^- - bromide
Cl - chloride
Dhc/VCr – Dehalococcoides Vinyl Chloride Reductase Gene
DO – dissolved oxygen
HCL – hydrochloric acid
$HN0_3$ – nitric acid
L – liters
mL – milliliters
VOA – volatile organic analysis
ASTM - American Society for Testing and Materials
NA – not applicable
NaOH – sodium hydroxide
NO_2^- - nitrite
NO_3^-- nitrate
PCR – polymerase chain reaction
ORP – oxidation reduction potential
rRNA - ribosomal ribonucleic acid
SO_4^{2-} - sulfate
spc – specific conductance

TABLE B3.2

FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION

QAPP WORKSHEET #22 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 3.1.2.4)

Remedial Action Sampling and Analysis Plan

Installation Restoration Site 70 Naval Weapons Station Seal Beach

Seal Beach, California

FIELD EQUIPMENT	CALIBRATION ACTIVITY	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	RESPONSIBLE PERSON	REFERENCE[1]	COMMENTS (RESOLUTION)
YSI™ multimeter or equivalent	Specific Conductance	At least once daily	± 5 mS/cm or 3% of measured value, whichever is greater	Check, investigate, correct, recalibrate, and return to manufacturer if necessary	On-site field team lead	SAP Section 3.4.1	0.1 mS/cm
	Temperature	Once per sampling round	± 0.15 °C				0.01 °C
	pH	At least once daily	± 0.05 pH unit				0.01 pH unit
	Dissolved Oxygen	At least once daily	± 0.5 mg/L				0.01 mg/L
	ORP	At least once daily	± 35 mV or 10% of measured value, whichever is greater				0.1 mV
	Turbidity	At least once daily	± 0.5 NTUs or 5% of measured value, whichever is greater				0.1 NTU
Water Level Indicator	Water Level	Pre-calibrated tape	N/A			SAP Section 3.4.2	0.01 ft

TABLE B3.2 (Continued)

FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION

QAPP WORKSHEET #22 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 3.1.2.4)

Remedial Action Sampling and Analysis Plan

Installation Restoration Site 70 Naval Weapons Station Seal Beach

Seal Beach, California

Notes:

[1] Section of the SAP that describes the calibration/maintenance/testing/inspection procedures.

Acronyms/Abbreviations:

ft – feet
mg/L – milligrams per liter
mS/cm – milliSiemens per centimeter
mV – millivolts
NTU – nephelometric turbidity units
N/A – not applicable
ORP – oxidation reduction potential
SAP – Sampling and Analysis Plan
°C – degrees Celsius

TABLE B3.3

FIELD QUALITY CONTROL SAMPLE SUMMARY

QAPP WORKSHEET #20 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 3.1.1)

Remedial Action Sampling and Analysis Plan

Installation Restoration Site 70 Naval Weapons Station Seal Beach

Seal Beach, California

MATRIX	ANALYTICAL GROUP	ANALYICAL AND PREPARATION REFERENCE[1]	# OF PRIMARY SAMPLING LOCATIONS [2]	# OF FIELD DUPLICATES	# OF MS/MSDs	# OF SOURCE BLANKS	# OF EQUIPMENT RINSATES	# OF TRIP BLANKS	TOTAL # OF SAMPLES TO LAB
GW	8260B	SAP Section 3.7	30	3	2	1	One per day that non-dedicated equipment used	One per cooler	≥ 37
GW	300.0	SAP Section 3.7	30	3	2	1	One per day that non-dedicated equipment used	0	≥ 36
GW	415.1	SAP Section 3.7	30	3	2	0	0	0	≥ 35
GW	RSK 175	SAP Section 3.7	30	3	2	0	0	0	≥ 35
GW	300M	SAP Section 3.7	30	3	2	0	0	0	≥ 35
GW	6010B	SAP Section 3.7	30	3	2	1	One per day that non-dedicated equipment used	0	≥ 36
GW	310.0	SAP Section 3.7	30	3	0	0	0	0	≥ 33
GW	376	SAP Section 3.7	30	3	0	0	0	0	≥ 33
GW	*Dhc/VCr*[3]	SAP Section 3.7	30	0	0	0	0	0	≥ 30

Notes:

[1] SAP Section that describes the sample collection procedures.

[2] Number of samples collected during each performance monitoring event. Additional samples will be collected from the sentinel monitoring network during some performance monitoring events. Samples collected at discrete depths at the same location are each counted as a separate sampling location.

[3] Samples for (*Dhc/VCr*) analysis to determine *Dhc*/*VCr* collected only every other performance monitoring event.

Acronyms/Abbreviations:

TABLE B3.3 (Continued)

FIELD QUALITY CONTROL SAMPLE SUMMARY
QAPP WORKSHEET #20 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 3.1.1)
Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70 Naval Weapons Station Seal Beach
Seal Beach, California

Dhc/VCr – Dehalococcoides Vinyl Chloride Reductase Gene
GW – groundwater
– number
SAP – Sampling and Analysis Plan
MS/MSD – Matrix spike/ matrix spike duplicate
VCr – vinyl chloride reductase enzyme

TABLE B3.4

MEASUREMENT PERFORMANCE CRITERIA TABLE – FIELD QC SAMPLES

QAPP WORKSHEET #12 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 2.6.2)

Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70 Naval Weapon Station Seal Beach
Seal Beach, California

QC SAMPLE	ANALYTICAL GROUP	FREQUENCY	DATA QUALITY INDICATORS (DQIs)	MEASUREMENT PERFORMANCE CRITERIA	QC SAMPLE ASSESSES ERROR FOR SAMPLING (S), ANALYTICAL (A) OR BOTH (S&A)
Field Duplicate	VOCs Anions Alkalinity TDS TOC Dissolved metals Dissolved Hydrogen Sulfide VFAs	One per 10 samples	Precision - overall	RPD ≤ 30% when analytes detected in both field duplicate samples	S&A
MS/MSD	VOCs	One MS/MSD pair per 20 samples	Accuracy/Bias	Laboratory established QC acceptance criteria. Advisory recover limit: 75-125%	S&A
	Anions TOC Dissolved metals VFAs			Laboratory established QC acceptance criteria. Advisory recover limit: 80-120%	
	DHG - Ethane - Ethene - Methane			Laboratory established QC acceptance criteria. Advisory recover limit: - 50-140% - 60-140% - 60-140%	

TABLE B3.4 (Continued)

MEASUREMENT PERFORMANCE CRITERIA TABLE – FIELD QC SAMPLES

QAPP WORKSHEET #12 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 2.6.2)

Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70 Naval Weapon Station Seal Beach
Seal Beach, California

QC SAMPLE	ANALYTICAL GROUP	FREQUENCY	DATA QUALITY INDICATORS (DQIs)	MEASUREMENT PERFORMANCE CRITERIA	QC SAMPLE ASSESSES ERROR FOR SAMPLING (S), ANALYTICAL (A) OR BOTH (S&A)
MS/MSD	Dissolved Hydrogen Sulfide	One MS/MSD pair per 20 samples	Accuracy/Bias	Laboratory established QC acceptance criteria. Advisory recover limit: 75-125%	S&A
Equipment Rinsate	VOCs Anions Dissolved Metals	One per day for each day that non-disposable or non-dedicated sampling equipment is used	Contamination (Accuracy/Bias)	No target compounds ≥ QL	S&A
Source Blank	VOCs Dissolved Metals Anions	One per sampling event	Contamination (Accuracy/Bias)	No target compounds ≥ QL	S&A
Trip Blank	VOCs	One per cooler	Contamination (Accuracy/Bias)	No target compounds ≥ QL	S&A
Temperature Blank	Temperature	One per cooler	Preservation (Accuracy/Bias)	4 ± 2°C	S

TABLE B3.4 (Continued)

MEASUREMENT PERFORMANCE CRITERIA TABLE – FIELD QC SAMPLES

QAPP WORKSHEET #12 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 2.6.2)

Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70 Naval Weapon Station Seal Beach
Seal Beach, California

Notes: A – analytical
Dhc/VCr – Dehalococcoides Vinyl Chloride Reductase Gene. Analysis of *Dhc*/*VCr* by molecular genetic probe method (SiREM method [non-EPA])
DHG – dissolved hydrocarbon gases (ethene, ethane, methane)
DQI – data quality indicator
MS – matrix spike
MSD – matrix spike duplicate
QC – quality control
QL – quantitation limit
RPD – relative percent difference
S – sampling
S & A – sampling and analytical
TDS – total dissolved solids
TOC – dissolved organic carbon
VOCs – volatile organic compounds
VFAs- Volatile Fatty Acids
°C – degrees Celsius

TABLE B5.1

VERIFICATION PROCESS

QAPP WORKSHEET #34 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 5.2.1)

Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70 Naval Weapons Station Seal Beach
Seal Beach, California

VERIFICATION INPUT	DESCRIPTION	INTERNAL/ EXTERNAL	RESPONSIBLE FOR VERIFICATION (NAME, ORGANIZATION)
Chain of custody forms	Chain-of-custody forms will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody should be initialed by the reviewer, a copy of the chain-of-custody retained in the project file, and the original and remaining copies taped inside the cooler for shipment.	I	On-site Field Team Lead (Geosyntec)
Audit reports	Upon report completion, a copy of all audit reports will be placed in the project file. If corrective actions are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the project file. At the beginning of each week, and at the completion of the site work, project file audit reports will be reviewed internally to ensure that all appropriate corrective actions have been taken and that corrective action reports are attached. If corrective actions have not been taken, the project manager will be notified to ensure action is taken.	I	(Geosyntec)
Field notes/logbook	Field notes will be reviewed internally and placed in the project file. A copy of the field notes will be attached to the final report.	I	On-site Field Team Lead (Geosyntec)
Laboratory data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal. All received data packages will be verified externally according to the data validation procedures specified in Section 4.2 of the Sampling and Analysis Plan.	I, E	Laboratory and Data Validators (to be determined)

Acronyms/Abbreviations
I – Internal
E - External

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TABLE B5.2

PROJECT DOCUMENTS AND RECORDS

QAPP WORKSHEET #29 – NAVFAC SW SAP (UFP-QAPP MANUAL SECTION 3.5.1)

Remedial Action Sampling and Analysis Plan

Installation Restoration Site 70 Naval Weapons Station Seal Beach

Seal Beach, California

DOCUMENT	WHERE MAINTAINED
Field notes/logbook	Project file
Chain of custody forms	Project file and laboratory
Laboratory raw data package	Project file
Audit/assessment checklists/reports	Project file and laboratory
Corrective action forms/reports	Project file and laboratory
Laboratory equipment calibration logs	Laboratory
Sample preparation logs	Laboratory
Run logs	Laboratory
Validated data	Project file, NIRIS, and NAVFAC SW Administrative Record
Hard copy of analytical results	NAVFAC SW Administrative Record

Acronyms/Abbreviations:

NIRIS – Naval Installation Restoration Information Solution

NAVFAC SW – Naval Facilites Engineering Command Southwest

TABLE B5.3

GC/MS DATA DELIVERABLES PACKAGE REQUIREMENTS
Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70 Naval Weapons Station Seal Beach
Seal Beach, California

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
Data summary for each blank and sample[1]	I	X	X	X
Laboratory control sample/laboratory control sample duplicate (LCS/LCSD) 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		
Sample preparation bench sheets		X	X	
Gel permeation chromatography clean-up		X		

TABLE B5.3 (Continued)

GC/MS DATA DELIVERABLES PACKAGE REQUIREMENTS
Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70 Naval Weapons Station Seal Beach
Seal Beach, California

DELIVERABLE REQUIREMENT	EQUIVALENT EPA FORM	CLP OR CLP-LIKE PACKAGE, LEVEL IV	SW-846 PACKAGE, LEVEL III	STANDARD LABORATORY REPORT
logs				
Method blank summary	IV	X	X	
Standard preparation logs		X	X	
Analysis run logs	VIII	X	X	
Percent moisture		X	X	X
pH		X [2]		

Notes:
ASTM – American Society for Testing and Materials
CLP –Contract Laboratory Program
EPA – U.S. Environmental Protection Agency
GC/MS – gas chromatography/mass spectroscopy
ID - Identification
LCS – laboratory control sample
LCSD – laboratory control sample duplicate
MS – matrix spike
MSD – matrix spike duplicate
QC – quality control
RPD – relative percent difference

[1] Must include: field sample ID, laboratory ID, date/time sampled, date received, extracted/analyzed, practical quantitation limits, method detection limit, dilution factor(s), results, comments, approval signature/date.
[2] For water samples volatile analysis only.

TABLE B5.4

INORGANIC DATA DELIVERABLES PACKAGE REQUIREMENTS
Remedial Action Sampling and Analysis Plan
Installation Restoration Site 70 Naval Weapons Station Seal Beach
Seal Beach, California

DELIVERABLE REQUIREMENT	EQUIVALENT EPA FORM	CLP OR CLP-LIKE PACKAGE, LEVEL IV	SW-846 PACKAGE, LEVEL III	STANDARD LABORATORY REPORT
INORGANIC ANALYSIS BY ICP				
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
Data summary for each blank and sample[1]	I-IN	X	X	X
Laboratory control sample/laboratory control sample duplicate (LCS/LCSD) 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 (MS) report (including concentration spiked, percent recovered, percent recovery acceptance limits)	V (Part 1)-IN	X	X	X
Duplicate sample report	VI-IN	X	X	X
Calibrations, initial and verification	II (Part 1)-IN	X	X	
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

Notes:
ASTM – American Society for Testing and Materials
CLP – contract laboratory program
EPA – U.S. Environmental Protection Agency
ICP – Inductively Coupled Plasma
ID – Identification
LCS – laboratory control sample
LCSD – laboratory control sample duplicate
MS – matrix spike
QC – quality control
RPD – relative percent difference

[1] Must include: field sample ID, laboratory ID, date/time sampled, date received, extracted/analyzed, practical quantitation limits, method detection limit, dilution factor(s), results, comments, approval signature/date.

FIGURES

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Figure B1.1

Site Location

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

Geosyntec consultants

Project No: HY1034

Date: September 2007

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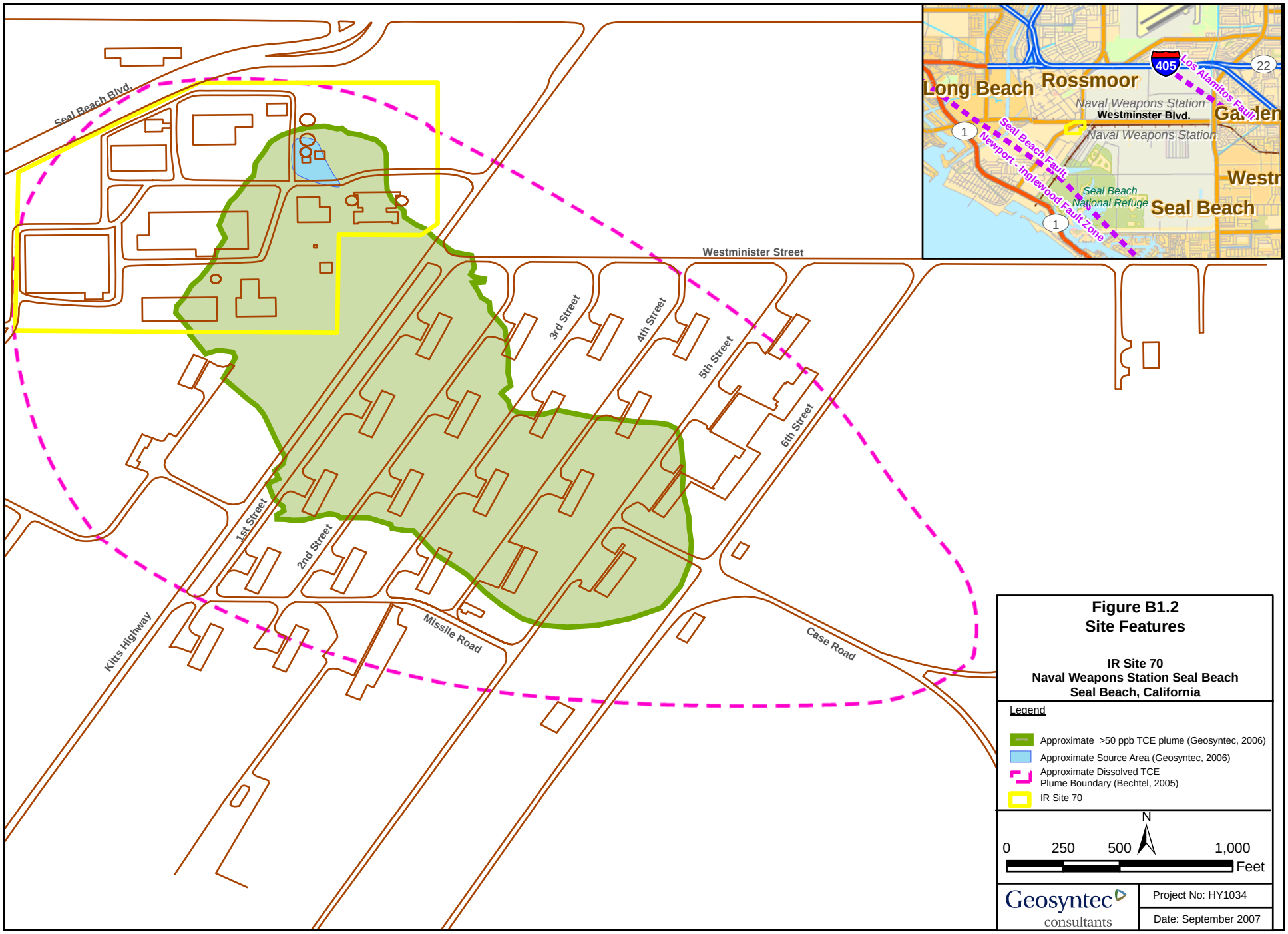

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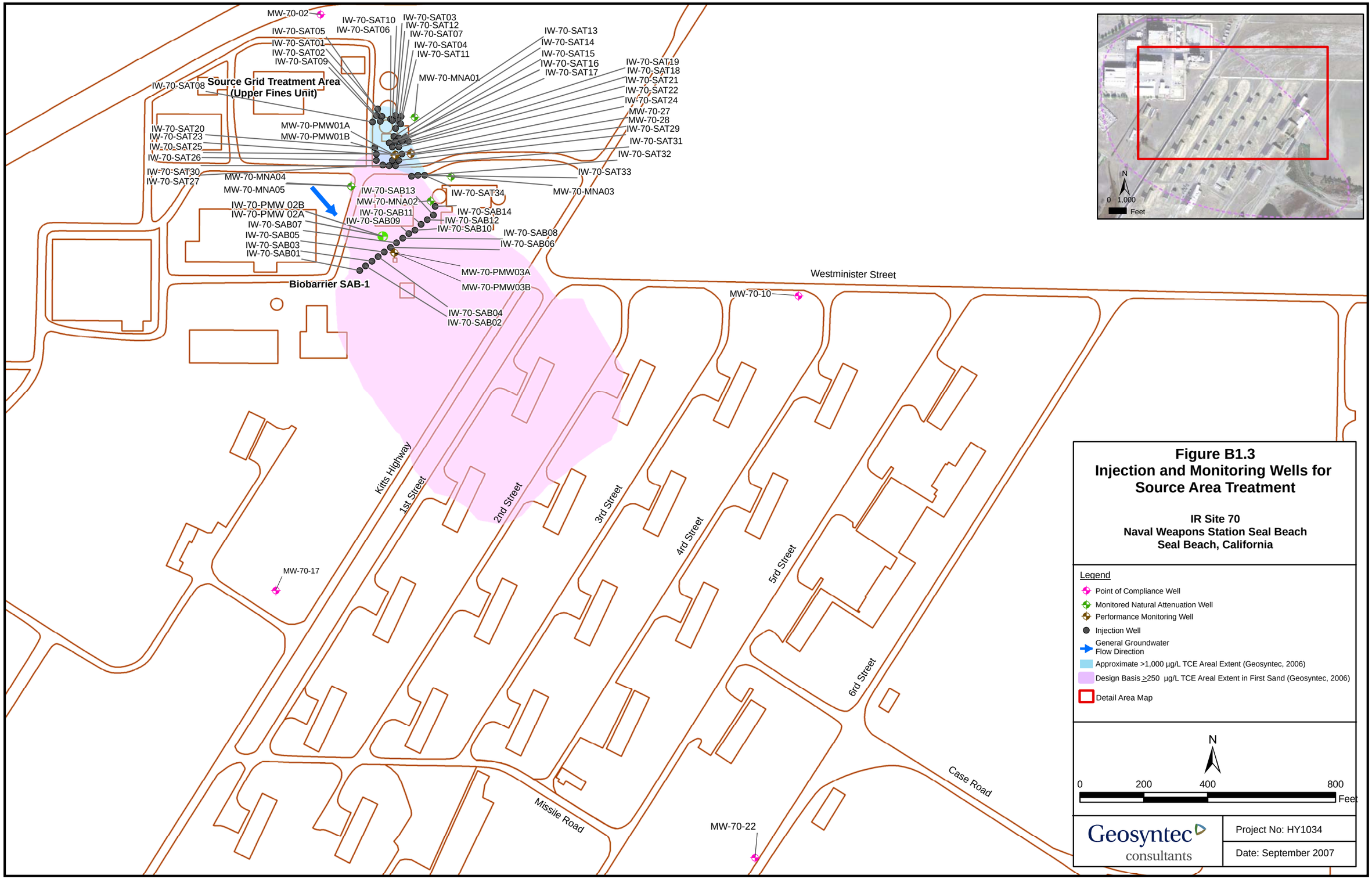

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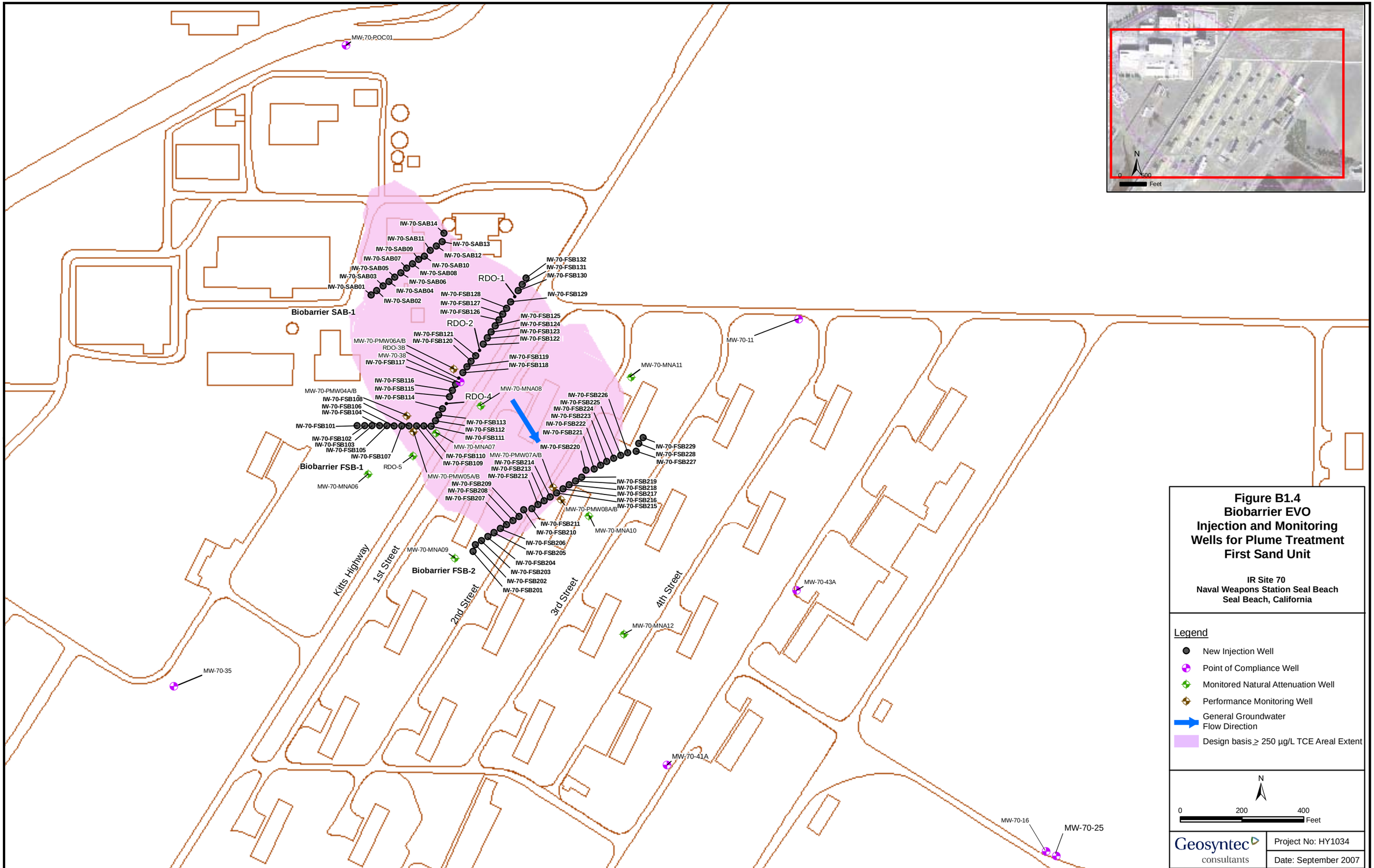

Figure B1.4
Biobarrier EVO
Injection and Monitoring
Wells for Plume Treatment
First Sand Unit

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

Legend

- New Injection Well
- Point of Compliance Well
- Monitored Natural Attenuation Well
- Performance Monitoring Well
- General Groundwater Flow Direction
- Design basis ≥ 250 µg/L TCE Areal Extent

N

0 200 400 Feet

Geosyntec consultants

Project No: HY1034

Date: September 2007

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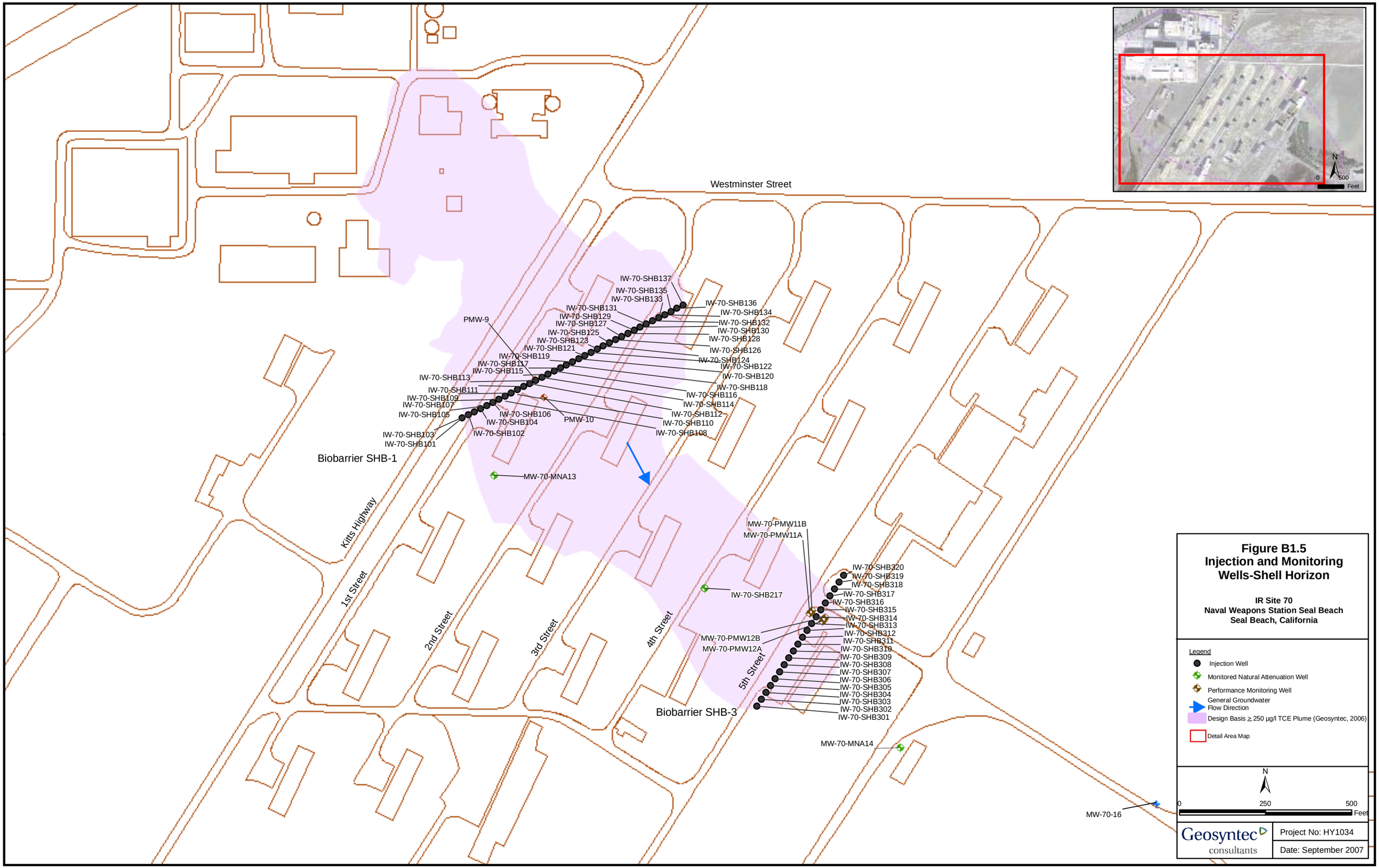

Figure B1.5
Injection and Monitoring Wells-Shell Horizon

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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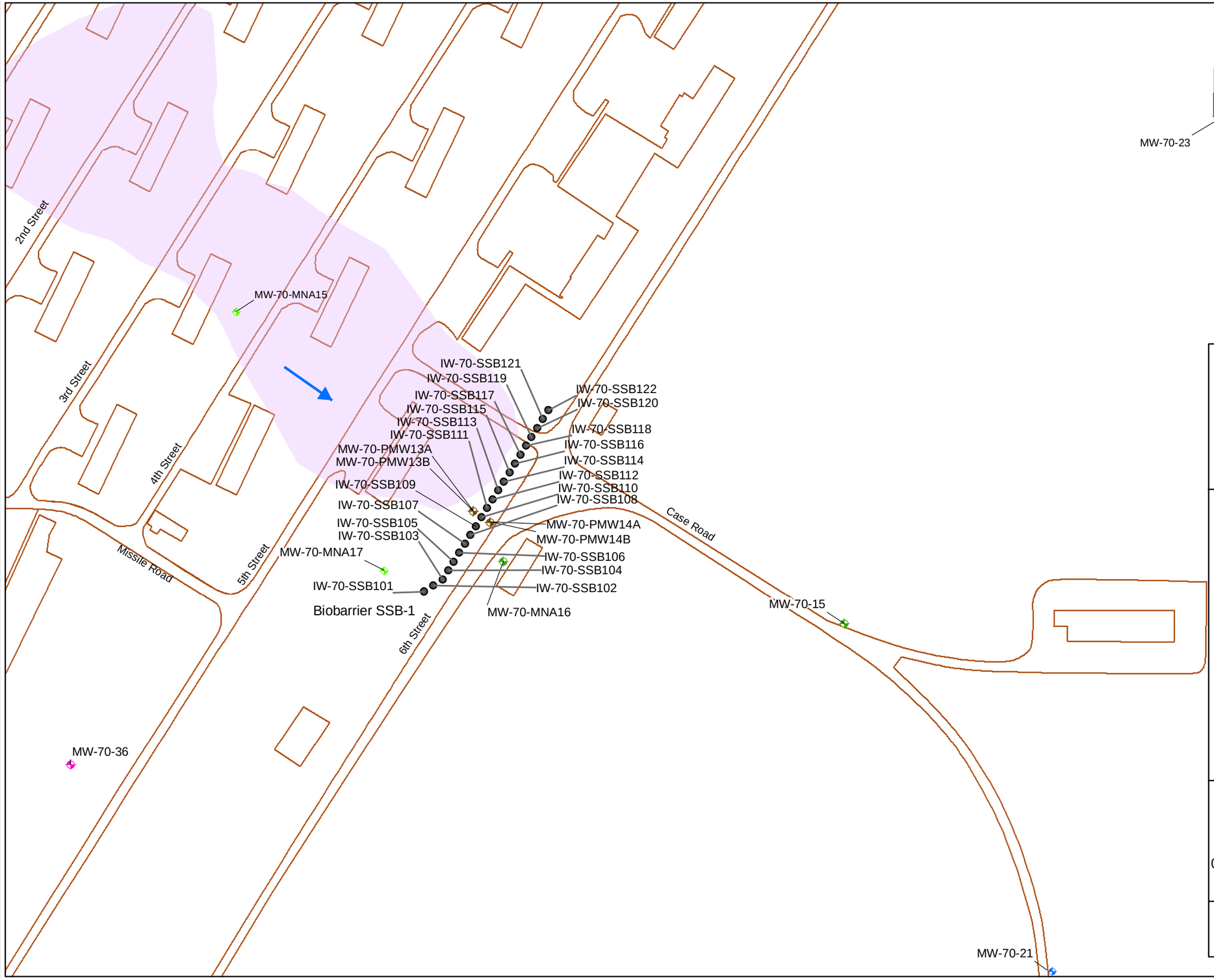

Figure B1.6
Biobarrier EVO
Injection and Monitoring
Wells for Plume Treatment
Second Sand Unit

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

Legend

- Injection Well
- Point of Compliance Well
- Monitored Natural Attenuation Well
- Performance Monitoring Well
- General Groundwater Flow Direction
- Design basis >_250 µg/l TCE Plume (Geosyntec, 2006)
- Detailed Area Map

N

0 150 300 600 Feet

Geosyntec consultants

Project No: HY1034

Date: September 2007

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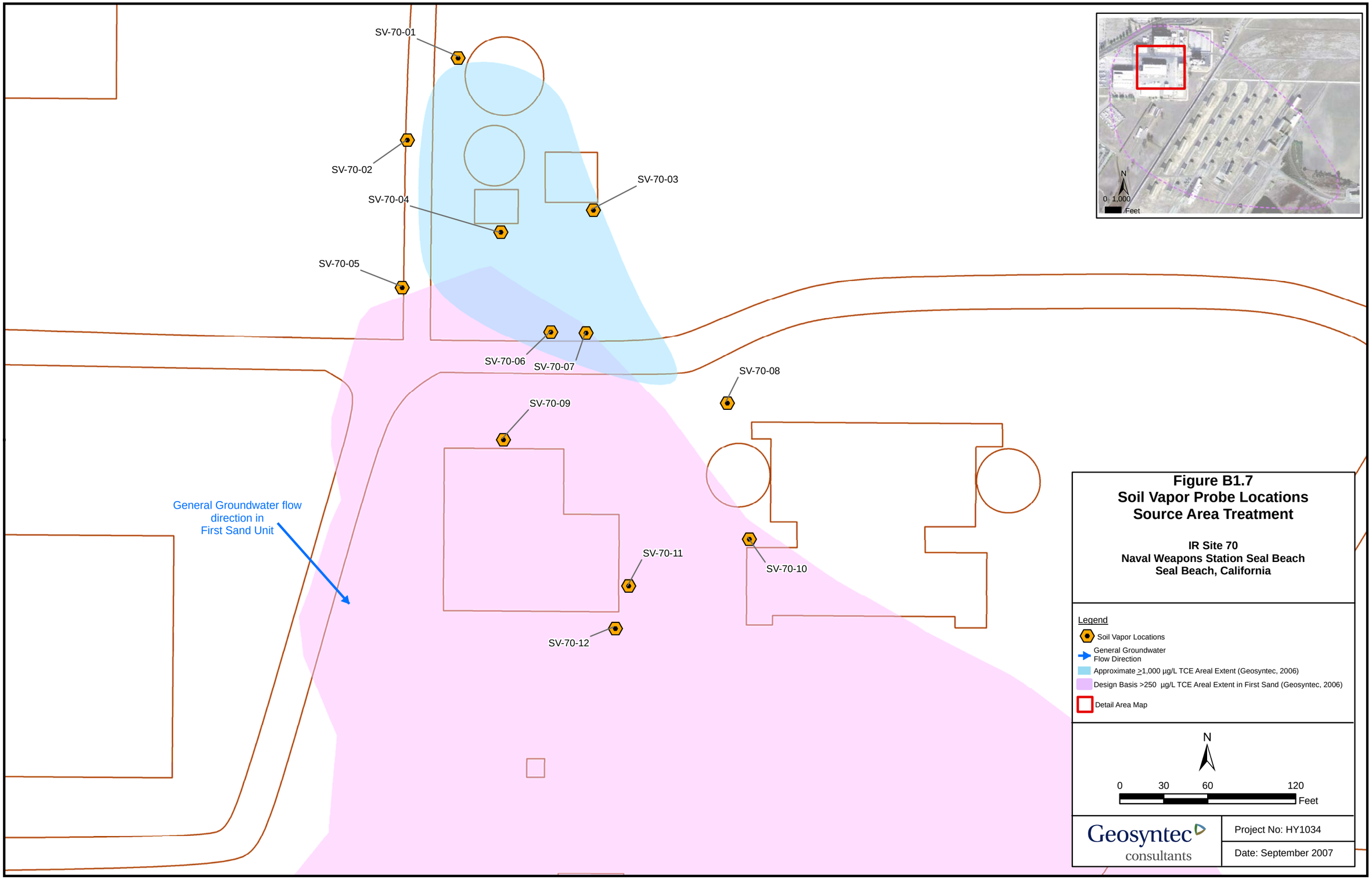

Figure B1.7
Soil Vapor Probe Locations
Source Area Treatment

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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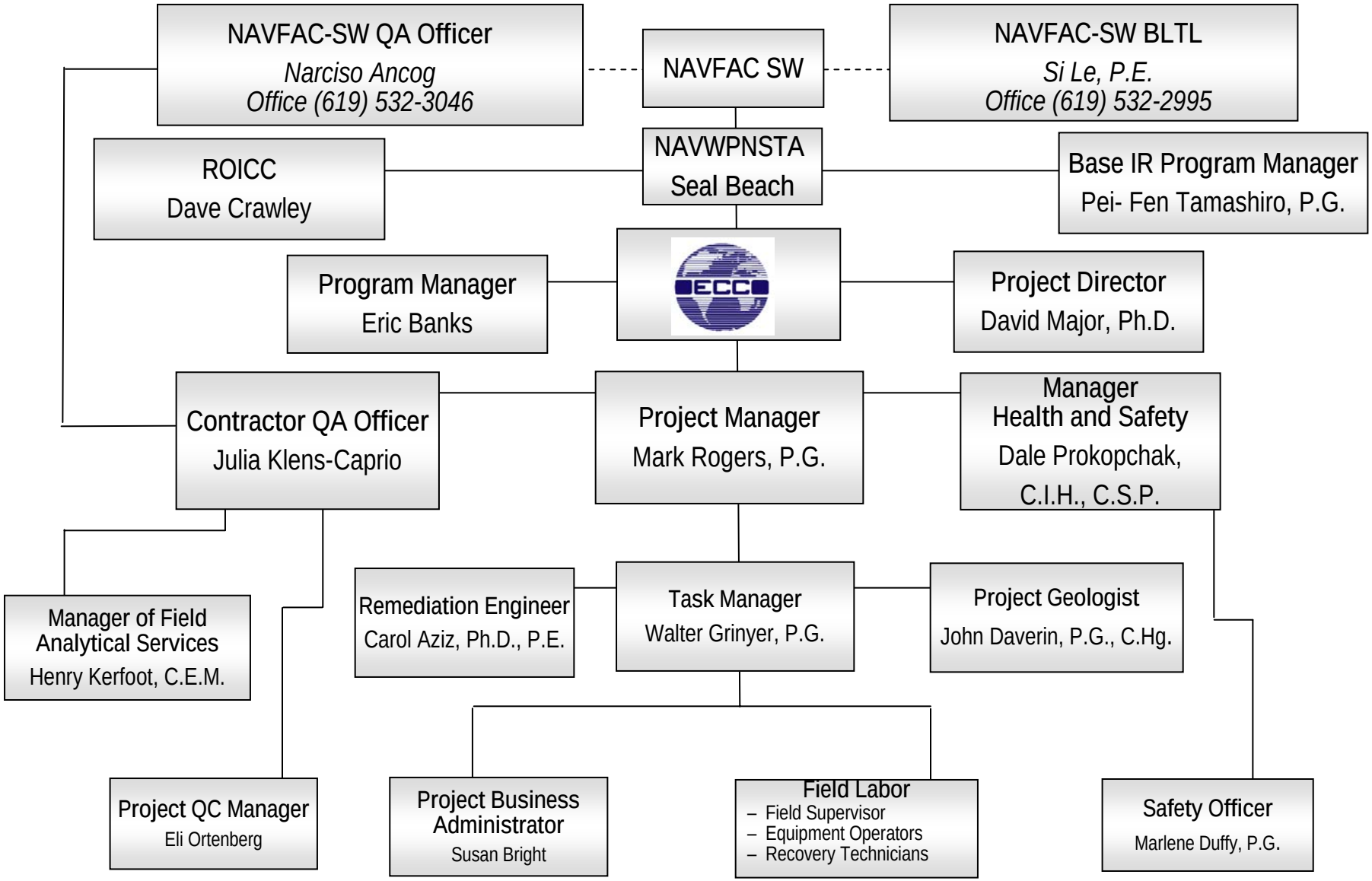

FIGURE B2.1

Project Organization Chart

IR Site 70

Naval Weapons Station Seal Beach, California

Date: September 2007	Project No. HY1034

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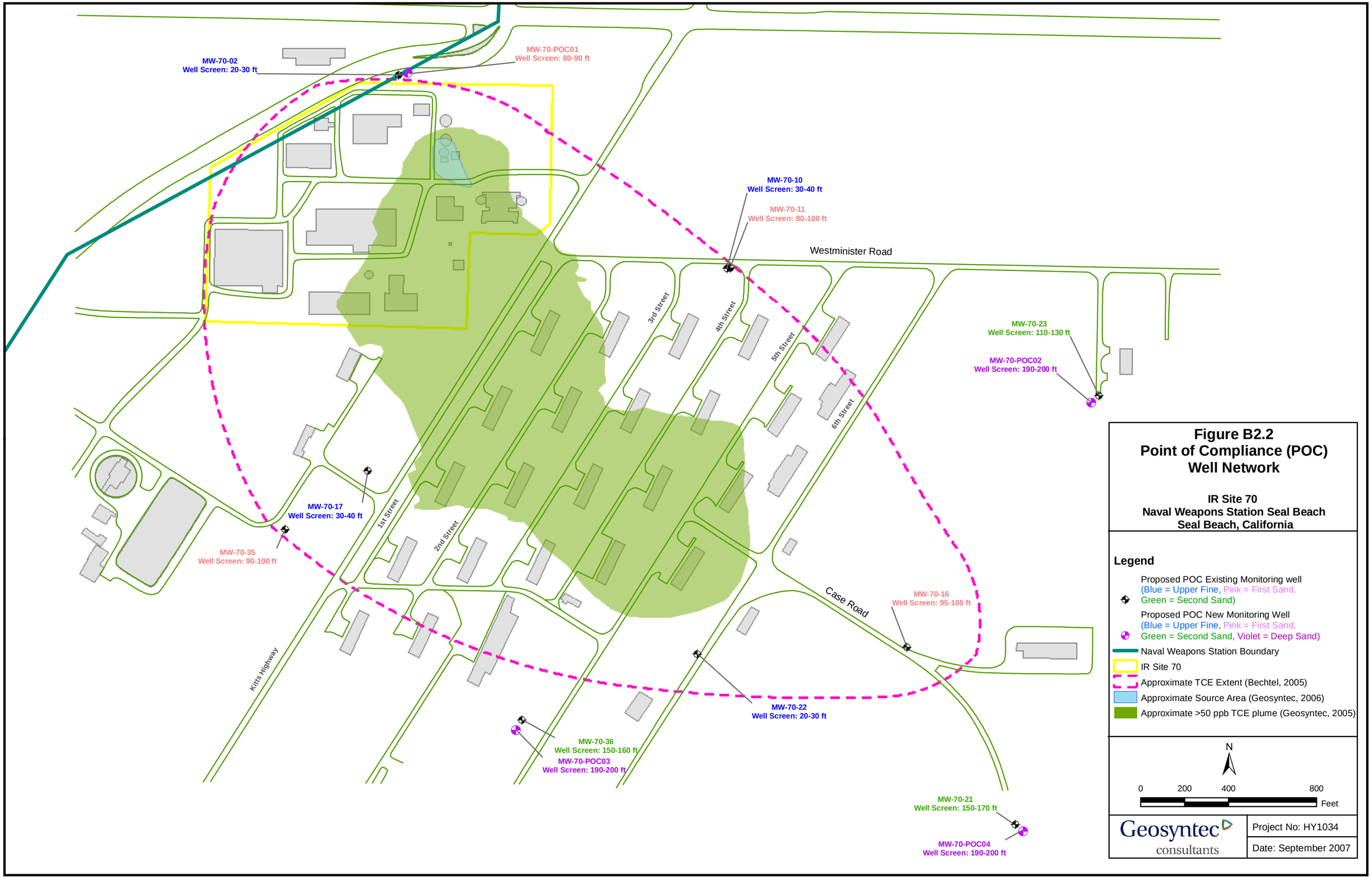

Figure B2.2
Point of Compliance (POC)
Well Network

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

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ATTACHMENT B-1
SAMPLE COLLECTION AND ANALYTICAL PROCEDURES FOR GENE-TRAC-VC ASSAY

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Naval Facilities Engineering Command, Southwest
San Diego, California
Contract No. N68711-04-D-1106
Contract Task Order 003
Document Control Number ECC-1106-0003-0002

Attachment B-1
Gene Trac VC Assay
Final Remedial Action Work Plan
Installation Restoration Program Site 70
Implementation of Enhanced In Situ Bioremediation
Naval Weapons Station Seal Beach
Seal Beach, California

Prepared by:

ECC

1240 Bayshore Highway
Burlingame, California 94010

in Association with

Geosyntec consultants

2100 Main Street, Suite 150
Huntington Beach, California 92648-2648

January 2008

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SiREM
Site Recovery & Management
www.siremlab.com
130 Research Lane, Suite 2
Guelph, Ontario N1G 5G3
Phone: (519) 822-2265
Fax: (519) 822-3151

SAMPLING AND SHIPPING PROTOCOL FOR GENE-TRAC TESTING

Sample Containers:
Clean, new, wide-mouth screw cap 1-liter (L) high-density polyethylene (HDPE) bottles (e.g., Nalgene or equivalent) should be used for Gene-Trac samples. For your convenience, SiREM can ship appropriate containers to your location at cost. Please provide a minimum of three business days notice for this service.

Sample Collection:
Groundwater samples should not be collected until oxidation/reduction potential (ORP) measurements of the purged water stabilizes to within about 10% of the previous reading. Turbidity in the Gene-Trac samples is desirable as it increases the likelihood of capturing microorganisms; surging the well prior to sample collection is recommended so that turbid samples can be collected. One 1L groundwater sample should be collected from each well for Gene-Trac analysis. Samples should be collected with minimum possible headspace. Preservatives should not be used.

Quality Assurance/Quality Control (QA/QC):
Gene-Trac testing is extremely sensitive, so care must be taken to prevent contamination of the samples with any foreign material, including groundwater from other sampling points. QA/QC samples consist of field blanks and equipment blanks (if non-dedicated equipment is used). A field blank is used to determine if sample contamination in the field or in transit has occurred. The field blank consists of 1L of commercially available distilled water (customer to provide) placed in a 1L sample bottle at one sampling location. Where non-dedicated sampling equipment is used, equipment should be thoroughly decontaminated between sampling locations using standard procedures for VOC analysis. An equipment blank should be prepared by passing distilled water through non-dedicated equipment after the cleaning process, to determine if decontamination procedures were effective. The field blank and equipment blank are to be collected at the customer's discretion. Please be advised that the field blank and the equipment blank will be treated as groundwater samples and will be charged as such.

Sample Custody, Shipping and Handling:
Samples should be clearly labeled and individually sealed in re-sealable freezer bags then placed in a plastic cooler with cool packs (not ice). Please indicate on the chain of custody which of the following analysis you require for your samples; **Method 1-Quantitative Gene-Trac-DHC *(dehalococcoides)*, Method 2-Gene-Trac-VC (vinyl chloride reductase), or Method 3- Gene-Trac-DHB *(dehalobacter)*** Ship the samples priority overnight courier under chain-of-custody to SiREM for analysis. Label samples on waybill "groundwater samples for destructive analysis". **Samples from all locations should be given a nominal total value of $10-20; otherwise a 15% duty will be applied to the stated value (to be paid by customer).** No special regulations apply to the shipping of groundwater samples to Canada. Holding time for Gene-Trac samples is 30 days at 4°C.

Send Coolers to:
SiREM Laboratory
130 Research Lane, Suite 2
Guelph, Ontario
Canada, N1G 5G3

Direct Inquiries to:
Ximena Druar or Phil Dennis
Phone: 1-866-251-1747/519-822-2265
Fax: 519-822-3151
E-mail: xdruar@siremlab.com or pdennis@siremlab.com

Chain-of-Custody Form

130 Research Lane, Suite 2 · Guelph, Ontario, Canada N1G 5G3 · Phone (519) 822-2265 or toll free 1-866-251-1747 Fax (519)822-3151
www.siremlab.com

SiREM Site Recovery & Management

No. 0001

Lab #

Page ____ of ____

Project Name	Project #
Project Manager	
Company	
Address	
Phone #	Fax #
Sampler's Signature	Sampler's Printed Name

Analysis

Preservative

Preservative Key
0. None
1. HCL
2. Other _____
3. Other _____
4. Other _____
5. Other _____
6. Other _____

Client Sample ID	Lab ID	Sampling Date	Sampling Time	Matrix	# of Containers												Other Information

Sample Receipt

Cooler Condition:

Cooler Temperature:

Custody Seals: Yes ☐ No ☐

Invoice Information

P.O. #

Bill To:

For Lab Use Only

Relinquished By:	Received By:	Relinquished By:	Received By:	Relinquished By:	Received By:
Signature	Signature	Signature	Signature	Signature	Signature
Printed Name	Printed Name	Printed Name	Printed Name	Printed Name	Printed Name
Firm	Firm	Firm	Firm	Firm	Firm
Date/Time	Date/Time	Date/Time	Date/Time	Date/Time	Date/Time

Distribution: White - Return to Originator: Yellow - Lab Copy: Pink - Retained by Client

In the absence of an executed agreement, submission of samples to SiREM implies consent for performance of analyses specified on this Chain-of-Custody form and agreement with the terms and conditions of the SiREM Laboratory Services Agreement. The entity submitting samples shall be responsible for payment in full for said analyses.

FedEx International Air Waybill
Lettre de transport aérien internationale

Sender's Copy
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Phone / Téléphone: 519-822-2265

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130 Research Lane, Suite 2
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N1G 5G3
CANADA

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9. Conditions of sale and terms of payment
(i.e. sale, consignment shipment, leased goods, etc.)
Conditions de vente et modalités de paiement
(p. ex. vente, expédition en consignation, location de marchandises, etc.)

SAMPLES for destructive analysis

10. Currency of settlement - Devises du paiement

US

11. Number of packages Nombre de colis	12. Specification of commodities (kind of packages, marks and numbers, general description and characteristics, i.e., grade, quality) Désignation des articles (nature des colis, marques et numéros, description générale et caractéristiques, p. ex. classe, qualité)	13. Quantity (state unit) Quantité (précisez l'unité)	Selling price - Prix de vente: 14. Unit price Prix unitaire	15. Total
1	groundwater sample for destructive analysis	1.000 unit/unité	10.00	10.00
		unit/unité		0.00
		unit/unité		0.00
		unit/unité		0.00
		unit/unité		0.00
		unit/unité		0.00
		unit/unité		0.00
		unit/unité		0.00
		unit/unité		0.00
		unit/unité		0.00
		unit/unité		0.00
		unit/unité		0.00

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16. Total weight - Poids total
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17. Invoice total
Total de la facture
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19. Exporter's name and address (if other than vendor)
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20. Originator (name and address) - Expéditeur d'origine (nom et adresse)

21. CCRA ruling (if applicable) - Décision de l'Agence (s'il y a lieu)

22. If fields 23 to 25 are not applicable, check this box
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23. If included in field 17 indicate amount:
Si compris dans le total à la zone 17, précisez :

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Les frais de transport, dépenses et assurances à partir du point d'expédition directe vers le Canada

(ii) Costs for construction, erection and assembly incurred after importation into Canada
Les coûts de construction, d'érection et d'assemblage après importation au Canada

(iii) Export packing
Le coût de l'emballage d'exportation

24. If not included in field 17 indicate amount:
Si non compris dans le total à la zone 17, précisez :

(i) Transportation charges, expenses and insurance to the place of direct shipment to Canada
Les frais de transport, dépenses et assurances jusqu'au point d'expédition directe vers le Canada

(ii) Amounts for commissions other than buying commissions
Les commissions autres que celles versées pour l'achat

(iii) Export packing
Le coût de l'emballage d'exportation

25. Check (if applicable):
Cochez (s'il y a lieu) :

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(ii) The purchaser has supplied goods or services for use in the production of these goods
L'acheteur a fourni des marchandises ou des services pour la production de ces marchandises ☐

Dans ce formulaire, toutes les expressions désignant des personnes visent à la fois les hommes et les femmes.

ATTACHMENT B-2
STANDARD OPERATING PROCEDURES

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Naval Facilities Engineering Command, Southwest
San Diego, California
Contract No. N68711-04-D-1106
Contract Task Order 003
Document Control Number ECC-1106-0003-0002

Attachment B-2
Standard Operating Procedures
Final Remedial Action Work Plan
Installation Restoration Program Site 70
Implementation of Enhanced In Situ Bioremediation
Naval Weapons Station Seal Beach
Seal Beach, California

Prepared by:

ECC

1240 Bayshore Highway
Burlingame, California 94010

in Association with

Geosyntec consultants

2100 Main Street, Suite 150
Huntington Beach, California 92648-2648

January 2008

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Figure B-2.2 Emulsified Oil Proportional Delivery System

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Attachment B-2.1 Example Field Forms and Logs

ACRONYMS AND ABBREVIATIONS

C	Degrees Celsius
CH_4	Methane
CO_2	Carbon Dioxide
DO	Dissolved Oxygen
DTW	Depth to water
ECC	Environmental Chemical Corporation
EPA	Environmental Protection Agency
EVO	Emulsified Vegetable Oil
ft	feet
gal	gallons
gpm	Gallons per Minute
HASP	Health and Safety Plan
H_2S	Hydrogen Sulfide
I.D.	Inside Diameter
Id	Identification
IDW	Investigation Derived Waste
In.	Inches
In-H_20	inches of Water
IR	Installation Restoration
KB-1 ®	Mixed dehalorespiring bacterial culture
L	Liter
µm	micrometer
m	meter
mg/L	milligrams per liter
min	minute
mL	milliliter
mm	millimeter
mV	millivolts
MSDS	Material Safety Data Sheet
NASA	National Aeronautics and Space Administration
NTU	Nephelometric Turbidity Units
O_2	Oxygen
O.D.	Outside Diameter
ORP	Oxidation Reduction Potential
PID	Photoionization Detector
psi	Pounds per Square Inch
PVC	Polyvinyl chloride
QA	Quality Assurance
QC	Quality Control
RD	Remedial Design

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ROI	Radius of Injection
SAP	Sampling and Analysis Plan
SHB	Shell Horizon Biobarrier
SOPs	Standard Operating Procedures
TCE	Trichloroethene
USCS	Unified Soil Classification System
VOCs	Volatile Organic Compounds
WP	Work Plan

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B-2.1 INTRODUCTION

This attachment comprises the standard operating procedures (SOPs) for the enhanced in situ bioremediation and monitoring program for Naval Weapons Station Seal Beach IR Site 70. The following sections present SOPs as follows:

Section	SOP
B-2.2	Amendment Injection Procedures
B-2.3	Groundwater Sampling Procedures
B-2.4	Water Level Measurement Procedures
B-2.5	Equipment Decontamination Procedures
B-2.6	Drilling Procedures
B-2.7	Soil Sampling and Characterization Procedures
B-2.8	Well Installation Procedures
B-2.9	Well Development Procedures
B-2.10	Soil Gas Probe Installation Procedures
B-2.11	Soil Gas Sampling Procedures
B-2.12	Well Packer Installation and Operation

These SOPs are intended to provide detailed guidance for conducting EISB implementation and have been compiled for use in conjunction with the Installation Restoration Program Site 70 Work Plan for Naval Weapons Station Seal Beach. Material safety data sheets (MSDS) for EVO and KB-1® are included in the health and safety plan (HASP) (Appendix D of the Work Plan).

B-2.2 AMENDMENT INJECTION PROCEDURES

This SOP describes the general procedural steps pertaining to the subsurface injection of emulsified vegetable oil (EVO) and bioaugmentation culture KB-1®.

EVO is amended to the subsurface by introducing a volume of water containing the desired concentration of emulsified oil to a well or set of wells installed for this purpose. Injection volumes are designed to achieve a target radius of injection (ROI) around each injection well. Well spacings are selected to achieve reasonable coverage based on well ROI and groundwater flow conditions, creating a continuous passive biobarrier/bioreactive zone. The biobarrier is typically oriented perpendicular to the average horizontal groundwater flow direction to intercept the contaminant plume. Since the objective is to inject a target design volume of amendment, the injection duration will be governed by the rate at which the formation will accept flow.

KB-1® is amended to each injection well part way through the EVO injection process. During KB-1® injection, anoxic water is used for EVO dilution and injection to provide the appropriate geochemical environment for growth of the KB-1® culture. The KB-1® culture is amended directly to the injection well.

B-2.2.1 EVO and KB-1® Injection Objectives

Injection of EVO is intended to emplace a long-lasting source of electron donor (the soybean oil) within a targeted zone of the subsurface to promote biological activity and hence long-term biological degradation of target contaminants. The purpose of the injection is to distribute the EVO over the target interval and throughout a target volume of the formation such that additional injections are required infrequently or perhaps not at all. Injection of KB-1® is intended to provide the required dechlorinating microorganisms to the subsurface targeted zone to encourage complete dechlorination of trichloroethene (TCE) to ethene.

B-2.2.2 Equipment and/or Instrumentation

The overall injection process is illustrated in the process flow schematic in Figure B-2.1. The injection apparatus is shown in more detail in Figure B-2.2. The following equipment/supplies are required:

1. **Water supply**. The injections require fairly large volumes of water. Options for water supply are as follows:

    a. **Site groundwater**. Use of site groundwater is preferred, since it can be extracted from the contaminant plume and will therefore emplace the emulsified oil along with the target contaminants and with water chemistry that corresponds to the existing conditions. This is especially important when ground water is already anaerobic and bioaugmentation is going to be implemented. The use of groundwater also mitigates potential spreading of the plume in an adverse manner by maintaining a near neutral water balance. To use site groundwater, there must be extraction wells with sufficient capacity to supply the total injection flow rate; this approach works best when the extraction output can be plumbed directly to the proportional feed system and to the injection well array. This approach requires:

        i. **Extraction wells.** These may subsequently become injection wells.

ii. **Extraction pumps**. Submersible pumps with flow control, run dry protection and a suitable power source.

iii. **Piping and manifold**. To connect extraction wells to dosing pump(s).

iv. **Power supply.** To operate the submersible extraction pump(s). If the site does not have power, one or more generator(s) are required. For refueling, each generator will require secondary containment in the form of 6 mL visqueen underlying and surrounding each generator, and bermed around the edges to provide containment.

b. **Potable water.** The use of potable water may be necessary for tight formations where sufficient groundwater cannot be supplied. Two options for a supply of potable water exist: (i) direct connection to a source of potable water (e.g., fire hydrant) during injections, or (ii) storage of potable water in a tank. A direct connection with the water supply is preferable, but an alternate method is to use one or more large holding tanks (~20,000 gallon (gal); storage tank) and simply refill it periodically. In locations where it is impractical to maintain a continuous connection to the source, this would allow longer operating times each day, as injections could get underway quicker and run longer if time was not required to set up and take down the fire hose each day. The hose could be rolled out to refill the tank during daily operation, as required. Use of a tank will depend on factors such as length of fire hose required, injection rate (which determines both how quickly a tank will be used up and pump requirements), and site access and utility considerations. The use of potable water will likely require:

i. **Fire hose**. Ensure that there is sufficient length of hose, including a few spare segments (to allow replacement of leaking connections or worn sections), to run from the selected hydrant to the staging area. A flow meter or hydrant access permit may be required to monitor the volume of hydrant water used. If the fire hose will cross an active transportation corridor, it may be necessary to procure a hose guard to protect it and to post proper traffic warning signs, as appropriate.

ii. **Adaptor with shut off valve.** This component is assembled from standard piping to allow connection of the supply line (i.e. fire hose) to the injection manifold or pump intake lines. It has female fire-hose thread on one end and reduces to a brass 2-inch male cam on the other, with a ball valve in between to allow quick shut-off of the water supply immediately adjacent to the injection equipment. A 2-inch spa hose completes the connection from the cam to the Dosmatic™ assembly (typically the inlet side of the in-line filter).

iii. **Water supply.** If using clean water, and depending on the distance to the water supply, it is generally a good idea to plumb a simple tap off of the adaptor so that there is a ready source of clean water near the work area.

iv. **Pump.** If the water tank is used, a pump is required to transfer water from the water tank to the injection manifold. The transfer pump must have sufficient flow capacity to handle the targeted total injection rate, and must supply sufficient pressure to overcome losses in the manifold, lines and formation. (Note that the vacuum breaker on the 10-channel injection manifold causes significant losses, 15-20 psi)

v. **Power supply.** To operate the transfer pump. If the site does not have power, a generator will be required. Each generator will require secondary containment for refueling in the form of 6 milliliter (mL) visqueen underlying and surrounding each generator and will be bermed around the edges to provide containment.

2. **Groundwater Receiving Chamber**. The central header will act to receive groundwater processed from the extraction pumps (or water supply source) and control the water pressure to the EVO amendment manifold (Figure B-2.2). The chamber consists of a header made of standard 4-inch polyvinyl chloride (PVC) pipe with multiple inputs connected by cam-lok quick connectors (2-inch polypropylene) to the effluent lines from each extraction pump. A pressure regulating valve is connected to the effluent side of the chamber to reduce downgradient pressure below 100 psi.

3. **In-line filter.** Two bag filters will be plumbed in parallel in-line, downstream of the groundwater receiving chamber to remove fines from the extracted groundwater. The bag filter must have a minimum of 200 gallons per minute (gpm) capacity, and the filter element must have a nominal filter size of 74 micrometer (µm) at minimum. Pressure gauges with 0 to 100 psi capacity will be plumbed on either side of the bag filters to monitor pressure drop across the filters. Each bag filter will have ball valves installed on either side to allow for isolation of the filter for filter element changes.

4. **EVO Amendment Manifold**. Rather than use a second transfer pump to move the EVO, the injection equipment features proportional feed pumps (Dosmatic™ Advantage Injectors) that are water-driven. The proportional feed pumps are designed to dose the amendment into the water stream in direct proportion to the water flow rate. Five proportional feed pumps are shown in Figure B-2.2, which illustrates the delivery system, and additional Dosmatic™ Advantage Injectors can be added in parallel to increase the throughput of the system. A ball valve will be installed at the influent to the EVO amendment manifold to allow for isolation of the entire manifold. Individual Dosmatic™ Injectors will be installed in parallel within the manifold. Upstream globe valves on each branch allow control over the flow rate going through each Dosmatic™ Advantage Injector. Each Dosmatic™ Advantage Injectors will be installed on a bypass with ball valves on either side to allow for isolation of the injector for maintenance, and allow for flow of groundwater without amendment through the manifold for equipment flushing purposes. Flow meters with a minimum capacity of 50 gpm will be installed downstream of each Dosmatic™ Advantage Injector on individual branches to monitor flow rates and ensure that the capacity of each Dosmatic™ Advantage Injector (40 gpm) is not exceeded.

5. **Distribution Manifold**. A multi-channel distribution manifold splits the EVO-amended water stream between multiple lines, for delivery to multiple injection wells simultaneously (refer to Figure B-2.2). The distribution manifold consists of a ball valve at the influent end for isolation of the entire manifold, a header made of standard 4-inch Schedule 40 PVC pipe and a mechanical totalizing flow meter (brass; minimum capacity up to 30 gpm) on each delivery channel. A needle valve is situated on the effluent side of each flowmeter to adjust the flow rate in each line independent of the other channels. The manifold

outputs feature male cam-lok quick connectors (2-inch plastic) threaded into each needle valve.

6. **Amendment Delivery Lines**. The lines that carry the amendment solution from the distribution manifold to the individual injection wells are 2-inch braided PVC hose with female cam-lok quick connect fittings fixed to the hose ends with hose barbs and gear clamps. Most of the lines are 50 feet (ft) long, but can be readily connected together to cover longer runs as needed (requires a male/male adaptor to connect hoses).

7. **Injection Wells**. Injection well construction details will be discussed in the Technical Memorandum slated to be issued by ECC in 2007.

8. **Well-Head Fittings**. Each injection well requires a custom-built well-head fitting such as the one depicted in Figure B-2.2, which is designed for use with a 4-inch well. The fitting consists of a PVC cross to which 2 ball valves (2-inch), a dual vacuum/pressure gauge (-30 to 30 psi) and a clear sight tube are attached. The sight tube is 2-inch clear PVC pipe. The well-head fitting is secured to the well with a Schedule 80 PVC flange fitting (9-inch outer diameter [O.D.], 4-inch inside diameter [I.D.]). This flange fitting is bolted to the flange fitting installed on the well head with a rubber gasket between flanges to provide a tight seal for pressurized injections. The clear PVC of the well head is connected to the flange fitting through a 4-inch to 2-inch reducing coupling solvent welded to the flange and clear PVC pipe. The ball valve on top of the well-head fitting serves as a vent, allowing air to leave the well as it is filled with fluid. The ball valve and vent line on the top of the well must have a 1-inch ID or greater to allow water level measurements through this port. The amendment delivery line attaches, via cam-lok quick connectors, to the 2-inch ball valve on the side. This valve can shut off flow to the well quickly if necessary.

9. **Sampling ports**. Sampling ports, consisting of PVC tees with cam-lok quick connectors and a simple valve, can be added to the lines after the dose pump, or at an injection well-head fitting, if samples are to be collected.

10. **Equipment decontamination supplies**. It is necessary to periodically clean the amendment delivery lines, the proportional feed system and the distribution manifold. This is typically accomplished by recirculating solutions of detergent (Alconox), bleach and water. The following supplies will be needed:
    a. Buckets.
    b. Brush with plastic bristles. To clean filter etc.

c. Alconox.
d. Household bleach (~5-6% sodium hypochlorite).
e. Trash pump and power supply to recirculate cleaning solutions.
f. 1,000 gal Tanks. At least 4, to hold cleaning solutions and act as recirculation reservoirs.

11. **Tools**. Various small tools, such as screwdrivers and pipe wrenches, will be useful to tighten fittings on the equipment. Buckets for water, at least one of which has been calibrated for volume, are required. Squirt bottles, filled with Alconox solution and clean water, are useful for cleaning well casings and other pieces of equipment.

12. **Trailer**. The EVO proportional feed delivery system will be mounted to a trailer to allow for ease of transportation of the equipment to various locations within the site, and allow for easy storage of equipment.

13. **Emulsified Oil**. The EVO should be ordered well in advance (6 months notice, 3 months to delivery) of planned field activities to ensure that supplier will have sufficient material available for the job. Ensure that necessary arrangements are made to unload delivery truck and stage the shipping totes (e.g., large tire, off-road fork-lift on hand to move totes).

14. **Secondary containment**. The totes will be stored on site in a Connex storage box or under a shade canopy to minimize exposure to the sun. These areas will be underlain by 6 mL visqueen and bermed around the edges to provide containment.

15. **Spill kit**. The kit should contain absorbent socks and granular absorbent, as well as a storage drum for spent sorbent. It should include a shovel and/or broom for picking up spent sorbent.

B-2.2.3 Preparation

All the equipment should be assembled and inspected (for cracks, leaks, worn seals, dirty equipment, missing parts, etc.) in advance of field activities. Materials and equipment should be ordered prior to commencing field work. The work plan and the health and safety plan should be reviewed by all personnel involved. If the project requires multiple phases of injection, the injection sequence should be determined in advance and a suitable staging area for the injection equipment and the containers of EVO should be selected.

B-2.2.4 Field Procedures

B-2.2.4.1 Emulsified Vegetable Oil Injection

B-2.2.4.1.1 Set-up

The injection equipment should be assembled as depicted in Figure B-2.2. The well-head fittings should be securely attached to the wells by using the flange fittings. The Dosmatic™ injector must be located no more than 15 ft vertically and 50 ft horizontally from the bottom of the amendment (EVO) container(s). A solution filter (125 μm filter mesh) should be kept on the Dosmatic™ uptake line to protect the injector from damage, and a weighted end is useful to ensure that the uptake line remains submerged in the EVO. The proportional feed system and injection manifold should be situated such that the operator can safely and easily take readings (injection volumes, flow rates) and make flow rate adjustments over the course of the injection process.

Assemble the equipment as follows:

1. Measure water level elevations in all monitoring and injection wells to establish the baseline condition prior to injection.
2. Attach a well-head fitting securely to each injection well by using the flange fitting. Ensure that the two flanges are clean where the rubber gasket must seal against the two flanges.
3. Install groundwater extraction pumps into each of the selected extraction wells.
4. Connect groundwater extraction lines to central header (4-inch PVC) at inlet side of pressure gauges.
5. Connect output channels on the distribution manifold to well-head fittings by using the amendment delivery lines (2-inch braided hose). Close the manifold inlet valve and all output valves. Make certain that any unused channels have closed valves and, if available, end caps.
6. Connect an uptake hose to the suction piston of the Dosmatic™ injector. A check valve attaches to the base of the piston. The suction line should have a solution filter on the inlet end, preferably attached to a weight (for example, a metal bell reducer with a hose barb that connects the solution filter and the suction hose).

B-2.2.4.1.2System Testing and Calibration

Upon completion of the system set-up, the system should be tested for leaks and the instrumentation checked prior to beginning the injection of EVO, as follows:

1. Record totalizer readings from all mechanical flow meters. Note which meters connect to which injection wells, and put temporary labels at all meters that correspond to the injection well identifiers.
2. Fill a couple of buckets with water. Place Dosmatic™ injector uptake hose in a bucket of water. Adjust the turndown ratio of the injector(s) to maximum (2.5% on the A40 model). Monitor the water level in the bucket so that the suction side of the injector does not run dry.
3. Close all valves except for valves at the extraction well head to prevent flow through the system. One by one, turn on each groundwater extraction pump long enough to pressurize the hose, and then turn the pump off. Inspect all hose connections to the extraction well for leaks and address as needed.
4. Open the ball valve at the inlet end of the amendment injection manifold, allowing flow to the system and initiate groundwater extraction from one well long enough to pressurize the system, and then terminate pumping. Inspect system for leaks and address as needed.
5. Following a similar process, partially open one globe valve within the amendment injection manifold and all other ball valves on the branch for the corresponding Dosmatic™ injector, keeping the ball valve at the inlet to the distribution manifold closed. Inspect for leaks and address as needed. Do not build pressure beyond 100 psi at the Dosmatic™.
6. Open the ball valve at the inlet to the distribution manifold and a needle valve on one output channel. Open the ball valve at the corresponding well head, allowing water to flow into the well. Keep the vent valve closed. Inspect delivery line and connections for leaks and address as needed.
7. Once continuous flow is established, check the Dosmatic™ injector. It should make a noticeable click; the frequency of the clicks increases as the flow rate through the pump increases. Check that the suction hose is in fact taking up water from the bucket.
8. Monitor flow rate with the sweep hand on the water meter. Monitor pressure at the well-head. Increase flow (open needle valve further) gradually, monitoring the pressure in the well (may need to open globe valve further at this point). Continue to increase the flow rate until the

pressure in the well reaches 20 psi and note the flow rate. If the flow rate reaches anticipated injection rates, note the maximum pressure reached. Anticipated injection rates for Source Area Treatment, Source Area Biobarrier, First Sand Biobarriers, and Shell Horizon Biobarriers are approximately 10 gpm. The anticipated injection rate for the Second Sand Biobarrier is approximately 25 gpm

9. Once one well has been leak and pressure tested and the injector has been inspected, the Dosmatic™ injector should be calibrated. While there is no flow through the system, place the injector suction hose into a bucket of water that has volume calibration markings. Adjust the turndown ratio to the desired setting. The turndown ratio is the ratio of emulsion being injected to water passing through the injector. For example, an injector setting of 2.1% will yield 1% oil (1.1% injector setting will yield 0.5% oil) in the amendment fluid when using Newman Zone, which is 48% oil by volume. Upon completion of calibration, close the ball valve at the well head, close the needle valve at the distribution manifold, the ball valve at the inlet to the distribution manifold, and close all valves within the manifold to prevent flow through the calibrated Dosmatic™ injector (keeping the ball valve at the inlet to the amendment injection manifold open). If the well is pressurized, slowly open the vent valve to release the pressure.
10. Repeat steps 5 to 9 for each injection well and Dosmatic™ injector, until all lines, injectors, and well-head fittings have been tested.
11. As each well is tested, take note of the volume taken up by the injector and compare this to the volume applied to the well. Adjust the turndown ratio to achieve the desired feed ratio and note the actual setting (scale reading) required to deliver this ratio on the log sheet.
12. Inspect the in-line filters. With the water supply shut off, drain the cartridge into an empty bucket if solids have accumulated. Clean filter element if necessary.

B-2.2.4.1.3Amendment Addition

The EVO will be amended over a period of several days to weeks, with daily operating periods of 8 to 10 hours. Since the EVO injection is governed by the total volume injected, the duration will be dependent on the specific capacity of the injection and/or extraction wells, which in turn depends on the hydraulic conductivity of the target formation. The procedure to be followed for each EVO injection day is:

1. Water levels in the injection wells will be measured prior to start of injection in the morning and after the well has been depressurized at the end of the day (through the vent ball valve - after the well has been depressurized), to evaluate the rate at which the injection mound dissipates. Water level measurements will be recorded in the comments section of the log sheet Emulsified Vegetable Oil Injection - Injection Flow Measurements (Attachment B-2.1).

2. Connect all equipment as outlined in Section B-2.2.5. Make sure that the correct channels are connected to the correct wells and that the log sheet, Emulsified Vegetable Oil Injection – Injection Flow Measurements, for each injection well indicates which flow totalizer is in use for that well. Each well should have its own injection log sheet.

3. Ensure that the Dosmatic™ uptake hose is submerged in the EVO. Secure the hose in place if necessary (due to pulsing of the pump). Check that the injector is set to the proper turndown ratio.

4. Record totalizer readings from all water meters that will be used. Record start time, and quantity of amendment in source (tote).

5. With all valves closed, turn on the extraction pumps.

6. Open the valves on the bypasses to each bag filter. Open valves on the amendment injection manifold, beginning with the ball valve at the inlet end, then upstream globe valves and moving towards downstream valves. On each branch of the manifold, the bypass valves to the Dosmatic™ injectors will be opened, and the main branch valves will remain closed to ensure that all groundwater is fed through the Dosmatic™ injectors. Open the ball valve at the inlet to the distribution manifold.

7. Open the appropriate needle valves. Open the well-head ball valves, one at a time, ensuring that the flow rate into each well is acceptable. Adjust the flow rate in individual channels by using the needle valves.

   Note: What flow rate is 'acceptable' will depend on the site. If this is the first time injecting into the well, a flow rate of 1-2 gpm should be used initially, to evaluate the pressure development. Otherwise, the flow should be about what was achieved the previous day. The pressure at the well head should be maintained below the site target, and certainly below the maximum pressure achieved during leak testing (Section B-2.2.5).

8. As flow proceeds into the well, pressure may build up. Pressure in the well can be relieved by carefully opening the vent valve. Be sure that the operator's face is not directly above the vent valve. When venting, stay

by the well. Watch the site tube to see how amendment is flowing. Under certain conditions the fluid level in the well can be brought up to just above the base of the site tube.

9. Once flow appears to be relatively stable, note the pressure at each well.

10. The sweep hands on the water meters can be timed to estimate the flow rate. Use the needle valves to balance the flow rates on individual channels as much as possible.

    Note: At some sites the decision can be made to simply operate each well as fast as possible without exceeding the maximum pressure.

11. Periodically (every 1 to 2 hours), time and date, flow totalizer readings, well-head pressure gauge readings and the volume of EVO remaining in the tote should be recorded on the log sheets (Injection Flow Measurements).

    Note: The disposable shipping totes are not graduated, so volume must be estimated by visual inspection. A graduated stick (suggest narrow diameter PVC with round end cap as it must not puncture the tote liner) can be used as an aid, since the shipping tote has a square cross-section.

12. Periodically monitor water levels in the designated wells, per step 1 above.

13. Monitor the volume of EVO remaining. Ensure that a replacement tote is on hand, unless it is the final quantity of EVO to be injected, .

    a. If necessary, flow can be stopped to the wells to facilitate the change-over between EVO containers. To do this, shut off the ball valve at the inlet to the distribution manifold, then the ball valve at the inlet to the amendment injection manifold. Move the injector uptake hose to the new container. Re-open the upstream ball valve at the inlet to the amendment injection manifold and then the downstream ball valve at the inlet to the distribution manifold to re-initiate injection.

    b. Record time of stop and re-start, along with flow totalizer readings. This data is important for checking the bulk oil dose ratio.

14. Check the calibration of the Dosmatic™ injector periodically. The actual frequency will depend on how long each tote is lasting, but a reasonable guideline is once per tote (250 gal).

    a. Fill a calibrated vessel with EVO.

b. Stop flow through the apparatus by closing the ball valves at the inlet to the amendment injection and distribution manifolds as outlined in step 13a above. Record time and flow totalizer readings. Place the injector uptake hose in the calibrated vessel. Re-start flow by opening the valves. Record time of re-start.

c. Before the injector runs out of EVO to draw up, stop injection again. Record time and flow totalizer readings.

d. Use the ratio of EVO used to volume injected to check the calibration of the injector. Adjust turndown ratio if necessary. Document change on log sheets (Injection Flow Measurements) if an adjustment is made.

e. Repeat steps a to d until desired setting is reached.

f. Place the injector uptake hose back in the EVO tote. Re-start flow by opening the valves. Record time of re-start. Record volume of EVO taken up during calibration test.

15. At the end of day, collect the final set of water level data prior to shutting down injection. Cease injection.

16. Prior to leaving the site at the end of the day, run some clean, non-EVO-amended water through the equipment and the delivery lines.

a. First, record the well-head pressures.

b. Stop flow by closing the downstream ball valve at the inlet to the distribution manifold, then the upstream ball valve at the inlet to the amendment injection manifold. Record time and flow totalizer readings.

c. Place injector uptake hose in a bucket of clean water. Seal EVO tote. Restart flow through the system by opening the valves.

d. Allow about 25 to 50 gal to flow into each well to flush EVO out of the equipment. Once a line has received sufficient flush volume, stop flow in that channel by closing the needle valve. Close the ball valve at the well-head to ensure no flow in the delivery line. Shut down extraction pumps as required to limit pump stress while maintaining adequate flow through to the injection wells still in operation. If all wells are complete, shut off flow with the ball valves at the inlet to the amendment injection manifold and at the inlet to the distribution manifold. Close all other valves within the amendment injection manifold.

e. Record flow totalizer readings.

f. Shut off the groundwater extraction pumps.

g. As the water level in the injection well recedes, it will put negative pressure on the well. Allow pressure in the well to return to nearly zero and then slowly open the vent valve.

h. Check that there is no pressure remaining in the injection equipment, and release it if there is. This might require reopening one delivery line and well-head vent.

17. On subsequent operating days for the same wells, inspect the equipment and connections before proceeding from step 2 above.

18. If EVO addition is complete or at the end of each work week, the final water flush should be approximately 250 gal into each injection well. This will push the amendment out of the well and filter pack and avoid biofouling of the well screen.

B-2.2.4.1.4Contingency Plan

The injection design will designate target injection volumes for each well, and the estimated duration of the injection process will be based on average injection well flow capacities. Factors that may influence the system performance have been identified and discussed in detail in the RD (Remedial Design). Possible contingency plans for those circumstances are as follows:

1. The average achievable injection flow rate in the target area is lower-than-expected, resulting in longer-than-expected durations to achieve injection of the target volumes. In this case, it is likely that the work period will be extended.

2. Achievable injection flow rate varies considerably between wells, resulting in certain wells reaching injection of their targets volumes before others. In this case, injection into the wells that have reached their targets should be terminated and extraction rates decreased proportionally while, injection into the remaining wells should continue until their target volumes are achieved.

3. Achievable extraction flow rates for a given drawdown and interception of injected EVO at the operating extraction wells are two important considerations. Extracting groundwater at a rate that exceeds the capacity of the well to recover should be avoided and the extraction rate decreased to a sustainable rate in the well. The total injection rate will then decrease correspondingly, which will result in longer injection times. Interception of the EVO at the extraction wells will increase the

likelihood of biofouling within the distribution manifold, extraction pumps, process lines and extraction and injection wells as they sit idle during off hours. Should this occur, a more frequent and detailed decontamination effort will be required at the end of each operating day. This will have a direct impact on achievable daily injection times.

4. If extracted water contains a significant amounts of sediment as evidenced by clogging of the filter bag, frequent filter changes/cleaning will be required.

B-2.2.4.2 Bioaugmentation

The addition of KB-1™ (a mixed dehalorespiring bacteria culture) to promote complete dechlorination of TCE (including; cis-1,2-dichloroethene, and vinyl chloride) to ethene should be completed in the early stages of amendment addition (i.e., after approximately one-quarter to one-half of the total amendment fluid has been injected) so that the microorganisms can be distributed over a large area. Most dechlorinating cultures, including KB-1™, are sensitive to oxygen and should be applied under anaerobic conditions. It is recommended that anoxic water be generated as described below.

The target quantities of KB-1™ culture that are to be amended to each well are determined as part of the implementation plan, in consultation with the vendor (SiREM). KB-1™ will be shipped to the site in stainless-steel pressure vessels. Storage facilities for these vessels should be available. A MSDS for KB-1™ is provided in the HASP.

Amendment of KB-1™ culture should be performed by personnel trained to do so. KB-1™ will be amended directly to each well through the well-head fitting. It will not be injected via the manifold and delivery lines. The process involves the following steps:

1. At least 8 to 12 days prior to introducing KB-1™, prepare a tank of a suitable size (6,500 gal) to contain 400-600 gallons of anoxic water per bioaugmentation location (injection well). This is prepared by mixing sodium lactate and water and allowing the naturally occurring bacteria to consume the oxygen. If hydrant water is used to fill the tank, it is best to add several hundred gallons of groundwater to the tank as well. This will increase the initial bacterial population within the tank, decreasing the length of time for the tank of water to reach anoxic conditions.

2. Use a water parameter meter to monitor the dissolved oxygen (DO) and oxidation reduction potential (ORP) once the tank has been sitting for at least 8 days on a daily basis until the DO has decreased to at least 0.5 mg/L and the ORP to -75 mV. When this has occurred, the tank of water is considered to be anoxic and ready for use during KB-1™ bioaugmentation.
3. Prior to introducing KB-1™, prepare the well by injecting some anoxic water from the tank (approximately 200 to 300 gal) amended with EVO per the WP (Work Plan). This will create reducing conditions in the vicinity of the injection well.
4. By using a drop line, flush the well with an oxygen-free gas, such as argon (supply of argon should be available onsite), to purge any residual oxygen from the water in the well and from the air standing in the well bore.
5. Transfer the desired volume of culture from the KB-1™ shipping vessel to the volumetric delivery vessel. This is done by using the pressure from the argon gas to push the KB-1™ solution from one vessel to the other.
6. Deliver the specified volume of KB-1™ to the middle of the screened interval through a drop line, again using argon gas to push KB-1™ from the delivery vessel into the well.
7. Add another 200 to 300 gal of anoxic water, with EVO amendment, to the well immediately after KB-1™ addition to push the culture out of the well and into the formation.
8. Resume regular EVO injection.

B-2.2.5 Equipment Decontamination and Disposal

B-2.2.5.1 Supplies and Equipment

The decontamination procedures will require the following equipment:

1) Four 1,000 gal tanks, initially clean, to hold decon water.
2) Alconox. Prepare solution according to manufacturer's instructions.
3) Household bleach (up to 6% sodium hypochlorite). Prepare a 10% solution of bleach, adding one volume of bleach to 9 volumes of water.
4) A pump to circulate water through the lines to be cleaned. The pump should be capable of relatively high flow rates. Pump output fitting

should have a male cam-lok quick connect for easy attachment to distribution manifold and the amendment lines. Pump intake should be protected by a filter if possible.

B-2.2.5.2 Decontamination Procedure

B-2.2.5.2.1Amendment\Groundwater Conveyance Lines

The injection equipment (and extraction lines if EVO is present in those lines), in particular the amendment delivery lines, may gradually start to develop some biological growth as a result of lying in the sun filled with the EVO electron donor. It is best to limit this to the extent possible by periodically (at minimum once per week) cleaning the delivery lines. The decontamination procedure is as follows:

1) If possible, have spare, clean amendment delivery line available. This can be substituted for the segments to be cleaned, with little disruption to the injection process.
2) Prepare four 1,000-gal tanks for decontamination liquids. One containing Alconox solution, one containing bleach (10% solution,), and two containing water.
3) Shut down flow in affected line to be decontaminated. Record time and flow totalizer reading. Once the well-head indicates negative pressure, drain the line into the well by disconnecting at the manifold (needle valve).
4) Remove amendment line(s). Replace with clean amendment lines.
5) Re-start flow to the well. Record time of re-start.
6) Connect affected amendment delivery lines, in series, to the recirculation pump.
7) First circulate water (container A) to rinse residual injection fluid from the hose. This should be a separate container because the rinsate will be quite milky. A quick rinse is sufficient. Drain tubing back to container A.
8) Recirculate the Alconox solution (container B) through the tubing for ~20 minutes. Flex the tubing if necessary to dislodge biofilm. Drain tubing back to container B.
9) Recirculate the bleach solution (container C) through the tubing for ~20 minutes. Drain tubing back to container C.

10) Recirculate water (container D) through the tubing for ~20 minutes. Drain tubing back to container D.

11) Tubing should be ready to be used again (store in cool dark place until reuse).

12) Note that if multiple sections are affected, it is possible to treat several sections together by simply connecting the tubing in series to form a large coil. While this saves time on the recirculation, it may make it difficult to drain back to each drum. Total volume of the coil must also be less than the volume of solution available.

B-2.2.5.2.2Injection Manifold

The entire distribution apparatus should be decontaminated after each week of use. This can best be done toward the end of the day, since the first step is to rinse as much EVO from the equipment as possible. Proceed as follows:

1) With the injector uptake hose in a pail of clean water, run several gallons through the entire injection apparatus.

2) With flow stopped, drain the filter cartridge and remove the housing. Clean the filter element and replace.

3) Switch the water supply for the manifold to that delivered from a pump, so that decon solutions can be recirculated.

4) Make sure all injection lines return to the appropriate source tank. Note that depending on the flow rate achievable by the pump, it might be necessary to clean only a few channels at a time, to make sure that the recirculation rate is sufficiently high to dislodge material from the hoses. All channels should be operated eventually, to ensure there are no dead end spaces within the manifold.

5) Recirculate the Alconox solution (container B) through the apparatus for ~30 minutes. Flex the tubing if necessary to dislodge biofilm. Drain the tubing back to the container B, if possible. A bucket of Alconox solution for the injector uptake should also be used.

6) Recirculate the bleach solution (container C) through the apparatus for ~30 minutes. Drain tubing back to container C, if possible. A bucket of bleach solution for the injector uptake can also be used.

7) Recirculate water through the apparatus for ~30 minutes. Drain tubing back to container D, if possible. Use a bucket of clean water for the injector uptake.

8) When finished, drain the filter cartridge and remove the housing. Clean the filter element and replace.

9) If possible, run clean water though the manifold and amendment delivery lines and direct this water to waste.

B-2.2.6 Documentation

Sample log sheets (Attachment B-2.1) will be completed in conjunction with a routine daily field log of all pertinent site activities. Copies of the log sheets and field QC (quality control) will be provided/communicated to the project manager on a daily basis.

B-2.2.7 Quality Assurance

Quality assurance (QA) during EVO injection will be accomplished by following these standard operating procedures. In addition, the project manager or designated field QA person will review all field notes, daily field logs, water level measurement logs and injection flow logs (Attachment B-2.1) to ensure that the field operations conform with these guidelines. Daily tracking of injection flow rates and total volumes will allow the progress to be monitored as the work proceeds.

B-2.3 GROUNDWATER SAMPLING PROCEDURES

This SOP describes the procedure that will be used for groundwater sampling.

B-2.3.1 Field Preparation

Prior to the start of each sampling event, the following activities shall be performed to prepare for the sampling event:

- The site-specific Health and Safety Plan (HASP) and Sampling and Analysis Plan (SAP) shall be reviewed and signed by all sampling personnel.

- The sampling personnel shall gather the appropriate containers and forms for the samples to be analyzed for the required constituents. Appropriate forms include the chain of custody, labels, and a purge and sampling record.

- The sampling team will collect the appropriate QA samples as specified by the (SAP) for each day's sampling listed using the appropriate sample containers, naming conventions, analyses, and quantity.

- Ensure a water level meter will be present during sampling.

- Obtain a Horiba U-10 meter (or equivalent) to measure pH, specific conductivity, temperature, dissolved oxygen, turbidity, and oxidation reduction potential (ORP).

- Calibrate Horiba U-10 (or equivalent) at the beginning of every day in accordance with manufacturer's instructions by using provided calibration solution. The Horiba instrument shall also be recalibrated any time during sampling activities if inconsistent readings are suspected.

- Ensure that calibrated containers or drums are available in order to measure discharge rates, total discharge, and contain purge water.

- Ensure that new tubing will be available for every sample taken.

B-2.3.2 Groundwater Sampling

B-2.3.2.1 Pre-Sampling Activities

Groundwater sampling will be conducted no sooner than one week after the completion of development of the sampled wells. Before purging, purging and sampling equipment will be thoroughly cleaned and decontaminated to prevent cross-contamination. Additionally, water levels will be measured by using an electric water level indicator by using the following procedure:

- Measure the depth to water to the nearest ±0.01 ft (0.003 meter [m]) by using a water level meter consisting of a graduated cable and probe. Calibration of the water level meter will be checked with a measuring tape before use. Decontaminate the water level meter prior to introduction into the well.

- Lower the water level meter probe into the well slowly. The water level indicator will create a sound or turn on a light when the probe comes into contact with water.

- Confirm that the water encountered by the water level indicator probe is the groundwater level by raising and lowering the indicator into and out of the water several times. False indications of water level may be provided by condensation along the well casing or high humidity within the well.

- Document the reading (in feet) indicated by the graduated cable at the reference point (water level depths will be measured from a surveyed elevation, typically, the north edge of the top of casing, or the top of the flange (north side) for the injection wells). Subtract this value from the surveyed reference point elevation (in feet above mean sea level) to calculate the water level elevation (in feet above mean sea level).

- While extracting the water level indicator cable and probe from the well casing, remove water and particles from the cable by passing the cable through a clean paper towel.

B-2.3.2.2 Purging Activities

A low-flow purging method will be used to gather samples, using the following procedures (as per microseeps laboratory):

- Gloves worn during purging shall be discarded and replaced with clean gloves for sampling;

- Measure the depth to water (DTW) of the well and the total depth;

- Use a variable speed pump and direct the pump effluent through a flow-through cell that contains properly calibrated probes for conductivity, pH, temperature and D.O. Ensure that the effluent of the pump leads into a proper waste receptacle.

- Begin pumping at the fastest rate possible without displaying significant draw-down.

- If the static head decreases more than a half inch, decrease the flow-rate, record the new DTW and continue.

- Purge until readings from the flow-through cell stabilize. (Three successive readings taken five minutes apart should all be within 10% of their mean.)

- If purging is done appropriately, stabilization will occur rapidly after one well volume of water is pumped.

- Begin recording probe readings after one well volume is purged.

Water purged from the wells will be monitored for temperature, pH, conductivity, dissolved oxygen, oxidation/reduction potential, and turbidity to document changes in water quality. Water quality field parameters will be recorded every three minutes or each time the internal volume of the flow cell is replaced with water during purging. Additionally, color, appearance, and any noticeable odors will be documented.

After the groundwater has reached stabilization and purging is complete, sampling should be conducted immediately. For bulk sampling, laboratory-provided sample containers (with appropriate type and volume of preservative) will be filled directly from the bladder pump discharge hose while maintaining the flow rate established during purging to minimize any potential agitation of the groundwater.

B-2.3.2.3 Sampling Activities

Samples will be collected in accordance with the following guidelines:

- Gloves worn during purging shall be discarded and replaced with clean gloves for sampling;

- Sample containers shall not be opened until immediately prior to filling;

- The insides of sample containers shall not be touched, including with clean gloves;

- VOC samples will be collected using a bladder pump;

- Sampling containers shall be filled slowly and with minimal aeration through the hose from the pump (do not touch the tubing to the inside of the sample container);

- Sampling with VOA vials for VOC sampling will be first;

- Sampling containers shall be filled completely, but not overfilled, as this will result in the loss of preservative;

- QA samples will be collected as specified on the sample collection log, will be properly labeled, and entered on the chain-of-custody.

- Sampling containers shall be filled as expeditiously as possible to minimize the time between filling the first sample container and the last; and

- Filled sample containers shall be labeled, prepared for transport, and stored in an ice chest or cooler as described below.

Immediately following sample collection, each sampling container will be sealed, labeled, and preserved with ice in an ice chest (at a temperature of 4±2°C). Breakable or otherwise fragile sample containers will be stored in travel cases or wrapped in plastic bubble-wrap to reduce potential damage during delivery to the laboratory. Typically, samples will be delivered within 24 hours of sample collection to provide time for sample preparation and testing within EPA holding times.

B-2.3.2.4 Sample Labeling and Chain of Custody Protocol

Each sample container shall be labeled with a distinct and clearly written label. The field sampling personnel shall complete the information on the sample label at the time of sampling by using indelible ink. The coding to be used to identify each sample shall be standardized.

A note in the field activity report sheet shall be made to correlate the sample identification number to the well identification number. Labels shall be affixed to a clean and dry surface of the sample bottle and double-checked for completeness. Sampling containers shall be stored properly in an ice chest or cooler to reduce the potential for breakage, spillage, or label deterioration. Proper sample storage consists of "bubble wrap" around glass bottles or vials, sealable Ziploc®-type bags around sample containers, ice and/or blue ice packs in the cooler, and packing material to occupy remaining voids. Sample containers shall be stored in ice chests immediately following sampling. The samples shall be maintained in the cooler with ice or blue ice packs between the time the samples are collected and the time the samples are analyzed in the laboratory. The presence of solid ice in the ice-cooler will be periodically checked in the field and recorded on daily field sheets. The presence of ice or blue ice packs and the temperature of the samples shall be measured and recorded upon receipt by the laboratory. On hot days, the field samplers shall periodically monitor the cooler to replace melted ice, as needed, to maintain the acceptable volume of ice. The coolers containing the groundwater sample containers shall be delivered to the Laboratory on the same day the samples are collected or the following day by courier. Each set of

samples shall be accompanied by a chain-of-custody form, which outlines the contents of the cooler. QA samples will be kept with the respective sample containers to maximize representativeness of the QA samples. Information to be included on the chain-of-custody form is described below.

Chain-of-custody records will be maintained for each sample collected to provide an accurate written record of the possession and holding of samples from the time of collection through laboratory receipt. At a minimum, the following information will be specified for each sample on the chain-of-custody form:

- Site identification;
- Sample identification;
- Sample date;
- Sample time;
- Type of preservative, if appropriate;
- Laboratory analyses/methods;
- Special instructions to the laboratory (e.g., short hold time, quick turn-around time); and
- Signature(s) of the sampler(s).

The sampler and any other intermediate handlers of the samples (i.e.,shipping company representative, laboratory courier) will sign the form and record the date and time at which the samples changed possession. The completed chain-of-custody form will be attached to the ice chest. Upon receipt of samples by the laboratory, the laboratory will be responsible for maintaining internal chain of custody of the samples.

B-2.3.3 Dissolved Hydrogen Sampling

B-2.3.3.1 Pre-Sampling Activities

Before sampling, sampling equipment will be thoroughly cleaned and decontaminated to prevent cross-contamination. Then choosing a pump for sampling will be done with the following procedures (as per microseeps website):

- A peristaltic pump will be used if possible such as the Geopump II or equivalent.

- If a submersible pump is used, there must be no current passed down-hole. An air actuated pump is preferred.

- If a bladder pump is used, the surge of the fill and squeeze cycle can create flow rates well above the optimum 300 ml/min. To compensate for this, use one of the following options:

    1. Decrease the duty cycle as much as possible so that the bladder does not completely fill and these rapid flow rates are not generated.

    2. Get a five gallon bucket, place the pump effluent hose into the bottom of the bucket and start the pump. When the bucket is near full, the standing water in the bucket can be used as a protective layer to impede atmospheric contamination of the dissolved gas content of the water at the bottom of the bucket. Use the bucket as a surge tank and use a peristaltic pump, with the intake hose place dnear the end of the bladder pump effluent hose, to pump water from the bottom of the bucket and through the bubble strip apparatus or equivalent.

B-2.3.3.2 Sampling Activities

A low-flow purging method will be used to gather samples, using the following procedures (as per microseeps laboratory):

- Gloves worn during purging shall be discarded and replaced with clean gloves for sampling;

- Measure the depth to water (DTW) of the well and the total depth;

- Use a variable speed pump and direct the pump effluent through a flow-through cell that contains properly calibrated probes for conductivity, pH, temperature and D.O. Ensure that the effluent of the pump leads into a proper waste receptacle.

- Begin pumping at the fastest rate possible without displaying significant draw-down.

- If the static head decreases more than a half inch, decrease the flow-rate, record the new DTW and continue.

- Purge until readings from the flow-through cell stabilize. (Three successive readings taken five minutes apart should all be within 10% of their mean.)

- If purging is done appropriately, stabilization will occur rapidly after one well volume of water is pumped.

- Begin recording probe readings after one well volume is purged.

1. Remove one of the cell assemblies from the packing carton.

2. Connect the inlet tube of the cell to the outlet of your pump. The inlet tube is designed to connect to 1/4 O.D. hard tubing. Secure the connection using binder clips or cable ties.

3. Insert the drain tube of the cell into a waste container, keeping the end of the tube at the bottom of the container. Any waste container of suitable size may be used. A 2-Liter soda pop bottle may be placed in the waste container to determine pumping flow rate.

4. Secure the cell assembly so that the housing cover (stopper) is above the glass housing (i.e. upright). A ring stand and clamp are recommended for this purpose.

5. Turn the pump on and check for leaks. If any leaks are found, seal them before proceeding.

6. Measure, in mL per minute, the flow rate of the pump. If a 2-Liter soda pop bottle is used, the flow rate can be determined by measuring how many minutes it takes to fill the bottle and substituting the measured time into the following equation: Flow = 2000 mL/Time to fill (in minutes) Consult Table 1 to determine the equilibrium time needed to bubble strip at this flow rate.
Note: Use a flow rate between 100 mL/min. and 500 mL/min. Do not turn off the pump.

Flow rate (ml/ min)	Sampling time (min)
100-120	30
130-150	25
160-200	20
210-300	15
>300	10

7. Unclamp the cell assembly, invert it, and re-secure the assembly in the inverted position. Make sure the drain tube is still in the waste container and the end of the drain tube is near the bottom of the bottle.

8. Connect the stopcock to the syringe and the needle to the stopcock (zoom in on image). Place the stopcock in the open position (so that the stopcock handle is in-line with the syringe). Draw the plunger back on the syringe to the 20.0 mL mark pulling ambient air into the syringe.

9. Keeping the cell in the inverted position, insert the needle into the needle guide. Pierce the septum and inject the air into the cell creating the bubble. Withdraw the needle from the assembly and carefully place the needle into the cover. Do not discard the syringe apparatus.

10. Start timing and let the groundwater pump through the cell for time specified in the table from step 6 for your particular pumping speed. Meanwhile, be sure that the sample vial is properly labeled and that the flow rate and any other relevant field data are recorded in the field log.
Note: Be sure to keep the end of the drain tube at the bottom of the waste container. This will insure that outside air is not drawn into the cell. Failure to do this will invalidate the sample.

11. When equilibration time is up, turn off the pump, unclamp the cell, and re-clamp it in its upright position. See Image from step 1. Verify that the plunger of the syringe is pushed all the way in and that the stopcock is in the open position.

12. Insert the needle into the needle guide and pierce the septum. Withdraw 1 mL of gas by pulling back on the syringe plunger while holding the syringe body in place. Remove the syringe from the cell and expel the sample.

13. Immediately re-insert the needle into the needle guide and pierce the septum. Withdraw a 15 mL sample of gas (being careful not to pull any water into the syringe). With the needle still through the septum, close the stopcock and withdraw the needle from the septum.

14. Immediately insert the needle through the septum on the sample vial. Keeping the syringe and vial "in line", open the stopcock and completely depress the syringe plunger injecting the entire sample into the vial.

15. Keeping the plunger depressed, quickly remove the vial from the needle. Your sample is now ready to be packaged and shipped back to Microseeps for analysis. Do not cool the samples.

DECONTAMINATION

Pump at least 1 liter of potable water through the cell. The cell assembly is now ready for re-use. The only expendable part of the cell is the sampling septum. Normally, each septum may be used for the collection of up to 5 samples. If bubbles are seen rising up from the septum when the cell is inverted the septum MUST be replaced. Instructions for replacing the septum are provided below.

B-2.4 WATER LEVEL MEASUREMENTS PROCEDURES

This SOP describes the procedure that will be used to measure and record water level measurements.

B-2.4.1 Objective

The objective of water level measurements is to gain accurate measurements (to within 0.01 ft) of the depth of ground water for use during well installation, in the recording of data for the preparation of ground water elevation contour maps, purge volume calculations during ground water sampling, slug tests, packer tests, and pump tests.

B-2.4.2 Equipment

The following list of equipment may be utilized during water level measurements. Site-specific conditions may warrant the use of additional or deletion of items from this list.

- Electronic water level indicators – graduated

- Tap Water
- Alconox, liquinox or other non-phosphate concentrated laboratory grade soap
- Deionized Water
- Pump Sprayer
- Pint Squeeze bottles
- Any necessary personal protective equipment (gloves, eyewear, Tyvek suits)
- Air Monitoring instruments as required (HNu, OVM, etc.)
- Field logbook and monitoring form
- Well keys
- Previous measurement data (if available)
- Oil/water interface probe
- Plunker on tape

B-2.4.3 Field Procedure

The following procedures should be followed during water level measurements. Procedures may vary depending on the equipment used and contaminants present at the site. Site specific conditions may warrant the use of stringent air monitoring and potentially more significant decontamination scenarios.

1. Record the condition of the well (protective casing, concrete collar, and lock in place etc.).

2. Check that the water level tape has no obvious kinks or damage.

3. Put on latex or other sterile gloves. Stand upwind of the well; unlock and open the well. If a vented cap is present, conduct well mouth air monitoring from the vent. If a non-vented well cap is present, remove the cap and monitor the well mouth immediately. Record all pertinent air monitoring results (sustained, dissipating, background, odor).

4. Identify the previous measuring point marking or notch on the riser or casing (if present). Record this location in the field logbook or on the water level monitoring form (Attachment B-2.1).

5. Using a previously decontaminated water level indicator, turn on the meter, check the audible indicator, reel the electronic probe into the well riser (with the increments visible) slowly until the meter sounds, grasp the tape with hand, withdraw the tape and lower it again slowly until the

sound is again audible. Check the depth to water on the tape and make a note of the depth to within .01 feet. Lower the probe again slowly and repeat the measurement for accuracy. A one-foot error is the most common measurement type during water level measurements. Be sure to read the depth correctly on the tape.

6. Record the depth to water from the measuring point in the field logbook or on the water level monitoring form.

7. Procedures utilized during water level measurements where free phase petroleum products are floating on the water table should be modified to include the use of the oil/water interface probe. The procedures during the use of this probe should be implemented similarly and by manufacturers' specifications. Through the use of this probe, product thickness can be determined.

8. Decontaminate the probe and any obviously soiled tape. Refer to Section 5 below for equipment decontamination.

B-2.5 EQUIPMENT DECONTAMINATION PROCEDURES

This SOP will be used to direct field personnel as to the proper procedure for decontamination of field equipment used during the investigation of sites with hazardous waste.

B-2.5.1 Objective

The objective of equipment decontamination is to remove potential contaminants from a sampling device or item of field equipment prior to and between collection of samples for laboratory analysis and limit personnel exposure to residual contamination that may be present on used field equipment.

B-2.5.2 Equipment

The following equipment may be utilized when decontaminating equipment. Site-specific conditions may warrant the use or deletion of items from this list.

- Alconox, liquinox or other non-phosphate concentrated laboratory grade soap;
- Deionized water;
- Pump sprayer;
- 1-pint squeeze bottle filled with pesticide-grade hexane;

- 1-pint squeeze bottle filled with pesticide-grade methanol;
- 1-pint squeeze bottle filled with ten (10) percent nitric acid;
- 1-pint squeeze bottle filled with one (1) percent nitric acid;
- Five large plastic wash basins (24 inches by 30 inches by 6 inches deep);
- Two coarse scrub brushes;
- Small wire brush;
- Aluminum foil;
- Polyethylene sheeting;
- Two large capacity barrels;
- All necessary personal protective equipment (gloves, eyewear, Tyvek);
- Extra quantities of above listed liquids;
- 4 inch Schedule 40 PVC pipe 4 feet in length with an end cap for decontaminating groundwater pumps and associated tubing (if needed); and
- High pressure sprayer with water supply.

B-2.5.3 General Procedures

The following procedures should be used for decontaminating field equipment. Procedures will vary with equipment used and potential contaminants present at the site.

B-2.5.4 Procedure for Groundwater Sampling Equipment

Ground water sampling equipment, such as submersible pumps, will be cleaned using the following procedure.

1. Place five wash basins in an established decontamination area that has a low permeability liner (e.g., polyethylene) and secondary containment. The decontamination area must be of sufficient size to allow placement of the five plastic wash basins in a line, and provide an air drying area for equipment.

2. Fill the first wash basin with potable tap water. Add sufficient soap powder or solution to cause suds to form in the basin. Do not use an excessive amount of soap or rinsing the soap residue off the equipment will be difficult.

3. Wash the sampling equipment in the soap solution in the first basin, removing all residues. Be sure to wash inside surfaces of equipment as well as exterior surfaces. Allow excess soap to drain off the equipment when finished.

4. Rinse the equipment with tap water in the second basin.

5. If the equipment is being used to sample for metals, rinse the equipment with nitric acid in the third basin. A 10 percent solution is used on stainless steel equipment. A one percent solution is used on all other equipment. If no metals sampling is being performed, this step may be omitted.

6. Spray down the equipment in the third basin, using deionized water.

7. Spray down the equipment in the fourth basin, using pesticide-grade methanol, if sampling for organic compounds is to be performed. If oily, a two-step process using methanol, followed by hexane should be used to remove both water soluble and non-soluble compounds. If no organic compounds sampling is being performed, this step may be omitted.

8. Allow the equipment to completely air dry on clean polyethylene sheeting.

9. Rinse the equipment in the fifth basin, using deionized water.

10. Allow the equipment to completely air dry on clean polyethylene sheeting.

11. Reassemble equipment, if necessary, and wrap completely in clean, unused aluminum foil, shiny side out for transport. Re-use of equipment on the same day without wrapping in foil is acceptable.

12. Allow spent cleaning solutions in the trays to evaporate into the air. If evaporation is not possible, all spent cleaning solutions shall be drummed for disposal along with any other contaminated fluids generated during the field investigation.

13. Record the decontamination procedure in the field logbook or appropriate field form.

14. If step 8, rinsing with organic solvents, was performed, check the equipment for the presence of residual solvents with a photoionization or flame ionization detector prior to use. If a detection occurs, disassemble the equipment and allow to air dry until no readings are observed. Re-rinse with deionized water.

Note that if temperature or humidity conditions preclude air drying equipment, sufficient spares should be available so that no item of sampling equipment need be used more than once. Alternatively, the inability to air dry equipment

completely prior to reuse should be noted in the field log. In this case, additional rinses with deionized water should be used and recorded.

B-2.5.5 Procedure for Measuring Equipment

Measuring equipment, such as pressure transducers or water level indicators, will be cleaned using the following procedure.

1. Fill two clean basins with tap water.
2. Add sufficient concentrated soap to one basin to form a thin layer of soap suds.
3. Immerse the device in the soap containing basin and gently agitate. Scrub device if it is soiled. Do not submerse any electrical connectors or take up reels, only that portion of the device in contact with potentially contaminated water.
4. Immerse the device in the basin containing the rinse water and gently agitate. Do not submerse any electrical connectors or take up reels, only that portion of the device in contact with contaminated water.
5. Spray rinse equipment with deionized water.
6. Allow the equipment to air dry.
7. Record the decontamination procedure in the field logbook or appropriate field

B-2.5.6 Procedure for Oversized Equipment

Oversized equipment, such as submersible pumps, will be cleaned using the following procedure.

1. Fill two clean barrels with tap water.
2. Add sufficient concentrated soap to one barrel to form a thin layer of soap suds.
3. Immerse the pump in the soap containing barrel and start pump. Circulate the soap solution through the pump and feed discharge into a waste disposal drum.
4. Immerse the pump in the barrel filled with clean tap water and start pump. Circulate the water through the pump and feed discharge into a

waste disposal drum. Run the pump until no soap residue is visible in the discharge.

5. Deionized water should then be run through the pump and used to rinse all submersible parts and hoses.

6. Record the decontamination procedure in the field logbook or appropriate field form.

B-2.5.7 Procedure for Drilling and Development Equipment

Drilling equipment will also need to be decontaminated. Down-hole drilling and well development equipment (cutting bit, core barrel, drive casings, well surge block, pump and bailer) will be decontaminated with a steam power washer prior to drilling and development of each borehole and well in an attempt to reduce the potential for cross-contamination. Both the inside and outside of whatever piping or casing should be power washed. The decontamination should be performed at a previously determined zone with a contained area for the water runoff. The water and excess sediment should be collected and disposed off accordingly.

B-2.6 DRILLING PROCEDURES

Injection and monitoring well boreholes will be drilled by using hollow-stem auger and/or sonic drilling methods for source area treatment and First Sand biobarrier wells. Deeper biobarrier injection wells will be drilled by using sonic, mud rotary, or other appropriate drilling methods. This SOP describes information specific to each drilling method which is provided below.

B-2.6.1 Hollow-Stem Auger Drilling

A California-licensed driller will be contracted to perform drilling and soil sampling operations with a hollow-stem auger as needed. This type of auger consists of a hollow steel stem or shaft with a continuous, spiraled steel flight welded onto the exterior stem. A hollow auger bit, generally with carbide teeth, disturbs soil material when rotated, whereupon the spiral flights transport the cuttings to the surface. This method is best suited in soils that have a tendency to collapse when disturbed. A monitoring or injection well can be installed inside of hollow-stem augers with little or no concern for the caving potential of the soils and/or water table. If caving sands exist during monitoring well installations, a drilling rig must be used that has enough power to extract the augers from the borehole without having to rotate them. A bottom plug, trap door, or pilot bit assembly can be fastened onto the bottom of the augers to keep out most of the soils and/or water that have a tendency to clog the bottom of the augers

during drilling. Water-tight center plugs are not acceptable because they create suction when extracted from the augers. Augering without a center plug or pilot bit assembly is permitted, provided that the soil plug, formed in the bottom of the augers, is removed before sampling or installing well casings. Removing the soil plug from the augers can be accomplished by washing out the plug by using a side discharge rotary bit, or augering out the plug with a solid-stem auger bit sized to fit inside the hollow-stem auger. The type of bottom plug, trap door, or pilot bit assembly proposed for the drilling activity should be approved by a senior field geologist prior to drilling operations. Soil cuttings will be temporarily stored on Site in roll-off bins while drilling and well installation/development activities are being conducted.

B-2.6.2 Mud Rotary Drilling

Mud rotary borings will be advanced by rapid rotation of the drilling bit, which cuts, chips, and grinds the material at the bottom of the hole into small particles. The cuttings are removed by drilling fluid (potable water and bentonite drilling mud) from an aboveground, leak-resistant container down through the drill rods and bit, and up the annulus between the borehole wall and the drill rods. This fluid flows first into an aboveground trough and ultimately back to the main container for recirculation. Quality Assurance/Quality Control (QA/QC) samples of drilling mud and potable water will be sampled at a point of discharge from the circulation system prior to their disposal or from the drilling mud container.

B-2.6.3 Sonic Drilling

Sonic drilling combines rotation with high frequency vibration to advance a core barrel to a desired depth. Sonic borings will be drilled by using an 8.5-inch outside diameter (O.D.) casing and a 3.5-inch (I.D.) diameter core barrel to collect soil samples.

B-2.7 SOIL SAMPLING AND CHARACTERIZATION PROCEDURES

Continuous cores will be obtained from one out of every six boreholes in the injection well field. Soil samples will be obtained from continuous cores for purposes of lithologic logging and field PID screening. Drill cuttings will be sampled at locations corresponding to lithologic changes from all other wells for purposes of lithologic logging only. Sections B-2.7.1, B-2.7.2, and B-2.7.3 below describe the soil sampling methodology, field PID screening, and the lithologic logging procedures respectively.

B-2.7.1 Soil Sampling Methodology

The methodologies to be followed for obtaining soil samples by using hollow-stem auger, mud-rotary and sonic drilling techniques are outlined in more detail below.

B-2.7.1.1 Hollow Stem Auger Soil Sampling

Where continuous cores are desired, a drive sample will be collected every five feet over the continuous core interval. Soil samples will be collected with a Christensen 94-millimeter (mm) Wireline Core Barrel System (or equivalent). The sampler will be fitted with a string of 2-inch diameter, 6-inch long stainless steel (or brass) sample sleeves laid end to end within the sample barrel. This method can collect up to 5 feet of core if the lithology allows. Sample lengths can be reduced if recovery is compromised by coarse-grained material.

In boreholes where drill cuttings are to be logged and sampled, formation samples will be collected at approximately 5-foot intervals from cuttings at the top of the auger flight. Samples will be obtained from a point as near to the borehole as possible. The samples will be contained within a sample box and labeled for the representative depth. The cuttings will be examined and logged. Auger flight time will be accounted for in the logging.

B-2.7.1.2 Mud Rotary Soil Sampling

Where continuous cores are desired, a drive sample will be collected every five feet over the continuous core interval. Soil samples will be collected with a Christensen 94-mm Wireline Core Barrel System (or equivalent). The sampler will be fitted with a string of 2-inch diameter, 6-inch long stainless steel (or brass) sample sleeves (laid end to end), which can collect up to 5 feet of core if the lithology allows. Sample lengths can be reduced if recovery is compromised by coarse-grained material.

In boreholes where drill cuttings are to be logged and sampled, formation samples will be collected at approximately 5-foot intervals from cuttings within the drilling fluid. Samples will be obtained from a point as near to the borehole as possible, but prior to entering the mechanical separation equipment. Samples of the drilling fluid, including the entrained formation cuttings, will be collected by using an appropriate container and or strainer. The fluid/cutting mixture will be allowed to stand for approximately 1 minute, the drilling fluid will be decanted away, and the remaining cuttings examined and logged. Drilling fluid circulation time will be accounted for in the logging.

B-2.7.1.3 Sonic Core Recovery

The core barrel will be advanced ahead of the casing for core collection. Continuous core will be collected from the ground surface to the total targeted depth of the borehole. Soil samples will be vibrated out of the core barrel and into a plastic sleeve, knotted at both ends. These will be examined, photographed, and logged while the samples are fresh from the borehole.

B-2.7.2 Soil PID Screening

Soil samples collected from the continuous cores recovered from every sixth boring will be field-screened for total ionizable volatile organic compounds (VOCs) by a hand-held photoionization detector (PID) per the HASP (Appendix D of the Work Plan). Approximately one half pint of soil from each sample interval will be sealed in a Ziploc® bag, stored for ten minutes, and then screened for total ionizable VOCs in the headspace of the Ziploc® bag.

B-2.7.3 Lithologic Logging

Detailed soil lithology logs will be developed for one out of every six boreholes within the injection well field by a geologist under supervision of a State of California Professional Geologist. At these boreholes, continuous cores will be obtained and logged from ground surface through the screened interval. At all other wells, lithology logs identifying lithologic changes with depth will be developed from visual screening of drill cuttings.

B-2.7.4 Record Keeping

Maintaining an organized and complete set of records is an integral part of drilling and well installation and development procedures and is a regulatory requirement. This includes completing field data sheets and maintaining daily field report sheets. Record keeping during drilling and soil sampling procedures will include completing boring logs and maintaining daily field report sheets (Attachment B-2.1). During drilling activities, the field boring log will be completed for each location. The boring log sheet shall contain, at minimum, the following information:

- Project (facility) name, boring name, date started and finished, geologist's and driller's names, boring location, rig type, auger size, sampling equipment used, and classification scheme used for soils;

- Lithology-Soils shall be described by using the Unified Soil Classification System (USCS). This will include soil/unconsolidated material/rock type, texture, plasticity, density, and gross petrology;

- Description of stratigraphic and/or lithologic structural features encountered. This will include a description of planar features (e.g., bedding planes, graded bedding), lineations, voids, cementation, nodules, bioturbated zones, organic matter, shell deposits, root holes and other features related to vegetation, and discontinuities. The orientation of these features will be measured when possible. This data will only be available from the drive samples, sonic borings, and continuous core pulled from the borehole.

- Qualitative moisture content (wet, moist, dry), degree of weathering, color (referenced to Munsell color charts), stain (e.g., presence of mottles, iron oxide [Fe_2O_3]), odor and depth to water bearing unit(s), and vertical extent of each water-bearing unit, where possible;

- Observations made during drilling. This includes advance rate, water loss, depth to water table or saturation, drilling difficulties; changes in drilling method or equipment, amounts and types of any drilling fluids used, presence of running sands, cave/hole stability, and depth of borehole and reason for termination of borehole;

- General observations made during sampling (e.g., depth of borehole, blow counts, sample recovery, sample depth/number/type, percent sample recovery);

- PID readings collected from soil samples and in the vicinity of the borehole at the surface. The PID will be used to monitor vapor emissions during drilling. Vapor emissions from the soil samples and from the open borehole casing will be monitored and recorded on the boring log; and

- Other remarks, including deviations from drilling plan, weather conditions, drilling observations, and possible contamination of soil or groundwater.

Daily field sheets will also be maintained during drilling. The daily field sheet will contain other pertinent information that is not on the boring logs, such as

observed arrival times and departure times of visitors and subcontractors on the site, drilling problems, and break times, etc.

B-2.8 WELL INSTALLATION PROCEDURES

This SOP describes the procedure that will be followed for the installation of monitoring and injection wells. Following the drilling of each borehole, a monitoring or injection well will be installed. For the EVO injection wells, the screened intervals should target the entire lithologic unit of interest. Monitoring wells will have 10-foot screens across depths that approximately correspond to the center of the injection well screen. Where two monitoring wells are to be constructed at two depths in one location, the screened intervals of the two wells should be selected to correspond to the screened interval of the corresponding injection wells (i.e., distances above, below and between the screened intervals of the monitoring wells in relation to the injection well are equal). Adjustment to the proposed screened intervals may be required to meet these objectives upon approval from the field program manager.

During well construction, the field geologist will keep a complete record of the design and construction of each well and of all materials installed in the borehole (i.e., depth of screen, length of screen and casing, volume of sand and bentonite pellets, bags of cement, etc.). Construction methods will also be verified and recorded in the field by the field geologist. Installation details specific to both EVO injection and monitoring well installation are included in Section B-2.8.1 and B-2.8.2 respectively.

B-2.8.1 Injection Well Installation

PVC centralizers will be installed above and below the screened interval and at 40-foot intervals along the blank casing. The annulus of each well will be filled with filter sand, which will extend from approximately 3 feet above the top of the screen to the bottom of the borehole. The filter sand, a number 2/12 sand or equivalent, will be carefully installed through the annulus between the well screen and the borehole. The sand will be poured slowly and its level will be measured by using a weighted tape measure at approximately one-half bag intervals. A surge block will be applied to the well following placement of the filter pack to induce settlement of the filter pack. Additional filter pack material will be added following surging of the well until the filter pack extends approximately 2 feet above the top of the screen interval. Approximately 1 foot of transition sand (finer grained number 30 or 1C sand or equivalent) will be placed above the filter pack sand to prevent intrusion of annular sealants into the filter pack. The top of the filter pack will be verified by using a weighted tape measure. An approximately 2-foot thick hydrated bentonite pellet/chip seal will be tremied down the annular space of the borehole to ensure a competent seal

above the transition sand and hydrated as necessary. The top of the bentonite seal will be verified by using a weighted tape measure. The remaining well annulus will be completed with cement/bentonite grout to provide a surface seal. The cement/bentonite grout will be installed under pressure by using a tremie pipe, leaving approximately 1 foot of exposed polyvinyl chloride (PVC).

Injection wells will be constructed of 4-inch diameter schedule 80 PVC. All injection wells will have 0.020-inch screens. The injection well blank casing will be tightly threaded and sealed to prevent leakage during the injection phase. Sealing can be with a Teflon seal, o-ring, or other method to maintain a seal to a maximum pressure of 50 pounds per square inch (psi). Special care will be taken to seal any connections within the top 10 ft of the well completion. Each well will be completed at surface with either a minimum 17-inch diameter traffic-rated well vault or cover, or an aboveground surface completion with protective posts. Wells constructed in low lying areas will have a minimum of 2 feet of stick up to avoid flooding the well head. A flange fitting (9-inch outside diameter) will be solvent welded to the top of the well casing for attachment of the EVO injection well head fitting and a nominal 4-inch J-plug will seal the annulus of the flange fitting while the injection well is not in operation. The fitting and J-plug will terminate just below the top of the well vault.

B-2.8.2 Monitoring Well Installation

All monitoring wells shall be installed in general accordance with the Cal-EPA guidance Monitoring Well Design, and Construction for Hydrogeologic *Characterization* (July, 1995). PVC centralizers will be installed above and below the screened interval and at 40-foot intervals along the blank casing. The annulus of each well will be filled with filter sand, which will extend from approximately 3 feet above the top of the screen to the bottom of the borehole. The filter sand, a number 2/12 sand or equivalent, will be carefully installed through the annulus between the well screen and the borehole. The sand will be poured slowly and its level will be measured by using a weighted tape measure at approximately one-half bag intervals. A surge block will be applied to the well following placement of the filter pack to induce settlement of the filter pack. Additional filter pack material will be added following surging of the well until the filter pack extends approximately 2 feet above the top of the screen interval. Approximately 1 foot of transition sand (finer grained, a number 30 or 1C sand or equivalent) will be placed above the filter pack sand to prevent intrusion of annular sealants into the filter pack. The top of the filter pack will be verified by using a weighted tape measure. An approximately 2-foot thick hydrated bentonite pellet/chip seal will be tremied down the annular space of the borehole to ensure a competent seal above the transition sand and hydrated as necessary. The top of the bentonite seal will be verified by using a weighted tape measure. The remaining well annulus will be

completed with cement/bentonite grout to provide a surface seal. The cement/bentonite grout will be installed under pressure using a tremie pipe, leaving approximately 1 foot of exposed polyvinyl chloride (PVC).

Monitoring wells will be constructed of 4-inch diameter PVC. Monitoring wells with a total depth less than 100 ft shall be constructed of schedule 40 PVC and monitoring wells with a total depth of greater than 100 ft shall be constructed of schedule 80 PVC. All monitoring wells will have 0.020-inch screens. Each monitoring well will be completed with a locking cap and either a traffic-rated cover or an aboveground surface completion with protective posts.

B-2.8.3 Record Keeping

During well installation, a well construction record and a well diagram, similar to the well construction log found in Attachment B-2.1, will be completed containing the following information:

- Project (facility) name, well name, date and time of well construction, geologist's and driller's names;
- Well depth (±0.1 ft), casing length and materials, screened interval, material and slot size/design;
- Filter pack material, size, and volume (calculated and actual);
- Annular sealant composition, placement method, and volume (calculated and actual);
- Surface sealant composition, placement method, and volume (calculated and actual); and
- Type and construction of protective casing (well box), well cap and lock.

B-2.9 WELL DEVELOPMENT PROCEDURES

This SOP describes the recommended procedures that will be followed for proper well development.

B-2.9.1 Initial Well Development

The wells will be allowed to set and recover for at least 48 hours after installation prior to development. This will allow curing of the grout so that

development activities do not damage the grout seal. Development of each well will be performed with a Smeal 5T rig, or equivalent, equipped with a steam cleaner, vented surge block, air lift and submersible pumps, bailers capable of removing sediments from the well, and a generator. Prior to and between individual well development, the rig and development equipment will be steam cleaned to reduce the potential for cross-contamination between wells. Water quality measurement instruments will be calibrated each day or more often if measurements are suspicious. Calibration will be performed per the manufacturer's instructions and with standards supplied by the instrument manufacturers. Field data collected during the well development procedure will be recorded on a well development log sheet. Initial procedures for well development include:

- Document well identification number, well construction details, bottom of well, screen interval, casing size, and well depth;
- Recording static water depth and total well depth with an electric water level indicator;
- Initially alternate surging and bailing with a surge block and a stainless steel or PVC bailer;
- When sands and silts have diminished in the water coming out of the bailer, pumping should begin in the development process and the following procedures will be implemented.
- Re-record static water depth and total well depth;
- Set the pump at approximately two feet off the bottom of the well;
- Begin pumping;
- Periodically record flow rate, drawdown (water level), and volume of water removed.
- Periodically monitor water quality parameters (pH, temperature, specific conductivity, and turbidity) with a Horiba U-10 meter (or equivalent).

Well development will be considered complete when at least three casing volumes of water have been removed and field readings have stabilized as follows:

- pH, ±0.1;
- temperature, ±10%;
- specific conductivity, ±3%;
- dissolved oxygen, ±0.3 milligrams per liter; and
- turbidity, ±10% (where turbidity is greater than 10 NTU), a turbidity reading of less than 5 Nephelometric Turbidity Units (NTUs) will be targeted.

During well development, field data sheets will be completed for each well location. The field data sheet will include, at a minimum, a well development log containing the following information:

- Project (facility) name, well name, date and time of development, geologist's and developer's names;
- Depth to static water level, total depth of well, boring and well casing I.D. and O.D., and calculation of well volume; and
- Time, depth to water, volume removed, flow rate, pH, temperature, turbidity, and specific conductance, ORP.

B-2.9.2 Well Rehabilitation

This SOP describes general procedures to be followed when it is determined that a treatment well needs to be rehabilitated. Indicators of the need for well rehabilitation may include: poor production performance; poor injection rates; water discoloration; and/or persistent odors

Initial well review will include downhole videos to help ascertain the nature of fouling. Once the nature is identified, rehabilitation methods will be instituted which will likely include injection of antibacterial and/or antifouling agents. The screen will be scrubbed with an abrasive wire brush, and then the well will be redeveloped as described in Section B-2.9.1 to remove any injected material associated with well

rehabilitation. Additional care must be taken to ensure any antibacterial compounds do not negatively affect the KB-1® culture.

B-2.10 SOIL GAS PROBE INSTALLATION

B-2.10.1 Soil Gas Probe Equipment

The following list of equipment may be utilized during soil gas probe installation and development. Site-specific conditions may warrant the use of additional or deletion of items from this list.

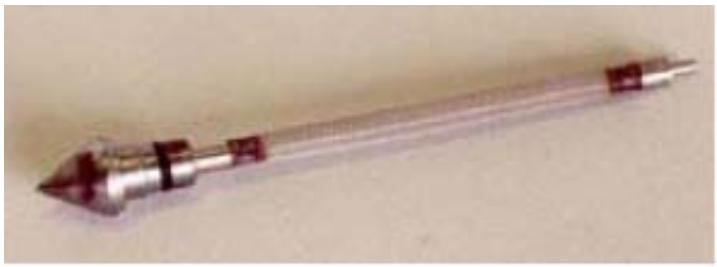
- Summa Canister
- ¼ inch Nylaflow tubing
- Alconox
- Deionized Water
- Coarse Scrub Brush
- Tap-water
- Steam cleaner
- Polyethylene Sheeting
- Disposable Gloves
- GeoProbe Dual Tube DT325
- Silica Sand
- Bentonite
- 0-100’’ Vacuum Gauge
- 6 Valves
- Vacuum Pump
- Magnehelic Gauge
- 0-500mL/min Rotameter Flow Meter
- 1L Tedlar Bags
- Lung Box
- Screen
- Landtec Portable GEM-500 Gas Analyzer

B-2.10.2 Soil Gas Probe Installation Procedure

The following SOP describes the procedure for constructing and installing soil gas probes:

1. Connect Summa canister to new piece of ¼-inch diameter Nylaflow tubing, draw a sample of air from the tubing as an equipment blank (one for each roll of tubing)

2. Decontaminate all downhole equipment with Alconox and water wash with brush, tap-water rinse, steam-cleaning and air-dry on new plastic sheeting.
3. Instruct drillers to handle all downhole equipment only with new, disposable gloves
4. Core soil to desired depth using GeoProbe Dual Tube DT325 sampling system, described at: http://www.geoprobe.com/products/tools/soil_sampling/dt325desc.htm
5. Remove soil core, visually inspect and record texture, color, moisture, density and plasticity in the field notes.
6. Continue coring until the saturated zone is encountered, and water level sounder can be used to confirm presence of a water column in the bottom of the borehole. Record static depth to water.
7. Cut probe tubing to length about 3 feet less than the depth to the water table, attach compression-fit valve and close valve, cover valve with plastic wrap to protect it from slurry during backfilling.
8. Attach GeoProbe stainless steel screen (as shown in photo, below) to bottom of probe tubing.



9. Install probe through cased corehole, backfill with silica sand to 6-inches above tip.
10. Add a minimum 3-inch lift of dry granular bentonite above sand-pack, and pull casing up ~1 ft (to top of granular bentonite).
11. Seal borehole with thick slurry of granular bentonite and water (mixed as shown in photo below), withdraw casing after slurry is emplaced.

12. Secure permanent probes with locking flush-mount protective casing set in concrete, troweled to slope away from the probe and promote runoff of rainfall.
13. Remove plastic wrap from valve on top of probe, ensure valve is closed.
14. Record probe installation details on Well Construction Log (Attachment B-2.1).
15. Fasten permanent label to soil gas probe, specifying location ID and depth.

16. Arrange for appropriate storage or disposal of soil core.
17. Restore cleanliness of area surrounding drilling site, repair any damage to grass.

B-2.10.3 Soil Gas Probe Development

After probe installation, the atmospheric air entrained during the installation process should be removed. Measurement of flow and vacuum during this activity provides data for calculating the gas-permeability of the soil and verifying sample collection flow rate.

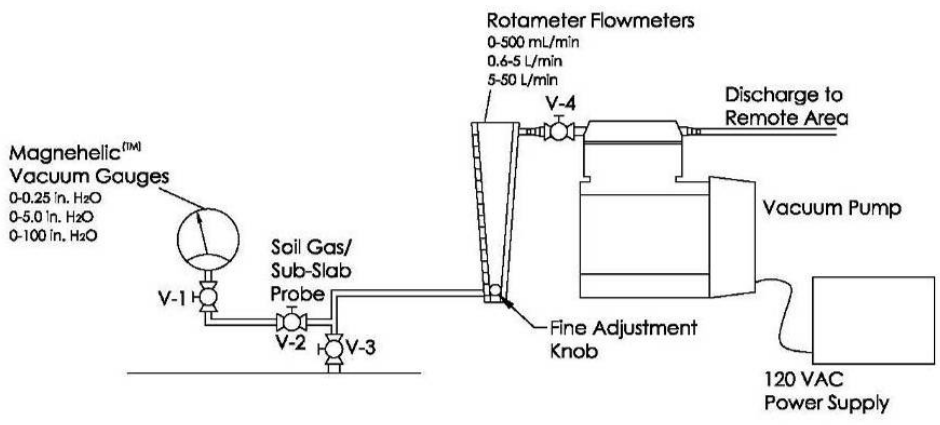
1. Assemble pneumatic testing apparatus as shown in Figure A below (valve V-2 is not necessary).
2. Perform leak test (shut-in test). Attach 0 to 100 in-H_2O vacuum gauge to V-1, close V-3, run pump to evacuate line to between 50 to 100 in-H_2O, and shut-in vacuum by closing V-4. Monitor vacuum to ensure it does not dissipate. Repair or replace fittings if vacuum is not held. Open V-4 to dissipate vacuum, close V-1 and disconnect Magnehelic gauge.
3. Level and zero the 0 to 0.25-in-H_2O Magnehelic gauge and connect to V-1. Close V-4, open V-1 (and V-2, if included) and record initial reading of static vacuum. If negative, close V-1, reverse polarity on vacuum gauge and repeat, recording static positive pressure.
4. Close the fine adjustment knob on the 0 to 500 mL/min rotameter-style flow meter, and open valves V-1 through V-4. Turn the pump on and slowly open the fine adjustment knob on the flowmeter until there is a measurable flow (~100 mL/min) and a measurable vacuum (>0.01 in-H2O). Both readings should stabilize quickly; record them both on the Field Form without delay. Open the fine adjustment knob until the flow equals 500 ml/min, record flow and vacuum without delay and close the flow control valve.
5. If at any time the vacuum is greater than the 0 to 0.25" H_2O scale, close valve V-4, close V-1 or V-2, switch to the next Magnehelic gauge (0 – 5" H_2O scale) and reopen valves V-4 and V-1 or V-2.
6. Total testing time should be no more than a few minutes, with a total purged volume of no more than a few liters. If a flow of at least 100 mL/minute cannot be sustained with a vacuum of less than 10 in-H_2O, or if the ratio of the flow rate divided by the vacuum is not nearly the same for both measurements, call the Project Manager for instructions.
7. Fill a 1L Tedlar bag using a lung box and screen using a calibrated Landtec portable GEM-500 gas analyzer to measure the concentrations of CH_4 (as lower explosive limit or "LEL"), CO_2, H_2S and O_2.. Fill a second bag and repeat. If readings increase for CO_2 and decrease for O_2 (indicating that atmospheric air entrained during probe installation is still being removed), repeat until readings stabilize or trend reverses.

8. Complete pneumatic testing field form with all relevant data fields completed.
9. Re-close valve at top of probe and allow probe to re-equilibrate prior to sampling.

B-2.10.4 Soil Gas Probe Decontamination

In order to attempt to reduce cross contamination and increase effectiveness of the soil vapor probes, between the installations of each probe the equipment will need to be decontaminated.

Removing or neutralizing contaminants from equipment which must be reused minimizes the likelihood of sample cross contamination. It also reduces or eliminates the transfer of contaminants to clean areas and prevents the mixing of incompatible substances. Gross contamination can be removed by physical decontamination procedures. These abrasive and nonabrasive methods include the use of brushes, air and water blasting, and high and low pressure water cleaning. Solvents may then be used to remove trace amounts of contaminants which may still remain on the equipment. A suggested method is to set up a decontamination line that consists of three to four stations where washing or rinsing of the sampling equipment is performed. These stations typically consist of buckets containing wash or rinse water. The first station is used to remove the most of the contamination. Subsequent stations are utilized to remove traces of wash water or contaminants. After any contaminants are physically removed by scraping or brushing the sampling equipment, the equipment should be submerged in a detergent (nonphosphate) and tap water wash, contained in the first bucket, and scrubbed with a brush, to remove any remaining visible particulate matter and residual oils and grease. This step may be preceded by a steam or high-pressure, hot water wash to facilitate the removal of residuals. The next step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent.



A - Flow and Vacuum Check

B-2.11 SOIL GAS SAMPLING

B-2.11.1 Soil Gas Probe Purging and Field Screening Equipment

The following list of equipment may be utilized during soil gas sampling. Site-specific conditions may warrant the use of additional or deletion of items from this list.

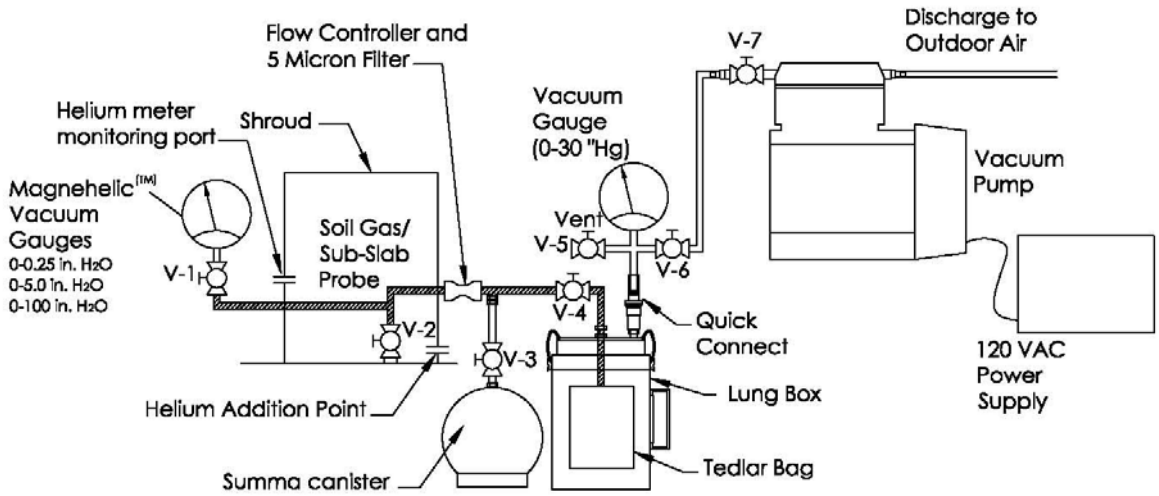
- 0-30’’ Hg Vacuum Gauge
- Shroud
- 5 micron filter
- Helium tank

B-2.11.2 Soil Gas Probe Purging and Field Screening Procedures

This SOP describes the recommended procedures for soil gas probe purging and field screening. Prior to sample collection, the soil gas point should be purged and field screening should be conducted according to the procedure below:

1. Initiate recording of barometric pressure using an on-site transducer and data logger.
2. Assemble apparatus as shown in Figure B. Attach the 0-30” Hg vacuum gauge to the top of the lung box via the quick connect. The shroud is a clear plastic container with four ¼-inch diameter holes drilled in the side for tubing access. The discharge from the pump should be directed through tubing to a location at

least 10 ft away and downwind. The goal is to maintain a vacuum at the soil gas probe less than 10 in-H_2O (inches of water), and a flow rate of less than 200 mL/min. If the permeability of the geologic materials is too low, the flow controller set-point may need to be adjusted based on the pneumatic test data recorded during probe development. All tubing and valves between valve V-3 and the black Tedlar Bag, including the 5-micron filter/critical flow orifice (supplied by laboratory) must be new, or certified clean and dedicated (i.e. must not be reused at other locations). Tubing between V-5 and the black Tedlar bag must be secured through the lid of the lungbox. Do not use tubing that has been stored in driller's warehouses, groundwater treatment plant buildings, or other areas where elevated concentrations of vapors may be present.



B - Purging and Sample Collection

3. Record the initial vacuum in the Summa canister (must be >25 in Hg) and complete the label.
4. Attach Summa canister via "T"-fitting between V-4 and the flow controller and verify Summa canister valve V-3 is closed.
5. Connect a new or dedicated 1L black Tedlar bag to the tubing through the lung-box lid and open the valve on the Tedlar bag. Close the lung-box lid and lock in place.
6. Perform leak test. Attach 0 to 100 in-H_2O vacuum gauge to V-1, open V-1, V-4 and V-6, close V-2, run pump to evacuate lung-box to between 5 to 8 in-Hg and close V-7. Ensure the Tedlar bag is not filling with air and that both vacuum gauges remain stable for 3 minutes. Repair or replace fittings if Tedlar bag fills or vacuum dissipates.

7. Open V-5 to release vacuum for shut-in test, then close V-5 and V-4 and open V-7 and V-2 in preparation for purging.
8. Fill the shroud with Helium and measure with the helium meter to ensure greater than 30% He in the shroud. Turn Helium flow off once shroud is filled. Leave vent-holes open so shroud does not become pressurized. See photo below for example layout.

9. Turn on the pump and evacuate the lungbox to a vacuum of about 15 in-H_2O. Close V-7 to the pump and turn off the pump. Verify the vacuum is sustained, or fix the lung-box seals and repeat.
10. Open V-4 to begin purging. Record the vacuum at the probe, and observe the vacuum in the lungbox, both of which should remain relatively steady. Collect sufficient volume for field screening (about 0.5 L).
11. Close V-4 and vent the lungbox by opening V-5. Take out the Tedlar bag and close Tedlar bag's valve.
12. Screen purged soil gas with the Landtec portable GEM-500 gas analyzer and Helium meter. All measurements must be at ambient pressure, including calibration checks. Record all values on the Field Form. If helium reading exceeds 5% of the He concentration in the shroud, stop, repair probe seals or replace probe if necessary and do not proceed with sample collection.
13. Repeat the purging and field screening process a minimum of 3 times. If there appears to be an increasing trend in Oxygen (O_2) combined with a decreasing trend in Carbon dioxide (CO_2), call the Project Technical Director prior to proceeding with sampling.

B-2.11.3 Soil Gas Sample Collection

The following SOP describes the recommended procedure to be followed while collecting soil gas samples.

Soil gas samples will be collected from the soil gas probes for laboratory analysis for Methane (CH_4) and Hydrogen Sulfide (H_2S), as discussed in the SAP, immediately after field screening demonstrates that steady readings have been reached. Soil gas samples will be collected in two types of sample container: new black Tedlar™ bags (for H_2S) with plastic valves and clean SUMMA™ canisters (CH_4). Sample containers will be provided by the laboratory.

Note that hydrogen sulfide is unstable in the presence of oxygen and moisture and is reactive on metallic or other non-passive surfaces. It is important therefore to avoid exposure of the soil gas sample with metal components in the sampling equipment.

To collect a sample for H_2S analysis, use a black Tedlar bag and follow Steps 7-11 in the purging section and then go to step 3 and 4 below to complete the chain of custody and sample collection form.

To collect a sample for other analyses using a SUMMA canister, follow the procedure below:

1. Ensure valves V-5 and V-6 are closed and valve V-4 is open and slowly open the Summa canister valve. The soil gas will enter the Summa canister through the flow controller, which will have been set at an appropriate level based on the gas permeability testing to maintain an acceptable vacuum at the probe, which should be verified by observing the Magnehelic gauge attached to V-1. After allowing sufficient time for 0.8 L of gas to enter the Summa canister, close the Summa canister valve V-3. The goal is to maintain a small residual vacuum in the canister, which provides a means of confirming sample integrity during return shipment to the laboratory.
2. Disconnect the Summa canister and connect the vacuum gauge to the Summa canister, measure and record the final Summa canister vacuum on the canister label and field form, close the Summa valve, remove the vacuum gauge, and secure the cap to the top of the Summa canister, ¼ turn past snug. Double-check that the Summa canister valve is closed. Do not refrigerate Summa canisters during storage or shipping.
3. Complete the laboratory chain of custody with the sample ID, date and time of collection, collector's initials, method of analysis, analyte list, and reporting limits specified in the Work Plan, and ship canisters in a sealed container (taped closed with signature across

seal) via secure means (e.g. courier with tracking number) to the contacted analytical laboratory according to the schedule specified in the Work Plan.

4. Complete sample collection form, including field screening data, purge rate and volume, field instrument calibration records, and any comments that may assist in data interpretation, including weather conditions, any noticeable odors, recent rainfall history, and any departures from this protocol.
5. Download and verify completeness of barometric pressure transducer data.
6. Dispose of tubing and used fittings following the IDW (investigation derived waste) plan (Appendix E of the Work Plan).
7. Close valve at top of probe and re-affix security cover.

B-2.11.4 Soil Gas Sample Decontamination

In order to attempt to reduce cross contamination and increase effectiveness of the soil vapor probe sampling, between the sampling of every well the equipment will need to be decontaminated.

All external parts should be wiped clean and washed as necessary to remove any soil or contaminant films. The internal vapor pathway should be purged with a minimum of five volumes of air or an inert gas, or replaced, or washed if contamination or water is present in the probe. Probes fitted with internal tubing offer advantages because the internal tubing can simply be replaced.

B-2.12 WELL PACKER INSTALLATION AND OPERATION

B-2.12.1 Well Packer Objectives

The use of well packers will be evaluated for both the amendment injection phase and during the groundwater monitoring program. Well packers provide a method for sealing the well bore against vertical flow during injection and sampling programs. During construction some wells were constructed with blank sections between two screen intervals.

During the amendment injection it may be necessary to inject in one portion of the screen versus another due to the permeability of the surrounding zone. The use of well packers will provide a method for sealing one portion of the well from another when there is a blank casing between the screened well sections.

B-2.12.2 Well Packer Equipment

Well packers equipment will be identified and added to the SOP as an addenda once a vendor and model(s) have been determined. The packer will be compatible with the chemicals and well materials within the treatment wells. There are two general types of packers that will be considered; mechanical and inflatable packers. Mechanical packers are placed within a well and fixed into position through mechanical means (screw into place such as compression fittings, etc.). An inflatable packer will have an expandable section which can be inflated to seal the well bore. Both type of packers can be removed after placement should that be necessary.

B-2.12.3 Well Packer Installation and Operation

The packer installation and operation will be in compliance with the manufacturer guidance. The packers will be placed during operational phases and may or may not be removed during the long term remediation phase. The determination to leave packers in place will be dependent on the application of the packers. When a packer is placed to allow differential injection within the same treatment zone, such as the First Sand, it can be removed after the injection phase is complete. Where a packer is used between two different treatment zones such as the First Sand and the Shell Horizon (eg., SHB-3) then the packer may be left for extended periods of time.

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Naval Facilities Engineering Command, Southwest
San Diego, California
Contract No. N68711-04-D-1106
Contract Task Order 003
Document Control Number ECC-1106-0003-0002

Attachment B-2.1
Example Field Forms and Logs
Final Remedial Action Work Plan
Installation Restoration Program Site 70
Implementation of Enhanced In Situ Bioremediation
Naval Weapons Station Seal Beach
Seal Beach, California

Prepared by:

ECC

1240 Bayshore Highway
Burlingame, California 94010

in Association with

Geosyntec consultants

2100 Main Street, Suite 150
Huntington Beach, California 92648-2648

January 2008

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Geosyntec consultants

Project: HY1034 Phase _____

Collector Name and Signature: _____ Date:_____

Area: _____

Type of Sampler: _____

Sample I.D.	Location I.D.	Date/Time	Depth	Notes

Geosyntec consultants

DAILY FIELD REPORT

PROJECT: _____

LOCATION: _____ PROJECT NO.: _____ TASK NO.: _____

DESCRIPTION: _____ DATE: _____ day _____ month _____ year

CONTRACTOR(S): _____

WEATHER, TEMPERATURE: _____

NAME: _____ PROJECT NO.: _____ HOURS: _____

Sheet No. _____ of _____

EMULSIFIED OIL INJECTION -
INJECTION FLOW MEASUREMENTS

GeoSyntec Consultants
130 Research Lane, Suite 2
Guelph, Ontario ◆ N1G 5G3 ◆ Canada
Tel: (519) 822-2230 ◆ Fax: (519) 822-3151

Project Name: IR Site 70, Seal Beach
Project No.: HY0888
Site Location: Seal Beach, CA

Injection Well ID: _____
Monitored By: _____
Mainfold No.: _____

Date	Time	Mechanical / Digital Totalizer Reading (gal)	Flow Rate (gpm)	Well-Head Pressure (psi)	Emulsion Dose Ratio (%)	Comments (i.e., amount of oil remaining in tote, visual observations, note if water flush)

Last Updated: 2005.08.22

EMULSIFIED OIL INJECTION - *TOTE TRACKER*

GeoSyntec Consultants
130 Research Lane, Suite 2
Guelph, Ontario ◆ N1G 5G3 ◆ Canada
Tel: (519) 822-2230 ◆ Fax: (519) 822-3151

Project Name: IR Site 70, Seal Beach
Project No.: HY0888
Site Location: Seal Beach, CA

Monitored By: _____
Mainfold No.: _____

Tote No.	Tote Complete	Start Date	Start Time	End Date	End Time	Comments (i.e., amount of oil remaining in tote, visual observations)

Last Updated: 2005.08.22

EMULSIFIED OIL INJECTION -
MANIFOLD DOSE CALIBRATION

GeoSyntec Consultants
130 Research Lane, Suite 2
Guelph, Ontario ◆ N1G 5G3 ◆ Canada
Tel: (519) 822-2230 ◆ Fax: (519) 822-3151

Project Name: IR Site 70, Seal Beach
Project No.: HY0888 Monitored By: _____
Site Location: Seal Beach, CA Mainfold No.: _____

Pump No.	Date	Time (Start)	Time (End)	Elapsed Time (min)	Totalizer (Start)	Totalizer (End)	Total Volume (gal)	Emulsion Uptake (gal)	Dose Ratio (%)	Comments (i.e., amount of oil remaining in tote, visual observations)

Last Updated: 2005.08.22

Geosyntec consultants
2100 Main St
Suite 150
Huntington Beach, CA 92648
Tel: (714) 969-0800
Fax: (714) 969-0820

GS FORM:
WELL BORE 01/04

BOREHOLE LOG

BORING .
SHEET 1 OF 1
START DRILL DATE
FINISH DRILL DATE
LOCATION
PROJECT
NUMBER

ELEVATION DATA:
GROUND SURF.
TOP OF CASING
DATUM

DEPTH (ft-bgs)	DESCRIPTION 1) Unit/Formation, Mem. 2) Soil/Rock Name 3) Color 4) Moisture 5) Grain Size 6) Percentage 7) Plasticity 8) Density/Consistency 9) Structure 10) Other (Mineralization, Discoloration, Odor, etc.)	GRAPHIC LOG	WELL LOG	GROUNDWATER OR STRUCTURE	ELEVATION (ft)	SAMPLE: SAMPLE NO.	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (%)	SAMPLE: PID READING (ppm)	SAMPLE: TIME (00:00)	COMMENTS 1) Rig Behavior 2) Air Monitoring
5												
10												
15												
20												
25												
30												

CONTRACTOR
EQUIPMENT
DRILL MTHD
DIAMETER
LOGGER
REVIEWER
NORTHING
EASTING
COORDINATE SYSTEM:

NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

Geosyntec consultants
2100 Main St
Suite 150
Huntington Beach, CA 92648
Tel: (714) 969-0800
Fax: (714) 969-0820

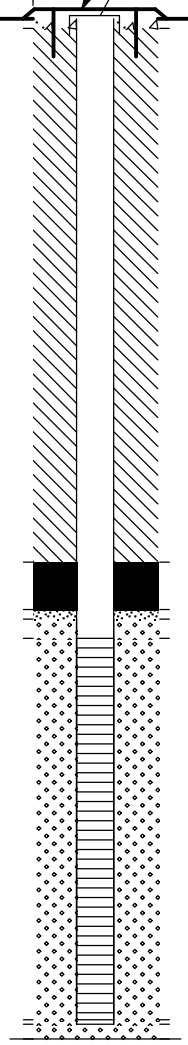
GS FORM:
WELL COMP BG 01/04

WELL CONSTRUCTION LOG

BORING -- **SHEET 1 OF 1**
START DRILL DATE
FINISH DRILL DATE
LOCATION
PROJECT
NUMBER

ELEVATION DATA:
GROUND SURF.
TOP OF CASING
DATUM

DEPTH (ft-bgs)	COMMENTS 1) Groundwater 2) Surge Time 3) Dedicated Pump	GRAPHIC LOG	WELL MATERIAL DEPTH (ft-bgs)



BELOW GROUND SURFACE COMPLETION:

SURFACE COMPLETION:
TYPE _____
WELL CASING DEPTH _____

BORING DEPTH _____
PILOT BORING DIAMETER _____
REAM BORING DIAMETER _____

WELL CONSTRUCTION
WELL CONSTRUCTION DATE _____
WELL DEPTH _____
WELL CASING DIAMETER _____
WELL CASING MATERIAL _____
SCREEN SLOT SIZE/DIRECTION _____
TOP OF SCREEN _____
BOTTOM OF SCREEN _____
END CAP/SUMP LENGTH _____

GROUT
TOP DEPTH _____
TYPE/BRAND _____
QUANTITY USED _____
VOLUME FLUID USED _____
PLACEMENT METHOD _____

BENTONITE SEAL
TOP DEPTH _____
TYPE/BRAND _____
QUANTITY USED _____
VOLUME FLUID USED _____
SET-UP TIME _____
PLACEMENT METHOD _____

TRANSITION SAND
TOP DEPTH _____
TYPE/BRAND _____
QUANTITY USED _____
PLACEMENT METHOD _____

SAND/GRAVEL PACK
TOP DEPTH _____
TYPE/BRAND _____
QUANTITY USED _____
PLACEMENT METHOD _____

BOTTOM FILL
TOP DEPTH _____
TYPE/BRAND _____
QUANTITY USED _____
PLACEMENT METHOD _____

CONTRACTOR ProSonic
EQUIPMENT
DRILL MTHD Sonic
DIAMETER
LOGGER **REVIEWER**

NORTHING
EASTING
COORDINATE SYSTEM:

DEDICATED PUMP SYSTEM:
TYPE/BRAND:
MODEL:
CONTROLLER TYPE:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

GEOSYNTEC CONSULTANTS

WELL DEVELOPMENT LOG

PROJECT NAME		WELL NO.
PROJECT NO.	SITE	PREPARED BY

METHOD
- PUMP _____
- BAILER _____
- OTHER _____

DEVELOPMENT CRITERIA

REMARKS

WELL CONSTRUCTION DATA (ft)

WELL CASING:

TOP OF CASING HEIGHT/DEPTH (TOC) = _____

INSIDE DIAM $d_w ID$ = _____

OUTSIDE DIAM $d_w OD$ = _____

HOLE DIAMETER d_h = _____

DEPTH TO:

SCREENED INTERVAL _____ TO _____

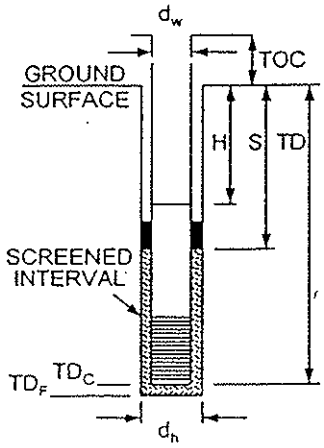
WATER LEVEL H = _____

BASE OF SEAL S = _____

BASE OF CASING TD_C = _____

BASE OF FILTER PACK TD_F = _____

ESTIMATED FILTER PACK POROSITY P = 0.25



WELL VOLUME CALCULATION

CASING VOLUME =

$$V_c = \pi\left(\frac{d_w ID}{2}\right)^2 (TD_C - H) = 3.14\left(\frac{\quad}{2}\right)^2 (\quad - \quad) = \quad ft^3$$

FILTER PACK PORE VOLUME =

$$V_f = \pi\left[\left(\frac{d_h}{2}\right)^2 - \left(\frac{d_w OD}{2}\right)^2\right](TD_F - (S \text{ or } H))(P)$$

$$= 3.14\left[\left(\frac{\quad}{2}\right)^2 - \left(\frac{\quad}{2}\right)^2\right](\quad - \quad)(\quad) = \quad ft^3$$

(if S > H, use S. If S < H, use H)

TOTAL WELL VOLUME =

$V_T = V_c + V_f =$ + = $ft^3 \times 7.48 =$ GAL

DEVELOPMENT LOG					TOTAL	WATER QUALITY					COMMENTS
DATE	TIME	FLOW RATE (gpm)	DEPTH TO WATER (ft-btoc)	WATER REMOVED (gal)	WATER REMOVED (gal)	pH	SPECIFIC CONDUCTIVITY (mS/cm)	TURBIDITY (NTU)	TEMPERATURE (Degrees C)		

PAGE ____ OF ____

ATTACHMENT B-3
LABORATORY QUALITY ASSURANCE/QUALITY CONTROL

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APPENDIX C
EQUIPMENT LIST

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APPENDIX C
Final Equipment List

INSTALLATION RESTORATION PROGRAM SITE 70
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

March 2008

Department of the Navy
Naval Facilities Engineering Command Southwest
San Diego, CA 92132

Environmental Multiple Award Contract
Contract Number N68711-04-D-1106, CTO 003
Document Control Number ECC-1106-0003-0002

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APPENDIX C

Final Equipment List

INSTALLATION RESTORATION PROGRAM SITE 70
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

March 2008

Prepared for:

Department of the Navy
Naval Facilities Engineering Command Southwest
San Diego, CA 92132

Prepared by:

ECC
1240 Bayshore Highway
Burlingame, CA 94010

In association with:

2100 Main Street, Suite 150
Huntington Beach, CA 92648

Prepared under:
Environmental Multiple Award Contract
Contract Number N68711-04-D-1106, CTO 003
Document Control Number ECC-1106-0003-0002

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APPENDIX C

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EQUIPMENT INVENTORY AND NEEDS FOR GROUNDWATER SAMPLING
Remedial Action Plan
Installation Restoration Site 70, Naval Weapons Station Seal Beach
Seal Beach, California

	Equipment	Quantity Required	Comments
General	Submersible Pump (0-40 gpm)	1	
	Electrical Cable Extension for Submersible Pump	1	long enough to reach power source
	Stanless Steel Cable	1 @ 165 ft	cable connection to stabilize pump in well
	Submersible Pump Hose	1 @ 165 ft	
	Generator (or Power Supply)	1	Support for pumps
	Water Tank (6,500 gal Tank)	2	storage of purge water before disposal
	Five Gallon Bucket	2	
	Spill Kit	1	
Sampling Supplies	Water Level Tape	1	rent or purchase
	Horiba U-10 or equivalent	1	rent or purchase
	Flow through cell	1	for use with horiba
	Gloves (boxes)	5	to use during field activities
	Plastic bubble wrap		to protect samples
	Ziploc- type bags (boxes)	5	to put around sample jars with bubble wrap
	Sample Containers	70	Set from Lab per well
	Forms/Logs		Enough for duration of sampling
	Chain of Custody		
	Sampling Record		
	Purge Water Record		
	Calibration Logs		
	Ice Chest	5	
Decon	Water Tank (1,000 gal Tank)	2	rent, to hold decon water
	Alconox (gal container)	1	
	Pump Sprayer	1	
	Large Plastic Wash Basins	5	24 inches by 30 inches by 6 inches deep
	Coarse Scrub Brushes	2	
	Small Wire Brush	1	
	Deionized Water		
	Bleach (gal container)	1	10% solution

Acronyms/Abbreviations

% - percent
ft - feet
gal - gallons
gpm - galons per minute

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APPENDIX D
ACCIDENT PREVENTION PLAN

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APPENDIX D
Accident Prevention Plan

INSTALLATION RESTORATION PROGRAM SITE 70
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

March 2008

Department of the Navy
Naval Facilities Engineering Command Southwest
San Diego, CA 92132

Environmental Multiple Award Contract
Contract Number N68711-04-D-1106, CTO 003
Document Control Number ECC-1106-0003-0002

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APPENDIX D

Accident Prevention Plan

INSTALLATION RESTORATION PROGRAM SITE 70
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

March 2008

Prepared for:

Department of the Navy
Naval Facilities Engineering Command Southwest
San Diego, CA 92132

Prepared by:

ECC
1240 Bayshore Highway
Burlingame, CA 94010

In association with:

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DISCLAIMER

This Accident Prevention Plan (APP) has been prepared in accordance with Geosyntec Consultants' Accident Prevention Procedures for use by Geosyntec project staff at the request of the Navy. This plan complies with Geosyntec internal review procedures for Accident Prevention Plans. Geosyntec does not endorse the use of this APP by others. The use of this document or its contents by firms or persons other than Geosyntec and Geosyntec employees should not be used without a thorough peer review by their Health and Safety Managers. Should the work outlined in this Accident Prevention Plan be executed by contractors other than Geosyntec, the APP should be modified and reviewed to comply with that company's corporate health and safety procedures. In the event that a contractor other than Geosyntec executes this work, the contractor should complete a hazard analysis, mitigation measures, and perform an update of all APP tables, text, figures, and appendices prior to commencing work. Geosyntec assumes no responsibility for the accuracy, content, or health and safety of non-Geosyntec personnel during the implementation of this APP by other parties.

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ACCIDENT PREVENTION PLAN (APP)

Project Name: **Naval Weapons Station Seal Beach Installation Restoration Program Site 70**

Project Number: **HY1034**

This APP, which must be kept on site, addresses the health and safety hazards of each phase of site operation, including the requirements and procedures for worker protection. This APP is intended to be used in conjunction with the site specific health and safety plan (HASP) also provided as Appendix D-A. Only the Site Health and Safety Officer (SHSO) can change or amend this document in agreement with the Environmental Health and Safety Coordinator (EHSC), Project Manager, and Principal-in-Charge. The SHSO must initial any change made to the APP at the relevant section. Major amendments (e.g., changes in personal protective equipment not provided for in this plan, addition of tasks, etc.) must be documented by indicating the amendment date shown on this page.

Prepared by: 3-10-08

Eli Ortenberg, SHSO — Date

Reviewed by: 3-5-08

Marlene Duffy, EHSC — Date

Concurrence by: 3-10-08

Walt Grinyer, Project Manager — Date

Approved by: 3-10-08

David Major, Principal-in-Charge — Date

Copy Cover Sheet to: EHSC

Brief Description of Amendment **Amendment Date**

_____

_____

_____

This APP has been given to the following subcontractor(s) in accordance with OSHA 29 CFR 1910.1200 (Hazard Communication Standard):

Subcontractor: _____ **Representative:** _____ **Date:** _____

Subcontractor: _____ **Representative:** _____ **Date:** _____

Geosyntec site workers must read this APP. A pre-entry briefing conducted by the SHSO (or a designated person) must be held prior to initiating this project. All sections of this APP must be reviewed during this briefing. Any worker not in attendance at the initial meeting must be trained by the SHSO (or a designated person) on the information covered in the pre-entry briefing meeting. ***Tailgate meetings must be held at the beginning of the work shift by the SHSO (or designated person) to discuss important safety and health issues concerning tasks performed on that day. A brief description of topics discussed in tailgate meetings must be documented in the Field Logbook.*** After reading the APP and attending a pre-entry briefing, workers must sign the following acknowledgment statement.

I have read, understand, and agree with the information set forth in this APP. I have also attended a pre-entry briefing. I agree to perform my work in accordance with this APP.

Name	Date	Name	Date

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Appendix D-A: Site Specific Health and Safety Plan (HASP)

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Attachment D-A-2: Contaminant Fact Sheets

Attachment D-A-3: Hazard Mitigators

Attachment D-A-4: Air Monitoring Equipment, Frequency of Readings, and Action Guidelines per Task

Attachment D-A-5: Personal Protective Equipment per Task

Attachment D-A-6: Material Safety Data Sheets

Attachment D-A-7: Decontamination Procedures & Equipment

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LIST OF REFERENCES

Reference D-A-1: OSHA and NIOSH Chemicals Requiring Air Monitoring and Medical Surveillance

Reference D-A-2: National Primary Drinking Water Regulations

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1. SIGNATURE SHEETS

Signature sheets may be found at the beginning of this document.

2. BACKGROUND INFORMATION

This Accident Prevention Plan (APP) defines the health and safety requirements in support of remediation of groundwater contaminated with chlorinated solvents at Naval Weapons Station (NAVWPNSTA) Seal Beach Installation Restoration (IR) Program Site 70 (IR Site 70), Seal Beach, California (Figure D-1) defined in the Remedial Action Work Plan (RAWP). Environmental Chemical Corporation (ECC), in collaboration with Geosyntec Consultants (Geosyntec), prepared this APP under contract N68711-04-D-1106, Contract Task Order (CTO) 003 to Naval Facilities Engineering Command, Southwest (NAVFAC SW).

NAVWPNSTA Seal Beach is an active federal facility that is being remediated under the IR Program. The station is not on the National Priorities List. The lead agency for remedial investigation (RI) and remedial action (RA) at this station is the Department of the Navy (DON). Regulatory agencies providing support and oversight include the California Environmental Protection Agency (Cal-EPA), Department of Toxic Substances Control (DTSC), and the California Regional Water Quality Control Board (RWQCB) Santa Ana Region.

The DON, Naval Facilities Engineering Command Southwest (NAVFAC SW), directs this remedial action in accordance with requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Upon review of the IR Site 70's operational history and site-specific groundwater data, the DON has determined that IR Site 70 groundwater contains elevated concentrations of trichloroethene (TCE) that require a response action. The DON has initiated the remedial action for the impacted groundwater at IR Site 70 to reduce potential threats to human health and the surrounding environment.

This APP was generated under contract Work performed under this plan will be conducted in accordance with OSHA standards. This APP is intended to be used in conjunction with the site specific health and safety plan (HASP) provided as Appendix D-A.

Geosyntec currently holds an experience modification rate (EMR) of 0.73 for 2007. EMRs for 2004 through 2007 are included in Attachment D-1. Attachment D-1 also

includes a table showing Health and Safety statistics for Geosyntec from 2002 through 2006. A corporate Health and Safety trend analysis of the statistics shows a generally downward trend in incidents. Additionally, OSHA form 300 for years 2004 through 2007 are included in Attachment D-1.

General project information follows:

- Site Usage: Naval Weapons Station
- Site Location: South of the intersection of Westminster Blvd and Seal Beach Blvd; Seal Beach, CA (Figure D-1)
- Size of Site: Approximately 80 acres for dissolved phase plume
- Expected Field Dates: July 2007 to July 2008
- Tasks for this project include:
  - ① Aquifer Testing (tracer tests, pump tests)
  - ② Well Rehabilitation
  - ③ Groundwater Sampling/Monitoring and Soil Sampling
  - ④ Soil Gas Sampling/Monitoring
  - ⑤ Injection of KB-1™
  - ⑥ Injection of Emulsified Vegetable Oil (EVO)/Bromide Tracer
  - ⑦ Drilling/Well Construction/Well Development

3. STATEMENT OF HEALTH AND SAFETY AND POLICY

Geosyntec Consultants (Geosyntec) provides earth sciences services to its clients through its employees in the office, laboratory, and field. With its employees working in environments ranging from benign to hazardous, Geosyntec is aware of the challenges of maintaining a high level of health and safety. We pride ourselves on the high level of quality work performed by our professionals and are committed to achieving the same level of health and safety performance. We are aware that the maintenance of a workplace free of recognized hazards is also an integral part of our business performance, and we are committed to achieving this goal. At all times, our operations will be planned and operated in compliance with the spirit and letter of all Federal, state, and local health and safety regulations.

Geosyntec's health and safety objectives are included in the following programs and procedures and are published collectively as a controlled document. This information is a compilation of regulatory requirements as well as procedures that have been developed by our Director of Environment, Health, and Safety. It is our commitment that these programs and procedures are understood, implemented and maintained at all levels in our organization. To facilitate this endeavor, we have established a training program to provide relevant health and safety training to appropriate personnel in a timely manner. A formal audit system, including management and staff, is in place to ensure compliance at each branch and laboratory, and at our project sites. An integral part of our health and safety program includes at least an annual review of this controlled document. However, programs and procedures may be changed at any time based on regulatory changes, input from our employees, or experience gained during implementation of these programs and procedures.

It is our commitment to provide appropriate resources to implement our health and safety program. At Geosyntec, the management of health and safety is considered a prime responsibility of line management. Our health and safety program is guided by our Director of Environment, Health, and Safety. Each branch has designated an Environmental, Health, and Safety Coordinator to assist the Director of Environment, Health, and Safety in the day-to-day health and safety issues at the branch level. We view all employees as integral parts of the health and safety program. As such, the health and safety of fellow workers must be a part of everyone's daily concern.

4. RESPONSIBILITIES AND LINES OF AUTHORITIES

Table D-A-1 lists project personnel and their responsibilities in regard to health and safety concerns on this project at both a project and corporate level. In summary, each individual is responsible for reading, understanding, and implementing the health and safety plan. Individuals are also responsible for reporting incidents and unsafe conditions to the SHSO. The SHSO is responsible for implementing the HASP, checking that all individuals on Site have the appropriate training, verifying that PPE is in good working order, calibrating monitoring devices, checking that decontamination procedures are being followed, and implementing the sequence of steps listed below. The EHSC is responsible for reviewing and auditing the HASP, assisting with the implementation of the HASP, and consulting on health and safety issues. The principle in charge is responsible on a corporate level for approving the HASP and checking that the HASP is being implemented.

In the event of an incident in the field, the following steps will be followed:

- If serious and/or life threatening, seek immediate medical attention at the hospital/ER listed in the HASP.
- If non-life threatening:
  - Employee reports an incident, injury, and near miss to their Geosyntec Home Office Manager or Supervisor IMMEDIATELY
  - Manager/Supervisor calls the EH&S Director Dale Prokopchak-Office: (804) 332-6376; Cell: (804) 349-8067 to discuss appropriate medical attention. If unable to contact Dale Prokopchak within two (2) hours, WorkCare is to be contacted at (800) 455-6155 Ext. 110 to advise on appropriate medical care.
  - Manager/Supervisor contacts his/her Manager and Human Resources (HR) Denise Emmanuelli-Office: (561) 922-1112 with the details of the incident, illness, etc., by the end of the work shift.
  - Within 24 hours, the Manager/Supervisor completes a draft of the Manager's Accident Report that is found on the Human Resources website (under Workers Compensation). If the incident involves an employee, he/she must complete the Employee's Accident Report (also found under the Workers Compensation link). Contractors are responsible for compliance with their company's own internal safety procedures regarding Incident Reporting. Geosyntec will document the Contractor's incident, injury, etc., in their Project Logbook.
  - Manager/Supervisor forwards the appropriate paperwork within 24 hours to both EH&S (dprokopchak@geosyntec.com); fax (804) 332-6732 and HR (demmanuelli@geosyntec.com); fax (561) 922-1101 for review, documentation, and implementation into our case management program.

5. SUBCONTRACTORS AND SUPPLIERS

5.1 Identification of Subcontractors and Suppliers

Lists of subcontractors and suppliers will be provided upon award of contract and will be attached to the APP.

5.2 Managing Subcontractors

The successful performance on projects is highly dependent on subcontractor safety. At a minimum, subcontractors will comply with the provisions of this APP, the Site Health and Safety Plan (SSHP), and the Activity Hazard Analyses (AHAs). Their safety performance will be reviewed and monitored during regular site inspections and audits. Each subcontractor will be required to submit health and safety documentation for review and approval prior to starting site work. Specifically, each subcontractor will be responsible for submitting activity hazard analyses for work they are contracted to perform to the SHSO for review and approval prior to mobilizing to the site.

5.3 Safety Responsibilities of Subcontractors

Subcontractors will be responsible for adhering to and meeting their own health and safety requirements. Review of the plan will be required for approval by the prime contractor. Subcontractors will possess a HASP that is at least as stringent as Geosyntec's safety protocol; in addition, they will be responsible for submitting an individual APP that is consistent with Geosyntec's safety protocol.

6. TRAINING

Table D-A-2 of the HASP documents workers that have received the appropriate training requirements according to the company Environmental, Health, and Safety (EH&S) Training Program. All field personnel will have 40-hour HAZWOPER training and be current on 8-hour OSHA annual refresher training. The SHSO will be responsible for checking that training for on Site employees is current for the duration of time spent on Site. SHSO conducted health and safety indoctrination meetings will be required of all field personnel and will at a minimum include the following:

- Emergency Procedures
- Review of Hazards on Site
- Base Procedures
- Decontamination Procedures
- Work Exclusion Zones
- Review of Activity Hazard Analysis
- Review of Health and Safety Plan
- Explosives Training

6.1 Mandatory Training and Certifications

Mandatory training and certification of Geosyntec employees is listed in Table D-A-2 of the HASP.

6.2 Meetings

Mandatory daily tailgate meetings with the SHSO and all field personnel will be held. Weekly meetings will be held between the contractor and the Navy. During the meetings the SHSO will discuss findings of weekly Site inspections will be tracked on forms presented inAttachment D-A-1.

7. HEALTH AND SAFETY INSPECTIONS

The duration of the project is expected to be one year. The SHSO will receive training on site inspections from the EHSC, Dale Prokopchak, C.I.H. After the training, the SHSO will conduct weekly Weekly Health &Safety inspections at the site. The inspections will be documented using the Weekly Health & Safety Inspection checklist included in Attachment D-A-1. The Weekly Health & Safety Inspection Checklist will be kept on file at the Site. Significant discrepancies will be recorded in the health and safety logbook. Health and safety inspections will also be conducted every month by the Project Manager. Significant discrepancies will be recorded on a work-site inspection form found in Attachment D-A-1. Copies of the inspection reports will be kept on file for review by the ESHC. For long-term projects, the corporate EHSC (or their delegate) will conduct a yearly audit. Discrepancies noted during these inspections will be posted on the site and updated daily. The SHSO and site supervisor will be assigned to correct each discrepancy within a designated time period.

7.1 Inspection Protocol

Employees at field locations have the opportunity to prepare for inspections on a daily basis. Geosyntec places the burden of responsibility on all employees to make their work environment safe by correcting unsafe conditions on an ongoing basis. A complete set of inspection forms can be found in Attachment D-A-1.

7.2 Correcting Unsafe Conditions

All hazards discovered during an inspection or coming to the attention of Geosyntec must be corrected in a timely manner consistent with the seriousness of the hazard. All reasonable efforts should be made to abate recognized hazards as soon as possible and

to advise employees of any uncorrected hazards. However, if there is an imminent danger of serious harm, an immediate corrective action, such as taking the piece of equipment or workstation out of service, is required. If an imminent hazard exists which cannot be immediately abated without endangering people/property, then all potentially exposed personnel will be removed from the area except those necessary to correct the hazardous condition. Employees correcting the hazardous condition shall be provided with the necessary safeguards. With regard to correcting unsafe conditions, the Geosyntec Site Supervisors and/or SHSOs shall protect the safety and health of their employees/guests by:

- Promptly correcting unsafe or unhealthy conditions;
- Setting a target date for correcting any hazard that cannot be immediately corrected and following up to confirm the hazard abatement;
- Utilizing the area inspection checklist to track and document identified hazards and corrective measures;
- Providing interim protection to employees during the correction of hazards;
- Informing area personnel of the status of the hazardous condition;
- Immediately removing/supporting the removal of any personnel exposed or potentially exposed to an imminent hazard; and
- Securing the resources (maintenance personnel, safety and health specialists, consultants) necessary to assess the hazard severity and recommend corrective action and abate the hazard.

8. HEALTH AND SAFETY EXPECTATIONS, INCENTIVE PROGRAMS, AND COMPLIANCE

8.1 Health and Safety Program Expectations

It is the goal of Geosyntec to achieve ZERO INCIDENTS on our projects and achieve SAFETY EXCELLENCE. All work will be conducted in accordance with OSHA, NAVFAC, and other applicable safety regulations and guidelines.

8.2 Health and Safety Program Incentives

Health and Safety is part of the daily routine at Geosyntec. Spot awards and incentives are given to employees when their actions on a project or in the office go above and beyond the normal call of duty. In our OSHA 8-hr HAZWOPER Annual Refresher, we invite project managers to highlight the successful execution of the high risk projects so all attendees benefit from the safe procedures practiced by their team members.

In addition, Geosyntec's Director of Environment, Health and Safety sends out company-wide e-monthly EHS Alerts with input from staff who have something to contribute to the safety awareness. In the process, the contributing employee is recognized throughout the company.

8.3 Health and Safety Program Compliance

Geosyntec strives for 100% compliance with health and safety regulations, utilizing state-of-the art PPE, and ensuring compliance with the most current occupational exposure limits. Each person is responsible for his/her own health and safety, for completing tasks in a safe manner, and for reporting any unsafe acts or conditions to his/her supervisor and/or the SHSO.

All personnel are responsible for continuous adherence to established health and safety procedures during the performance of their work. All personnel are strongly encouraged to report unsafe conditions to their supervisor without fear of reprisal. No person may work in a manner that conflicts with the letter or intent of safety and environmental precautions expressed in these applicable health and safety procedures. After due warnings, Geosyntec will dismiss from the work site any person who repeatedly violates health and safety procedures.

8.4 Health and Safety Program Accountability

Managers and supervisors will be held accountable for safety performance during the course of this project. Safety performance on projects will be reflected in performance appraisals and bonuses programs, as deemed appropriate by senior management.

9. ACCIDENT REPORTING

Accident reporting shall be carried out according to NAVFAC and OSHA requirements. The Navy NTR will be notified of all accidents (including major accidents) on Site.

9.1 Exposure Data

The SHSO will provide a monthly incident summary to the Project Health and Safety Manager including the person-hours worked and a list of incidents occurring during the summary period.

9.2 Incident Investigations, Reports, and Logs

An OSHA 300 Log will be kept at the job site. A copy of this form can be found in Appendix D-A. All incidents will be reported immediately to the Supervisor. The Supervisor and SHSO will investigate incidents and complete the necessary reports and logs (available from human resources). These incidents include:

- OSHA recordable injuries or illnesses requiring treatment beyond first aid
- Fires and explosions of any magnitude
- Spills and environmental releases
- Tool or equipment failure resulting or possibly resulting in serious injury

9.3 Immediate Notification of Major Accidents

Accidents that involve a fatality, permanent or partial disability, or person admitted to the hospital will be reported immediately to the Supervisor and the Navy NTR.

10. MEDICAL SUPPORT

Should medical support be needed on the project, the procedures documented in the HASP should be followed. Off-site trauma and non-trauma medical facilitates have been identified and are presented on Figures D-A-1A and D-A-1B. the On site medical facility is not designed to handle trauma cases and non-life threatening issues may be addressed by the nearby civilian medical clinic, therefore there is no need for project personnel to use the Navy medical facility

10.1 On-Site First Aid and CPR Support

All Geosyntec field and management personnel on site will have current First Aid/CPR and blood-borne pathogens training. On-site first aid kits will be complete and checked weekly to ensure contents are replaced when used. The nearest trained individual will be responsible for providing CPR and First Aid during an incident. Training to maintain field and management personnel's CPR and First Aid certification will be scheduled with the local American Red Cross or other professional, licensed trainer. At

least two personnel trained and certified in adult first aid/CPR and the blood-borne pathogens will be on-site while field activities are being conducted.

11. PERSONAL PROTECTIVE EQUIPMENT (PPE)

The use and need for personal protective equipment (PPE) is addressed in section D-8 of the HASP.

12. PLANS REQUIRED BY THE SAFETY MANUAL

The HASP contains the following plans required for the work at this site:

- Emergency Action Plan – Table D-A-7
- Spill Containment – Section 12
- Hazard Communication – Section 13
- Site Specific Health and Safety Plan – Appendix D-A

13. CONTRACTOR MONITORING INFORMATION

Exposure monitoring will be conducted to identify and evaluate chemical and physical hazards anticipated during this project on an as needed basis. Records of monitoring activities will include the date, time, contaminants or hazards monitored, person conducting the monitoring, operation and location of the monitoring, and results of the monitoring.

14. SITE SPECIFIC HAZARDS AND CONTROLS

This section addresses AHA and mitigation measures. Site specific hazards must be identified (through hazard analysis) to determine the appropriate safety and health hazard mitigators needed to protect workers from the identified hazards. Hazard analysis involves a complete review of chemical, physical, and biological hazards. The AHAs for this site are located in the attached tables.

ACITIVITY HAZARD ANALYSIS TABLES

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ACTIVITY HAZARD ANALYSIS FOR BROMIDE TRACER TESTING[1]

SECTION 1

Location: **Naval Weapons Station Seal Beach**	Contract No.: **N68711-04-D-1106**	Project Title: **IR Site 70**
Activity: **Bromide Tracer Testing**	Prime Contractor[2]: **Geosyntec Consultants, Inc.**	Subcontractors:
General description for scope[3], work of this activity: **Tracer and Pump Tests of Aquifer**		Minimum PPE Requirements: **Level D**
Date of Preparatory Inspection:	Estimated Start Date of Activity: **January 2008**	

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Equipment check	Lifting (Lifting heavy loads) Pinch Points	• Do not lift more weight than can be handled comfortably, regardless of load weight. If necessary, help should be requested to lift a load so that the lifting is comfortable (>50 lbs) • Use proper lifting techniques • Be aware of potential pinch points • Keep clear of moving parts and items being moved around
Air Monitoring	Compressed Calibration Gas (Compressed Gases)	• Point tubing away from body. • Stand to the side of the compressed gas cylinder when opening valves • Use appropriate regulator and fittings. • Be aware of pressurized lines when connecting and disconnecting fittings • Store cylinders upright in well ventilated environment away from temperature extremes properly identified.
Preparation of Amendment Water/Injection of Bromide	Skin Absorption (Skin Absorption)	• Minimize contact with site water • Avoid wearing contacts • Safety glasses should be worn
	Electric wiring (Electrocution)	• Check the condition of the wiring prior to putting pump into well • Repair any damaged protective coverings on wiring
General Hazards	Slipping and Tripping (Slips, Trips, Falls)	• Clear walkways, platforms, access steps and work areas of equipment, tools, and debris • Mark, identify, or barricade other obstructions • Work areas, platforms and walkways should be kept free of materials, debris, and obstructions such as grease or oil that could cause a surface to become slick or otherwise hazardous.

[1] Modify the AHA as often as necessary to address new or unanticipated hazards. Use standard company health and safety protocols in order to facilitate field changes to the HASP.
[2] Ensure that every employee understands this AHA (Activity Hazard Analysis) and the equipment operation
[3] Work should only be completed by a qualified person.

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EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Drum Dollies • Power Generator • Water Sounders • Pumps • Alconox • Deionized Water • Bromide Tracer • Bromide Meter • Bromide calibration kit • PID • PID Calibration Gas	• Check equipment daily for cleanliness. • Check all electrical equipment to verify that there are no frayed wires. • Check that switches on larger equipment are working properly. • Persons operating machinery and vehicles should be properly trained and verify that their machine of operation is in proper working condition, check for loose screws and bolts. • Check for proper storage techniques. • Perform daily calibration where applicable.	• Knowledge and training on operation of machinery • 40 Hour HAZWOPER training • Training in use of bromide tracer tests • Training in use of equipment • Knowledge of Health and Safety Plan (HASP) and AHA • Training in SOP • Attend preliminary Site training

REVIEWED BY:

Safety Officer (signature)

Health and Safety Manager

Client Representative (REVIEWED BY)

SITE PERSONNEL: Sign and date below to indicate you have read and understand the above AHA.

Name	Date	Name	Date

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ACTIVITY HAZARD ANALYSIS FOR WELL REHABILITATION AND DEVELOPMENT[4]

SECTION 1

Location: **Naval Weapons Station Seal Beach**	Contract No.: **N68711-04-D-1106**	Project Title: **IR Site 70**
Activity: **Well Rehabilitation and Development**	Prime Contractor[5]: **Geosyntec Consultants, Inc.**	Subcontractors: **WDC for Development**
General description for scope[6], work of this activity: **Rehabilitation of Monitoring Wells**		Minimum PPE Requirements: **Level D**
Date of Preparatory Inspection:	Estimated Start Date of Activity: **January 2008**	

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Container reception and equipment check	Heavy Loads (Lifting Heavy Loads)	• Inspect container integrity upon arrival at the field site and verify that all valves are closed and all connections are secure • Do not lift more weight than can be handled comfortably, regardless of load weight. If necessary, help should be requested to lift a load so that the lifting is comfortable
Injection of antibacterial / antifouling agents	Chemical reaction of antibacterial / antifouling agents (Reactivity)	• Read MSDSs for all chemicals used • Be aware of potential reactions between chemicals of concern and injected chemicals. • Use gloves to avoid contact.
Surging/Bailing	Pinch Points (Hand/Foot Injury)	• Be aware of potential pinch points • Keep clear of moving parts and items being removed from wells
Water Extraction	Skin absorption (Skin Absorption)	• Minimize contact with site water • Avoid wearing contacts • Use gloves and wear safety glasses to avoid contact.
	Electric wiring (Electrocution)	• Look up before towering up the mast of the development vehicle • Check the condition of the wiring prior to putting pump into well • Repair any damaged protective coverings on wiring
Water Storage	Falling while walking on top (Fall protection)	• Make sure guardrails are in place when walking on top of Baker tanks • Inspect ladders and steps prior to use for structural integrity

[4] Modify the AHA as often as necessary to address new or unanticipated hazards. Use standard company health and safety protocols in order to facilitate field changes to the HASP.
[5] Ensure that every employee understands this AHA (Activity Hazard Analysis) and the equipment operation
[6] Work should only be completed by a qualified person.

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Air Monitoring	Compressed Calibration Gas (Compressed Gases)	• Point tubing away from body. • Stand to the side of the compressed gas cylinder when opening valves • Use appropriate regulator and fittings. • Be aware of pressurized lines when connecting and disconnecting fittings • Store cylinders upright in well ventilated environment away from temperature extremes properly identified.
All Site Activities	Tripping / Falling (Slips, Trips, and Falls)	• Clear work areas of equipment, tools, and debris • Mark, identify, or barricade other obstructions • Be aware of uneven surfaces on Site and take care while walking

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• PPE • Smeal 5T rig (or equivalent) • Steam Cleaner • Vented Surge Block • Submersible pump • Bailer • Generator • Water Level Indicator • Horiba U-10 (or equivalent) • Flow meter • Abrasive wire brush • Antibacterial/antifouling agents • Hoses • Electrical Wiring • Baker Tank • PID • Calibration Gas	• Check equipment daily for cleanliness. • Check all electrical equipment to verify that there are no frayed wires. • Check that switches on larger equipment are working properly. • Persons operating machinery and vehicles should be properly trained and verify that their machine of operation is in proper working condition, check for loose screws and bolts. • Check for proper storage techniques. • Calibrate Horiba U-10 daily • Calibrate PID daily	• Proper Health and Safety Plan (HASP) and AHA training to ensure the practice of proper procedure. • Standard Operating Procedure (SOP) review. • Knowledge of well construction details and proper cleaning techniques. • 40 Hour HAZWOPER • Initial Site Safety Briefing • Training on equipment use and maintenance

Geosyntec consultants

REVIEWED BY:

Safety Officer (signature)

Health and Safety Manager

Client Representative (REVIEWED BY)

SITE PERSONNEL: Sign and date below to indicate you have read and understand the above AHA.

Name	Date	Name	Date

Geosyntec consultants

ACTIVITY HAZARD ANALYSIS FOR GROUNDWATER SAMPLING AND MONITORING[7]

SECTION 1

Location: **Naval Weapons Station Seal Beach**	Contract No.: **N68711-04-D-1106**	Project Title: **IR Site 70**
Activity: **Groundwater Sampling and Monitoring**	Prime Contractor[8]: **Geosyntec Consultants, Inc.**	Subcontractors: **Blaine Tech**
General description for scope[9], work of this activity: **Groundwater Sampling and Monitoring of Developed Wells. Sampling of Soils at Site.**		Minimum PPE Requirements: **Level D**
Date of Preparatory Inspection:	Estimated Start Date of Activity: **January 2008**	

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Groundwater Sampling and Monitoring	Heavy equipment (Lifting heavy loads)	• Do not lift more weight than can be handled comfortably, regardless of load weight. • If necessary, help should be requested to lift a load (>50 lbs) so that the lifting is comfortable. • Use proper lifting techniques as outlined in hazard mitigator.
Groundwater sampling and monitoring	Handling of compressed gases for purging (Compressed Gases)	• Always point tubing away from body. • Stand to the side of the compressed gas cylinder when opening valves • Always use appropriate regulator and fittings. • Be aware of pressurized lines when connecting and disconnecting fittings. • Properly store gas cylinders
	Sharp objects (Knives/hand foot injury)	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all tools in a safe condition. Use the correct tool for the activity. • Keep guards in place during use • Use abrasion resistant gloves
	High/Low Ambient Temperature (Heat Stress/cold stress)	• Protect skin from ultraviolet rays by wearing your hard hat, long pants, long sleeved shirts, and sunscreen lotion, • Wear clothing / PPE suitable for weather and working conditions • Keep an eye on your working buddy for signs of heat or cold stress. • Drink fluids and rest when needed. • Work in pairs

[7] Modify the AHA as often as necessary to address new or unanticipated hazards. Use standard company health and safety protocols in order to facilitate field changes to the HASP.
[8] Ensure that every employee understands this AHA (Activity Hazard Analysis) and the equipment operation
[9] Work should only be completed by a qualified person.

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Groundwater sampling and monitoring (continued)	Electric wiring (Electrocution)	• Look up before towering up the mast of the development vehicle • Check the condition of the wiring prior to putting pump into well • Repair any damaged protective coverings on wiring
	Pinch points (Drum and container handling)	• Wear proper work gloves when the possibility of pinching, or other injury may be caused by moving/ handling large or heavy objects. • Use safe drum dolly handling techniques. • Always check drum rings to insure they are tight before moving drums. • Neatly stack pipe, rods, and similar tools on racks or sills to prevent spreading, rolling or sliding • Use appropriate tools such as drum wrench and vise grips
Air Monitoring	Compressed Calibration Gas (Compressed Gases)	• Point tubing away from body. • Stand to the side of the compressed gas cylinder when opening valves • Use appropriate regulator and fittings. • Be aware of pressurized lines when connecting and disconnecting fittings • Store cylinders upright in well ventilated environment away from temperature extremes properly identified.
Decontamination	Pressure washer injuries (Portable Power/Hand Tools; Slips, trips, and falls; Eye injury)	• Pressure washer operator will use raingear waterproof boots with steel toecaps and metatarsal and leg guards, face shield and hearing protection. • Check hoses, pipes, and fittings for excessive wear. Replace damaged equipment. • Use pressure washer manufacturer's operating instructions and checklist • Arrange hose to avoid trip hazard • Always use the buddy system, one to operate the pump, the other the gun.
Demobilization	Vehicle traffic (Thoroughfares)	• Use spotter when backing. • Survey exit route and inform crew of any hazards. • Mark work zones with cones or other appropriate signs • Use flaggers and/or barricades to direct traffic around equipment when necessary.
	Handling heavy objects (Lifting heavy loads; Drum and Container handling)	• Use proper lifting techniques • Obey sensible lifting limits (50-lb maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, drum dolly, forklift, trucks) to move drums and large, awkward loads.

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
All tasks	Slipping and tripping (Slips, trips, and falls)	• Clear walkways and work areas of equipment, vegetation, excavated material, tools, and debris • Mark, identify, or barricade other obstructions • Be aware of uneven surfaces naturally occurring at the site • Work areas, platforms, and walkways should be kept free of materials, debris, and obstructions such as grease or oil that could cause a surface to become slick or otherwise hazardous.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Submersible Pump (0-40 gpm) • Smeal Rig 5T or equivalent • Electrical Cable Extension • Submersible Pump Hose • Stainless Steel Cable • Extraction Well Flow Control Valves • Compressed Gas (for bladder pump sampling) • Pump Flow Control System (recirculation line or electronic controller) • Water Level Meter • Flow meter or calibrated container • Horiba U-22 • Flow through Cell • Horiba Calibration Fluid • Plastic Bubble Wrap • Ziploc-type Bags/Boxes • Cooler • Ice • Alconox • Brushes • Deionized Water • Pump Sprayer • PID • Calibration Gas • Sample containers	• Check equipment daily for cleanliness • Check all electrical equipment to verify that there are no frayed wires. • Check switches on larger equipment are working properly. • Calibrate Horiba U-22 • Calibrate PID • Persons operating machinery and vehicles should be properly trained and check that their machine of operation is in proper working condition, check for loose screws and bolts.	• Standard Operating Procedure (SOP) review. • Proper Health and Safety Plan (HASP) and AHA training to ensure the practice of proper procedure. • Proper SOP training. • 40-Hour HAZWOPER training. • Sampling and Analysis Plan (SAP) training. • Training in equipment use.

Geosyntec consultants

REVIEWED BY:

Safety Officer (signature)

Health and Safety Manager

Client Representative (REVIEWED BY)

SITE PERSONNEL: Sign and date below to indicate you have read and understand the above AHA.

Name	Date	Name	Date

Geosyntec consultants

ACTIVITY HAZARD ANALYSIS FOR SOIL GAS SAMPLING AND MONITORING[10]

SECTION 1

Location: **Naval Weapons Station Seal Beach**	Contract No.: **N68711-04-D-1106**	Project Title: **IR Site 70**
Activity: **Soil Gas Sampling and Monitoring**	Prime Contractor[11]: **Geosyntec Consultants, Inc.**	Subcontractors:
General description for scope[12], work of this activity: **Tracer and Pump Tests of Aquifer**		Minimum PPE Requirements: **Level D**
Date of Preparatory Inspection:	Estimated Start Date of Activity: **January 2008**	

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Equipment check	Lifting (Lifting heavy loads) Pinch Points	• Inspect containers delivered and check that all valves are closed and secure • Do not lift more weight than can be handled comfortably, regardless of load weight. If necessary, help should be requested to lift a load so that the lifting is comfortable (>50lbs) • Use proper lifting techniques • Be aware of potential pinch points • Keep clear of moving parts and items being moved around
Install Soil Gas Probes	Direct push boring (Drilling; Hand/Foot Injury; Eye Injury; Electrocution)	• Review Emergency Shutoff procedures • Ensure all personnel are clear of dangerous parts of equipment • Check equipment for leaks and fraying • Identify Subsurface Utilities
	Above ground wiring (Electrocution)	• Look up before towering up the mast of the development vehicle • Check the condition of the wiring prior to putting pump into well • Repair any damaged protective coverings on wiring
	Placement of Probes in boring (Power/hand tools; inhalation)	• Only use tools for intended purposes • If using bentonite, avoid breathing in the dust. Wear a dust mask as necessary. • Minimize air borne dust.

[10] Modify the AHA as often as necessary to address new or unanticipated hazards. Use standard company health and safety protocols in order to facilitate field changes to the HASP.
[11] Ensure that every employee understands this AHA (Activity Hazard Analysis) and the equipment operation
[12] Work should only be completed by a qualified person.

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Install Soil Gas Probes (continued)	Disposal of Soil from borings (Drum and Container Handling)	• Wear proper work gloves when the possibility of pinching, or other injury may be caused by moving/ handling large or heavy objects. • Use safe drum dolly handling techniques. • Always check drum rings to insure they are tight before moving drums. • Neatly stack pipe, rods, and similar tools on racks or sills to prevent spreading, rolling or sliding • Use appropriate tools such as drum wrench and vise grips
Gas Probe Development	Injuries to hands and feet (Power/hand tools; Hand/Foot injuries; Electrocution)	• Only use tools for intended purposes • Check equipment is in good condition • Ensure all personnel are clear of dangerous parts of equipment • Check the condition of the wiring prior to putting pump into well • Repair any damaged protective coverings on wiring
Air Monitoring	Compressed Calibration Gas (Compressed Gases)	• Point tubing away from body. • Stand to the side of the compressed gas cylinder when opening valves • Use appropriate regulator and fittings. • Be aware of pressurized lines when connecting and disconnecting fittings • Store cylinders upright in well ventilated environment away from temperature extremes properly identified.
Soil Gas Sampling and Screening	Injuries to hands and feet (Power/hand tools; Hand/Foot injuries; Electrocution)	• Only use tools for intended purposes • Check equipment is in good condition • Ensure all personnel are clear of dangerous parts of equipment • Check the condition of the wiring prior to putting pump into well • Repair any damaged protective coverings on wiring
	Purging shroud with helium (Compressed Gas Cylinder)	• Point tubing away from body. • Stand to the side of the compressed gas cylinder when opening valves • Use appropriate regulator and fittings. • Be aware of pressurized lines when connecting and disconnecting fittings • Store cylinders upright in well ventilated environment away from temperature extremes properly identified.
	Sample reaction with containers (Reactivity)	• Avoid exposure of the soil gas sample with metal components in the sampling equipment • Be aware of potential presence of hydrogen sulfide in sample • Be aware of chemical properties and incompatibilities of COCs at the Site.

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Soil Gas Sampling and Screening (continued)	Slips, Trips, Falls	• Clear walkways, platforms, access steps and work areas of equipment, tools, and debris • Mark, identify, or barricade other obstructions • Work areas, platforms and walkways should be kept free of materials, debris, and obstructions such as grease or oil that could cause a surface to become slick or otherwise hazardous.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Summa canisters • ¼-inch nylaflow tubing • Alconox • Deionized water • Tap water • Coarse scrub brush • Steam cleaner • Polyethylene sheeting • Disposable gloves • GeoProbe Dual Tube DT325 • Silica Sand • Bentonite • 0-100” Vacuum Gauge • Valves and fittings • Vacuum Pump • Magnehelic Gauge • 0-500 mL/min Rotameter Flow Meter • 1L Tedlar Bags • Lung Box • Screen or vapor implant • Landtec Portable GEM-500 Gas Analyzer • PID • Calibration Gas • 0-30” Hg Vacuum Gauge • Shroud • 5 micron filter • Helium tank	• Check equipment daily for cleanliness • Check all electrical equipment to verify that there are no frayed wires. • Calibrate PID • Persons operating machinery should be properly trained and check that their machine is in proper working condition, check for loose screws and bolts. • Check that all equipment and materials are stored properly	• Proper Health and Safety Plan (HASP) and AHA training to ensure the practice of proper procedure. • Standard Operating Procedure (SOP) review. • Sampling and Analysis Plan (SAP) review. • 40-Hour HAZWOPER training. • Proper use of equipment and knowledge sampling techniques.

Geosyntec consultants

REVIEWED BY:

Safety Officer (signature)

Health and Safety Manager

Client Representative (REVIEWED BY)

SITE PERSONNEL: Sign and date below to indicate you have read and understand the above AHA.

Name	Date	Name	Date

ACTIVITY HAZARD ANALYSIS FOR KB-1 INJECTION[13]

SECTION 1

Location: **Naval Weapons Station Seal Beach**	Contract No.: **N68711-04-D-1106**	Project Title: **IR Site 70**
Activity: **KB-1 Injection**	Prime Contractor[14]: **Geosyntec Consultants, Inc.**	Subcontractors:
General description for scope[15], work of this activity: **KB-1 Vessel and associated fittings will be used to inject culture into monitoring wells.**		Minimum PPE Requirements: **Level D**
Date of Preparatory Inspection:	Estimated Start Date of Activity: **January 2008**	

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
KB-1 vessel reception and equipment check	Moving bulky equipment (Lifting heavy loads)	• Inspect containers delivered and check that all valves are closed and secure • Do not lift more weight than can be handled comfortably, regardless of load weight. If necessary, help should be requested to lift a load so that the lifting is comfortable (>50lbs) • Use proper lifting techniques • Be aware of potential pinch points • Keep clear of moving parts and items being moved around
Preparation of Amendment Water	Skin Absorption (Skin Absorption)	• Minimize contact with site water • Avoid wearing contacts • Use gloves and wear safety glasses to avoid contact.
	Electric wiring (Electrocution)	• Check the condition of the wiring prior to putting pump into well • Repair any damaged protective coverings on wiring
Water Storage	Falling while walking on top (Fall protection)	• Make sure guardrails are in place when walking on top of Baker tanks • Inspect ladders and steps prior to use for structural integrity
Flushing Well	Flushing well with Argon Gas (Compressed Gas Cylinders)	• Point tubing away from body. • Stand to the side of the compressed gas cylinder when opening valves • Use appropriate regulator and fittings. • Be aware of pressurized lines when connecting and disconnecting fittings • Store cylinders upright in well ventilated environment away from temperature extremes properly identified.

[13] Modify the AHA as often as necessary to address new or unanticipated hazards. Use standard company health and safety protocols in order to facilitate field changes to the HASP.
[14] Ensure that every employee understands this AHA (Activity Hazard Analysis) and the equipment operation
[15] Work should only be completed by a qualified person.

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
KB-1 injection with Argon	Compressed Gases / KB-1 (Compressed Gas Cylinders)	• Goggles should be worn when injecting KB-1 • Point tubing away from body. • Stand to the side of the compressed gas cylinder when opening valves • Use appropriate regulator and fittings. • Be aware of pressurized lines when connecting and disconnecting fittings • Store cylinders upright in well ventilated environment away from temperature extremes properly identified.
	Spills	• Refer to KB-1 and EVO MSDS for appropriate spill response steps
Air Monitoring	Calibration of gas monitor (Compressed Gas Cylinder)	• Point tubing away from body. • Stand to the side of the compressed gas cylinder when opening valves • Use appropriate regulator and fittings. • Be aware of pressurized lines when connecting and disconnecting fittings • Store cylinders upright in well ventilated environment away from temperature extremes properly identified.
All Tasks	Slips, Trips, Falls	• Clear walkways, platforms, access steps and work areas of equipment, tools, and debris • Mark, identify, or barricade other obstructions • Work areas, platforms and walkways should be kept free of materials, debris, and obstructions such as grease or oil that could cause a surface to become slick or otherwise hazardous. • Quickly cleanup spills of EVO • Be aware of uneven surfaces on site

EQUIPMENT TO BE USED		INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Piping and Manifold • Power Supply • Fire Hose • Adaptor with Shut off valve • 20,000 Gal Tank • Pump • Pressure gauges • In-line filters • A40 Proportional Feed pumps • Flow Meter • Ball Valve • Header • Totalizing Flow meter • Male cam lock connectors • Female cam lok fittings • Male/Male adaptor • PVC cross • 2 Ball valves • Dual Vacuum/pressure gauge • Clear sight tube • Flange Fitting • Rubber gasket	• Reducing coupling solvent • Cam-lok quick connector • Valve • Alconox • Bleach • Water • Buckets • Brushes with plastic bristles • Trash pump • Tools (screwdriver, pipe wrenches, squirt bottle) • Trailer–for EVO delivery feed system • EVO • Totes • Storage Tank • KB-1 Culture in container • Connex Box or Shade Canopy • 6 mL Visqueen • Spill Kit • Absorbent Socks • Granular absorbent • Decon Drums • Argon gas canister	• Check equipment daily for cleanliness • Check all electrical equipment to verify that there are no frayed wires. • Check pressure gauges for built up pressure in any portion of system • Persons operating machinery and vehicles should be properly trained and check that their machine of operation is in proper working condition, check for loose screws and bolts. • Inspect tanks, pipes, and fittings for leaks • Check manufacturer's specifications for equipment-specific requirements.	• Proper Health and Safety Plan (HASP) and AHA training to ensure the practice of proper procedure. • Standard Operating Procedure (SOP) review. • Training with equipment • Proper Storage of KB-1 Culture. • 40-Hour HAZWOPER training. • Pre-Entry Briefing

Geosyntec consultants

REVIEWED BY:

Safety Officer (signature)

Health and Safety Manager

Client Representative (REVIEWED BY)

SITE PERSONNEL: Sign and date below to indicate you have read and understand the above AHA.

Name	Date	Name	Date

ACTIVITY HAZARD ANALYSIS FOR EVO INJECTION[16]

SECTION 1

Location: **Naval Weapons Station Seal Beach**	Contract No.: **N68711-04-D-1106**	Project Title: **IR Site 70**
Activity: **Emulsified Vegetable Oil (EVO) Injection**	Prime Contractor[17]: **Geosyntec Consultants, Inc.**	Subcontractors:
General description for scope[18], work of this activity: **Injection of emulsified vegetable oil into monitoring wells**		Minimum PPE Requirements: **Level D**
Date of Preparatory Inspection:	Estimated Start Date of Activity: **January 2008**	

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Vessel reception and equipment check	Handling bulky equipment (Lifting Heavy Loads) Pinch Points Forklifts	• Inspect containers delivered and check that all valves are closed and secure • Do not lift more weight than can be handled comfortably, regardless of load weight. If necessary, help should be requested to lift a load so that the lifting is comfortable (>50lbs) • Use proper lifting techniques • Be aware of potential pinch points • Keep clear of moving parts and items being moved around
Preparation of Amendment Water	Skin Absorption (Skin Absorption)	• Minimize contact with site water • Avoid wearing contacts • Use gloves and wear safety glasses to avoid contact.
	Electric wiring (Electrocution)	• Check the condition of the wiring prior to putting pump into well • Repair any damaged protective coverings on wiring
Well Pressurization and Disconnection of Potentially Pressurized Lines	Handling of Compressed gases and liquids (Compressed Gas Cylinder)	• Goggles should be worn during injection • Stand to the side of the compressed gas cylinder when opening valves • Use appropriate regulator and fittings. • Be aware of pressurized lines when connecting and disconnecting fittings • Store cylinders upright in well ventilated environment away from temperature extremes properly identified.

[16] Modify the AHA as often as necessary to address new or unanticipated hazards. Use standard company health and safety protocols in order to facilitate field changes to the HASP.
[17] Ensure that every employee understands this AHA (Activity Hazard Analysis) and the equipment operation
[18] Work should only be completed by a qualified person.

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Air Monitoring	Calibration of monitor (Compressed Gas Cylinder)	• Point tubing away from body. • Stand to the side of the compressed gas cylinder when opening valves • Use appropriate regulator and fittings. • Be aware of pressurized lines when connecting and disconnecting fittings • Store cylinders upright in well ventilated environment away from temperature extremes properly identified.
All Tasks	Spills	• Refer to EVO SOP for appropriate spill response steps
	Slips, Trips, Falls	• Clear walkways, platforms, access steps and work areas of equipment, tools, and debris • Mark, identify, or barricade other obstructions • Work areas, platforms and walkways should be kept free of materials, debris, and obstructions such as grease or oil that could cause a surface to become slick or otherwise hazardous. • Be careful when handling EVO and when opening valves to avoid EVO slicks forming

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Ball valves • Dual Vacuum/pressure gauge • Clear sight tube • Flange Fitting • Rubber gasket • Reducing coupling solvent • Cam-lok quick connector • Valve • Trailer -for EVO delivery feed system • EVO Totes • Storage Tank • Connex Box or Shade Canopy • 6 mL Visqueen • Spill Kit • Absorbent Socks • Granular absorbent • Storage Drum • Alconox • Bleach • Buckets • Brush with plastic bristles • Power Supply • Water • Trash pump • Tools (Screwdriver, pipe wrenches, etc.) • Forklift for unloading • Delivery truck with lift gate	• Check equipment daily for cleanliness • Check all electrical equipment to verify that there are no frayed wires. • Check switches on larger equipment are working properly. • Persons operating machinery and vehicles should be properly trained and check that their machine of operation is in proper working condition, check for loose screws and bolts. • Check tanks and fittings for leaks.	• Proper Health and Safety Plan (HASP) and AHA training to ensure the practice of proper procedure. • 40-Hour HAZWOPER training • Pump Regulations and associated training. • Operation and Set-up of Trailer training. • Standard Operating Procedure (SOP) review. • Proper use of equipment, including turning on and off of machines. • Proper Storage of EVO Culture. • Pre-Entry Site Briefing.

Geosyntec consultants

REVIEWED BY:

Safety Officer (signature)

Health and Safety Manager

Client Representative (REVIEWED BY)

SITE PERSONNEL: Sign and date below to indicate you have read and understand the above AHA.

Name	Date	Name	Date

ACTIVITY HAZARD ANALYSIS FOR DRILLING AND WELL CONSTRUCTION[19]

SECTION 1

Location: **Naval Weapons Station Seal Beach**	Contract No.: **N68711-04-D-1106**	Project Title: **IR Site 70**
Activity: **Drilling and Well Construction**	Prime Contractor[20]: **Geosyntec Consultants, Inc.**	Subcontractors: **Prosonic**
General description for scope[21], work of this activity: **Drilling and construction wells**		Minimum PPE Requirements: **Level D**
Date of Preparatory Inspection:	Estimated Start Date of Activity: **January 2008**	

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Drilling Setup	Untrained workers	• Ensure that every worker is informed of safe operating practices on and around the rig • Preliminary meeting will cover the voice and hand signals associated with this type of activity. • Before work is started, ensure that everyone who operates the rig has had adequate training and is thoroughly familiar with the rig, controls, capabilities and operating manual.
Drilling Setup	Contacting Underground/Overhead Utilities (Utility Protection)	• Obtain and review all pertinent drawings • Contact USA for utility clearance • Obtain all base intrusive permits and make required contacts • Check work areas for overhead lines and obstructions (trees, structures, etc.) • Scan, mark, and locate all utilities around the site before work commences • Cease work immediately if unknown utility markers are uncovered • Air knife/hand auger 0-10 feet before pushing rods • Lower boom prior to moving rig, if applicable • Check that routes are planned which provide clear passage of the vehicle • Check that extended mast height will clear overhead obstruction
Equipment Inspection, Walk-around	Slipping and Tripping (Slips, trips, and falls)	• Clear walkways, platforms, access steps and work areas of equipment, tools, and debris • Mark, identify, or barricade other obstructions • Work areas, platforms and walkways should be kept free of materials, debris, and obstructions such as grease or oil that could cause a surface to become slick or otherwise hazardous. • Be aware of uneven surfaces at the site
Mobilization / Set-Up of Rig	Security – unauthorized personnel in work area	• Area of operation to be cordoned off. • Set up Exclusion Zone and Support Zone.

[19] Modify the AHA as often as necessary to address new or unanticipated hazards. Use standard company health and safety protocols in order to facilitate field changes to the HASP.
[20] Ensure that every employee understands this AHA (Activity Hazard Analysis) and the equipment operation
[21] Work should only be completed by a qualified person.

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Mobilization / Set-Up of Rig (continued)	Hydraulic hose leakage (Spills)	• Inspect equipment daily for leaks • Cleanup spills in a timely manner
	Vehicle traffic (Thoroughfares)	• Use spotter when backing. • Survey exit route and inform crew of any hazards. • Mark work zones with cones or other appropriate signs • Use flaggers and/or barricades to direct traffic around equipment when necessary.
	Handling heavy objects and drums (Lifting heavy objects)	• Use proper lifting techniques • Obey sensible lifting limits (50-lb maximum per person manual lifting) • Use mechanical lifting equipment (hand carts,drum dolly, forklift, trucks) to move drums and large, awkward loads.
	Hand and foot injury (Hand/foot injury)	• Keep hands and feet free from moving parts • Keep feet out from under equipment • Don't place hands, feet and /or limbs into or through openings of equipment frames or structures which were never intended to be used in such a fashion. • Lock and tag out before any maintenance. • Use abrasion resistant gloves when handling equipment, pipes, etc.
	Slipping and Tripping (Slips, trips, and falls)	• Clear walkways, platforms, access steps and work areas of equipment, tools, and debris • Mark, identify, or barricade other obstructions • Work areas, platforms and walkways should be kept free of materials, debris, and obstructions such as grease or oil that could cause a surface to become slick or otherwise hazardous. • Be aware of uneven surfaces at the site
Rig Operation	Hand and foot injury (Hand/foot injury)	• Keep hands and feet free from moving parts • Keep feet out from under equipment • Don't place hands, feet and /or limbs into or through openings of equipment frames or structures which were never intended to be used in such a fashion. • Lock and tag out before any maintenance. • Use abrasion resistant gloves when handling equipment, pipes, etc.
	Drilling operations (Drilling)	• Test the two kill switches during each startup • Rig helper and other site personnel must know location of the two emergency shutoff switches. • Area of drilling operation must be cordoned off/barricaded • When hazardous conditions are deemed present, operation must be shut down.

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Rig Operation (continued)	Slipping and Tripping (Slips, trips, and falls)	• Clear walkways, platforms, access steps and work areas of equipment, tools, and debris • Mark, identify, or barricade other obstructions • Work areas, platforms and walkways should be kept free of materials, debris, and obstructions such as grease or oil that could cause a surface to become slick or otherwise hazardous. • Be aware of uneven surfaces at the site
	Inclement weather (Heat Stress; Cold stress)	• Cease operations during electrical storm. • Protect skin from UV rays with sunscreen and clothing • Drink fluids • Keep an eye on working buddy for signs of heat or cold stress
	Skin Absorption (Skin Absorption)	• Minimize contact with site water and soil • Avoid wearing contacts • Use gloves and wear safety glasses to avoid contact.
	High Noise levels	• Use hearing protection if noise levels exceed 85 decibels, A-scale.
	Pinch points, nip points, struck by or caught in moving parts	• Crew members shall not wear loose clothing, long hair, jewelry, or equipment that might become caught in moving machinery. Unauthorized personnel must be kept clear of the rig. • Shut down, lock and tag out rig to make repairs or adjustments to the rig or to lubricate fittings. Release all pressure on the hydraulic systems, the drilling fluid system, and the air pressure systems prior to performing maintenance. • Identify equipment which may cause crushing, pinching, or similar injuries • Neatly stack pipe, rods, and similar tools on racks or sills to prevent spreading, rolling or sliding • Wear proper work gloves when the possibility of pinching, or other injury may be caused by moving/handling large or heavy objects • Keep all guards in place during use • **Establish a system of responsibility for the operator and helpers to follow during the series of various activities**, such as connecting and disconnecting sections and inserting and removing the sections. • **Avoid reaching behind or around rotating equipment** • Don't place hands, feet and /or limbs into or through openings of equipment frames or structures
	Handling heavy objects (Lifting Heavy Objects)	• Inspect containers delivered and check that all valves are closed and secure • Do not lift more weight than can be handled comfortably, regardless of load weight. If necessary, help should be requested to lift a load so that the lifting is comfortable (>50lbs) • Use proper lifting techniques

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Rig Operation (continued)	Sharp objects (Knives)	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all tools in a safe condition. Use the correct tool for the activity. • Keep guards in place during use • Use abrasion resistant gloves
	Suspended well construction materials (Eye injury; hand/foot injury)	• Be aware of potential pinch points • Keep clear of moving parts and items being removed from wells • Wear safety glasses • Avoid touching the face and eyes • Do not approach rig while casing is being pulled up.
Air Monitoring	Calibration of monitor (Compressed Gas Cylinder)	• Point tubing away from body. • Stand to the side of the compressed gas cylinder when opening valves • Use appropriate regulator and fittings. • Be aware of pressurized lines when connecting and disconnecting fittings • Store cylinders upright in well ventilated environment away from temperature extremes properly identified.
Handling Investigation Derived Waste	Skin absorption (Skin Absorption)	• Minimize contact with site water and soil • Avoid wearing contacts • Use gloves and wear safety glasses to avoid contact.
	Hand injuries from working around storage containers (Pinch Points and Hand/Foot Injuries)	• Don’t place hands, feet and /or limbs into or through openings of equipment frames or structures • Keep hands and feet free from moving parts • Keep feet out from under equipment • Don’t place hands, feet and /or limbs into or through openings of equipment frames or structures which were not intended to be used in such a fashion. • Lock and tag out before any maintenance. • Use abrasion resistant gloves when handling equipment, pipes, etc. • Be aware of potential pinch points • Keep clear of moving parts and items being moved around
Decontamination	Pressure washer injuries (Eye injury; hand/foot injury; Slips, Trips, and Falls)	• Pressure washer operator will use raingear waterproof boots with steel toecaps and metatarsal and leg guards, face shield and hearing protection. • Check hoses, pipes, and fittings for excessive wear. Replace damaged equipment. • Use pressure washer manufacturer’s operating instructions and checklist • Arrange hose to avoid trip hazard • Always use the buddy system, one to operate the pump, the other the gun.

PRINCIPAL STEPS	POTENTIAL SAFETY / HEALTH HAZARDS (Hazard Mitigator)	RECOMMENDED CONTROLS
Demobilization	Vehicle traffic	• Use spotter when backing. • Survey exit route and inform crew of any hazards. • Mark work zones with cones or other appropriate signs • Use flaggers and/or barricades to direct traffic around equipment when necessary.
	Handling heavy objects (Lifting heavy objects)	• Use proper lifting techniques • Obey sensible lifting limits (60-lb maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, drum dolly, forklift, trucks) to move drums and large, awkward loads.
All Tasks	Slipping or Tripping (Slips, Trips, and Falls)	• Clear walkways, platforms, access steps and work areas of equipment, tools, and debris • Mark, identify, or barricade other obstructions • Work areas, platforms and walkways should be kept free of materials, debris, and obstructions such as grease or oil that could cause a surface to become slick or otherwise hazardous.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Steam Cleaner • Generator • Horiba U-22 • Calibration Fluid • PID • Calibration Gas • Drill Rig • PPE • Munsell soil color chart • Soil sample knife • Boring logs • Support truck • Water tanks • Well construction materials	• Check equipment daily for cleanliness • Check all electrical equipment to verify that there are no frayed wires. • Check switches on larger equipment are working properly. • Persons operating machinery and vehicles should be properly trained and check that their machine of operation is in proper working condition, check for loose screws and bolts. • Check tanks and fittings for leaks.	• Proper Health and Safety Plan (HASP) And AHA training to ensure the practice of proper procedure. • 40-Hour HAZWOPER training. • Drill Rig Special Practice and Procedures. • Drilling Special Methods. • Standard Operating Procedures (SOP) review. • Knowledge of specifics with regards to drilling, • Knowledge of drilling types and techniques. • Pre-Entry Briefing

SECTION 2
ACTIVITY: PROSONIC / WDC RIG SPECIFIC HAZARDS

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Drilling rig and associated equipment • Level D personal protection: Hard hat, safety vest, safety boots, Safety eyewear, long pants, ear protection, abrasion resistant gloves	• Inspect equipment daily before work starts. • Inspect and operate in accordance with the drill rig manufacturer's operation manual	• Tailgate Safety Meeting • Site-specific orientation • Hazard Communication • HAZWOPER 40-hour training • HAZWOPER 8-hour refresher • 8 hour Supervisor training • Worker must be trained in the safe application of task specific tools, equipment and materials • More than one worker must be certified in operation of vehicle

Geosyntec consultants

REVIEWED BY:

Safety Officer (signature)

Health and Safety Manager

Client Representative (REVIEWED BY)

SITE PERSONNEL: Sign and date below to indicate you have read and understand the above AHA.

Name	Date	Name	Date

FIGURES

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Figure D-1

Site Location

IR Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

Geosyntec consultants

Project No: HY1034

Date: February 2008

S:\GIS\HY1034\Projects\WorkPlan\Figure1-1_SiteLocation_2007.mxd lv 20070914

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ATTACHMENT D-1
HEALTH AND SAFETY STATISTICS

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MARSH

MARSH MERCER KROLL
GUY CARPENTER OLIVER WYMAN

Patricia Ibba VP ARM AIS AAI
Client Advisor

Marsh USA Inc.
1560 Sawgrass Corporate Parkway
Suite 300
Sunrise, FL 33323
954 838 3456 Fax 954 838 3656
Patricia.Ibba@Marsh.com
www.marsh.com

February 07, 2008

Ms. Mary Masty SPHR
Director of Human Resources
Geosyntec Consultants
5901 Broken Sound Parkway NW
Suite 300
Boca Raton, FL 33487

Subject: Experience Modifications

Dear Mary,

As requested, the Interstate experience modifications for Geosyntec Consultants are as follows:

- 9/1/2004 - .79
- 9/1/2005 - .80
- 9/1/2006 - .75
- 9/1/2007 - .73

Please call me if you have any questions regarding this.

Thank you.

Sincerely,

Pat Ibba

Patricia Ibba VP ARM AIS AAI
Client Advisor

/pi

Health and Safety Statistics for Geosyntec

	2006	2005	2004	2003	2002
1. # of Hours Employees Worked	1,063,938	1,091,319	1,043,365	907,205	862,897
2. # of Fatalities (Col. G)	0	0	0	0	0
3. # of restricted and lost workday cases (Col. H & I)	2	2	0	1	1
Restricted/lost workday frequency rate	.38	.37	0	.22	.23
4. # of cases defined as recordable with lost workdays (Col. H)	1	2	0	1	0
Lost workday frequency rate	.19	.37	0	.22	0
5. # of cases defined as recordable but without lost workdays or restricted work days (Col. J)	2	5	6	7	4
Recordable Injury without lost workday frequency rate	.38	.92	1.15	1.54	.93
6. Total no. of cases for 2,3 and 5	4	7	6	8	5
7. Recordable Injury Frequency rate	.75	1.28	1.15	1.76	1.16
8. # of lost workdays (Col. K)	11	2	0	3	0
9. Lost Time Incident Rate	2.06	.37	0	.66	0
10. Experience Mod Rate (EMR)	.75	.80	.79	.92	.82
Automotive accidents	4	5	5	4	3
Vehicle Accident Rate	4.4	6.1	6.4	5.7	6.5
Number of company vehicles	45	41	39	35	23

OSHA's Form 300A (Rev. 01/2004)

Summary of Work-Related Injuries and Illnesses

Year 2004

U.S. Department of Labor
Occupational Safety and Health Administration
Form approved OMB no. 1218-0176

All establishments covered by Part 1904 must complete this Summary page, even if no injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the log. If you had no cases write "0."

Employees former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR 1904.35, in OSHA's Recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
0	0	0	6
(G)	(H)	(I)	(J)

Number of Days

Total number of days away from work	Total number of days of job transfer or restriction
0	0
(K)	(L)

Injury and Illness Types

Total number of...
(M)

(1) Injury	4	(4) Poisoning	0
(2) Skin Disorder	0	(5) Hearing Loss	0
(3) Respiratory Condition	0	(6) All Other Illnesses	2

Post this Summary page from February 1 to April 30 of the year following the year covered by the form

Public reporting burden for this collection of information is estimated to average 50 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave, NW, Washington, DC 20210. Do not send the completed forms to this office.

Establishment information

Your establishment name GeoSyntec Consultants

Street 5901 Broken Sound Parkway NW Suite 300

City Boca Raton State FL Zip

Industry description (e.g., Manufacture of motor truck trailers)
Consulting Engineers

Standard Industrial Classification (SIC), if known (e.g., SIC 3715)

OR North American Industrial Classification (NAICS), if known (e.g., 336212)

Employment information

Annual average number of employees 503

Total hours worked by all employees last year 1,043,364.54

Sign here Mary K Masty

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

Mary K. Masty
Company executive

Director of HR
Title

561.922.1005
Phone

Date

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 2004

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

You must record information about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an injury and illness incident report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Establishment name GeoSyntec Consultants

City Boca Raton State Florida

Identify the person				Describe the case		Classify the case											
						CHECK ONLY ONE box for each case based on the most serious outcome for that case:				Enter the number of days the injured or ill worker was:		Check the "injury" column or choose one type of illness:					
								Remained at work				(M)					
(A) Case No.	(B) Employee's Name	(C) Job Title (e.g., Welder)	(D) Date of injury or onset of illness (mo./day)	(E) Where the event occurred (e.g. Loading dock north end)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (e.g. Second degree burns on right forearm from acetylene torch)	Death	Days away from work	Job transfer or restriction	Other record-able cases	Away From Work (days)	On job transfer or restriction (days)	Injury	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other illnesses
						(G)	(H)	(I)	(J)	(K)	(L)	(1)	(2)	(3)	(4)	(5)	(6)
4121		Site Mgr	3/24	Oak Hammock Disposal Facility	Lacerated left index finger and mid-knucle				X			X					
4171		Proj. Eng	4/8	Welsh Rd LF	Punctured Right Calf				X			X					
4172		Proj. Eng	5/24	Buszby LF	Lyme's Disease Symptoms				X								X
4211		Sr. Eng. Tech	7/7	San Marcos II LF	contusion on lft ft from manhole cover				X			X					
4131		Sr. Eng	9/4	Big Creek	bee sting resulting in allergic reaction				X								X
ca41		Associate	10/2004	Office	Rt wrist and finger pain from computer use				X			X					
					Page totals	*0*	*0*	*0*	*6*	*0*	*0*	*4*	*0*	*0*	*0*	*0*	*2*

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

	Injury	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other illnesses
	(1)	(2)	(3)	(4)	(5)	(6)

Public reporting burden for this collection of information is estimated to average 14 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave, NW, Washington, DC 20210. Do not send the completed forms to this office.

OSHA's Form 300A
Summary of Work-Related Injuries and Illnesses

Year 2005

U.S. Department of Labor
Occupational Safety and Health Administration
Form approved OMB no. 1218-0176

All establishments covered by Part 1904 must complete this Summary page, even if no injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete and

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the log. If you had no cases write "0."

Employees former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR 1904.35, in OSHA's Recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
0	2	0	5
(G)	(H)	(I)	(J)

Number of Days

Total number of days of job transfer or restriction	Total number of days away from work
0	2
(K)	(L)

Injury and Illness Types

Total number of...

	(M)		
(1) Injury	7	(4) Poisoning	0
(2) Skin Disorder	0	(5) All other illnesses	0
(3) Respiratory Condition	0		

Post this Summary page from February 1 to April 30 of the year following the year covered by the form

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Establishment information

Your establishment name GeoSyntec Consultants

Street 5901 Broken sound Parkway Suite 300

City Boca Raton State FL Zip 33487

Industry description (e.g., Manufacture of motor truck trailers)
Consulting Engineers

Standard Industrial Classification (SIC), if known (e.g., SIC 3715)
8 7 1 1

Employment information

Annual average number of employees 493

Total hours worked by all employees last year 1,091,319

Sign here Mary K. Masty

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

Mary K. Masty	Director of HR
Company executive	Title
561.922.1005	1/23/2006
Phone	Date

OSHA's Form 300
Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 2005

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

You must record information about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an injury and illness incident report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Establishment name GeoSyntec Consultants Consolidated

City All U.S. and Canada Locations State

Identify the person		Describe the case				Classify the case										
(A) Case No.	(B) Employee's Name	(C) Job Title (e.g., Welder)	(D) Date of injury or onset of illness (mo./day)	(E) Where the event occurred (e.g. Loading dock north end)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (e.g. Second degree burns on right forearm from acetylene torch)	Using these categories, check ONLY the most serious result for each case:				Enter the number of days the injured or ill worker was:		Check the "injury" column or choose one type of illness: (M)				
						Death	Days away from work	Remained at work		On job transfer or restriction (days)	Away from work (days)	Injury	Skin Disorder	Respiratory Condition	Poisoning	All other illnesses
								Job transfer or restriction	Other record-able cases							
						(G)	(H)	(I)	(J)	(K)	(L)	(1)	(2)	(3)	(4)	(5)
70018		Bookkeeper	1/26/2005	Boca facilty	Carpal tunnel Syndrome		0	0	X	0	0	X				
70012		Sr. Staff Prof	2/26/2005	Yeoman Creek LF	strained/bruised lower back		0	0	X	0	0	X				
70015		Eng. Tech	5/9/2005	Lanchester LF	Pulled muscle in back		X	0	0	0	1	X				
70016		Eng Tech	6/20/2005	Field Site	Back Strain		0	0	X	0	0	X				
70019		Office Mgr	10/6/2005	Boca Facility	Carpal tunnel Syndrome		0	0	X	0	0	X				
70021		Staff Scientist	10/28/2005	Santa Barbara Facilty	strain right wrist		X	0	0	0	1	X				
70020		Eng Tech	11/9/2005	Job Site BrawleyCA	Contused Right small Finger		0	0	X	0	0	X				
					Page totals	*0*	*2*	*0*	*5*	*0*	*2*	*7*	*0*	*0*	*0*	*0*

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

	Injury	Skin Disorder	Respiratory Condition	Poisoning	All other illnesses
	(1)	(2)	(3)	(4)	(5)

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OSHA's Form 300A (Rev. 01/2004)

Summary of Work-Related Injuries and Illnesses

Year 2006

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

All establishments covered by Part 1904 must complete this Summary page, even if no injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the log. If you had no cases write "0."

Employees former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR 1904.35, in OSHA's Recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
0	1	1	2
(G)	(H)	(I)	(J)

Number of Days

Total number of days away from work	Total number of days of job transfer or restriction
11	19
(K)	(L)

Injury and Illness Types

Total number of...

	(M)		
(1) Injury	0	(4) Poisoning	0
(2) Skin Disorder	0	(5) Hearing Loss	0
(3) Respiratory Condition	0	(6) All Other Illnesses	0

Post this Summary page from February 1 to April 30 of the year following the year covered by the form

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Establishment information

Your establishment name Geosyntec Consultants - Consolidated

Street 5901 Broken Sound Parkway,NW Suite 300

City Boca Raton State FL Zip 33487

Industry description (e.g., Manufacture of motor truck trailers)
Consulting Engineers

Standard Industrial Classification (SIC), if known (e.g., SIC 3715)
8 7 1 1

OR North American Industrial Classification (NAICS), if known (e.g., 336212)

Employment information

Annual average number of employees 506

Total hours worked by all employees last year 1,063,938.00

Sign here Mary K Masty

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

Mary K. Masty, SPHR
Company executive

HR Ddirector
Title

561.022.1005
Phone

1/20/2006
Date

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 2006

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

You must record information about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an injury and illness incident report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Establishment name Geosyntec Consultants

City Boca Raton State FL

Identify the person			Describe the case			Classify the case											
(A) Case No.	(B) Employee's Name	(C) Job Title (e.g., Welder)	(D) Date of injury or onset of illness (mo./day)	(E) Where the event occurred (e.g. Loading dock north end)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (e.g. Second degree burns on right forearm from acetylene torch)	CHECK ONLY ONE box for each case based on the most serious outcome for that case:				Enter the number of days the injured or ill worker was:		Check the "injury" column or choose one type of illness: (M)					
						Death	Days away from work	Remained at work		Away From Work (days)	On job transfer or restriction (days)	Injury	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other illnesses
								Job transfer or restriction	Other record-able cases								
						(G)	(H)	(I)	(J)	(K)	(L)	(1)	(2)	(3)	(4)	(5)	(6)
70024		Site Mgr	1/12/2006	Job Site	Sprained Right Ankle			X			19						
70023		Staff Geologist	1/25/2006	Job site	Lacerated left hand				X								
70028		Mktg Coordinator	6/21/2006	Sidewalk outside office bldg	Broken Elbow		X			11							
70033		Sr.Staff Scientist	8/22/2006	Job site	Infected spider bite				X								
					Page totals	*0*	*1*	*1*	*2*	*11*	*19*	*0*	*0*	*0*	*0*	*0*	*0*

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

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OSHA's Form 300A (Rev. 01/2004)
Summary of Work-Related Injuries and Illnesses

Year 2007

U.S. Department of Labor
Occupational Safety and Health Administration
Form approved OMB no. 1218-0176

All establishments covered by Part 1904 must complete this Summary page, even if no injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the log. If you had no cases write "0."

Employees former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR 1904.35, in OSHA's Recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
0	1	4	2
(G)	(H)	(I)	(J)

Number of Days

Total number of days away from work	Total number of days of job transfer or restriction
9	64
(K)	(L)

Injury and Illness Types

Total number of...

(M)			
(1) Injury	5	(4) Poisoning	0
(2) Skin Disorder	0	(5) Hearing Loss	0
(3) Respiratory Condition	0	(6) All Other Illnesses	1

Post this Summary page from February 1 to April 30 of the year following the year covered by the form

Public reporting burden for this collection of information is estimated to average 50 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave. NW, Washington, DC 20210. Do not send the completed forms to this office.

Establishment information

Your establishment name Geosyntec Consultants

Street 5901 Broken Sound Parkway NW, Suite 300

City Boca Raton State Florida Zip 33487

Industry description (e.g., Manufacture of motor truck trailers)
Consulting Engineers

Standard Industrial Classification (SIC), if known (e.g., SIC 3715)
8 7 1 1

OR North American Industrial Classification (NAICS), if known (e.g., 336212)
__ __ __ __ __ __

Employment information

Annual average number of employees 650

Total hours worked by all employees this year 1,394,000

Sign here Dale M. Prokopchak

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

Dale M. Prokopchak, CIH,CSP
Company executive

Director of EH&S
Title

(804) 332-6376
Phone

20-Jan-08
Date

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APPENDIX D-A
SITE-SPECIFIC HEALTH AND SAFETY PLAN (HASP)

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APPENDIX D-A
Site-Specific Health and Safety Plan

INSTALLATION RESTORATION PROGRAM SITE 70
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

March 2008

Department of the Navy
Naval Facilities Engineering Command Southwest
San Diego, CA 92132

Environmental Multiple Award Contract
Contract Number N68711-04-D-1106, CTO 003
Document Control Number ECC-1106-0003-0002

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APPENDIX D-A

Site-Specific Health and Safety Plan

INSTALLATION RESTORATION PROGRAM SITE 70
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

March 2008

Prepared for:

Department of the Navy
Naval Facilities Engineering Command Southwest
San Diego, CA 92132

Prepared by:

ECC
1240 Bayshore Highway
Burlingame, CA 94010

In association with:

2100 Main Street, Suite 150
Huntington Beach, CA 92648

Prepared under:
Environmental Multiple Award Contract
Contract Number N68711-04-D-1106, CTO 003
Document Control Number ECC-1106-0003-0002

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DISCLAIMER

This Health and Safety Plan has been prepared in accordance with Geosyntec Consultants Health and Safety Procedures for use by Geosyntec project staff at the request of the Navy. This plan complies with Geosyntec internal review procedures for Health and Safety Plans (HASPs). Geosyntec does not endorse the use of this HASP by others. The use of this document or its contents by firms or persons other than Geosyntec and Geosyntec employees should not be used without a thorough peer review by their Health and Safety Managers. Should the work outlined in this Health and Safety Plan be executed by contractors other than Geosyntec, the HASP should be modified and reviewed to comply with that companies corporate health and safety procedures. In the event that a contractor other than Geosyntec execute this work, the contractor should complete a hazard analysis, mitigation measures, and perform an update of all HASP tables, text, figures, and appendices prior to commencing work. Geosyntec assumes no responsibility for the accuracy, content, or Health and Safety of non-Geosyntec personnel during the implementation of this HASP by other parties.

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Geosyntec consultants

SITE-SPECIFIC HEALTH AND SAFETY PLAN (HASP)

Project Name: **Naval Weapons Station Seal Beach Installation Restoration Program Site 70**

Project Number: **HY1034**

This HASP, which must be kept on site, addresses the safety and health hazards of each phase of site operation, including the requirements and procedures for worker protection. This HASP is included as an appendix D-A and meant to be used in conjunction with the Accident Prevention Plan (APP). Only the Site Health and Safety Officer (SHSO) can change or amend this document in agreement with the Environmental Health and Safety Coordinator (EHSC), Project Manager, and Principal-in-Charge. The SHSO must initial any change made to the HASP at the relevant section. Major amendments (e.g., changes in personal protective equipment not provided for in this plan, addition of tasks, etc.) must be documented by indicating the amendment date shown on this page.

Prepared by: 3-10-08

Eli Ortenberg, SHSO — Date

Reviewed by: 3-5-08

Marlene Duffy, EHSC — Date

Concurrence by: 3-10-08

Walt Grinyer, Project Manager — Date

Approved by: 3-10-08

David Major, Principal-in-Charge — Date

Copy Cover Sheet to: EHSC

Brief Description of Amendment **Amendment Date**

This APP has been given to the following subcontractor(s) in accordance with OSHA 29 CFR 1910.1200 (Hazard Communication Standard):

Subcontractor: _____ **Representative:** _____ **Date:** _____

Subcontractor: _____ **Representative:** _____ **Date:** _____

Geosyntec site workers must read this HASP. A pre-entry briefing conducted by the SHSO (or a designated person) must be held prior to initiating this project. All sections of this HASP must be reviewed during this briefing. Any worker not in attendance at the initial meeting must be trained by the SHSO (or a designated person) on the information covered in the pre-entry briefing meeting. ***Tailgate meetings must be held at the beginning of the work shift by the SHSO (or designated person) to discuss important safety and health issues concerning tasks performed on that day. A brief description of topics discussed in tailgate meetings must be documented in the Field Logbook.*** After reading the HASP and attending a pre-entry briefing, workers must sign the following acknowledgment statement.

I have read, understand, and agree with the information set forth in this HASP. I have also attended a pre-entry briefing. I agree to perform my work in accordance with this HASP.

Name	Date	Name	Date

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Attachment D-A-4: Air Monitoring Equipment, Frequency of Readings, and Action Guidelines per Task

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Attachment D-A-6: Material Safety Data Sheets

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LIST OF REFERENCES

Reference D-A-1: OSHA and NIOSH Chemicals Requiring Air Monitoring and Medical Surveillance

Reference D-A-2: National Primary Drinking Water Regulations

1. SITE/TASK DESCRIPTION

Brief description of site (including information as to current and previous site usage, location and approximate size of site, and a description of the tasks):

- Site Usage: Naval Weapons Station
- Site Location: South of the intersection of Westminster Blvd and Seal Beach Blvd; Seal Beach, CA (Figure D-1)
- Size of Site: Approximately 80 acres for dissolved phase plume
- Expected Field Dates: July 2007 to June 2012
- Tasks for this project include:
  - ① Aquifer Testing (tracer tests, pump tests)
  - ② Well Rehabilitation
  - ③ Groundwater Sampling/Monitoring and Soil Sampling
  - ④ Soil Gas Sampling/Monitoring
  - ⑤ Injection of KB-1™
  - ⑥ Injection of Emulsified Vegetable Oil (EVO)/Bromide Tracer
  - ⑦ Drilling/Well Construction/Well Development
- Description of Surrounding Property / Population:

North:	Agricultural / Highway	East:	Railroad (approximately 100 feet from nearest well), warehouses, and National Wildlife Refuge
South:	Light industrial and warehouses	West:	Industrial Property / Offices

2. KEY PERSONNEL AND HEALTH AND SAFETY RESPONSIBILITIES

Table D-A-1 lists project personnel and their responsibilities in regard to health and safety concerns on this project. Field level health and safety will be handled by the Site Health and Safety Officer (SHSO). Any occurrence will be reported to the Environmental Health and Safety Coordinator (EHSC) by the SHSO, who will assess the severity. Further action will be taken when the occurrence is reported to the Project Manager by the EHSC, who evaluates the incident and determines whether the issue should be submitted to the Person in Charge (PIC), with whom the matter will be appropriately resolved. An OSHA 300 log will be kept at the job site. This is included in Attachment D-A-1

Specific subcontractors have been identified to perform all tasks. Subcontractors will possess a HASPHASP that corresponds to Geosyntec's safety protocol; in addition, they will be responsible for submitting an individual APP that is concurrent with Geosyntec's safety protocol.

The nearest trained individual will be responsible for administering CPR and First Aid.

3. WORKER TRAINING

Table D-A-2 documents that workers have received the appropriate training requirements according to the company Environmental, Health, and Safety (EH&S) Training Program. A pre-entry briefing and daily tailgate meetings are also conducted to facilitate onsite training.

4. SITE CONTROL

Site control procedures must be implemented before the start of site tasks to control worker exposures to hazardous substances. As discussed in Section D-4.3, work areas will be cordoned off when possible.

Work will be completed on an active military facility and will conform to military operations and guidance. Site access for general contractors is located on the north side of the Site. All contractors and visitors to the Site must gain access through base security. This requires legal identification, proof of insurance and vehicle registration. All visitors must notify the base in advance. Base contact information is included on Table D-A-3.

4.1 Site Map

Access to the Site is provided by two different access gates. Therefore two hospital route maps showing the two available entrances/exits are included in Figures D-A-1A and D-A-1B. The hospital route maps will be available in the work area. Refuge Stations are also presented on Figure D-A-2. The egress from the station will occur at the same gate entered that day. The proper map and route to use will be discussed during the daily tailgate meeting and the appropriate route map will be defined for that day. All emergency departures from the base will be via the gate entered that day.

Site maps of proposed field work locations are included in the Work Plan, Figures 7.1-7.4. Changes may be made to the Site map by the SHSO, as needed, based on site conditions.

4.2 Buddy System

APPLIES TO TASK ①☒ ②☒ ③☒ ④☒ ⑤☒ ⑥☒ ⑦☒

The Buddy System is required in the task(s) indicated above. The buddy system includes maintaining regular contact (see Section D-4.6) with onsite Geosyntec personnel, clients and/or contractors. The Buddy System will maintain compliance with base operations requirements.

In situations where task work does not require the buddy system, on-site personnel must have appropriate communication device(s) on his/her person(s) at all times, and shall maintain contact with office personnel, at a minimum, upon arriving at and departing from the Site on a daily basis. Radio communication may be restricted in certain designated areas of the base, as such the Buddy System will be enforced in these areas.

4.3 Work Zones

The Exclusion Zone is defined as the area on-site where contamination is suspected and tasks are to be performed. The Contamination Reduction Zone (CRZ) is defined as the area where equipment and workers are to be decontaminated. The Support Zone is defined as the command area and serves as a storage area for supplies. In areas where elevated soil concentrations are expected, a modified contamination reduction zone (CRZ) will be maintained. All equipment in this zone will be decontaminated prior to moving to another location.

Work zones will be moved in conjunction with work. The exact location and extent will vary from each work area based on access, base requirements, operational needs, and scope of work.

The boundaries of the Exclusion Zone must be marked using the following methods:

☒ Warning Tape ☐ Traffic Cones
☒ Signs ☐ Fence
☒ Other: Physical Barriers

Site control procedures, when applicable, will include a road closure implemented accordingly. These closures will be planned previous to start of work activities and a traffic control map such as Figure D-A-2 will be used. These maps and closures will increase the safety of the workers and general public.

4.4 Basic Sanitation

Portable toilets with service and hand wash station will be provided on the site outside exclusion zones.

Drinking water on site will be provided through bottled water and igloo coolers which will be cleaned and filled on a daily basis.

4.5 Site Access

Access to the base may be restricted by military activities. As part of our work zone delineation, the contractor will notify the base of the work schedule and areas of operation. Access to the Site will be controlled using the following methods:

☒ Sign In / Sign Out Log ☐ Guard ☐ Identification Badges
☒ Other: Access to base is restricted at gates

4.6 Visitors

Visitors to the Site must be continually escorted in order to assure their safety since they may be unfamiliar with the Site. Visitors must not be allowed into the Work Zone unless they read, understand, and meet the requirements outlined in this HASP. All visitors to the Site must gain access through base security. This requires legal identification, proof of insurance and vehicle registration. All visitors must notify the base in advance.

4.7 Communications

☒ Verbal ☒ Two-Way Radio ☒ Cellular Telephone
☐ Hand Signals ☒ Horn ☐ Siren
☐ Other: _____

4.8 Safe Work Practices

General Safe Work Practices that must be implemented during work activities at this site are included in Table D-A-4.

4.9 Inspections

For projects lasting longer than one week, the SHSO (or appointed delegate) must conduct weekly health and safety inspections. The inspections must be documented using the Weekly Health & Safety Inspection checklist included in Attachment D-A-1. The Weekly Health & Safety Inspection Checklist must be kept on file at the Site.

5. HAZARD ANALYSIS AND MITIGATORS

Site specific hazards must be identified (through hazard analysis) to determine the appropriate safety and health hazard mitigators needed to protect workers from the identified hazards. Hazard analysis involves a complete review of chemical, physical, and biological hazards.

5.1 Chemical Hazards

☒ APPLICABLE ☐ NOT APPLICABLE

A comparison has been made between previous environmental sampling results and EPA Primary Drinking Water Standards (for liquids) to select those contaminants that may cause health and safety concerns, henceforth referred to as Contaminants of Concern. Based on this comparison, only contaminants that exceed 5 times these standards have been considered Contaminants of Concern as indicated in Table D-A-5. Contaminant Fact Sheets for each of the Contaminants of Concern for this project are provided in Attachment D-A-2.

Information from the Contaminant Fact Sheets or Material Safety Data Sheets (e.g., flash point, water reactive, etc.) have been utilized in performing the chemical hazard analysis in Table D-A-6 (e.g., fire, inhalation, reactivity, and skin absorption hazards). If, based on the hazard analysis, chemical hazards exist, hazard mitigators must be utilized to control these hazards (Attachment D-A-3). In addition, air monitoring

equipment (Section 6.1) and personal protective equipment (Section 8) must also be utilized to evaluate airborne concentrations and protect workers.

5.1.1 Trichloroethene

Trichloroethene is the main contaminant of concern due to its concentration and the possibility that it may be encountered in pure phase. Key details are summarized below.

Trichloroethene is a colorless liquid with a sweet organic-like odor. It is very slightly soluble in water and the density is 1.465 g/ml at 20□C. Trichloroethene is used as a solvent, as an anesthetic, in dry cleaning and in metal degreasing. The exposure routes are inhalation, ingestion, dermal absorption, and contact with the eyes. The target organs are the eyes, skin, respiratory system, liver, kidneys, and central nervous system. The trichloroethene exposure levels are presented in the Contaminant Fact Sheet provided in Attachment D-A-2.

Use of air monitoring (Attachment D-A-4) and the proper use of personal protective equipment (Attachment D-A-5) can significantly reduce the potential for chemical exposure.

5.1.2 Electron Donor Supply

Emulsified vegetable oil (EVO) will be used as an electron donor during operations at the Site. The Material Safety Data Sheets (MSDS) is provided in Attachment D-A-6. A Hazard Mitigator, which outlines key issues that may arise when handling the electron donor before, during and after injection is included in Attachment D-A-3. Personnel working with EVO should have the proper PPE (Attachment D-A-5).

5.2 Physical Hazards

☒ APPLICABLE ☐ NOT APPLICABLE

Physical hazards associated with tasks to be performed (e.g., electrocution, and heavy lifting) and Site location (e.g., slips, trip, or falls due to rocky terrain) have been analyzed in Table D-A-6. Based on the hazard analysis, physical hazards exist. Hazard mitigators (Attachment D-A-3) must be implemented. In the following section, a small number of potential physical hazards have been highlighted as they are specific to the tasks that will be performed. However, all physical hazards must be reviewed prior to starting each task.

5.2.1 Liquids under Pressure (EVO, KB-1™)

During well injection phases, there will be liquids under pressure at the Site. All personnel are required to wear the proper PPE (Attachment D-A-5) and pay attention to all hazard mitigators (Attachment D-A-3). MSDS sheets for the appropriate liquids (EVO and KB-1™) are provided in Attachment D-A-6.

5.2.2 Compressed Gas

During KB-1™ injection, there will be compressed gases used at the Site. All personnel are required to wear the proper PPE (Attachment D-A-5) and pay attention to any hazard mitigators (Attachment D-A-3). An MSDS sheet for argon has been provided in Attachment D-A-6. If alternate gases are used the SHSO will provide an MSDS before bringing the product onto the Site and inform workers of the addition to the HASPHASP.

5.2.3 Explosive Safety (Decontamination in Blast Zone)

Unexploded ordnance (UXO) is not expected at IR Site 70. However, in the event that ordnance or explosive waste (OEW) is discovered, the following procedure will be followed:

1. Stop all work activities immediately upon discovering potential UXO.
2. Contact NAVFAC SW Remediation Project Manager, ROICC, and SHSO. Geosyntec and subcontractors will not handle any ordnance item. Only trained explosive ordnance disposal personnel will handle OEW or UXO.
3. Terminate use of all equipment that may generate electromagnetic waves (i.e., cellular phones, radios, lasers, generators, and alternators) for a distance of 200 yards.
4. Do not disturb the object suspected as being UXO or OEW.
5. Vacate employees from the area and move to a minimum distance of 200 yards from the UXO or OEW.

Work will resume only after clearance of the area by qualified UXO personnel.

5.2.4 Thoroughfare or Motor Vehicle

A significant portion of the Remedial Action field activities will be performed in and around the parking lots and buildings of the station. In addition, a portion of the field activities (drilling, development, sampling and injection) will be performed along the streets and roads. As appropriate, all work affecting Base operations will be coordinated with the ROICC and/or Building managers (Port Operations). The ROICC and building manager will be notified at least three days in advance of any work that will affect parking or vehicular traffic in the specific areas. If any activities affect traffic, work will be coordinated with the Base Police.

In order to control motor vehicle hazards, a variety of measures will be implemented to ensure both the safety of the Site workers as well as Base personnel.

These measures include:

- Minimum 3-day advance notice to ROICC of project activities affecting parking at the buildings or roads;
- Clearly visible demarcation of work areas (e.g., with caution tape, traffic cones, and/or barricades);
- Use of barricades, K-rails, and/or secure steel plates to cover road-cuts and trenches, and divert traffic; and
- Use of reflective safety vests for all Site workers so that they are clearly visible to Base personnel that are operating motor vehicles.

5.2.5 Handling Emulsified Vegetable Oil

The emulsified vegetable oil (EVO) may be packaged in large 1,000 kg totes. Only certified fork lift operators shall be used to move the totes. Care should be taken not to puncture the totes. Refer to the Heavy Equipment and Electron Donor Injection into Groundwater Hazard Mitigators provided in Attachment D-A-4.

5.3 Biological Hazards

☒ APPLICABLE ☐ NOT APPLICABLE

Based on the hazard analysis (Table D-A-6), biological hazards exist associated with tasks to be performed and site location (e.g., allergic reactions to poisonous plants or insects indigenous to the area, etc.). Hazard mitigators (Attachment D-A-4) must be

implemented. In the following sections, select biological hazards are discussed. A complete list of biological hazards is available in Table D-A-6.

5.3.1 Insects and Spiders

The primary insect and spider hazards for fieldwork are bees (including wasps and yellow jackets) and spiders (i.e., black widow and brown recluse). Spiders, in particular, like the warm, wet environments provided by protective well casings and vault enclosures.

Before initial assignment, personnel with known allergic responses to insect stings or bites will be identified, and field supervisors will be made aware of this condition. In all cases, a victim suspected of being bitten by either a black widow or brown recluse spider shall receive immediate medical attention. The venom from the brown recluse spider is capable of causing coma and kidney failure in its victim.

During the initial well inspection, the field crew will look for spiders (i.e., spider webs) prior to placing their hands into the enclosure. The field crew will be wearing PPE (e.g., gloves), which will provide additional protection from insect bites and/or stings.

5.3.2 Hantavirus

The Hantavirus has been detected in mice and voles indigenous to Southern California (Centers for Disease Control and Prevention [CDC] 2003). Exposure to a Hantavirus can result in hanta virus pulmonary syndrome, a rare though potentially deadly respiratory disease with a fatality rate of 50 percent. Mice and voles are the primary reservoir for the Hantavirus. These rodents shed the virus in their saliva, urine, and feces, and virus-containing particles or droplets can become airborne. The virus can then be spread when people breathe contaminated air.

The CDC recommends avoiding contact with or disturbing mice, mouse burrows, infested areas, and nesting sites. For fieldwork in southern California, the field crew should be especially cautious in the following areas:

- old buildings/structures;
- opened (i.e., neglected) well vaults; and
- on-site debris piles and burrows.

5.3.3 West Nile virus

West Nile virus has been detected in southern California (DHS 2004). This virus is primarily transmitted among wild birds by infected mosquitoes; however, infected mosquitoes also can transmit the virus to humans. Most humans infected with the virus have either no symptoms or mild flu-like illnesses lasting a few days. In rare cases, the virus can cause inflammation of the brain, a condition called "encephalitis." Potential exposure increases during mosquito season (May to October). Precautions to prevent infection include decreasing exposure to mosquitoes by wearing long-sleeved shirts and long pants and applying insect repellent containing DEET [N,N-diethyl-m-toluamide].

5.3.4 Arenavirus

The Arenavirus has been documented in rodents in Southern California (Bennett et al. 2000). Like the Hantavirus, the Arenavirus is believed to be transmitted through inhalation of airborne particles or droplets contaminated with an Arenavirus from the urine, feces, or saliva of infected rodents. Human infection from Arenavirus is rare; however, it can result in a fatal respiratory disease. Precautions implemented to minimize exposure to the Hantavirus will also be used to reduce exposure to the Arenavirus.

6. AIR MONITORING

6.1 Real-Time Air Monitoring

☒ APPLICABLE ☐ NOT APPLICABLE

The types of air monitoring equipment required, initial frequency of readings, and action guidelines for each task are provided in Attachment D-A-4. Action guidelines for contaminant vapor(s) and particulate matter are based on the hazard analysis (Section 5) and an analysis of any previous sampling results. Consideration is also given to vapor density and carcinogenicity where applicable.

Frequency of air monitoring readings will be adjusted on site accordingly, with the consent of the SHSO. Equipment must be calibrated at least before work begins each day and at the end of the day. Air monitoring readings and calibration records must be documented in the Field Logbook.

6.2 Personal / Area Air Monitoring

☐ APPLICABLE ☒ NOT APPLICABLE

Personal/area air monitoring is required for the following contaminants of concern:

_____ _____

_____ _____

7. MEDICAL SURVIELLANCE

☐ APPLICABLE ☒ NOT APPLICABLE

Table D-A-2 indicates the workers who participate in the company Medical Surveillance Program.

☐ YES ☐ NO Additional project-specific medical surveillance is required for the following contaminants of concern:

_____

_____

8. PERSONAL PROTECTIVE EQUIPMENT (PPE)

☒ APPLICABLE ☐ NOT APPLICABLE

The levels of personal protection required for each task are provided in Attachment D-A-5. Required equipment and types of protective clothing materials are listed, as well as an indication of the initial level of protection. The level of protection may be upgraded or downgraded (by the SHSO) based on the action guidelines provided in Attachment D-A-4. PPE levels must be indicated in the Field Logbook.

If respirators are utilized, workers must adhere to the company's Respiratory Protection Program (29 CFR §1910.134). Table D-A-2 provides a record of the Site workers' last annual fit test. Beards (i.e., facial hair interfering with the respirator seal) are not allowed.

9. DECONTAMINATION

☒ APPLICABLE ☐ NOT APPLICABLE

PPE must be decontaminated as per 29 CFR §1910.120(k). The decontamination procedures, equipment and decontamination solution required for each task are

provided in Attachment D-A-7. In an emergency, the primary concern is to prevent the loss of life or severe injury to site personnel. If immediate medical treatment is required to save a life, decontamination should be delayed until the victim is stabilized. If decontamination can be performed without interfering with essential life-saving measures or first aid, or if worker has been contaminated with an extremely toxic or corrosive material that could cause severe injury or loss of life, decontamination must be performed in coordination with or prior to initial medical treatment at the scene.

Single-use PPE will be disposed of in accordance with the waste management plan (provided as Appendix E of the Work Plan [Geosyntec. Draft Remedial Action Work Plan, Installation Restoration Program, Site 70, Naval Weapons Station Seal Beach, September 2007]).

Decontamination procedures for non-disposable sampling equipment are provided in the Sampling and Analysis Plan (SAP) (provided as Appendix B of the Work Plan [Geosyntec, Draft Remedial Action Work Plan, Installation Restoration Program, Site 70, Naval Weapons Station Seal Beach, September 2007]).

Personnel working in controlled areas will work to minimize the generation of hazardous waste. Disposable materials, wrapping, and packaging will not be brought into controlled areas unless required to prevent cross-contamination. The procedures for managing waste, including potentially-hazardous wastes, are described in Appendix E of the Work Plan (Geosyntec. Draft Remedial Action Work Plan, Installation Restoration Program, Site 70, Naval Weapons Station Seal Beach, September 2007).

10. EMERGENCY PREPAREDNESS AND RESPONSE

☒ APPLICABLE ☐ NOT APPLICABLE

A list of contacts and telephone numbers for the applicable local base and off-site emergency responders is provided in Table D-A-3. The nature of the Site work and Contaminants of Concern should be reviewed with the off-site responders before work begins on this project. The following emergency response equipment is required for this project:

☒ Fire Extinguisher: ☐ Type A ☐ Type B ☐ Type C ☒ Type ABC
☒ Eyewash (Note: 15 minutes of free-flowing fresh water)
☐ SCBA
☒ First Aid Kit
☐ Shower (Note: for acids and caustics)
☐ Other: _____

The emergency response communication system for the site is:

☒ Verbal
☐ Two-way radio
☐ Hand signals: Hand gripping throat = "Out of Air, Can't Breathe"
Grip partner's wrist or both hands around waist = "Leave area now"
Hands on top of head = "Need assistance"
Thumbs up = "OK; I am all right; I understand"
Thumbs down ="No; negative"
☐ Horn
☐ Siren
☒ Other: Cell Phone

In the event that an on-site emergency develops, the base ROICC must be notified immediately and then the procedures delineated in the Emergency Action Plan found on Table D-A-7 are to be followed without delay.

The Emergency Action plan will be exercised within the first 90 days of the project. The exercise will be critiqued by an outside observer (Quality Assurance Officer Julia Klens Caprio) and the participants will receive a debrief of the exercise to convey the lessons learned.

11. CONFINED SPACE ENTRY

☐ APPLICABLE ☒ NOT APPLICABLE

The task(s) for this project involve confined-space entry. Workers must adhere to the company's Confined Space Entry Program [29 CFR §1910.120(j)].

12. SPILL CONTAINMENT

☒ APPLICABLE ☐ NOT APPLICABLE

The task(s) for this project involve moving and transporting sample containers/drums/totes of EVO and KB-1TM. Workers must adhere to the hazard mitigation for drum handling in Attachment D-A-3.

Once KB-1™ or EVO injections begin, a spill kit containing containment, sorbant materials, gloves, and a shovel will be kept on Site in case a spill does occur. Training on the use and maintenance of the spill kit will be provided by the SHSO to field personnel. At least one person trained in the use and maintenance of the spill kit will be onsite during project activities. All spills, large and small, should be reported to the

SHSO. Any supplies that are taken from the spill kit should be replenished within 5 days.

13. HAZARD COMMUNICATION

☒ APPLICABLE ☐ NOT APPLICABLE

The following procedures must be followed for all chemicals brought on site (i.e., decontamination solution, sampling preservatives, Emulsified Vegetable Oil, Bromide, etc.):

- Labels on incoming primary chemical containers must not be defaced.
- Chemical containers must be stored in appropriate storage cabinets.
- Secondary containers and storage cabinets must be correctly and clearly labeled using the Hazardous Materials Identification System (HMIS).
- Incompatible chemicals must not be stored together.
- Workers have received training on the hazards of these chemicals as indicated in Table D-A-2.
- A Material Safety Data Sheet (MSDS) for each chemical must be included in Attachment D-A-6.

When chemicals are used on site, workers must adhere to the company's Hazard Communication Program (29 CFR §1910.1200).

TABLES

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Table D-A-1

Key Personnel and Health & Safety Responsibilities

Principal-in-Charge or Associate-in-Charge ***David Major***	***Project Manager (PM)*** ***Walt Grinyer***	***Site Health & Safety Officer (SHSO)*** ***Eli Ortenberg***	***Project Personnel*** ***See Table 2***	***Environmental, Health & Safety Coordinator (EHSC)*** ***Marlene Duffy***
• Approve this HASP and amendments, if any. • Ultimately responsible that elements of this HASP are implemented.	• Approve this HASP and amendments, if any. • Monitor the Field Logbooks for health and safety work practices employed. • Coordinate with SHSO so that emergency response procedures are implemented. • Verify corrective actions are implemented. • See to it that personnel receive this plan, are aware of its provisions, are aware of the potential hazards associated with site operations, are instructed in safe work practices, are familiar with emergency response procedures, and that this is documented. • Provide for appropriate monitoring, personal protective equipment, and decontamination materials. • Provide liason with base contacts	• Prepare and implement project (HASP) and amendments, if any, and report to the Project Manager for action if any deviations from the anticipated conditions exist, and authorize the cessation of work if necessary. • Confirm that site personnel meet the training and medical requirements. • Conduct pre-entry briefing and daily tailgate safety meetings. • Verify that all monitoring equipment and personal protective equipment is operating correctly according to manufacturer's instructions and such equipment is utilized by on-site personnel. Calibrate or verify calibration of all monitoring equipment and record results. • Verify that decontamination procedures are being implemented. • Implement site emergency response and follow-up procedures. • Notify the EHSC in the event an emergency occurs. • Performs weekly inspections	• Provide verification of required health and safety training and medical surveillance prior to arriving at the site. • Notify the SHSO of any special medical conditions (e.g., allergies). • Attend pre-entry briefings and daily tailgate safety meetings. • Immediately report any accidents and/or unsafe conditions to the SHSO. • Be familiar with and abide by the HASP. • Individuals are responsible for their own safety.	• Review and audit HASP and amendments • Maintain a copy of the cover sheet of each completed HASP. • Notify Director of Environment, Health & Safety in the event an emergency occurs. • Assist with the implementation of the corporate health and safety program. • Consult on health and safety issues.

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Geosyntec consultants

Geosyntec Consultants Inc.,

3/1/2007 07:31 PM

Table D-A-2

Training / Medical Surveillance / Respirator Fit Test Records

Employee name	Category	Initial 40 Hour	Initial 24 Hour	Annual 8 Hour Refresher	8 Hour Supervisor	CPR	First Aid	Medical Surveillance	Annual Respirator Fit Test	Other
AZIZ, CAROL	IV	5/8/1992		1/11/2007	1/30/2003					
BOGAART, MATT	I	9/1/2000		1/11/2007	2/1/2001	8/9/2007	8/9/2007	2/7/2007	11/13/2007	
DAVERIN, JOHN L	II	3/29/2006	3/29/2006	2/6/2007		5/8/2007	4/12/2006	3/21/2006		
DUFFY, MARLENE	I	10/7/2004		8/1/2007	2/16/2005	5/8/2007	4/7/2005	9/13/2007	4/21/2005	
FINEGAN, JAMES	I	10/16/2006		2/6/2007	2/5/2007	11/1/2006	11/7/2006	9/4/2007		
GRINYER, WALTER	II	2/10/1990		2/6/2007	2/16/2004	11/1/2006	4/12/2006	2/12/2007		
KOVACS, ROBERT	I	6/1/1992		8/1/2007	2/16/2005	5/8/2007	11/17/2005	10/5/2007	5/17/2007	
MEDINA, ROBERT	I	4/8/2004		2/6/2007	2/5/2007	5/8/2007	5/8/2007	5/25/2007	5/17/2007	
ORTENBERG, ELI	I	11/9/2006		8/1/2007	2/5/2007	11/13/2007	11/13/2007	4/18/2007		
SIMONS, ANDREW	I	10/7/2004		2/6/2007	2/5/2007	11/1/2006	6/30/2005	10/5/2007	12/8/2006	

Footnotes:

1 CPR Refresher: every year; First Aid Refresher: every three years.

2 Annual Medical Surveillance for EH&S Category I, Biannual Medical Surveillance for EH&S Categories II & III.

3 For EH&S Categories I & II Only.

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Table D-A-3: Emergency Response Contacts (1 of 2)

NOTE: NOTIFY MILITARY OF ANY EMERGENCY IMMEDIATELY

Name	Office	Home	Date of Pre-Emergency Notification (if required)
Fire Department – Seal Beach Fire Dept.	911	(562) 799-4100	
Base Fire Department	(562) 626-7333		
Hospital – Los Alamitos Medical Center	(562) 598-1311		
Police Department – Seal Beach Police Dept.	911	(800) 545-5585	
National Poison Control referral service	(800) 222-1222		
Navy Police Department	(562) 626-7229		
Navy Environmental Office – Pei-Fen Tamashiro	(562) 626-7897		
NAVFAC ROICC – Dave Crawley	(562) 572-5635		
Branch Office Manager – Bert Palmer, Ph.D.	(714) 969-0800	(714) 335-5948 (cell) (714) 375-9202 (home)	
Corporate Human Resources Director – Mary Masty	(561) 922-1005	(954) 224-8415 (cell) (561) 482-1010 (home)	
Corporate Human Resources Director – Judy Nunnally	(561) 922-1002		
Project Manager – Walt Grinyer	(951) 682-8576	(951) 808-7660 (cell) (951) 789-4516 (home)	
Principal-in-Charge – David Major	(519) 822-2230	(519) 241-8810	
Environmental, Health & Safety Coordinator – Marlene Duffy	(714) 969-0800	(714) 392-7994 (cell)	
Director of Environment, Health & Safety – Dale Prokopchak	(804) 332-6376	(804) 349-8067 (cell)	

Note: * To be completed before site activities are initiated.

Table D-A-3: Emergency Response Contacts
(2 of 2)

WRITTEN DIRECTIONS TO HOSPITAL:

Go North on Seal Beach Blvd.

Seal Beach Blvd turns into Los Alamitos Blvd.

Turn right on Katella Ave.

Hospital is at 3751 Katella Ave.

Table D-A-4

General Safe Work Practices

- Minimize contact with excavated or contaminated materials. Do not place equipment on the ground. Do not sit or kneel on potentially contaminated surfaces.
- Smoking, eating, or drinking after entering the work zone and before decontamination must not be allowed. Employees who are suspected of being under the influence of illegal drugs or alcohol will be removed from the site. Workers taking prescribed medication that may cause drowsiness should not be operating heavy equipment, and should be prohibited from performing tasks where Level C, B, or A personal protective equipment is required.
- Practice good housekeeping. Keep everything orderly and out of potentially harmful situations.
- Use of contact lenses on-site must not be allowed when dictated by working conditions.
- The following conditions must be observed when operating a motor vehicle.
  - Wearing of seat belts is mandatory
  - During periods of rain, fog, or other adverse weather conditions, the use of headlights is mandatory
  - A backup warning system or use of vehicle horn is mandatory when the vehicle is engaged in a backward motion
  - All posted traffic signs and directions from flagmen or military personnel must be observed
  - Equipment and/or samples transported in vehicles must be secured from movement
  - The use of GeoSyntec acquired vehicles by non-GeoSyntec personnel is prohibited
- In an unknown situation, always assume the worst conditions.
- Be observant of your immediate surroundings and the surroundings of others. It is a team effort to notice and warn of impending dangerous situations. Withdrawal from a hazardous situation to reassess procedures is the preferred course of action.
- Conflicting situations may arise concerning safety requirements and working conditions and must be addressed and resolved rapidly by the SHSO and PM to relieve any motivations or pressures to circumvent established safety policies.
- Unauthorized breaches of specified safety protocol must not be allowed. Workers unwilling or unable to comply with the established procedures must be discharged.

Table D-A-5

Contaminants of Concern

Contaminant	*Medium*	*Maximum Concentration* (mg/L)	*CalEPA/EPA National Primary Drinking Standard*[1] (mg/L)
1,2-Dichloroethane	groundwater	0.053	0.005
Trichloroethene	groundwater	240	0.005
Vinyl Chloride	groundwater	0.163	0.002
1,1-Dichloroethylene	groundwater	1.24	0.007
1,1,2-Trichloroethane	groundwater	0.053	0.005
Arsenic	groundwater	0.0595	0.05
Benzene	groundwater	0.003	0.0007
Methylene Chloride	groundwater	1.1	0.005
Tetrachloroethene	groundwater	0.0633	0.005
cis-1,2 Dichloroethene	groundwater	2.2	0.07

(1) California/Federal Maximum Contaminant Levels (MCLs)

Table D-A-6 Hazard Analysis

Tasks	
① Aquifer Testing	⑥ Injection of Emulsified Vegetable Oil
② Well Rehabilitation	⑦ Drilling/Well Construction/Well Development
③ Groundwater Sampling/Monitoring and Soil Sampling	
④ Soil Gas Sampling/Monitoring	
⑤ Injection of KB-1™	

	①	②	③	④	⑤	⑥	⑦
Fire	X	X	X	X	X	X	X
Inhalation (Dust)		X		X			X
Permanganate Handling							
Reactivity							
Skin absorption	X	X	X	X	X	X	X
Electron Donor Injection Boating						X	X
Chainsaw							
Cold Stress							
Compressed Gas Cylinder	X	X	X	X	X	X	X
Downhole Logging							
Drilling (including Indoor)				X			X
Drum and Container Handling	X	X	X	X	X	X	X
Electrocution	X	X	X	X	X	X	X
Excavation/Trenching		X		X			
Eye Injury	X	X	X	X	X	X	X
Fall Protection							
Flash flood	X	X	X	X	X	X	X
Hand/Foot Injury	X	X	X	X	X	X	X
Heat Stress	X	X	X	X	X	X	X
Heavy Equipment	X	X	X	X	X	X	X
Helicopter							

	①	②	③	④	⑤	⑥	⑦
Lifting Heavy Loads	X	X	X	X	X	X	X
Lockout/Tagout							
Noise	X	X	X	X	X	X	X
Nuclear Gauge Radiation Exposure							
Portable Power/Hand Tool	X	X	X	X	X	X	X
Slips, Trips, and Falls	X	X	X	X	X	X	X
Thoroughfares	X	X	X	X	X	X	X
Welding and Cutting		X				X	X
Other: Trains	X	X	X	X	X	X	X
Allergic Reaction to Poisonous Plants	X	X	X	X	X	X	X
Bees	X	X	X	X	X	X	X
Dogs	X	X	X	X	X	X	X
Insect/Vermin/Snake Bites	X	X	X	X	X	X	X
Medical Waste							
Mountain Lions							
Other:							

Table D-A-7: Emergency Action Plan

- If a worker is injured, first aid will be administered by workers certified in first aid.

Procedures for reporting fire or other emergency/employee alarm system

- If applicable, the SHSO must notify off-site emergency responders (i.e., fire department, hospital, police department, etc.) and must inform the response team as to the nature and location of the emergency on site. Contact numbers are located on Table D-A-3
- The SHSO (or alternate) should be immediately notified via the on-site communication system. The SHSO assumes control of the emergency action plan implementation.
- The SHSO notifies the PM, Principal-in-Charge, and the EHSC of the emergency. The EHSC must then contact the Director of Environment, Health Safety. If a GeoSyntec employee is injured, the SHSO must contact the worker's Branch Office Manager immediately. If the Branch Office Manager can not be contacted, then the Corporate Human Resources Department must be notified.

Procedures for emergency evacuation

- If applicable, the SHSO evacuates the site. Site workers should move to their respective refuge stations using the evacuation routes provided on the Site Map (Figure D-A-2).
- In the event of an evacuation, all workers will evacuate the site. No workers shall remain behind to continue working.
- In the event of an evacuation, the SHSO will use the daily sign in sheet to check that all workers have evacuated. If a worker is not accounted for, the SHSO will first attempt to contact this worker via cell phone or radio. If the worker is still not accounted for, the SHSO will inform the emergency responders.

Additional information

- If workers have further questions regarding this emergency action plan, they may contact the SHSO, Environmental Health and Safety Officer, Director of Health and Safety, or the project manager listed in Table D-A-3.

Employee alarm system

- The on-site communication system will include cell phones and vehicle horns. In the event of cell phone failure, 5 short, distinct blasts from a vehicle horn will indicate an emergency. A single long (approximately 3 seconds) blast from a vehicle horn will indicate an all clear condition.

Training

- The SHSO will designate and train employees to assist in a safe and orderly evacuation.
- This plan will be reviewed with all employees upon their assignment and arrival at the site, when an employees responsibilities under this plan change, or when the plan is changed.

Additional Emergency Procedures

- For small fires, flames should be extinguished using the fire extinguisher. Large fires should be handled by the local fire department. In the case of large fire, the SHSO shall notify the fire department listed in Table D-A-3.
- If chemicals are accidentally spilled or splashed into eyes or of skin, use eyewash and/or shower.
- Before continuing site operations after an emergency involving toxic gases, the SHSO will don a SCBA and utilize appropriate air monitoring equipment to verify that the site is safe.
- An injured worker must be decontaminated appropriately.
- After the response, the SHSO must complete accident investigation reports obtained from the Branch Office Manager.

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FIGURES

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FIGURE D-A-1A
Hospital Route Map
Main Gate
IR Site 70
Naval Weapons Station
Seal Beach, California

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FIGURE D-A-1B
Hospital Route Map
North Gate
IR Site 70
Naval Weapons Station
Seal Beach, California

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Figure D-A-2

This detailed station map has been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

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ATTACHMENT D-A-1
WEEKLY HEALTH AND SAETY INSPECTION CHECKLIST/OSHA 300 FORM

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Attachment D-A-1

Weekly Health & Safety Inspection Checklist

Project: _____ Date: _____

Inspected by: _____

Category	***Observations/Corrective Actions (N/A, if Not Applicable)***
Pre-entry briefing records are current and HASP on site	
Tailgate meeting records are current	
Training/medical surveillance/respiratory protection records are current	
Site map is posted	
Buddy system is implemented	
Work zones are identified	
Site access is controlled	
Visitors are being escorted	
On-site/off-site communications are in working order	
Safe work practices are being implemented	
Any additional hazards incurred?	
Air monitoring equipment is in working condition	
Air monitoring records are being recorded in field logbook	
Air monitoring calibration records are being recorded in field logbook	
PPE storage area is neat and organized	
Standard operating procedures are being implemented	
Housekeeping at decontamination zone is appropriate	
Decontamination procedures are being implemented	
Emergency response equipment is in working condition	
Route to hospital is posted	
Confined space entry program is being implemented	
Spill containment equipment is available	
Chemical inventory is up to date	
Material safety data sheets are available	
Primary and secondary containers are properly labeled	
Housekeeping at the chemical storage area is appropriate	

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 20__ __

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

You must record information about every work-related death and about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR Part 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an Injury and Illness Incident Report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Establishment name _____

City _____ State _____

Identify the person			Describe the case			Classify the case — CHECK ONLY ONE box for each case based on the most serious outcome for that case:				Enter the number of days the injured or ill worker was:		Check the "Injury" column or choose one type of illness:					
								Remained at Work									
(A) Case no.	(B) Employee's name	(C) Job title (*e.g., Welder*)	(D) Date of injury or onset of illness	(E) Where the event occurred (*e.g., Loading dock north end*)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (*e.g., Second degree burns on right forearm from acetylene torch*)	Death (G)	Days away from work (H)	Job transfer or restriction (I)	Other recordable cases (J)	Away from work (K)	On job transfer or restriction (L)	(M) Injury (1)	Skin disorder (2)	Respiratory condition (3)	Poisoning (4)	Hearing loss (5)	All other illnesses (6)
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					Page totals ➤	____	____	____	____	____	____	Injury (1) ____	Skin disorder (2) ____	Respiratory condition (3) ____	Poisoning (4) ____	Hearing loss (5) ____	All other illnesses (6) ____

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

Public reporting burden for this collection of information is estimated to average 14 minutes per response, including time to review the instructions, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any other aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistical Analysis, Room N-3644, 200 Constitution Avenue, NW, Washington, DC 20210. Do not send the completed forms to this office.

ATTACHMENT D-A-2
CONTAMINANT FACT SHEETS

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Attachment D-A-2

Contaminant Fact Sheet Directory

Included in HASP	*Chemical Name*	*Synonyms*	*Document Number*
☒	Acetone	Dimethyl Ketone; Ketone propane; 2-Propanone	GA971212
☐	Aldrin	HHDN; Octalene	GA980283
☐	Aniline	Aminobenzene; Aniline Oil; Benzeneamine; Phenylainine	GA980093
☒	Arsenic	Arsenic metal; Arsenia	GA981097
☒	Benzene	Benzol; Phenyl hydride	GA970125
☐	Bis(2-ethylhexyl)phthalate	Di(2-ethylhexyl)phthalate	GA970207
☐	Cadmium	Cadmium metal	GA970126
☐	Carbon disulfide	Carbon bisulfide	GA970832
☐	Chlorobenzene	Benzene chloride; Chlorobenzyl; MCB; Phenyl chloride	GA970127
☒	Chloroform	Methane trichloride; Trichloromethane	GA970128
☐	Chromic Acid	Chromic anhydride; Chromium trioxide	GA980758
☐	Chromium	Chromium metal	GA970129
☐	Copper	Copper metal dusts; Copper metal mists	GA980756
☐	2,4-D	Dichlorophenoxyacetic acid	GA971255
☐	DDT	p,p-DDT; Dichlorodiphenyltrichloroethane; 1,1,1-Trichloro-2-2-bis(p-chlorophenyl)ethane	GA980284
☐	1,2-Dichlorobenzene	O-DCB; Orthodichlorobenzene	GA970130
☒	1,2-Dichloroethane	Ethylene dichloride; Glycol dichloride	GA970954
☒	1,1 Dichloroethylene	Vinylidene chloride, 1,1 Dichloroethene	
☒	1,2-Dichloroethylene	1,2-Dichloroethene; (cis, trans, or sym-) Acetylene dichloride	GA970953
☐	1,2-Dichloropropane	Propylene dichloride; Dichloro-1,2-propane	GA970131
☐	2,4-Dinitrotoluene	Dinitrotoluene; DNT; Methyldinitrobenzene	GA990071
☐	Endosulfan	Benzoepin; Endosulphan ; Thiodan	GA971257
☐	Ethylbenzene	Ethylbenzol; Phenylethane	GA970132
☐	Ethylene Dibromide	EDB; 1,2-Dibromoethane, Ethylene bromide, Glycol dibromide	GA980285
☐	Gasoline	Motor fuel; Motor spirits; Natural gasoline; Petrol	GA970833
☐	Hexachloroehtane	Carbon hexachloride; Ethane hexachloride; Perchloroethane	GA971252

Attachment D-A-2

Contaminant Fact Sheet Directory
(continued)

Included in HASP	*Chemical Name*	*Synonyms*	*Document Number*
☐	Hydrochloric Acid	Anhydrous hydrogen chloride; Aqueous hydrogen chloride; Muriatic acid	GA980757
☐	Hydrogen Sulfide	Hydrosulfuric acid; Sewer gas; Sulfuretted hydrogen	GA980399
☐	Isophorone	Isoacetophorone; 3,5,5-Trimethyl 2- cyclohexenone	GA971253
☐	Isopropanol	Isopropyl alcohol; IPA; 2-Propanol	GA970133
☐	Lead (inorganic)	Lead metal	GA970134
☐	Mercury	Colloidal mercury; Metallic mercury; Quicksilver	GA970135
☐	Methane	Fire damp; March gas; Methyl hydride	GA970834
☐	Methoxyclor	P,p-Dimethoxydiphenyl/trichlorethane; DMDY	GA971256
☐	2-Methylphenol	Ortho-Cresol; 2-Cresol; O-Cresylic Acid; 1-Hydroxy-2-Methlbenzene; 2-Hydroxytoluene	GA980091
☐	Methyl ethyl ketone	2-Butanone; MEK; Methyl acetone	GA970136
☐	Methyl chloroform	1,1,1-Trichloroethane	GA970137
☒	Methylene chloride	Dichloromethane; Methylene Dichloride	GA970138
☐	Naphthalene	Naphthalin; Tar Camphor; White Tar	GA970139
☐	Nickel	Nickel catalyst	GA980759
☐	Nitroaniline	Para-aminonitrobenzene; 4-Nitroanline; 4-Nitrobenzenamine; p-Nitrophenylamine, PNA	GA980094
☐	Nitrobenzene	Essence of mirbane; Nitrobenzol; Oil of mirbane	GA980095
☐	Pentachlorophenol	PCP; Penta; 2,3,4,5,6-Pentachlorophenol	GA970140
☐	Phenol	Carbonic acid; Hydroxybenzene; Monohydroxybenzene; Phenol alcohol; Phenyl hydroxide	GA971250
☐	Phosgene	Carbonyl chloride; Carbon oxychloride; Chloroformyl chloride	GA990069
☐	Polychlorinated biphenyls (54%)	PCBs; Chlorodiphenyl	GA970141
☐	Silver	Silver metal; Argentum	GA970142
☐	2,4,5-T	2,4,5-Trichlorophenoxyacetic acid	GA971254
☒	Tetrachloroethylene	Tetrachloroethylene; Perchlorethylene; Perk	GA971274

Attachment D-A-2

Contaminant Fact Sheet Directory
(continued)

Included in HASP	*Chemical Name*	*Synonyms*	*Document Number*
☐	o-Toluidene	2-Methybenzeneamine; O-Aminotoluene; 1-Methyl-2-aminobenzene; O-Methylaniline; 2-Methylaniline, ortho-Toluidine	GA980096
☐	Toluene	Methyl benzene; Methyl benzol	GA970143
☐	Toluene-2,4-Diisocyanate	TDI; 2,4-TDI; 2,4-Toluene diisocyanate	GA990070
☐	Toxaphene	Chlorinated camphene	GA970153
☒	1,1,2-Trichloroethane	Ethane trichloride; B-Trichloroethane; Vinyl trichloride	GA971249
☐	1,2,4-Trichlorobenzene	Trichlorobenzene; 1,2,4-Trichlorobenzel	GA971251
☒	Trichloroethene	Trichloroethylene; TCE	GA970145
☐	Trichlorofluoromethane	Fluorotrichloromethane; Freon II	GA970144
☐	1,2,3-Trichloropropane	Allyl trichloride, Glycerol trichorohydrin, Glyceryl trichlorohydrin; Trichlorohydrin	GA980286
☒	Vinyl chloride	Chloroethene; VC; VCM	GA970146
☐	Xylene (Mixed Isomers)	o-xylene; p-xylene; m-xylene	GA970147

CONTAMINANT FACT SHEET - 1,1,2-TRICHLOROETHANE

CAS Number:79-00-5	**Molecular Weight: 133.4**	**Color: Colorless**	**Ionization Potential (eV): 11.00**	**Vapor Density (Air=1):NA**
Synonyms: Ethane trichloride; B-Trichloroethane; Vinyl trichloride	**Physical State: Liquid**	**Odor: Chloroform-like**	**Henry's Constant:**	**Vapor Pressure: 19 (mmHg@20C)**

Fire Hazard	**Reactivity Hazard**	**Health Hazard**
NFPA rating: 0 **HMIS rating: 0**	**NFPA rating: 0** **HMIS rating: 0**	**NFPA rating: 1** **HMIS rating: 1**

Flash Point(°F): NA
LEL(%): 6 UEL(%): 15.5

Fire Extinguishing Media:
☒ Dry Chemical ☒ Foam
☐ Water Spray ☒ CO_2

Fire Extinguisher:
☐ Class A ☐ Class B
☐ Class C ☐ Class D
☒ Class A/B/C

DOT: ☐ Flammable Liquid
☒ Combustible Liquid

Incompatibilities: Strong oxidizers & caustics; chemically-active metals (such as aluminum, magnesium, sodium and potassium)

DOT: ☐ Oxidizer
☐ Water Reactive

Odor Threshold (ppm): NA

IDLH (ppm): 100

Source	TWA (ppm)	STEL (ppm)	C (ppm)
OSHA PELs	10	NA	NA
ACGIH TLVs	10	NA	NA

Signs/Symptoms of Acute Exposure: Irritation of eyes & nose; Central nervous system depression; liver & kidney damage; dermatitis

DOT: ☐ Poison

Carcinogenic:
OSHA: ☐ Yes ☒ Not listed

IARC: ☐ Group 1 ☐ Group 2A
☐ Group 2B ☒ Group 3
☐ Group 4 ☐ Not listed

NTP: ☐ Known ☐ Anticipated
☐ Process ☒ Not listed

ACGIH: ☐ A1 ☐ A2
☒ A3 ☐ A4
☐ A5 ☐ Not listed

Skin Absorbable: ☒ Yes ☐ No
Skin Corrosive: ☐ Yes ☒ No

DOT: ☐ Corrosive

Air Monitoring

Type	Brand/Model No.	Calibration Method/Media
☐ Explosimeter	GasTech GX-82	Methane
☐ PID	MiniRAE	Isobutylene
☒ FID	Foxboro OVA	Methane
☐ Colorometric Tubes	Drager/	Check pump for leaks
☐ Chemical Monitor ☐ Dust Monitor		
☒ Collection Medium/Sampling Pump	Gilian Pump/NIOSH#1003	Calibrate pump w/ media

Protective Clothing

Glove Type/Brand (Breakthrough >2 hrs unless noted):
☐ Viton/North ☐ Viton/Best ☐ Silvershield/North ☐ 4H/Safety
☐ Neoprene/Mapa ☐ Neoprene/Ans.Ed. ☐ Neoprene/BestUltraflex ☐ Neoprene/BestNeo.
☐ PVC/Ans.Ed. ☐ PVC/BestHustler ☐ Nitrile/LabSafe.(27min) ☐ Nitrile/Ans.Ed.
☐ Butyl/North (31min) ☐ PVA/Ans.Ed. ☒ Other

Suit Type (Breakthrough >1hr unless noted): ☐ Tyvek ☐ Tyvek QC ☐ Tyvek/Saranex ☐ Tychem7500 (49min) ☐ Tychem 9400 ☐ Tychem 10,000 ☒ Other

Respiratory Protection

☒ Air Purifying ☐ Air Supplied Only | Maximum Use Concentration (ppm): Half mask: Full face:

Notes:
Prepared by: Sherry Hall Date: 13 October 1997, Rev. 30 January 2002

CONTAMINANT FACT SHEET - 1,2 - DICHLOROETHANE

CAS Number: 107-06-2	**Molecular Weight: 99.0**	**Color: Colorless**	**Ionization Potential (eV): 11.05**	**Vapor Density (Air=1): 3.4**
Synonyms: Ethylene dichloride	**Physical State: Liquid**	**Odor: Pleasant; Chloroform like**	**Henry's Constant:**	**Vapor Pressure:64 (mmHg@20C)**

Fire Hazard	**Reactivity Hazard**	**Health Hazard**	
NFPA rating: 3 **HMIS rating: 3**	**NFPA rating: 0** **HMIS rating: 0**		**NFPA rating: 2** **HMIS rating: 1**
Flash Point(°F): **56** LEL(%): 6.2 UEL(%):16 Fire Extinguishing Media: ☐ Dry Chemical ☐ Foam ☐ Water Spray ☐ CO_2 Fire Extinguisher: ☐ Class A ☐ Class B ☐ Class C ☐ Class D ☐ Class A/B/C DOT: ☒Flammable Liquid ☐Combustible Liquid	Incompatibilities: Strong oxidisers & caustics; chemically-active metals such as magnesium or aluminum powder, sodium & potassium; liquid ammonia. (Note: Decompses to vinyl chloride & HC above 1112oF) DOT: ☐ Oxidizer ☐ Water Reactive	Odor Threshold (ppm): 6-185 IDLH (ppm): 50 *5 min peak in any 3 hrs Signs/Symptoms of Acute Exposure: Irritation of eyes; corneal capacity; CNS depression; nausea; vomiting; dermatitis; liver; kidney; CVS damage DOT: ☐ Poison	Carcinogenic: OSHA: ☐ Yes ☒ Not listed IARC: ☐ Group 1 ☐ Group 2A ☒ Group 2B ☐ Group 3 ☐ Group 4 ☐ Not listed NTP: ☐ Known ☒ Anticipated ☐ Process ☐ Not listed ACGIH: ☐ A1 ☐ A2 ☐ A3 ☒ A4 ☐ A5 ☐ Not listed Skin Absorbable: ☐ Yes ☒ No Skin Corrosive: ☒ Yes ☐ No DOT: ☐ Corrosive

Source	TWA (ppm)	STEL (ppm)	C (ppm)
OSHA PELs	50	N/A	100,200*
ACGIH TLVs	10	NA	NA

Air Monitoring

Type	Brand/Model No.	Calibration Method/Media
☐ Explosimeter		
☒ PID	MiniRAE	Isobutylene
☒ FID	Foxboro OVA	Methane
☒ Colorometric Tubes	Drager/CH2730 (100-300ppm)	Check pump for leaks
☐ Chemical Monitor ☐ Dust Monitor		
☒ Collection Medium/Sampling Pump	Gilian Pump/NIOSH#1003	

Protective Clothing

Glove Type/Brand (Breakthrough >2 hrs unless noted):

☒Viton/North	☐Viton/Best	☒Silvershield/North	☒4H/Safety
☐Neoprene/Mapa	☐Neoprene/Ans.Ed.	☐Neoprene/BestUltraflex	☐ Neoprene/BestNeo.
☐PVC/Ans.Ed.	☐PVC/BestHustler	☐Nitrile/LabSafe.(27min)	☐Nitrile/Ans.Ed.
☒Butyl/North (31min)	☐PVA/Ans.Ed.	☐Other	

Suit Type (Breakthrough >1hr unless noted): ☐Tyvek ☐ Tyvek QC ☐Tyvek/Saranex ☐Tychem7500 (49min) ☒Tychem 9400 ☒Tychem 10,000 ☐Other

Respiratory Protection

☒Air Purifying	☐Air Supplied Only	Maximum Use Concentration (ppm): Half mask: Full face:

Notes:

Prepared by: Sherry Hall Date:17 July 1997, Rev. 28 January 2002

CONTAMINANT FACT SHEET - 1,2 - DICHLOROETHYLENE

CAS Number: 540-59-0; 156-59-2; 156-60-5	**Molecular Weight: 97.0**	**Color: Colorless**	**Ionization Potential (eV): 9.65**	**Vapor Density (Air=1):**
Synonyms: (cis, trans, or sym-) Acetylene dichloride	**Physical State: Liquid**	**Odor: Chloroform-like**	**Henry's Constant:**	**Vapor Pressure: 180-265 (mmHg@20C)**

Fire Hazard	**NFPA rating:** **HMIS rating:**	**Reactivity Hazard**	**NFPA rating:** **HMIS rating:**	**Health Hazard**	**NFPA rating: 2** **HMIS rating: 3**

Flash Point(°F): **36-39**
LEL(%): 5.6 UEL(%):12.8

Fire Extinguishing Media:
- ☐ Dry Chemical ☐ Foam
- ☐ Water Spray ☐ CO_2

Fire Extinguisher:
- ☐ Class A ☐ Class B
- ☐ Class C ☐ Class D
- ☐ Class A/B/C

DOT: ☐ Flammable Liquid
☐ Combustible Liquid

Incompatibilities: Strong oxidizers; strong alkalis; potassium hydroxide; copper (Note: Usually contains inhibitors to prevent polmerization)

DOT: ☐ Oxidizer
☐ Water Reactive

Odor Threshold (ppm): 0.08-17

IDLH (ppm): 1000

Source	TWA (ppm)	STEL (ppm)	C (ppm)
OSHA PELs	200	N/A	NA
ACGIH TLVs	200	NA	NA

Signs/Symptoms of Acute Exposure: Irritation of eyes & respiratory system; CNS depression.

DOT: ☐ Poison

Carcinogenic:
OSHA: ☐ Yes ☒ Not listed

IARC: ☐ Group 1 ☐ Group 2A ☐ Group 2B ☐ Group 3 ☐ Group 4 ☒ Not listed

NTP: ☐ Known ☐ Anticipated ☐ Process ☒ Not listed

ACGIH: ☐ A1 ☐ A2 ☐ A3 ☐ A4 ☐ A5 ☒ Not listed

Skin Absorbable: ☐ Yes ☒ No
Skin Corrosive: ☐ Yes ☐ No

DOT: ☐ Corrosive

Air Monitoring

Type	Brand/Model No.	Calibration Method/Media
☐ Explosimeter		
☒ PID	MiniRAE	Isobutylene
☒ FID	Foxboro OVA	Methane
☐ Colorometric Tubes		
☐ Chemical Monitor ☐ Dust Monitor		
☒ Collection Medium/Sampling Pump	Gilian Pump/NIOSH#1003	

Protective Clothing

Glove Type/Brand (Breakthrough >2 hrs unless noted):
- ☐ Viton/North ☐ Viton/Best ☐ Silvershield/North ☐ 4H/Safety
- ☐ Neoprene/Mapa ☐ Neoprene/Ans.Ed. ☐ Neoprene/BestUltraflex ☐ Neoprene/BestNeo.
- ☐ PVC/Ans.Ed. ☐ PVC/BestHustler ☐ Nitrile/LabSafe.(27min) ☐ Nitrile/Ans.Ed.
- ☐ Butyl/North (31min) ☐ PVA/Ans.Ed. ☐ Other

Suit Type (Breakthrough >1hr unless noted): ☐ Tyvek ☐ Tyvek QC ☐ Tyvek/Saranex ☐ Tychem7500 (49min) ☒ Tychem 9400 ☐ Tychem 10,000 ☒ Other

Respiratory Protection

☒ Air Purifying ☐ Air Supplied Only | Maximum Use Concentration (ppm): Half mask: 1000 Full face: 1000

Notes:
Prepared by: Sherry Hall Date: 17 July 1997, Rev. 4 March 2002

CONTAMINANT FACT SHEET - ACETONE

CAS Number:67-64-1	**Molecular Weight:58.1**	**Color: Colorless**	**Ionization Potential (eV): 8.76**	**Vapor Density (Air=1):NA**
Synonyms: Dimethyl ketone; Ketone propane; 2-Propanone	**Physical State: Liquid**	**Odor: Fragrant, mint-like**	**Henry's Constant: NA**	**Vapor Pressure: 180 (mmHg@20C)**

Fire Hazard	**NFPA rating: 3** **HMIS rating: 3**	**Reactivity Hazard**	**NFPA rating: 0** **HMIS rating: 0**	**Health Hazard**	**NFPA rating: 1** **HMIS rating: 1**

Flash Point(°F): 0
LEL(%): 2.5 UEL(%): 12.8

Fire Extinguishing Media:
☒ Dry Chemical ☒ Foam
☐ Water Spray ☒ CO_2

Fire Extinguisher:
☐ Class A ☐ Class B
☐ Class C ☐ Class D
☒ Class A/B/C

DOT: ☒Flammable Liquid
☐Combustible Liquid

Incompatibilities: Oxidizers, acids

DOT: ☐ Oxidizer
☐ Water Reactive

Odor Threshold (ppm): 3.6 - 653

IDLH (ppm): 2500

Source	TWA (ppm)	STEL (ppm)	C (ppm)
OSHA PELs	1000	NA	NA
ACGIH TLVs	500	750	NA

Signs/Symptoms of Acute Exposure: Irritation of eyes, nose, throat; headache; dizziness; central nervous system depression; dermatitis

DOT: ☐ Poison

Carcinogenic:
OSHA: ☐ Yes ☒ Not listed

IARC: ☐ Group 1 ☐ Group 2A
☐ Group 2B ☐ Group 3
☐ Group 4 ☒ Not listed

NTP: ☐ Known ☐ Anticipated
☐ Process ☒ Not listed

ACGIH: ☐ A1 ☐ A2
☐ A3 ☒ A4
☐ A5 ☐ Not listed

Skin Absorbable: ☐ Yes ☒ No
Skin Corrosive: ☐ Yes ☒ No

DOT: ☐ Corrosive

Air Monitoring

Type	**Brand/Model No.**	**Calibration Method/Media**
☒ Explosimeter	Gastech GX-82	Methane
☒ PID	MiniRAE	Isobutylene
☒ FID	Foxboro OVA	Methane
☒ Colorometric Tubes	Drager/CH22901 (100-12000ppm)	Check pump for leaks
☐ Chemical Monitor ☐ Dust Monitor		
☒ Collection Medium/Sampling Pump	Gilian Pump/NIOSH#1300	Calibrate pump w/ media

Protective Clothing

Glove Type/Brand (Breakthrough >2 hrs unless noted):
☐Viton/North ☐Viton/Best ☒Silvershield/North ☒4H/Safety
☐Neoprene/Mapa ☐Neoprene/Ans.Ed. ☐Neoprene/BestUltraflex ☐ Neoprene/BestNeo.(30min)
☐PVC/Ans.Ed. ☐PVC/BestHustler ☐Nitrile/LabSafe. ☐Nitrile/Ans.Ed.
☒Butyl/North ☐PVA/Ans.Ed. ☐Other

Suit Type (Breakthrough >1hr unless noted): ☐Tyvek ☐ Tyvek QC ☐Tyvek/Saranex(15 min) ☒Tychem7500 ☒Tychem 9400 ☐Tychem10,000 ☐Other

Respiratory Protection

☒Air Purifying ☐Air Supplied Only | Maximum Use Concentration (ppm): Half mask: 1000 ppm Full face: 1000 ppm

Notes:
Prepared by: Sherry Hall Date: 29 September 1997, Revised 20 February 2002

CONTAMINANT FACT SHEET - ARSENIC

CAS Number:7440-38-2	**Molecular Weight: 74.92**	**Color: silvery to black**	**Ionization Potential (eV): NA**	**Vapor Density (Air=1):NA**
Synonyms: Arsenic metal; Arsenia	**Physical State: solid**	**Odor: odorless**	**Henry's Constant: NA {(atm ×m^3)/mol}**	**Vapor Pressure: 1 (mm Hg at 20°C)**

Fire Hazard	**Reactivity Hazard**	**Health Hazard**
NFPA rating: 3 **HMIS rating: 2**	**NFPA rating: 2** **HMIS rating: 2**	**NFPA rating: 3** **HMIS rating: 3**

Flash Point(°F): NA
LEL(%): NA UEL(%): NA

Fire Extinguishing Media:
☒ Dry Chemical ☒ Foam
☒ Water Spray ☒ CO_2

Fire Extinguisher:
☐ Class A ☐ Class B
☐ Class C ☐ Class D
☒ Class A/B/C

DOT: ☐ Flammable Gas
☐ Combustible Liquid

Incompatibilities: Bromates, peroxides, chlorates, isodates, lithium, silver nitrate, potassium nitrate, potassium permanganate, chromium (VI) oxide; halogens; bromine azide; pulladium; dirubidium acetylide; zinc; and platinum

DOT: ☐ Oxidizer
☐ Water Reactive

Odor Threshold (ppm): NA

IDLH (**mg/m^3**): 500 **mg/m^3**

Source	TWA (mg/m^3)	STEL (mg/m^3)	C (mg/m^3)
OSHA PELs	0.5*, 0.01**	NA	NA
ACGIH TLVs	0.01	NA	NA

* = Organic Compounds
** = Inorganic Compounds

Signs/Symptoms of Acute Exposure: Inhalation may cause conjunctivitis; eyelid edema; nasal irritation; coughing; chest pain; inflamation of the mouth.

DOT: ☒ Poison

Carcinogenic:
OSHA: ☒ Yes ☐ Not listed

IARC: ☒ Group 1 ☐ Group 2A
☐ Group 2B ☐ Group 3
☐ Group 4 ☐ Not listed

NTP: ☒ Known ☐ Anticipated
☐ Process ☐ Not listed

ACGIH: ☒ A1 ☐ A2
☐ A3 ☐ A4
☐ A5 ☐ Not listed

Skin Absorbable: ☐ Yes ☒ No
Skin Corrosive: ☐ Yes ☒ No

DOT: ☐ Corrosive

Air Monitoring

Type	Brand/Model No.	Calibration Method/Media
☐ Explosimeter	Gastech GX-82	Methane
☐ PID	MiniRAE	Isobutylene
☐ FID	Foxboro OVA	Methane
☐ Colorometric Tubes	Drager	Check pump for leaks
☐ Chemical Monitor ☐ Dust Monitor	NA	NA
☒ Collection Medium/Sampling Pump	Gilian Pump/NIOSH#	Calibrate pump w/ media

Protective Clothing

Glove Type/Brand (Breakthrough >2 hrs unless noted):
☒ Viton/North ☒ Viton/Best ☒ Silvershield/North ☒ 4H/Safety
☒ Neoprene/Mapa ☒ Neoprene/Ans.Ed. ☒ Neoprene/BestUltraflex ☒ Neoprene/BestNeo.
☒ PVC/Ans.Ed. ☒ PVC/BestHustler ☒ Nitrile/LabSafe. ☒ Nitrile/Ans.Ed.
☒ Butyl/North ☒ PVA/Ans.Ed. ☐ Other

Suit Type (Breakthrough >1hr unless noted): ☒ Tyvek ☒ Tyvek QC ☒ Tyvek/Saranex ☒ Tychem7500 ☒ Tychem 9400 ☒ Tychem10,000 ☐ Other

Respiratory Protection

☒ Air Purifying ☐ Air Supplied Only | Maximum Use Concentration (ppm): Half mask: HEPA Full face: HEPA

Notes:
Prepared by: Sherry Hall Date: 16 January 1997, Rev. 28 January 2002

CONTAMINANT FACT SHEET - BENZENE

CAS Number:71-43-2	**Molecular Weight: 78.1**	**Color: Colorless to Lt. Yellow**	**Ionization Potential (eV): 9.24**	**Vapor Density (Air=1):2.7**
Synonyms: Benzol; Phenyl hydride	**Physical State: Liquid**	**Odor: Aromatic**	**Henry's Constant: 0.23**	**Vapor Pressure: 75 (mmHg@20C)**

Fire Hazard	**Reactivity Hazard**	**Health Hazard**
NFPA rating: 3 **HMIS rating: 3**	**NFPA rating: 0** **HMIS rating: 0**	**NFPA rating: 2** **HMIS rating: 3**

Flash Point(°F): 12
LEL(%): 1.2 UEL(%): 7.8

Fire Extinguishing Media:
- ☒ Dry Chemical
- ☒ Foam
- ☐ Water Spray
- ☒ CO_2

Fire Extinguisher:
- ☐ Class A
- ☐ Class B
- ☐ Class C
- ☐ Class D
- ☒ Class A/B/C

DOT: ☒ Flammable Liquid
☐ Combustible Liquid

Incompatibilities: Strong oxidizers; many fluorides & perchlorates; nitric acid

DOT: ☐ Oxidizer
☐ Water Reactive

Odor Threshold (ppm): 34-114

IDLH (ppm): 500

Source	TWA (ppm)	STEL (ppm)	C (ppm)
OSHA PELs	1*	5*	NA
ACGIH TLVs	.5	2.5	NA

* Table Z-2 for exclusions in 29CFR 1910, 1028

Signs/Symptoms of Acute Exposure: Irritation of eyes, skin, nose, & respiratory system; giddiness; headache; nausea; staggered gait

DOT: ☐ Poison

Carcinogenic:
OSHA: ☒ Yes ☐ Not listed

IARC: ☒ Group 1 ☐ Group 2A ☐ Group 2B ☐ Group 3 ☐ Group 4 ☐ Not listed

NTP: ☒ Known ☐ Anticipated ☐ Process ☐ Not listed

ACGIH: ☒ A1 ☐ A2 ☐ A3 ☐ A4 ☐ A5 ☐ Not listed

Skin Absorbable: ☒ Yes ☐ No
Skin Corrosive: ☐ Yes ☒ No

DOT: ☐ Corrosive

Air Monitoring

Type	Brand/Model No.	Calibration Method/Media
☒ Explosimeter	GasTech GX-82	Methane
☒ PID	MiniRAE	Isobutylene
☒ FID	Foxboro OVA 128	Methane
☒ Colorometric Tubes	Drager/6728561(0.5-10ppm)	Check pump for leaks
☐ Chemical Monitor ☐ Dust Monitor		
☒ Collection Medium/Sampling Pump	Gilian Pump/NIOSH#1500	Calibrate pump w/ media

Protective Clothing

Glove Type/Brand (Breakthrough >2 hrs unless noted):
- ☒ Viton/North
- ☐ Viton/Best
- ☒ Silvershield/North
- ☒ 4H/Safety
- ☐ Neoprene/Mapa
- ☐ Neoprene/Ans.Ed.
- ☐ Neoprene/BestUltraflex
- ☐ Neoprene/BestNeo.
- ☐ PVC/Ans.Ed.
- ☐ PVC/BestHustler
- ☒ Nitrile/LabSafe.(27min)
- ☐ Nitrile/Ans.Ed.
- ☒ Butyl/North (31min)
- ☐ PVA/Ans.Ed.
- ☐ Other

Suit Type (Breakthrough >1hr unless noted): ☐ Tyvek ☐ Tyvek QC ☐ Tyvek/Saranex ☒ Tychem7500 (49min) ☒ Tychem 9400 ☐ Tychem 10,000 ☐ Other

Respiratory Protection

☒ Air Purifying ☐ Air Supplied Only | Maximum Use Concentration (ppm): Half mask: 10 Full face: 50

Notes: Poor warning but OSHA allows Air Purifying Respirators
Prepared by: Sherry Hall Date: 16 January 1997, Rev. 24 January 2002

CONTAMINANT FACT SHEET - CHLOROFORM

CAS Number:67-66-3	**Molecular Weight:119.4**	**Color: Colorless**	**Ionization Potential (eV): 11.42**	**Vapor Density (Air=1):4.12**
Synonyms: Methane trichloride; Trichloromethane	**Physical State: Liquid**	**Odor: Pleasant**	**Henry's Constant: 0.11**	**Vapor Pressure: 160 (mmHg@20C)**

Fire Hazard	**Reactivity Hazard**	**Health Hazard**
NFPA rating: 0 **HMIS rating: 0**	**NFPA rating: 0** **HMIS rating: 0**	**NFPA rating: 2** **HMIS rating: 3**

Flash Point(°F): NA
LEL(%): NA UEL(%): NA

Fire Extinguishing Media:
- ☐ Dry Chemical ☐ Foam
- ☐ Water Spray ☐ CO_2

Fire Extinguisher:
- ☐ Class A ☐ Class B
- ☐ Class C ☐ Class D
- ☐ Class A/B/C

Incompatibilities: Strong caustics; chemically-active metals such as aluminum or magnesium powder, sodium and potassium; strong oxidizers; when heated to decomposition, forms phosgene gas

Odor Threshold (ppm): 133-276

IDLH (ppm): 500

Source	TWA (ppm)	STEL (ppm)	C (ppm)
OSHA PELs	NA	NA	50
ACGIH TLVs	10	NA	NA

Signs/Symptoms of Acute Exposure: Irritation of eyes and skin; dizziness; mental dullness

Carcinogenic:
OSHA: ☐ Yes ☒ Not listed

IARC: ☐ Group 1 ☐ Group 2A ☒ Group 2B ☐ Group 3 ☐ Group 4 ☐ Not listed

NTP: ☐ Known ☒ Anticipated ☐ Process ☐ Not listed

ACGIH: ☐ A1 ☐ A2 ☒ A3 ☐ A4 ☐ A5 ☐ Not listed

Skin Absorbable: ☐ Yes ☒ No
Skin Corrosive: ☐ Yes ☒ No

DOT: ☐ Flammable Liquid ☐ Combustible Liquid

DOT: ☐ Oxidizer ☐ Water Reactive

DOT: ☒ Poison

DOT: ☐ Corrosive

Air Monitoring

Type	Brand/Model No.	Calibration Method/Media
☐ Explosimeter		
☒ PID	MiniRAE	Isobutylene
☒ FID	Foxboro OVA	Methane
☒ Colorometric Tubes	Drager/6728861(2-10ppm)	Check pump for leaks
☐ Chemical Monitor ☐ Dust Monitor		
☒ Collection Medium/Sampling Pump	Gilian Pump/NIOSH#1003	Calibrate pump w/ media

Protective Clothing

Glove Type/Brand (Breakthrough >2 hrs unless noted):
- ☒ Viton/North
- ☐ Viton/Best
- ☐ Silvershield/North
- ☒ 4H/Safety
- ☐ Neoprene/Mapa
- ☐ Neoprene/Ans.Ed.
- ☐ Neoprene/BestUltraflex
- ☐ Neoprene/BestNeo.(30min)
- ☐ PVC/Ans.Ed.
- ☐ PVC/BestHustler
- ☐ Nitrile/LabSafe.
- ☐ Nitrile/Ans.Ed.
- ☐ Butyl/North
- ☐ PVA/Ans.Ed.
- ☐ Other

Suit Type (Breakthrough >1hr unless noted): ☐ Tyvek ☐ Tyvek QC ☐ Tyvek/Saranex ☐ Tychem7500 ☒ Tychem 9400 ☒ Tychen 10,000 ☐ Other

Respiratory Protection

☒ Air Purifying ☐ Air Supplied Only | Maximum Use Concentration (ppm): Half mask: Full face:

Notes:
Prepared by: Sherry Hall Date: 16 January 1997, Rev. 28 January 2002

Material Safety Data Sheet Collection
Genium Publishing Corp.
1171 RiverFront Center
Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2000-07

Vinylidene Chloride
MSDS 708
DIC4450

Section 1 - Chemical Product and Company Identification 54.1

Material Name: Vinylidene Chloride **CAS Number:** 75-35-4
Chemical Formula: $C_2H_2Cl_2$
Structural Chemical Formula: $H_2C{=}CCl_2$
Synonyms: 1,1-DICHLOROETHYLENE; ASYM-DICHLOROETHYLENE; CHLORURE DE VINYLIDENE; 1,1-DCE; 1,1-DICHLOROETHENE; 1,1-DICHLOROETHENE (9CI); AS-DICHLOROETHYLENE; ETHENE,1,1-DICHLORO-; ETHYLENE,1,1-DICHLORO-; SCONATEX; VDC; VINYLIDENE CHLORIDE; VINYLIDENE CHLORIDE (II); VINYLIDENE CHLORIDE (INHIBITED); VINYLIDENE CHLORIDE MONOMER; VINYLIDENE CHLORIDE(II); VINYLIDENE CHLORIDE,INHIBITED; VINYLIDENE CHLORIDE,MONOMER; VINYLIDENE DICHLORIDE; VINYLIDINE CHLORIDE
General Use: Reactive monomer in manufacture of vinylidene polymer plastics and copolymers.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
vinylidene chloride	75-35-4	>98

OSHA PEL
No data found.

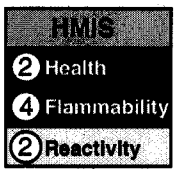
NIOSH REL
No data found.

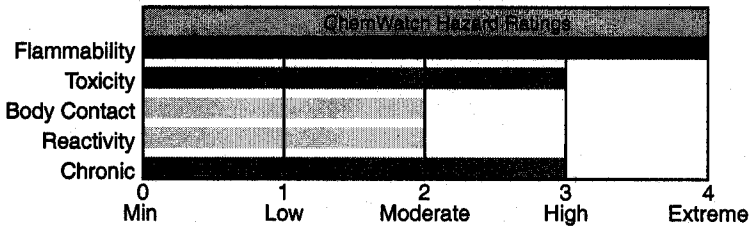
DFG (Germany) MAK
TWA: 2 ppm; 8 mg/m^3.

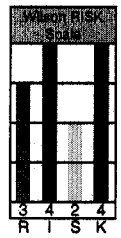
OSHA PEL Vacated 1989 Limits
TWA: 1 ppm; 4 mg/m^3.

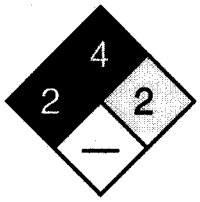
ACGIH TLV
TWA: 5 ppm; 20 mg/m^3; STEL: 20 ppm; 79 mg/m^3.

Section 3 - Hazards Identification









Fire Diamond

ANSI Signal Word
Danger!

Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless liquid; sweet odor. Irritating. Also causes: narcosis, drunkenness, unconsciousness, conjunctivitis, transient corneal injury, iritis. Chronic: hepatic/renal dysfunction. Flammable. Combustion by-products include phosgene and hydrogen chloride.

Potential Health Effects

Primary Entry Routes: inhalation
Target Organs: skin, eyes, central nervous system (CNS), liver, kidneys
Acute Effects
Inhalation: Depression of the central nervous system is the most outstanding effect of most halogenated aliphatic hydrocarbons. Inebriation and excitation, passing into narcosis, is a typical reaction. In severe acute exposures there is always a danger of death from respiratory failure or cardiac arrest due to a tendency to make the heart more susceptible to catecholamines (adrenalin).

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Vapor concentrations of 400 ppm are said to induce symptoms of drunkenness leading to unconsciousness.
Extensive hemorrhagic centrolobular liver necrosis was seen in rats 6 hours after a 4-hour exposure to 200 ppm.

Eye: The liquid is highly discomforting to the eyes and is capable of causing pain and severe conjunctivitis.
Corneal injury may develop, with possible permanent impairment of vision, if not promptly and adequately treated.
The vapor when concentrated has pronounced eye irritation; this gives some warning of high vapor concentrations. If eye irritation occurs seek to reduce exposure with available control measures, or evacuate area.

Skin: The liquid may produce skin discomfort following prolonged contact.
Defatting and/or drying of the skin may lead to dermatitis.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.
The liquid is highly discomforting to the gastrointestinal tract and toxic if swallowed.
Ingestion may result in nausea, pain, vomiting. Vomit entering the lungs by aspiration may cause potentially lethal chemical pneumonitis.
A single oral dose of 500 mg/kg elicited extensive liver enzyme changes.
Acute intoxication by halogenated aliphatic hydrocarbons appears to take place over two stages. Signs of a reversible narcosis are evident in the first stage and in the second stage signs of injury to organs may become evident, a single organ alone is (almost) never involved.

Carcinogenicity: NTP - Not listed; IARC - Group 3, Not classifiable as to carcinogenicity to humans; OSHA - Not listed; NIOSH - Listed as carcinogen; ACGIH - Class A3, Animal carcinogen; EPA - Class C, Possible human carcinogen; MAK - Class B, Justifiably suspected of having carcinogenic potential.

Chronic Effects: The material may accumulate in the human body and progressively cause tissue damage.
Chronic solvent inhalation exposures may result in nervous system impairment and liver and blood changes.
Vinylidene chloride is toxic to the liver and kidneys. After exposure to 48 ppm continuously for 90 days, liver damage was evident in rats and deaths occurred among monkeys and guinea pigs. In this study only rats showed evidence of renal (kidney) tubular injury.
It is proposed that vinylidene chloride may undergo microsomal oxidation to produce oxiranes. These are highly reactive and covalently bind to nucleic acids producing mutations and possibly cancers. The monohalogenated alkenes are thought be more carcinogenic than their dihalogenated counterparts.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.
Lay patient down. Keep warm and rested.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.
Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.
Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).
Wash affected areas thoroughly with water (and soap if available).
Seek medical attention in event of irritation.

Ingestion: Contact a Poison Control Center.
Do NOT induce vomiting. Give a glass of water.
Avoid giving milk or oils.
Avoid giving alcohol.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Treatment that is employed in carbon tetrachloride exposures follows:
1.Acute exposures to carbon tetrachloride present, initially, with CNS depression followed by hepatic and renal disfunction.
2.Respiratory depression and cardiac dysrhythmias are an immediate threat to life.
3.Since a major fraction of absorbed carbon tetrachloride is exhaled in first hour, good tidal volumes should be maintained in severely poisoned patients; hyperventilation may be an additional therapeutic modality.
4.Ipecac syrup, lavage, activated charcoal or catharsis may all be used in the first 4 hours.
5.Since reactive metabolites may cause hepatorenal toxicity, administration of N-acetyl-L-cysteine may reduce complications.
Experience with this therapy is limited.

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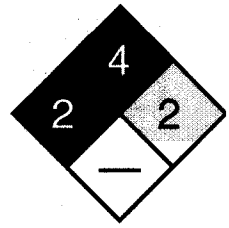
Section 5 - Fire-Fighting Measures



Fire Diamond

Flash Point: -16.111 °C Open Cup
Autoignition Temperature: 570 °C
LEL: 7.3% v/v
UEL: 16% v/v
Extinguishing Media: Foam, dry chemical powder, BCF (where regulations permit), carbon dioxide.
Water spray or fog - Large fires only.
General Fire Hazards/Hazardous Combustion Products: Liquid and vapor are highly flammable.
Severe fire hazard when exposed to heat, flame and/or oxidizers.
Vapor forms an explosive mixture with air.
Severe explosion hazard, in the form of vapor, when exposed to flame or spark. Vapor may travel a considerable distance to source of ignition.
Heating may cause expansion/decomposition with violent rupture of containers.
On combustion, may emit toxic fumes of carbon monoxide (CO). Other combustion products include hydrogen chloride and phosgene.
Fire Incompatibility: Avoid any contamination of this material as it is very reactive and any contamination is potentially hazardous. Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may result.
Polymerization may occur at elevated temperatures.
Polymerization may be accompanied by generation of heat as exotherm.
Process is self accelerating as heating causes more rapid polymerization.
Exotherm may cause boiling with generation of acrid, toxic and flammable vapor.
Polymerization and exotherm may be violent if contamination with strong acids, amines or catalysts occurs.
Polymerization and exotherm of material in bulk may be uncontrollable and result in rupture of storage tanks.
Polymerization may occur if stabilizing inhibitor becomes depleted by aging.
Stabilizing inhibitor requires dissolved oxygen to be present in liquid for effective action.
Specific storage requirements must be met for stability on ageing and transport.
Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
Fight fire from a safe distance, with adequate cover.
If safe, switch off electrical equipment until vapor fire hazard removed.
Use water delivered as a fine spray to control the fire and cool adjacent area. Avoid spraying water onto liquid pools.
Do not approach containers suspected to be hot.
Cool fire-exposed containers with water spray from a protective location.
If safe to do so, remove containers from path of fire.

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.
Avoid breathing vapors and contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb small quantities with vermiculite or other absorbent material. Wipe up. Collect residues in a flammable waste container.
Large Spills: Clear area of personnel and move upwind.
Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
No smoking, bare lights or ignition sources. Increase ventilation.
Stop leak if safe to do so. Water spray or fog may be used to disperse/absorb vapor. Contain spill with sand, earth or vermiculite.
Use only spark-free shovels and explosion proof equipment.
Collect recoverable product into labeled containers for recycling.
Absorb remaining product with sand, earth or vermiculite.
Collect solid residues and seal in labeled drums for disposal.
Wash area and prevent runoff into drains.
If contamination of drains or waterways occurs, advise emergency services.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

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Section 7 - Handling and Storage

Handling Precautions: Material contains a stabilizer / polymerization inhibitor system that provides workable but not indefinite shelf life.
Storage at higher temperatures and long term storage may result in polymerization with solidification. In larger quantities e.g. 200 l drums this may result in generation of heat (exotherm); which may release highly irritating hot vapor. Do not open hot exotherming drums - cool externally with water to avoid vapor release.
Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
Avoid smoking, bare lights, heat or ignition sources.
When handling, DO NOT eat, drink or smoke.
Vapor may ignite on pumping or pouring due to static electricity.
DO NOT use plastic buckets. Ground and secure metal containers when dispensing or pouring product. Use spark-free tools when handling.
Avoid contact with incompatible materials.
Keep containers securely sealed. Avoid physical damage to containers.
Always wash hands with soap and water after handling.
Work clothes should be laundered separately.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.
Recommended Storage Methods: Metal can; metal drum. Packing as recommended by manufacturer.
Check all containers are clearly labeled and free from leaks.
DO NOT use aluminum or galvanized containers.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use in a well-ventilated area. Local exhaust ventilation usually required.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection. NIOSH-approved self contained breathing apparatus (SCBA) may be required in some situations.
Provide adequate ventilation in warehouse or closed storage area.
Personal Protective Clothing/Equipment
Eyes: Safety glasses with side shields; or as required, chemical goggles.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.
Hands/Feet: Barrier cream and Butyl rubber gloves or Nitrile rubber gloves.
Safety footwear.
Respiratory Protection:
Exposure Range >5 to 250 ppm: Supplied Air, Constant Flow/Pressure Demand, Half Mask
Exposure Range >250 to 5000 ppm: Supplied Air, Constant Flow/Pressure Demand, Full Face
Exposure Range >5000 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Note: poor warning properties
Other: Overalls. Eyewash unit.
Glove Selection Index:
PVA .....A
VITON.....C

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Colorless highly flammable liquid with pleasant chloroform-like odor. Soluble in organic solvents. Presence of a stabilizing inhibitor prevents / retards peroxide formation.

Physical State: Liquid
Vapor Density (Air=1): >1
Formula Weight: 96.94
Specific Gravity (H_2O=1, at 4 °C): 1.2129
Water Solubility: 0.04% by weight
Evaporation Rate: Fast

pH: Not applicable
pH (1% Solution): Not applicable
Boiling Point Range: 31.7 °C (89 °F) at 760 mm Hg
Freezing/Melting Point Range: -122.5 °C (-188.5 °F)

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Section 10 - Stability and Reactivity

Stability/Polymerization: May form explosive peroxides on standing or following concentration by distillation. Review of stocks and testing for peroxide content by given tested procedures at 3-monthly intervals is recommended, together with safe disposal of peroxidic samples.
Peroxide containing residues can often be rendered innocuous by pouring into an excess of sodium carbonate solution.
Presence of a stabilizing inhibitor prevents/retards peroxide formation.
Stable under controlled storage conditions provided material contains adequate stabilizer/polymerization inhibitor.
Bulk storages may have special storage requirements.
In absence of inhibitor and in the presence of air, vinylidene chloride rapidly absorbs oxygen with formation of a violently explosive peroxide.
Peroxides initiate vinylidene chloride polymerization, producing insoluble polymer which absorbs peroxide. This results in separated polymer with concentrate of peroxide. In the dry state and 15% or more peroxide present this is readily detonated by heat or shock.
Hindered phenols are suitable inhibitors to prevent peroxidation.

Storage Incompatibilities: WARNING: Long standing in contact with air and light may result in the formation of potentially explosive peroxides.
Avoid any contamination of this material as it is very reactive and any contamination is potentially hazardous.
Explosion hazard may follow contact with incompatible materials.
Contamination with polymerization catalysts - peroxides, persulfates, oxidizing agents - also strong acids, strong alkalies, will cause polymerization with exotherm - generation of heat. Polymerization of large quantities may be violent - even explosive.
Light or water tend to promote self-polymerization.
Haloalkenes are highly reactive. Some of the more lightly substituted lower members are highly flammable; many members of the group are peroxidizable and polymerizable.
When stored at between -40 and 25 C in the absence of an inhibitor and in the presence of air, vinylidene chloride rapidly absorbs oxygen with the formation of a violently explosive peroxide. This peroxide initiates polymerization to produce an insoluble polymer which adsorbs the peroxide. Separation of the polymer in the dry state must be avoided since if more than 15% of the peroxide is present, the polymer may be detonatable by slight shock or friction.
Hindered phenols have been used to prevent peroxidation. Reaction products with ozone are particularly dangerous.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (rat) LD_{50}: 200 mg/kg
Inhalation (human) TC_{Lo}: 25 ppm
Inhalation (rat) LC_{50}: 6350 ppm/4h

IRRITATION
Nil reported

See NIOSH, *RTECS* KV 9275000, for additional data.

Section 12 - Ecological Information

Environmental Fate: Once in the atmosphere it will degrade rapidly by photooxidation with a half-life of 11 hours in relatively clean air or under 2 hours in polluted air. If spilled on land, part will evaporate and part will leach into the groundwater where its fate is unknown, but degradation is expected to be slow based upon microcosm studies. It would not be expected to bioconcentrate into fish.

Ecotoxicity: LC_{50} Cyprinodon variegatus (sheepshead minnow) 249 mg/l/24 hr, 48 hr, 72 hr, 96 hr in a static bioassay using sea water; EC_{50} Skeletonema costatum (alga) > 712,000 ug/l/96 hr, Toxic effects: Inhibition chlorophyll synthesis; reduced cell counts. /Conditions of bioassay not specified; LC_{50} Lepomis macrochirus (bluegill) 74 mg/l at 24 hr & 96 hr, temp at 21-23 °C, water hardness 32-48 mg/l (calcium carbonate), pH 6.7-7.8, dissolved oxygen concentration 7.0-8.8 mg/l (static bioassay); LC_{50} Mysidopsis bahia (mysid shrimp) > 798 mg/l/24 hr, 48 hr, 72 hr; 224 mg/l/96 hr in a static bioassay using seawater; LC_{50} Menidia beryllina (inland silverside) 250 ppm/96 hr in a static bioassay in synthetic seawater at 23 °C with mild aeration

Henry's Law Constant: 2.61×10^{-2}

BCF: not significant

Octanol/Water Partition Coefficient: log K_{OW} = 1.48

Soil Sorption Partition Coefficient: K_{OC} = estimated at 150

Section 13 - Disposal Considerations

Disposal: Consult manufacturer for recycling options and recycle where possible.
Follow applicable federal, state, and local regulations.
Incinerate residue at an approved site.

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Recycle containers where possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: VINYLIDENE CHLORIDE, INHIBITED
Additional Shipping Information:
Hazard Class: 3.1
ID No.: 1303
Packing Group: I
Label: Flammable Liquid[3]

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U078 Toxic Waste
CERCLA 40 CFR 302.4: Listed per CWA Section 311(b)(4); per RCRA Section 3001; per CWA Section 307(a) 100 lb (45.35 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date: .....1999-11 **Review Date:** 2000-07

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CAS # 75-35-4

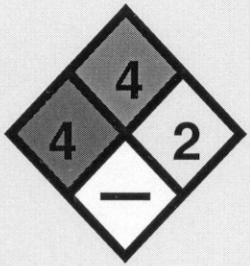
Danger! 1 3

Flammable

Vinylidene Chloride

1,1-DCE; 1,1-dichloroethene; asym-dichloroethylene; VDC; vinylidene dichloride

Colorless liquid; sweet odor. Irritating. Also Causes: narcosis, drunkenness, unconsciousness, conjunctivitis, transient corneal injury, iritis. Chronic: hepatic/renal dysfunction. Flammable. Combustion by-products include phosgene and hydrogen chloride.



Target Organs

3 9 10

Eyes

Skin

Respiratory System

Nervous System

Liver

Kidneys

Personal Protective Equipment

8

Goggles

Gloves

Apron

Check to see is respirator required?

Emergency Procedures

First Aid

4

Inhalation: Remove to fresh air and support breathing as needed. Eyes/Skin: Flush with flooding amounts of water for at least 15 minutes. This should prevent any adverse reaction. Ingestion: Consult physician before inducing vomiting.

Fire

5

Flammable. Can form explosive mixtures in the air. Combustion by-products include hydrogen chloride and phosgene. Use dry chemical, alcohol foam, or carbon dioxide. Use water to cool fire-exposed containers.

Spills & Leaks

6

Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Take up with inert material such as sand or vermiculite. Cleanup crew should protect against exposure.

Consult MSDS 0708 for more information

CONTAMINANT FACT SHEET - METHYLENE CHLORIDE

CAS Number:75-09-2	**Molecular Weight: 84.9**	**Color: Colorless**	**Ionization Potential (eV): 11.32**	**Vapor Density (Air=1):2.93**
Synonyms: Dichloromethane; Methylene dichloride	**Physical State: Liquid**	**Odor: Chloroform-like**	**Henry's Constant: 0.12**	**Vapor Pressure: 350 (mmHg@20C)**

Fire Hazard	**Reactivity Hazard**	**Health Hazard**	
NFPA rating: 1 **HMIS rating: 1**	**NFPA rating: 0** **HMIS rating: 0**		**NFPA rating: 2** **HMIS rating: 2**
Flash Point(°F): NA LEL(%): 13 UEL(%): 23 Fire Extinguishing Media: ☒ Dry Chemical ☒ Foam ☒ Water Spray ☒ CO_2 Fire Extinguisher: ☐ Class A ☐ Class B ☐ Class C ☐ Class D ☒ Class A/B/C DOT: ☐Flammable Liquid ☐Combustible Liquid	Incompatibilities: Strong oxidizers; caustics; chemically active metals such as aluminum, magnesium, potassium & sodium; concentrated nitric acid DOT: ☐ Oxidizer ☐ Water Reactive	Odor Threshold (ppm): 160 IDLH (ppm): 2300 See 29 CFR 1910.1052 Signs/Symptoms of Acute Exposure: Irritation of eyes & skin; fatigue; weakness; sleepiness; light-headed; numb tingling limbs; nausea DOT: ☐ Poison	Carcinogenic: OSHA: ☒ Yes ☐ Not listed IARC: ☐ Group 1 ☐ Group 2A ☒ Group 2B ☐ Group 3 ☐ Group 4 ☐ Not listed NTP: ☐ Known ☒ Anticipated ☐ Known ☐ Not listed ACGIH: ☐ A1 ☐ A2 ☒ A3 ☐ A4 ☐ A5 ☐ Not listed Skin Absorbable: ☐ Yes ☒ No Skin Corrosive: ☐ Yes ☒ No DOT: ☐ Corrosive

Source	TWA (ppm)	STEL (ppm)	C (ppm)
OSHA PELs	25	125	NA
ACGIH TLVs	50	NA	NA

Air Monitoring

Type	Brand/Model No.	Calibration Method/Media
☐ Explosimeter		
☒ PID	MiniRAE	Isobutylene
☒ FID	Foxboro OVA	Methane
☒ Colorometric Tubes	Drager/6724601(50-2000ppm)	Check pump for leaks
☐ Chemical Monitor ☐ Dust Monitor		
☒ Collection Medium/Sampling Pump	Gilian Pump/NIOSH#1005	Calibrate pump w/ media

Protective Clothing

Glove Type/Brand (Breakthrough >2 hrs unless noted):	☒Viton/North (1hr)	☒Viton/Best (113min)	☒Silvershield/North	☒4H/Safety
	☐Neoprene/Mapa	☐Neoprene/Ans.Ed.	☐Neoprene/BestUltraflex	☐ Neoprene/BestNeo.(30min)
	☐PVC/Ans.Ed.	☐PVC/BestHustler	☐Nitrile/LabSafe.	☐Nitrile/Ans.Ed.
	☐Butyl/North	☐PVA/Ans.Ed.	☐Other	

Suit Type (Breakthrough >1hr unless noted): ☐Tyvek ☐ Tyvek QC ☐Tyvek/Saranex ☐Tychem7500 ☒Tychem 9400 ☒Tychem 10,000 ☐Other

Respiratory Protection

☒Air Purifying	☐Air Supplied Only	Maximum Use Concentration (ppm): Half mask: Full face:

Notes: * = 2000 ppm 5 min. peak in any 2 hours

Prepared by: Sherry Hall Date: 16 January 1997, Rev. 30 January 2002

CONTAMINANT FACT SHEET – TETRACHLOROETHYLENE

CAS Number:127-18-4	**Molecular Weight:165.8**	**Color: Colorless to pale yellow**	**Ionization Potential (eV): 9.32**	**Vapor Density (Air=1): 5.85**
Synonyms: Tetrachloroethylene; Perchlorethylene; Perk	**Physical State: Liquid**	**Odor: Mild chloroform-like**	**Henry's Constant: NA {(atm ×m^3)/mol}**	**Vapor Pressure: 2.11 @ 22C (atm)**

Fire Hazard	**Reactivity Hazard**	**Health Hazard**	
NFPA rating: 0 **HMIS rating: 0**	**NFPA rating: 0** **HMIS rating: 0**		**NFPA rating: 2** **HMIS rating: 2**
Flash Point(°F): Nonflammable LEL(%): 1.8% UEL(%): 11.5% Fire Extinguishing Media: ☐ Dry Chemical ☐ Foam ☐ Water Spray ☐ CO_2 Fire Extinguisher: ☐ Class A ☐ Class B ☐ Class C ☐ Class D ☐ Class A/B/C DOT: ☐Flammable Gas ☐Combustible Liquid	Incompatibilities: Strong oxiders; chemically-active metals such as lithium, beryllium & barium; caustic soda; sodium hydroxide; potash DOT: ☐ Oxidizer ☐ Water Reactive	Odor Threshold (ppm): 47 IDLH (ppm): 150 *5 min. peak in any 3 hours Signs/Symptoms of Acute Exposure: Irritation of the eyes, nose, throat; nausea; flush face, neck; vertigo; dizziness; incorehent; headache DOT: ☒ Poison, Harmful	Carcinogenic: OSHA: ☐ Yes ☒ Not listed IARC: ☐ Group 1 ☒ Group 2A ☐ Group 2B ☐ Group 3 ☐ Group 4 ☐ Not listed NTP: ☐ Known ☒ Anticipated ☐ Process ☐ Not listed ACGIH: ☐ A1 ☐ A2 ☒ A3 ☐ A4 ☐ A5 ☐ Not listed Skin Absorbable: ☐ Yes ☒ No Skin Corrosive: ☐ Yes ☒ No DOT: ☐ Corrosive

Source	TWA (ppm)	STEL (ppm)	C (ppm)
OSHA PELs	100	NA	200,300*
ACGIH TLVs	25	100	NA

Air Monitoring

Type	Brand/Model No.	Calibration Method/Media
☒ Explosimeter	Gastech GX-82	Methane
☒ PID	MiniRAE	Isobutylene
☒ FID	Foxboro OVA	Methane
☒ Colorometric Tubes	Drager/8101501(2-300 ppm)	Check pump for leaks
☐ Chemical Monitor ☐ Dust Monitor	NA	NA
☒ Collection Medium/Sampling Pump	Gilian Pump/NIOSH#1003	Calibrate pump w/ media

Protective Clothing

Glove Type/Brand (Breakthrough >2 hrs unless noted): ☒ Viton/North ☐Viton/Best ☐Silvershield/North ☐4H/Safety ☐Neoprene/Mapa 28min ☐Neoprene/Ans.Ed. ☐Neoprene/BestUltraflex40min ☐ Neoprene/BestNeo.(30min) ☐PVC/Ans.Ed. ☐PVC/BestHustler ☐Nitrile/LabSafe. ☐Nitrile/Ans.Ed. ☐Butyl/North ☒ PVA/Ans.Ed. ☐Other

Suit Type (Breakthrough >1hr unless noted): ☐Tyvek ☐ Tyvek QC ☐Tyvek/Saranex ☐Tychem7500 ☐Tychem 9400 ☐Tychem10,000 ☐Other

Respiratory Protection

☒Air Purifying ☐ Air Supplied Only | Maximum Use Concentration (ppm): Half mask: Full face:

Notes: Noncombustible liquid, but decomposes in a fire to hydrogen chloride and phosgene

Prepared by: Sherry Hall Date: 10 October 1997, Rev. 30 January 2002

CONTAMINANT FACT SHEET - TRICHLOROETHENE

CAS Number:79-01-6	**Molecular Weight: 131.4**	**Color: Colorless**	**Ionization Potential (eV): 9.45**	**Vapor Density (Air=1):4.54**
Synonyms: Trichloroethylene; TCE	**Physical State: Liquid**	**Odor: Chloroform-like**	**Henry's Constant: 0.50**	**Vapor Pressure: 58 (mmHg@20C)**

Fire Hazard	**Reactivity Hazard**	**Health Hazard**	
NFPA rating: 2 **HMIS rating: 2**	**NFPA rating: 0** **HMIS rating: 0**		**NFPA rating: 2** **HMIS rating: 2**
Flash Point(°F): 90 LEL(%): 8 UEL(%): 10.5 Fire Extinguishing Media: ☒ Dry Chemical ☒ Foam ☐ Water Spray ☒ CO_2 Fire Extinguisher: ☐ Class A ☐ Class B ☐ Class C ☐ Class D ☒ Class A/B/C DOT: ☐Flammable Liquid ☐Combustible Liquid	Incompatibilities: Strong caustics; alkalis; chemically active metals (such as barium, lithium, sodium, magnesium, titanium and beryllium DOT: ☐ Oxidizer ☐ Water Reactive	Odor Threshold (ppm): 82 IDLH (ppm): 1000 *5-Min peak in any two hours. Signs/Symptoms of Acute Exposure: Irritation of eyes and skin; headache; vertigo; visual disturbance; fatigue; giddiness; tremor; sleepiness; nausea; vomiting; dermatitis DOT: ☐ Poison	Carcinogenic: OSHA: ☐ Yes ☒ Not listed IARC: ☐ Group 1 ☒ Group 2A ☐ Group 2B ☐ Group 3 ☐ Group 4 ☐ Not listed NTP: ☐ Known ☒ Anticipated ☐ Process ☐ Not listed ACGIH: ☐ A1 ☐ A2 ☐ A3 ☐ A4 ☒ A5 ☐ Not listed Skin Absorbable: ☐ Yes ☒ No Skin Corrosive: ☐ Yes ☒ No DOT: ☐ Corrosive

Source	TWA (ppm)	STEL (ppm)	C (ppm)
OSHA PELs	100	NA	200, 300*
ACGIH TLVs	50	100	NA

Air Monitoring

Type	Brand/Model No.	Calibration Method/Media
☐ Explosimeter	Gastech GX-82	Methane
☒ PID	MiniRAE	Isobutylene
☒ FID	Foxboro OVA	Methane
☒ Colorometric Tubes	Drager/CH24401 (10-500pmm)	Check pump for leaks
☐ Chemical Monitor ☐ Dust Monitor		
☒ Collection Medium/Sampling Pump	Gilian Pump/NIOSH#1022	Calibrate pump w/ media

Protective Clothing

Glove Type/Brand (Breakthrough >2 hrs unless noted):	☒Viton/North	☐Viton/Best	☒Silvershield/North	☒4H/Safety
	☐Neoprene/Mapa	☐Neoprene/Ans.Ed.	☐Neoprene/BestUltraflex	☐ Neoprene/BestNeo.(30min)
	☐PVC/Ans.Ed.	☐PVC/BestHustler	☐Nitrile/LabSafe.	☐Nitrile/Ans.Ed.
	☐Butyl/North	☐PVA/Ans.Ed.	☐Other	
Suit Type (Breakthrough >1hr unless noted):	☐Tyvek	☐ Tyvek QC	☐Tyvek/Saranex	☐Tychem7500 ☒Tychem 9400 ☐Other

Respiratory Protection

☒Air Purifying	☐Air Supplied Only	Maximum Use Concentration (ppm): Half mask: Full face:

Notes:

Prepared by: Sherry Hall Date: 16 January 1997, Rev. 30 January 2002

CONTAMINANT FACT SHEET - VINYL CHLORIDE

CAS Number:75-01-4	**Molecular Weight: 62.5**	**Color: Colorless**	**Ionization Potential (eV): 9.99**	**Vapor Density (Air=1):2.155**
Synonyms: Chloroethene; VC; VCM	**Physical State: Gas or Liquid**	**Odor: Pleasant**	**Henry's Constant: 8228**	**Vapor Pressure: 2530 (mmHg@20C)**

Fire Hazard	**Reactivity Hazard**	**Health Hazard**
NFPA rating: 4 **HMIS rating: 4**	**NFPA rating: 2** **HMIS rating: 2**	**NFPA rating: 2** **HMIS rating: 3**

Flash Point(°F): -108.4
LEL(%): 3.6 UEL(%): 33.0

Fire Extinguishing Media:
☒ Dry Chemical ☒ Foam
☐ Water Spray ☒ CO_2

Fire Extinguisher:
☐ Class A ☐ Class B
☐ Class C ☐ Class D
☒ Class A/B/C

DOT: ☐ Flammable Liquid
☐ Combustible Liquid

Incompatibilities: Copper; oxides; aluminum; peroxides; iron; steel

DOT: ☐ Oxidizer
☐ Water Reactive

Odor Threshold (ppm): 10-20

IDLH (ppm): 3600

Source	TWA (ppm)	STEL (ppm)	C (ppm)
OSHA PELs	1	5*	NA
ACGIH TLVs	1	NA	NA

*Ave. not exceeding any 15 min, See 29 CFR 1910.1045

Signs/Symptoms of Acute Exposure: Weakness abdominal pain; GI bleeding; Frostbite

DOT: ☐ Poison

Carcinogenic:
OSHA: ☒ Yes ☐ Not listed

IARC: ☒ Group 1 ☐ Group 2A
☐ Group 2B ☐ Group 3
☐ Group 4 ☐ Not listed

NTP: ☒ Known ☐ Anticipated
☐ Process ☐ Not listed

ACGIH: ☒ A1 ☐ A2
☐ A3 ☐ A4
☐ A5 ☐ Not listed

Skin Absorbable: ☐ Yes ☒ No
Skin Corrosive: ☐ Yes ☒ No

DOT: ☐ Corrosive

Air Monitoring

Type	Brand/Model No.	Calibration Method/Media
☐ Explosimeter		
☒ PID	MiniRAE	Isobutylene
☒ FID	Foxboro OVA	Methane
☒ Colorometric Tubes	Drager/67-28061(0.25-6 ppm)	Check pump for leaks
☐ Chemical Monitor ☐ Dust Monitor		
☒ Collection Medium/Sampling Pump	Gilian Pump/NIOSH#1007	Calibrate pump w/ media

Protective Clothing

Glove Type/Brand (Breakthrough >2 hrs unless noted):
☒ Viton/North ☐ Viton/Best ☒ Silvershield/North ☐ 4H/Safety
☐ Neoprene/Mapa ☐ Neoprene/Ans.Ed. ☐ Neoprene/BestUltraflex ☐ Neoprene/BestNeo.(30min)
☐ PVC/Ans.Ed. ☐ PVC/BestHustler ☐ Nitrile/LabSafe. ☐ Nitrile/Ans.Ed.
☐ Butyl/North ☐ PVA/Ans.Ed. ☐ Other

Suit Type (Breakthrough >1hr unless noted):
☐ Tyvek ☐ Tyvek QC ☐ Tyvek/Saranex ☒ Tychem7500 ☒ Tychem 9400 ☐ Other

Respiratory Protection

☒ Air Purifying ☐ Air Supplied Only | Maximum Use Concentration (ppm): Half mask: Full face:

Notes:
Prepared by: Sherry Hall Date: 22 January 2002, Rev. 31 January 2002

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ATTACHMENT D-A-3
HAZARD MITIGATORS

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Attachment D-A-3
Hazard Mitigators Directory

Included in HASP	*Hazards*
I. Chemical Hazards	
☒	Fire
☒	Inhalation (Dust)
☐	Permanganate Handling
☐	Reactivity
☒	Skin Absorption
☒	Other: Electron Donor Injection
II. Physical Hazards	
☐	Boating
☐	Chainsaw
☐	Cold Stress
☒	Compressed Gas Cylinder
☐	Downhole Logging
☒	Drilling (Including Indoor)
☒	Drum and Container Handling
☒	Electrocution
☐	Excavation/Trenching
☒	Eye Injury
☐	Fall Protection
☒	Flash Flood
☒	Hand/Foot Injury
☒	Heat Stress
☒	Heavy Equipment
☐	Helicopter
☒	Lifting Heavy Loads
☐	Lockout/Tagout
☒	Noise
☐	Nuclear Gauge Radiation Exposure
☒	Portable Power/Hand Tool
☒	Slips, Trips and Falls
☒	Thoroughfares
☐	Welding and Cutting
☒	Other: Trains
III. Biological Hazards	
☒	Allergic Reaction to Poisonous Plants
☒	Bees
☒	Dog
☒	Insect/Vermin/Snake Bites
☐	Medical Waste
☐	Mountain Lions

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ATTACHMENT D-A-4
AIR MONITORING EQUIPMENT, FREQUENCY OF READINGS, AND ACTION GUIDELINES PER TASK

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Attachment D-A-4

Air Monitoring Equipment / Frequency of Reading / Action Guidelines Per Task

Applies to Task: ☒ ① ☒ ② ☒ ③ ☒ ④ ☒ ⑤ ☒ ⑥ ☒ ⑦

☐ *Explosimeter*

Brand/Model No.: _____

Monitoring Frequency: _____

Source Reading (% LEL)	Action
1 to 10	Continue with caution.
Greater than 10	Stop work. Evacuate the area. If upon return, concentration still exceeds 10% LEL, ventilate till LEL is back to zero.

Note: _____

☐ *Oxygen Meter*

Brand/Model No.: _____

Monitoring Frequency: _____

Source Reading (%)	Action
Less than 19.5	Stop work. Evacuate the area. If upon return, concentration is still <19.5, Level B PPE must be acquired and worn by trained personnel.
19.5 to 23.5	Continue to work with caution.
Greater than 23.5	Stop work. Evacuate the area.

Note: _____

☒ *Photoionization Detector*

Brand/Model No.:RAE/MiniRae PID _____

Monitoring Frequency: Every 15 minutes initially _____

Breathing Zone Reading	Action
0 to 1 ppm	Level D PPE
1 to 5 ppm	Pull detector tubes for benzene and vinyl chloride
Greater than 5 ppm _____	Level C PPE and/or evacuate the area

Note: Attempt engineering controls to prevent 1 ppm levels/ sustained above background.

☒ *Chemical Detector Tube*

Brand/Model No.: Gas Tec Tube for benzene

Monitoring Frequency: Upon sustained reading of 1ppm from PID _____

Breathing Zone Reading (ppm)	Action
0 to 1 ppm	Level D PPE
1 to 10 ppm	Level C PPE
Greater than 10 ppm	Stop work. Evacuate the area.

Note: Sustained in breathing zone (> 5 minutes)

☒ *Chemical Detector Tube*

Brand/Model No.: Gas Tec Tube for vinyl chloride

Monitoring Frequency: Upon sustained reading of 1ppm from PID _____

Breathing Zone Reading (ppm)	Action
0 to 1 ppm	Level D PPE
1 to 10 ppm	Level C PPE
Greater than 10 ppm _____	Stop work. Evacuate the area.

Note: Sustained in breathing zone (> 5 minutes)

☐ *Other*

Brand/Model No.: _____

Monitoring Frequency: _____

Breathing Zone Reading ☐ ppm ☐ mg/m^3 ☐ Other:	Action
_____ to _____	Level D PPE
_____ to _____	Level C PPE
Greater than _____ _____	Stop work. Evacuate the area. If upon return, levels still exceed ____, Level B PPE must be acquired and worn by trained personnel.

Note: _____

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ATTACHMENT D-A-5
PERSONAL PROTECTIVE EQUIPMENT PER TASK

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Attachment D-A-5

Personal Protective Equipment Per Task

Applies to Task: ☒ ① ☒ ② ☒ ③ ☒ ④ ☒ ⑤ ☒ ⑥ ☒ ⑦

☒ *Modified Level D**		☐ *Level C**		☐ *Level B**	
Equipment	***Material/Type***	***Equipment***	***Material/Type***	***Equipment***	***Material/Type***
☒ Protective clothing	Long pants	☒ Full-face air-purifying respirator	Cartridge Type: OV/P100	☐ SCBA (pressure demand)	
☒ Outer gloves	Nitrile	☐ Half-mask air-purifying respirator	Cartridge Type:	☐ Air-line System (pressure demand)	
☐ Outer boots		☒ Protective clothing	Tyvek	☐ Protective clothing	
☒ Hard hat**		☒ Outer gloves	Nitrile	☐ Outer gloves	
☒ Safety glasses**		☐ Inner gloves		☐ Inner gloves	
☒ Hard-toed boots**		☐ Outer boots		☐ Outer boots	
☒ Hearing protection**		☒ Hard hat**		☐ Hard hat**	
☐ Other:		☒ Safety glasses**		☐ Hard-toed boots**	
		☒ Hard-toed boots**		☐ Hearing protection**	
		☒ Hearing protection**		☐ Escape respirator**	
		☐ Other:		☐ Safety “tag” rope**	
				☐ Other:	

* If checked, indicates initial level of PPE. Other completed columns indicate information to upgrade/downgrade.

** Optional as applicable

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ATTACHMENT D-A-6
MATERIAL SAFETY DATA SHEETS

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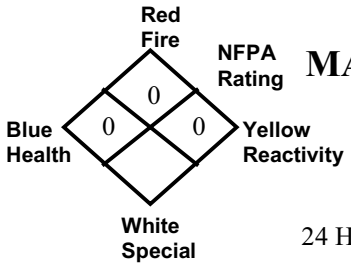
Attachment D-A-6

Material Safety Data Sheets Directory

Included in HASP	*Chemical*
☐	Acetone
☒	Alconox
☐	Ammonia
☒	Bentonite
☒	Diesel Fuel Oil No. 2-D
☐	*n*-Hexane
☐	Hydrochloric Acid
☒	Isobutylene Calibration Gas
☐	Isopropyl Alcohol
☒	KB-1
☐	Methane Calibration Gas
☐	Nitric Acid
☒	Portland Cement
☐	Sodium Permanganate
☐	Sulfuric Acid
☒	Unleaded Gasoline
☒	Other: ~~Bleach~~
☒	Other: ~~Bromide~~
☒	Other: ~~Emulsified Vegetable Oil~~

Alconox ®



MATERIAL SAFETY DATA SHEET

Alconox, Inc.
30 Glenn Street. Suite 309
White Plains, NY 10603

24 Hour Emergency Number – Chem-Tel (800) 255-3924

I. IDENTIFICATION

Product Name (as appears on label)	ALCONOX
CAS Registry Number:	Not Applicable
Effective Date:	January 1, 1999
Chemical Family:	Anionic Powdered Detergent
Manufacturer Catalog Numbers for sizes	1104, 1125, 1150, 1101, 1103 and 1112

II. HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

There are no hazardous ingredients in ALCONOX as defined by the OSHA Standard and Hazardous Substance List 29 CFR 1910 Subpart Z.

III. PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point (F):	Not Applicable
Vapor Pressure (mm Hg):	Not Applicable
Vapor Density (AIR=1):	Not Applicable
Specific Gravity (Water=1):	Not Applicable
Melting Point:	Not Applicable
Evaporation Rate (Butyl Acetate=1):	Not Applicable
Solubility in Water:	Appreciable-Soluble to 10% at ambient conditions
Appearance:	White powder interspersed with cream colored flakes.

IV. FIRE AND EXPLOSION DATA

Flash Point (Method Used):	None
Flammable Limits:	LEL: No Data UEL: No Data
Extinguishing Media:	Water, dry chemical, CO_2, foam
Special Fire fighting Procedures:	Self-contained positive pressure breathing apparatus and protective clothing should be worn when fighting fires involving chemicals.
Unusual Fire and Explosion Hazards:	None

V. REACTIVITY DATA

Stability:	Stable
Hazardous Polymerization:	Will not occur
Incompatibility (Materials to Avoid):	None
Hazardous Decomposition or Byproducts:	May release CO_2 on burning

VI. HEALTH HAZARD DATA

Route(s) of Entry:	Inhalation? Yes Skin? No Ingestion? Yes
Health Hazards (Acute and Chronic):	Inhalation of powder may prove locally irritating to mucous membranes. Ingestion may cause discomfort and/or diarrhea. Eye contact may prove irritating.
Carcinogenicity:	NTP? No IARC Monographs? No OSHA Regulated? No
Signs and Symptoms of Exposure:	Exposure may irritate mucous membranes. May cause sneezing.
Medical Conditions Generally Aggravated by Exposure:	Not established. Unnecessary exposure to this product or any industrial chemical should be avoided. Respiratory conditions may be aggravated by powder.
Emergency and First Aid Procedures:	Eyes: Immediately flush eyes with water for at least 15 minutes. Call a physician. Skin: Flush with plenty of water. Ingestion: Drink large quantities of water or milk. Do not induce vomiting. If vomiting occurs administer fluids. See a physician for discomfort.

VII. PRECAUTIONS FOR SAFE HANDLING AND USE

Steps to be Taken if Material is Released or Spilled:	Material foams profusely. Recover as much as possible and flush remainder to sewer. Material is biodegradable.
Waste Disposal Method:	Small quantities may be disposed of in sewer. Large quantities should be disposed of in accordance with local ordinances for detergent products.
Precautions to be Taken in Storing and Handling:	Material should be stored in a dry area to prevent caking.
Other Precautions:	No special requirements other than the good industrial hygiene and safety practices employed with any industrial chemical.

VIII. CONTROL MEASURES

Respiratory Protection (Specify Type):	Dust mask - Recommended
Ventilation:	Local Exhaust-Normal Special-Not Required Mechanical-Not Required Other-Not Required
Protective Gloves:	Impervious gloves are useful but not required.
Eye Protection:	Goggles are recommended when handling solutions.
Other Protective Clothing or Equipment:	None
Work/Hygienic Practices:	No special practices required

THE INFORMATION HEREIN IS GIVEN IN GOOD FAITH BUT NO WARRANTY IS EXPRESSED OR IMPLIED.

International Chemical Safety Cards

BENTONITE

ICSC: 0384

BENTONITE
Wilkinite

CAS # 1302-78-9
RTECS # CT9450000
ICSC # 0384

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Not combustible.		In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION			
EXPOSURE		PREVENT DISPERSION OF DUST!	
• **INHALATION**		Avoid inhalation of fine dust and mist.	
• **SKIN**		Protective gloves.	
• **EYES**		Safety spectacles.	
• **INGESTION**			

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Sweep spilled substance into containers; if appropriate, moisten first to prevent dusting (extra personal protection: P1 filter respirator for inert particles).		

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0384

Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities © IPCS CEC 1993

International Chemical Safety Cards

BENTONITE

ICSC: 0384

I M P O R T A N T D A T A	**PHYSICAL STATE; APPEARANCE:** ODOURLESS GRANULES OR POWDER IN VARIABLE COLOUR. **PHYSICAL DANGERS:** **CHEMICAL DANGERS:** The substance is a weak base in suspension in water. **OCCUPATIONAL EXPOSURE LIMITS (OELs):** TLV not established.	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation of dust. **INHALATION RISK:** Evaporation at 20°C is negligible; a harmful concentration of airborne particles can, however, be reached quickly. **EFFECTS OF SHORT-TERM EXPOSURE:** **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** The substance may have effects on the lungs , resulting in silicosis due to the presence of crystalline silica (see ICSC # 0808).
PHYSICAL PROPERTIES	Relative density (water = 1): 2.5	Solubility in water: none
ENVIRONMENTAL DATA		

NOTES

Bentonites are aluminate silicate and can contain crystalline silica. The content varies widely from less than 1% to about 24%.

ADDITIONAL INFORMATION

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OHIO STATE UNIVERSITY COLLEGE OF BIOLOGICAL SCIENCES MSDS FILE

CLOROX -- CLOROX LIQUID BLEACH - SODIUM HYPOCHLORITE SOLUTION MATERIAL SAFETY DATA SHEET FSC: 6810 NIIN: 013120376 Manufacturer's CAGE: 93098 Part No. Indicator: A Part Number/Trade Name: CLOROX LIQUID BLEACH

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General Information

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Item Name: SODIUM HYPOCHLORITE SOLUTION Company's Name: CLOROX COMPANY Company's Street: 7200 JOHNSON DRIVE Company's City: PLEASANTON Company's State: CA Company's Country: US Company's Zip Code: 94566 Company's Emerg Ph #: 303-573-1014 Company's Info Ph #: 415-847-6100 Record No. For Safety Entry: 001 Tot Safety Entries This Stk#: 001 Status: SMJ Date MSDS Prepared: 09NOV89 Safety Data Review Date: 19MAR93 MSDS Serial Number: BSBBW Hazard Characteristic Code: NK

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Ingredients/Identity Information

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Proprietary: NO Ingredient: HYPOCHLOROUS ACID, SODIUM SALT; (SODIUM HYPOCHLORITE) (SARA III) Ingredient Sequence Number: 01 Percent: 5.25 NIOSH (RTECS) Number: NH3486300 CAS Number: 7681-52-9 OSHA PEL: NOT APPLICABLE ACGIH TLV: NOT APPLICABLE

==========

Physical/Chemical Characteristics

==========

Appearance And Odor: CLEAR, LIGHT YELLOW LIQUID WITH CHLORINE ODOR. Boiling Point: SUPP DATA Specific Gravity: 1.085 (H*2O=1) Solubility In Water: COMPLETE pH: 11.4

==========

Fire and Explosion Hazard Data

==========

Extinguishing Media: USE MEDIA SUITABLE FOR SURROUNDING FIRE(FP N). Special Fire Fighting Proc: WEAR NIOSH/MSHA APPROVED SCBA & FULL PROTECTIVE EQUIPMENT (FP N). IN FIRE, COOL CONTAINERS TO PREVENT RUPTURE & RELEASE OF SODIUM CHLORATE. Unusual Fire And Expl Hazrds: NOT FLAMMABLE OR EXPLOSIVE.

==========

Reactivity Data

==========

Stability: YES Cond To Avoid (Stability): NONE SPECIFIED BY MANUFACTURER. Materials To Avoid: SEE DECOMPOSITION PRODUCTS. Hazardous Decomp Products: REACTS W/HOUSEHOLD CHEMS SUCH AS TOILET BOWL CLEANERS, RUST REMOVERS,

VINEGAR, ACIDS OR AMMONIA CNTNG PRODS TO (SUPDAT) Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT RELEVANT.
==========

Health Hazard Data
==========

LD50-LC50 Mixture: NONE SPECIFIED BY MANUFACTURER. Route Of Entry -
Inhalation: YES Route Of Entry - Skin: YES Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: CAUSES SEVERE BUT TEMPORARY EYE INJURY. MAY
IRRIT SKIN. MAY CAUSE NAUSEA & VOMIT IF INGEST. EXPOS TO VAP/MIST MAY IRRIT
NOSE, THROAT & LUNGS. UNDER NORMAL CONSUMER USE CONDITIONS THE
LIKELIHOOD
OF ANY ADVERSE HEALTH AFFECTS ARE LOW. Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO Carcinogenicity - OSHA: NO Explanation
Carcinogenicity: NOT RELEVANT. Signs/Symptoms Of Overexp: SEE HEALTH
HAZARDS. Med Cond Aggravated By Exp: FOLLOWING MED CNDTNS MAY BE
AGGRAVATED
BY EXPOS TO HIGH CONCENTRATION OF VAP/MIST: HEART CDNTNS, CHRONIC RESP
PROBLEMS SUCH AS ASTHMA, CHRONIC BRONCHITIS OR OBSTRUCTIVE LUNG DISEASE.

Emergency/First Aid Proc: EYES: IMMEDIATELY FLUSH EYES WITH PLENTY OF
REMOVE CONTAMD CLOTHING. WASH AREA WITH WATER FOR AT LEAST 15 MINUTES.
INGEST: DRINK A GLASSFUL OF WATER AND CALL MD. INHAL: IF BREATHING
PROBLEMS
DEVELOP REMOVE TO FRESH AIR.
==========

Precautions for Safe Handling and Use
==========

Steps If Matl Released/Spill: SMALL QTYS OF <5 GALS MAY BE FLUSHED DOWN
DRAIN. FOR LARGER QTYS WIPE UP W/ABSORB MATL/MOP & DISP OF IN ACCORDANCE
WITH LOCAL, STATE AND FEDERAL REGULATIONS. Neutralizing Agent: DILUTE WITH
WATER TO MINIMIZE OXIDIZING EFFECT ON SPILLED AREA. Waste Disposal Method:
DISPOSE OF IN ACCORDANCE WITH ALL LOCAL, STATE & FEDERAL REGULATIONS (FP
N)
Precautions-Handling/Storing: STORE IN A COOL, DRY PLACE. DO NOT REUSE
EMPTY CONTAINER; RINSE CONTAINER AND PUT IN TRASH CONTAINER. Other
Precautions: KEEP OUT OF REACH OF CHILDREN. DO NOT GET IN EYES/ON SKIN.
WASH THORO WITH SOAP & WATER AFTER HANDLING. DO NOT MIX W/OTHER
HOUSEHOLD
CHEMICALS.
==========

Control Measures
==========

Respiratory Protection: WEAR NIOSH/MSHA APPROVED RESPIRATOR APPROPRIATE FOR
EXPOSURE OF CONCERN(FP N). Ventilation: USE GENERAL VENTILATION TO MINIMIZE
EXPOSURE TO VAPOR OR MIST. Protective Gloves: IMPERVIOUS GLOVES (FP N). Eye

Protection: ANSI APPROVED CHEM WORK GOGGLES (FP N). Other Protective Equipment: AVOID EYE & SKIN CONTACT & INHALATION OF VAPOR OR MIST. Work Hygienic Practices: WEAR SAFETY GLASSES. WITH REPEATED OR PROLONGED USE, WEAR GLOVES. PRODUCE HAZARDOUS GASES, SUCH AS CHLORINE & OTHER CHLORINATED
SPECIES. PROLONGED CONTACT WITH METAL MAY CAUSE PITTING OR DISCOLORATION.

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Transportation Data

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Trans Data Review Date: 93308 DOT PSN Code: HNV DOT Proper Shipping Name: HYPOCHLORITE SOLUTIONS DOT Class: 8 DOT ID Number: UN1791 DOT Pack Group: III DOT Label: CORROSIVE IMO PSN Code: NTF IMO Proper Shipping Name: SODIUM HYPOCHLORITE, SOLUTION IMO Regulations Page Number: SEE 8186 IMO UN Number: 1791 IMO UN Class: 8 IMO Subsidiary Risk Label: - IATA PSN Code: NYC IATA UN ID Number: 1791 IATA Proper Shipping Name: HYPOCHLORITE SOLUTION * IATA UN Class: 8 IATA Label: CORROSIVE AFI PSN Code: NYC AFI Prop. Shipping Name: HYPOCHLORITE SOLUTIONS AFI Class: 8 AFI ID Number: UN1791 AFI Pack Group: III AFI Label: CORROSIVE AFI Special Prov: N34 AFI Basic Pac Ref: 12-5

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Disposal Data

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Label Data

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Label Required: YES Technical Review Date: 19MAR93 Label Date: 11MAR93 Label Status: G Common Name: CLOROX LIQUID BLEACH Chronic Hazard: NO Signal Word: WARNING! Acute Health Hazard-Slight: X Contact Hazard-Moderate: X Fire Hazard-None: X Reactivity Hazard-Slight: X Special Hazard Precautions: STRONG OXIDIZER! STORE IN A COOL, DRY PLACE. DO NOT GET IN EYES OR ON SKIN. DO NOT MIX W/OTHER HOUSEHOLD CHEMICALS. ACUTE:CAUSES SEVERE BUT TEMPORARY
EYE INJURY. MAY IRRITATE SKIN. MAY CAUSE NAUSEA & VOMITING IF INGESTED. EXPOSURE TO VAPOR OR MIST MAY IRRITATE NOSE, THROAT & LUNGS. UNDER NORMAL
CONSUMER USE CONDITIONS THE LIKELIHOOD OF ANY ADVERSE HEALTH AFFECTS ARE
LOW. Protect Eye: Y Protect Skin: Y Protect Respiratory: Y Label Name: CLOROX COMPANY Label Street: 7200 JOHNSON DRIVE Label City: PLEASANTON Label State: CA Label Zip Code: 94566 Label Country: US Label Emergency Number: 303-573-1014

==========

URL
for this msds http://hazard.com. If you wish to change, add to, or delete

information in this archive please sent updates to dan@hazard.com.

Remediation and Natural Attenuation Services Incorporated
6712 West River Road
Brooklyn Center, MN 55430

Product Information: 763-585-6191 Issue Date: March 28, 2002

==========

Section 1: IDENTIFICATION

1.1 Product Name: Newman Zone
1.2 Product Type: Inedible Industrial Nutrient for Microbial Organisms
1.3 Hazard Rating: Health: 1 Fire: 1 Reactivity: 1
1.4 Formula: Proprietary

Substances Subject to SARA 313 Reporting Are Indicated by "#"

It is our opinion that the above named product does not meet the definition of "hazardous Chemical" as defined in the OSHA "Hazard Communication Standard" regulation 29 CFR 1910.1200. This material Safety Data Sheet is provided as general information for health and safety guidelines.

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Section 2: INGREDIENTS/COMPOSITION

	CAS No.	%	PEL	(mg/m^3) TWA
Soybean Oil (food grade)	8001-22-7	45	15(Mist)	10(Mist)
Sodium-L-Lactate	867-56-1	4		
Food Additives/Emulsifiers/Preservatives	(Proprietary)	<10		
Water		<45		

EMERGENCY ONLY, 24-HOUR SERVICE: CHEMTREC: 1-800-424-9300

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Section 3: PHYSICAL AND CHEMICAL CHARACTERISTICS

This section completed per formulation ingredient data unless stated.

- Solubility: Dispersible in water (product)
- PH: 6 (product)
- Specific Gravity: 0.98 (product)
- Boiling Point: NA
- Vapor Pressure: NA
- Vapor Density: NA
- Percent Volatile By Volume (%): NA
- Evaporation Rate: NA
- Viscosity: 23.6 cps @ 68°F (Brookfield)(product)
- Product Appearance and Odor: Light yellow-cream colored liquid, vegetable oil odor.

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Section 4: FIRE AND EXPLOSION HAZARDS

This section completed per formulation ingredient data unless stated.

4.1 Special Fire Hazards: Product - none, does not support combustion.

Flash Point: >540 degrees F (Pure Soybean Oil Closed Cup).
Flammable Limits
LEL ND
UEL ND

4.2 Fire Fighting Methods: Use method appropriate for surrounding fire.

4.3 Extinguishing Media: Dry Chemical or CO_2 Preferable; water may cause spattering or spreading.

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Section 5: HEALTH HAZARD DATA

5.1 THIS PRODUCT IS NEITHER INTENDED NOR MANUFACTURED FOR HUMAN OR ANIMAL CONSUMPTION AND SHOULD NOT BE USED FOR FOOD OR FEEDSTUFFS.

5.2 Effects of Overexposure: NA

5.3 Emergency and First Aid Procedures: If inhaled, remove from contaminated atmosphere. For eye contact immediately flush eyes with large amounts of water. Ensure rinsing entire surface of eye & under lid. For skin contact wash affected areas thoroughly with soap and water. Seek medical help for persistent irritation.

5.4 Hydrolyzed soy protein has been identified by the United States Food and Drug Administration as a food allergen. Symptoms include swelling of the lips, stomach cramps, vomiting, diarrhea, skin hives, rashes, eczema and breathing problems.

5.5 Occupational Exposure Limits [8-hour time weighted averages (TWA)]:

	CAS No.	mg/m^3 OSHA PEL/ACGIH TLV
Soybean Oil (food grade)	8001-22-7	15(Mist)/10(Mist)

==========

Section 6: REACTIVITY DATA

This section completed per formulation ingredient data unless stated.

6.1 Stability: Stable under normal conditions.

6.2 Conditions to Avoid: NA

6.3 Incompatibilities: None known

6.4 Hazardous Decomposition Products: Product - None identified. Ingredients – Carbon oxides. Biological decomposition (spoilage) may result in offensive odors.

6.5 Hazardous Polymerization; None known

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Section 7: SPILL OR LEAK PROCEDURES

This section completed per formulation ingredient data unless stated.

7.1 Spill Response: Water dispersible. Same as for vegetable oil spills: isolate spill, prevent from entering waterways, and sewer systems. Sorb or remove spilled materials as soon as possible. Oils and specific quantities of oils may be reportable under federal, state, or local regulations.

7.2 Waste Disposal Method: This product is not hazardous, however, wastes must be disposed in accordance with local, state or federal regulations. Consult with local sewer authority, or solid waste facility prior to disposition.

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Section 8: SPECIAL PRECAUTIONS

No protective equipment is necessary under normal use conditions.

8.1 Eyes: If splashing may occur, eye protection recommended.
8.3 Skin: Wear impervious gloves for prolonged or repeated exposure.
8.4 Respiratory: Avoid breathing mists of this product

==========

Section 9: TRANSPORTATION PRECAUTIONS

This section completed per formulation ingredient data unless stated.

9.1 Transportation Considerations: This product is not classified as dangerous in the meaning of transport regulations. Shippers and transporters may need to meet packaging and transportation requirements for certain oils and respective quantities under CFR 49 Part 130.

The above information is believed to be correct with respect to the formula used to manufacture the product in the country of origin. As data, standards, and regulations change, and conditions of use and handling are beyond our control, NO WARRANTY, EXPRESS OR IMPLIED, IS MADE AS TO THE COMPLETENESS OR CONTINUING ACCURACY OF THIS INFORMATION.

130 Research Lane, Suite 2 Guelph◆Ontario ◆ N1G 5G3 ◆ Canada ◆ Tel: (519) 822-2265 ◆ Fax: (519) 822-3151

KB-1™ Dechlorinator Material Safety Data Sheet

Section 1: Material Identification

Trade Name: KB-1™ Dechlorinator
Chemical Family: bacterial mixture
Chemical name: No IUC name for mixture is known to exist
Manufacturer/Supplier: SiREM
130 Research Lane, Suite 2,
Guelph, Ontario,
Canada N1G 5G3

For Information call: 519-822-2265 / 1-866-251-1747
Emergency Number: 519-822-2265
Description: Microbial inoculum (non-pathogenic, non-hazardous)
Trade Name: KB-1™ Dechlorinator
Product Use: Bioremediation of contaminated groundwater.
Date Prepared: 2 February 2005

Section 2: Composition, Information on Ingredients

KB-1™ Dechlorinator is a microbial culture grown in an aqueous dilute mineral salt solution media containing no hazardous ingredients.

The microbial composition of KB-1™ Dechlorinator (as determined by phylogenetic analysis) is listed in Table 1. Identification of organisms was obtained by matching 16S rRNA gene sequence of organisms in KB-1™ Dechlorinator to other known organisms. The characteristics of related organisms can be used to identify potential or likely characteristics of organisms in KB-1™ Dechlorinator.

Table 1. Genus' identified in KB-1™ Dechlorinator Microbial Inoculum

Genus
Dehalococcoides sp.
Geobacter sp.
Methanomethylovorans sp.

Section 3: Hazards Identification:

A review of the available data does not indicate any known health effects related to normal use of this product.

Section 4: First Aid Measures:

Avoid direct contact with skin and eyes. In any case of any exposure which elicits a response, a physician should be consulted immediately.

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Eye Contact: Flush eyes with water for at least 15 minutes, occasionally lift upper and lower eyelids, if undue irritation or redness occurs seek medical attention.

Skin Contact: Remove contaminated clothing and wash skin thoroughly with water and antibacterial soap. Seek medical attention if irritation develops or open wounds are present.

Ingestion: Do not induce vomiting, drink several cups of water, seek medical attention.

Inhalation: Remove to fresh air. If not breathing give artificial respiration. In case of labored breathing give oxygen. Call a physician.

Section 5 - Fire Fighting Measures:

Non-flammable
Flash Point: not applicable
Upper flammable limit: not applicable
Lower flammable limit: not applicable

Section 6 – Accidental Release Procedures

Spilled KB-1™ Dechlorinator should be soaked up with sorbant and saturated with a 10% bleach solution (prepared by making a one in ten dilution of diluted standard bleach [normally sold at a strength of 5.25% sodium hypochlorite] to disinfect affected surfaces. Sorbant should be double bagged and disposed of as indicated in section 12. After removal of sorbant, area should be washed with 10% bleach solution to disinfect. If liquid from the culture vessel is present on the fittings, non-designated tubing or exterior of the stainless steel pressure vessel liquid should be wiped off and the area washed with 10% bleach solution.

Section 7 - Handling and Storage

KB-1™ Dechlorinator is shipped in stainless steel pressure vessels and connected to injection lines and inert gas is used to pressurize the vessel to displace the contents. KB-1™ Dechlorinator should be handled with care to avoid any spillage. Vessels are shipped with 1 pound per square inch (psi) pressure; valves should not be opened until connections to appropriate lines for subsurface injection are in place.

Storage Requirements: Avoid exposing stainless steel pressure vessels to undue temperature extremes (i.e., temperatures less than 0°C or greater than 30°C may result in harm to the microbial cultures and damage to the vessels). All valves should be in the closed position when the vessel is not pressurized to prevent the escape of gases and to maintain anaerobic conditions in the vessel. Avoid exposure of the culture to air as the presence of oxygen will kill dechlorinating microorganisms.

Section 8 - Exposure Controls/Personal Protection

Personal protective equipment:

Skin: Protective gloves (latex, vinyl or nitrile) should be worn.
Eye Protection: Wear appropriate protective eyeglasses or goggles when opening pressure vessels valves or when pressurizing vessels to inject contents into the subsurface.
Respiratory: No respiratory protection is required.
Engineering Controls: Good general room ventilation is expected to be adequate.

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Section 9: Physical and Chemical Properties:

Physical State: liquid
Odour: skunky odour
Appearance: dark grey, slightly turbid liquid under anaerobic conditions, pink if exposed to air (oxygen).
Specific gravity: not determined
Vapor pressure: not applicable
Vapor density: not applicable
Evaporation rate: not determined
Boiling point: ~100° C
Freezing point/melting point: ~ 0°C
pH: 6.5-7.5
Solubility: fully soluble in water

Section 10 – Stability and Reactivity Data

Stable and non-reactive.
Maintain under anaerobic conditions to preserve product integrity.
Materials to avoid: none known

Section 11 - Toxicological Information

Potential for Pathogenicity:

KB-1™ Dechlorinator has tested negative (i.e., the organisms are not present) for a variety of pathogenic organisms listed in Table 2. While there is no evidence that virulent pathogenic organisms are present in KB-1™ Dechlorinator, there is potential that certain organisms in KB-1™ Dechlorinator may have the potential to act as opportunistic (mild) pathogens, particularly in individuals with open wounds and/or compromised immune systems. For this reason standard hygienic procedures such as hand washing after use should be observed.

Table 2, Results of Human Pathogen Screening of KB-1™ Dechlorinator

Organism	**Disease(s) Caused**	***Test result***
Salmonella sp.	Typhoid fever, gastroenteritis	Not Detected
Listeria monocytogenes	Listerioses	Not Detected
Vibrio sp.,	Cholera, gastroenteritis	Not Detected
Campylobacter sp.,	Bacterial diarrhea	Not Detected
Clostridia sp.,	Food poisoning, Botulism, tetanus, gas gangrene	Not Detected
Bacillus anthracis	Anthrax	Not Detected
Pseudomonas aeruginosa	Wound infection	Not Detected
Yersinia sp.,	Bubonic Plague, intestinal infection	Not Detected
Yeast and Mold	Candidiasis, Yeast infection etc.	Not Detected
Fecal coliforms	Indicator organisms for many human pathogens diarrhea, urinary tract infections	Not Detected
Enterococci	Various opportunistic infections	Not Detected

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Section 12. Disposal Considerations

Material must be disinfected or sterilized prior to disposal. Consult local regulations prior to disposal.

Section 13 – Transport Information

Non-hazardous, non-pathogenic microbial inoculum – Biosafety Risk Group 1.

Chemicals, Not Otherwise Indexed (NOI), Non-hazardous

Not subject to TDG or DOT guidelines.

Disclaimer:

The information provided on the MSDS sheet is based on current data and represents our opinion based on the current standard of practice as to the proper use and handling of this product under normal, reasonably foreseeable conditions.

Last revised: 3 February 2005

Material Safety Data Sheet Collection
Genium Publishing Corp.
1171 RiverFront Center
Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2000-07

Portland Cement
MSDS 718
POR5000

Section 1 - Chemical Product and Company Identification 54.1

Material Name: Portland Cement **CAS Number:** 65997-15-1
Chemical Formula: Unspecified or Variable
Synonyms: CEMENT; HYDRAULIC CEMENT; PORTLAND CEMENT; PORTLAND CEMENT SILICATE
General Use: Hydraulic binder used for mixing concrete, concrete masonry, mortars and grouts; also soil stabilization.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
portland cement	65997-15-1	varies

OSHA PEL
TWA: 15 mg/m^3; total dust.

NIOSH REL
No data found.

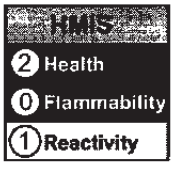
DFG (Germany) MAK
TWA: 5 mg/m^3.

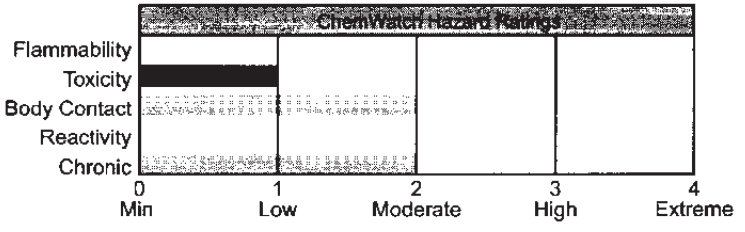
OSHA PEL Vacated 1989 Limits
TWA: 10 mg/m^3; total. Other Values: respirable mg/m^3; 5.

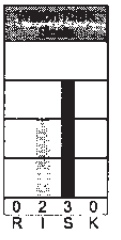
IDLH Level
5000 mg/m^3.

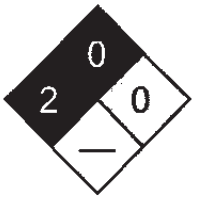
ACGIH TLV
TWA: 10 mg/m^3.

Section 3 - Hazards Identification









Fire Diamond

ANSI Signal Word
Caution

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Gray powder; odorless. Irritating to eyes/skin/respiratory tract. Also causes (on contact with wet cement): corneal edema, dermatitis, cracked skin. Chronic: bronchitis, dermatitis.

Potential Health Effects

Primary Entry Routes: inhalation, ingestion, skin contact
Target Organs: respiratory system, skin, eyes
Acute Effects

Inhalation: Generated dust may be highly discomforting if inhaled and may even cause in some cases, sensitization. Respiratory sensitization may result in allergic/asthma like responses; from coughing and minor breathing difficulties to bronchitis with wheezing, gasping.
Effects on lungs are significantly enhanced in the presence of respirable particles.

Eye: The solid/dust is highly discomforting, may be abrasive to the eyes and capable of causing a mild, temporary redness of the conjunctiva (similar to wind-burn), temporary impairment of vision and/or other transient eye damage/ulceration.

Skin: The dust is extremely discomforting to the skin and is capable of causing skin reactions which may lead to dermatitis.

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Handling wet cement can cause dermatitis. Cement when wet is quite alkaline and this alkali action on the skin contributes strongly to cement contact dermatitis since it may cause drying and defatting of the skin which is followed by hardening, cracking, lesions developing, possible infections of lesions and penetration by soluble salts. Cement contact dermatitis (CCD) may occur when contact shows an allergic response, which may progress to sensitization. Sensitization is due to soluble chromates (chromate compounds) present in trace amounts in some cements, cement products. Soluble chromates readily penetrate intact skin.

Cement dermatitis can be characterized by fissures, eczematous rash, dystrophic nails, and dry skin; acute contact with highly alkaline mixtures may cause localized necrosis.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.

The material is harmful if swallowed.

The dust is discomforting to the gastrointestinal tract.

Carcinogenicity: NTP - Not listed; IARC - Not listed; OSHA - Not listed; NIOSH - Not listed; ACGIH - Not listed; EPA - Not listed; MAK - Not listed.

Chronic Effects: Cement eczema may be due to chromium in feed stocks or contamination from materials of construction. Sensitization to chromium may be the leading cause of nickel and cobalt sensitivity and the high alkalinity of cement is an important factor in cement dermatoses.

Repeated, prolonged severe inhalation exposure may cause pulmonary edema and rarely, pulmonary fibrosis. Workers may also suffer from dust-induced bronchitis with chronic bronchitis reported in 17% of a group occupationally exposed to high dust levels.

Data suggests that occupational exposure to Portland cement dust may lead to a higher incidence of chronic respiratory symptoms and a reduction of ventilatory capacity.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.

Encourage patient to blow nose to ensure clear breathing passages.

Ask patient to rinse mouth with water but to not drink water.

Seek immediate medical attention.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.

Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.

Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).

Wash affected areas thoroughly with water (and soap if available).

Seek medical attention in event of irritation.

Ingestion: Contact a Poison Control Center.

Do NOT induce vomiting. Give a glass of water.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Treat symptomatically as for strong alkaline material.

Section 5 - Fire-Fighting Measures

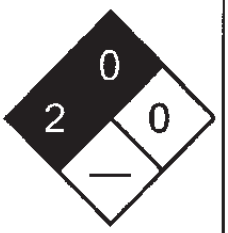
Flash Point: Noncombustible

Autoignition Temperature: Not applicable

LEL: Not applicable

UEL: Not applicable

Extinguishing Media: If small amounts are involved in a fire, there is no restriction on the type of extinguisher. Otherwise, use LARGE AMOUNTS of water to absorb heat generated.



Fire Diamond

General Fire Hazards/Hazardous Combustion Products: Noncombustible.

Not considered to be a significant fire risk; however, containers may burn.

Decomposes on heating and produces toxic fumes of caustic compounds.

Fire Incompatibility: No known incompatibility with normal range of industrial materials.

Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.

Wear breathing apparatus plus protective gloves for fire only. Prevent, by any means available, spillage from entering drains or waterways.

Use fire fighting procedures suitable for surrounding area.

Do not approach containers suspected to be hot.

Cool fire-exposed containers with water spray from a protected location.

If safe to do so, remove containers from path of fire.

Equipment should be thoroughly decontaminated after use.

Section 6 - Accidental Release Measures

Small Spills: Clean up all spills immediately. Avoid contact with skin and eyes.

Wear protective clothing, gloves, safety glasses and dust respirator.

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Use dry clean-up procedures and avoid generating dust.
Vacuum up or sweep up. Place in clean drum then flush area with water.
Large Spills: Clear area of personnel and move upwind.
Use dry clean-up procedures. Avoid generating dust.
If inhalation risk of exposure exists, wear NIOSH-approved dust respirator.
Collect recoverable product into labeled containers for recycling.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid generating and breathing dust. Limit all unnecessary personal contact.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area. Atmosphere should be checked against exposure standards to ensure safe working conditions are maintained.
Avoid contact with incompatible materials.
When handling, DO NOT eat, drink or smoke.
Always wash hands with soap and water after handling.
Use good occupational work practices.
Observe manufacturer's storing and handling recommendations.
Recommended Storage Methods: Packaging as recommended by manufacturer.
Check that containers are clearly labeled.
Metal pail or Paper bag with sealed plastic liner.
Multi-ply woven plastic or paper bag with sealed plastic liner.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use in a well-ventilated area.
If exposure to workplace dust is not controlled, respiratory protection is required; wear NIOSH-approved dust respirator.
General exhaust is adequate under normal operating conditions.
If risk of overexposure exists, wear NIOSH-approved dust respirator.
Correct fit is essential to obtain adequate protection.
Personal Protective Clothing/Equipment
Eyes: Safety glasses with side shields; or as required, chemical goggles.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.
Hands/Feet: Barrier cream and Wear chemical protective gloves, eg. PVC.
Wear safety footwear or safety gumboots, eg. Rubber.
Respiratory Protection:
Exposure Range >5 to 50 mg/m^3: Air Purifying, Negative Pressure, Half Mask
Exposure Range >50 to 500 mg/m^3: Air Purifying, Negative Pressure, Full Face
Exposure Range >500 to <5000 mg/m^3: Supplied Air, Constant Flow/Pressure Demand, Full Face
Exposure Range 5000 to unlimited mg/m^3: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Cartridge Color: dust/mist filter (use P100 or consult supervisor for appropriate dust/mist filter)
Other: Overalls. Eyewash unit. Ensure there is ready access to a safety shower.

Section 9 - Physical and Chemical Properties

Appearance/General Info: Finely divided grey to off-white colored powder with no odor. Hardens after reaction with water. A finely ground mixture of cement clinker and gypsum, surface area 300-500 m2/kg (Blaine Method).

Physical State: Divided solid
Vapor Pressure (kPa): Not applicable
Vapor Density (Air=1): Not applicable
Formula Weight: Not applicable.
Specific Gravity (H_2O=1, at 4 °C): 3.0-3.2
Water Solubility: Insoluble
Evaporation Rate: Not applicable
pH: alkaline
Boiling Point Range: No data found.
Freezing/Melting Point Range: > 1200 °C (2192 °F)
Decomposition Temperature (°C): Not applicable

Section 10 - Stability and Reactivity

Stability/Polymerization: Product is considered stable. Hazardous polymerization will not occur.
Storage Incompatibilities: Segregate from strong oxidizers and strong acids.

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Section 11 - Toxicological Information

No relevant toxicological data found at time of research.

See NIOSH, *RTECS* VV 8770000, for additional data.

Section 12 - Ecological Information

Environmental Fate: No data found.
Ecotoxicity: No data found.

Section 13 - Disposal Considerations

Disposal: Recycle wherever possible or consult manufacturer for recycling options.
Follow applicable federal, state, and local regulations.
Bury residue in an authorized landfill.
Recycle containers where possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: NONE
Hazard Class: None
ID No.: None
Packing Group: None
Label: No class label assigned

Additional Shipping Information:

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Not listed
CERCLA 40 CFR 302.4: Not listed
SARA 40 CFR 372.65: Not listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date: .....1999-11 **Review Date:** 2000-07

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CAS # 65997-15-1 **Caution** 1 3

Portland Cement

hydraulic cement; portland cement silicate

Gray powder; odorless. Irritating to eyes/skin/respiratory tract. Also Causes (on contact with wet cement): corneal edema, skin burns, dermal necrosis, first/second/third degree burns, esophagus/stomach burns. Chronic: bronchitis, dermatitis.

Target Organs

3 9 10

Eyes

Skin

Respiratory System

Personal Protective Equipment

8

Goggles

Gloves

Apron

Check to see is respirator required?

Emergency Procedures

First Aid

4

Inhalation: Remove to fresh air and support breathing. Eyes/Skin: Flush with flooding amounts of water. Thoroughly wash skin with soap and water. Ingestion: Do not induce vomiting. Contact physician immediately.

Fire

5

Noncombustible. Use agent suitable for surrounding fire.

Spills & Leaks

6

Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. DO NOT SWEEP! Carefully scoop up or vacuum (with a HEPA filter). Cleanup crew should protect against exposure.

Consult MSDS 0718 for more information

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1171 RiverFront Center
Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2000-07

Vinylidene Chloride
MSDS 708
DIC4450

Section 1 - Chemical Product and Company Identification 54.1

Material Name: Vinylidene Chloride **CAS Number:** 75-35-4
Chemical Formula: $C_2H_2Cl_2$
Structural Chemical Formula: $H_2C{=}CCl_2$
Synonyms: 1,1-DICHLOROETHYLENE; ASYM-DICHLOROETHYLENE; CHLORURE DE VINYLIDENE; 1,1-DCE; 1,1-DICHLOROETHENE; 1,1-DICHLOROETHENE (9CI); AS-DICHLOROETHYLENE; ETHENE,1,1-DICHLORO-; ETHYLENE,1,1-DICHLORO-; SCONATEX; VDC; VINYLIDENE CHLORIDE; VINYLIDENE CHLORIDE (II); VINYLIDENE CHLORIDE (INHIBITED); VINYLIDENE CHLORIDE MONOMER; VINYLIDENE CHLORIDE(II); VINYLIDENE CHLORIDE,INHIBITED; VINYLIDENE CHLORIDE,MONOMER; VINYLIDENE DICHLORIDE; VINYLIDINE CHLORIDE
General Use: Reactive monomer in manufacture of vinylidene polymer plastics and copolymers.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
vinylidene chloride	75-35-4	>98

OSHA PEL
No data found.

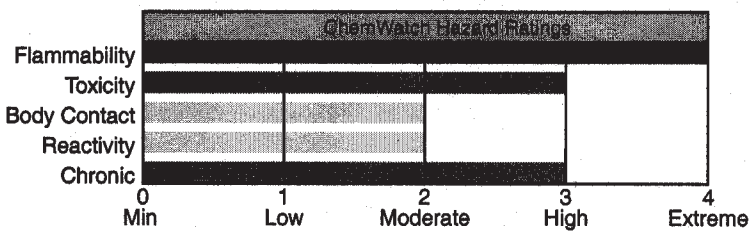
NIOSH REL
No data found.

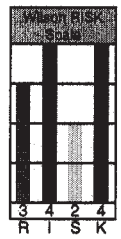
DFG (Germany) MAK
TWA: 2 ppm; 8 mg/m^3.

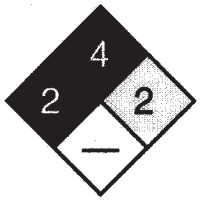
OSHA PEL Vacated 1989 Limits
TWA: 1 ppm; 4 mg/m^3.

ACGIH TLV
TWA: 5 ppm; 20 mg/m^3; STEL: 20 ppm; 79 mg/m^3.

Section 3 - Hazards Identification







Fire Diamond

ANSI Signal Word
Danger!

Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless liquid; sweet odor. Irritating. Also causes: narcosis, drunkenness, unconsciousness, conjunctivitis, transient corneal injury, iritis. Chronic: hepatic/renal dysfunction. Flammable. Combustion by-products include phosgene and hydrogen chloride.

Potential Health Effects

Primary Entry Routes: inhalation
Target Organs: skin, eyes, central nervous system (CNS), liver, kidneys
Acute Effects
Inhalation: Depression of the central nervous system is the most outstanding effect of most halogenated aliphatic hydrocarbons. Inebriation and excitation, passing into narcosis, is a typical reaction. In severe acute exposures there is always a danger of death from respiratory failure or cardiac arrest due to a tendency to make the heart more susceptible to catecholamines (adrenalin).

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Vapor concentrations of 400 ppm are said to induce symptoms of drunkenness leading to unconsciousness.
Extensive hemorrhagic centrolobular liver necrosis was seen in rats 6 hours after a 4-hour exposure to 200 ppm.

Eye: The liquid is highly discomforting to the eyes and is capable of causing pain and severe conjunctivitis.
Corneal injury may develop, with possible permanent impairment of vision, if not promptly and adequately treated.
The vapor when concentrated has pronounced eye irritation; this gives some warning of high vapor concentrations. If eye irritation occurs seek to reduce exposure with available control measures, or evacuate area.

Skin: The liquid may produce skin discomfort following prolonged contact.
Defatting and/or drying of the skin may lead to dermatitis.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.
The liquid is highly discomforting to the gastrointestinal tract and toxic if swallowed.
Ingestion may result in nausea, pain, vomiting. Vomit entering the lungs by aspiration may cause potentially lethal chemical pneumonitis.
A single oral dose of 500 mg/kg elicited extensive liver enzyme changes.
Acute intoxication by halogenated aliphatic hydrocarbons appears to take place over two stages. Signs of a reversible narcosis are evident in the first stage and in the second stage signs of injury to organs may become evident, a single organ alone is (almost) never involved.

Carcinogenicity: NTP - Not listed; IARC - Group 3, Not classifiable as to carcinogenicity to humans; OSHA - Not listed; NIOSH - Listed as carcinogen; ACGIH - Class A3, Animal carcinogen; EPA - Class C, Possible human carcinogen; MAK - Class B, Justifiably suspected of having carcinogenic potential.

Chronic Effects: The material may accumulate in the human body and progressively cause tissue damage.
Chronic solvent inhalation exposures may result in nervous system impairment and liver and blood changes.
Vinylidene chloride is toxic to the liver and kidneys. After exposure to 48 ppm continuously for 90 days, liver damage was evident in rats and deaths occurred among monkeys and guinea pigs. In this study only rats showed evidence of renal (kidney) tubular injury.
It is proposed that vinylidene chloride may undergo microsomal oxidation to produce oxiranes. These are highly reactive and covalently bind to nucleic acids producing mutations and possibly cancers. The monohalogenated alkenes are thought be more carcinogenic than their dihalogenated counterparts.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.
Lay patient down. Keep warm and rested.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.
Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.
Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).
Wash affected areas thoroughly with water (and soap if available).
Seek medical attention in event of irritation.

Ingestion: Contact a Poison Control Center.
Do NOT induce vomiting. Give a glass of water.
Avoid giving milk or oils.
Avoid giving alcohol.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Treatment that is employed in carbon tetrachloride exposures follows:
1.Acute exposures to carbon tetrachloride present, initially, with CNS depression followed by hepatic and renal disfunction.
2.Respiratory depression and cardiac dysrhythmias are an immediate threat to life.
3.Since a major fraction of absorbed carbon tetrachloride is exhaled in first hour, good tidal volumes should be maintained in severely poisoned patients; hyperventilation may be an additional therapeutic modality.
4.Ipecac syrup, lavage, activated charcoal or catharsis may all be used in the first 4 hours.
5.Since reactive metabolites may cause hepatorenal toxicity, administration of N-acetyl-L-cysteine may reduce complications.
Experience with this therapy is limited.

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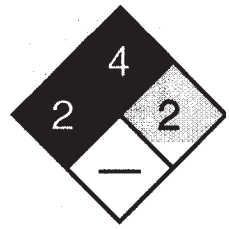
Section 5 - Fire-Fighting Measures

Flash Point: -16.111 °C Open Cup
Autoignition Temperature: 570 °C
LEL: 7.3% v/v
UEL: 16% v/v
Extinguishing Media: Foam, dry chemical powder, BCF (where regulations permit), carbon dioxide.
Water spray or fog - Large fires only.



Fire Diamond

General Fire Hazards/Hazardous Combustion Products: Liquid and vapor are highly flammable.
Severe fire hazard when exposed to heat, flame and/or oxidizers.
Vapor forms an explosive mixture with air.
Severe explosion hazard, in the form of vapor, when exposed to flame or spark. Vapor may travel a considerable distance to source of ignition.
Heating may cause expansion/decomposition with violent rupture of containers.
On combustion, may emit toxic fumes of carbon monoxide (CO). Other combustion products include hydrogen chloride and phosgene.

Fire Incompatibility: Avoid any contamination of this material as it is very reactive and any contamination is potentially hazardous. Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may result.
Polymerization may occur at elevated temperatures.
Polymerization may be accompanied by generation of heat as exotherm.
Process is self accelerating as heating causes more rapid polymerization.
Exotherm may cause boiling with generation of acrid, toxic and flammable vapor.
Polymerization and exotherm may be violent if contamination with strong acids, amines or catalysts occurs.
Polymerization and exotherm of material in bulk may be uncontrollable and result in rupture of storage tanks.
Polymerization may occur if stabilizing inhibitor becomes depleted by aging.
Stabilizing inhibitor requires dissolved oxygen to be present in liquid for effective action.
Specific storage requirements must be met for stability on ageing and transport.

Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
Fight fire from a safe distance, with adequate cover.
If safe, switch off electrical equipment until vapor fire hazard removed.
Use water delivered as a fine spray to control the fire and cool adjacent area. Avoid spraying water onto liquid pools.
Do not approach containers suspected to be hot.
Cool fire-exposed containers with water spray from a protective location.
If safe to do so, remove containers from path of fire.

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.
Avoid breathing vapors and contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb small quantities with vermiculite or other absorbent material. Wipe up. Collect residues in a flammable waste container.

Large Spills: Clear area of personnel and move upwind.
Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
No smoking, bare lights or ignition sources. Increase ventilation.
Stop leak if safe to do so. Water spray or fog may be used to disperse/absorb vapor. Contain spill with sand, earth or vermiculite.
Use only spark-free shovels and explosion proof equipment.
Collect recoverable product into labeled containers for recycling.
Absorb remaining product with sand, earth or vermiculite.
Collect solid residues and seal in labeled drums for disposal.
Wash area and prevent runoff into drains.
If contamination of drains or waterways occurs, advise emergency services.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

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Section 7 - Handling and Storage

Handling Precautions: Material contains a stabilizer / polymerization inhibitor system that provides workable but not indefinite shelf life.
Storage at higher temperatures and long term storage may result in polymerization with solidification. In larger quantities e.g. 200 l drums this may result in generation of heat (exotherm); which may release highly irritating hot vapor. Do not open hot exotherming drums - cool externally with water to avoid vapor release.
Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
Avoid smoking, bare lights, heat or ignition sources.
When handling, DO NOT eat, drink or smoke.
Vapor may ignite on pumping or pouring due to static electricity.
DO NOT use plastic buckets. Ground and secure metal containers when dispensing or pouring product. Use spark-free tools when handling.
Avoid contact with incompatible materials.
Keep containers securely sealed. Avoid physical damage to containers.
Always wash hands with soap and water after handling.
Work clothes should be laundered separately.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.
Recommended Storage Methods: Metal can; metal drum. Packing as recommended by manufacturer.
Check all containers are clearly labeled and free from leaks.
DO NOT use aluminum or galvanized containers.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use in a well-ventilated area. Local exhaust ventilation usually required.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection. NIOSH-approved self contained breathing apparatus (SCBA) may be required in some situations.
Provide adequate ventilation in warehouse or closed storage area.
Personal Protective Clothing/Equipment
Eyes: Safety glasses with side shields; or as required, chemical goggles.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.
Hands/Feet: Barrier cream and Butyl rubber gloves or Nitrile rubber gloves.
Safety footwear.
Respiratory Protection:
Exposure Range >5 to 250 ppm: Supplied Air, Constant Flow/Pressure Demand, Half Mask
Exposure Range >250 to 5000 ppm: Supplied Air, Constant Flow/Pressure Demand, Full Face
Exposure Range >5000 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Note: poor warning properties
Other: Overalls. Eyewash unit.
Glove Selection Index:
PVA .....A
VITON.....C

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Colorless highly flammable liquid with pleasant chloroform-like odor. Soluble in organic solvents. Presence of a stabilizing inhibitor prevents / retards peroxide formation.

Physical State: Liquid
Vapor Density (Air=1): >1
Formula Weight: 96.94
Specific Gravity (H_2O=1, at 4 °C): 1.2129
Water Solubility: 0.04% by weight
Evaporation Rate: Fast

pH: Not applicable
pH (1% Solution): Not applicable
Boiling Point Range: 31.7 °C (89 °F) at 760 mm Hg
Freezing/Melting Point Range: -122.5 °C (-188.5 °F)

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Section 10 - Stability and Reactivity

Stability/Polymerization: May form explosive peroxides on standing or following concentration by distillation. Review of stocks and testing for peroxide content by given tested procedures at 3-monthly intervals is recommended, together with safe disposal of peroxidic samples.
Peroxide containing residues can often be rendered innocuous by pouring into an excess of sodium carbonate solution.
Presence of a stabilizing inhibitor prevents/retards peroxide formation.
Stable under controlled storage conditions provided material contains adequate stabilizer/polymerization inhibitor.
Bulk storages may have special storage requirements.
In absence of inhibitor and in the presence of air, vinylidene chloride rapidly absorbs oxygen with formation of a violently explosive peroxide.
Peroxides initiate vinylidene chloride polymerization, producing insoluble polymer which absorbs peroxide. This results in separated polymer with concentrate of peroxide. In the dry state and 15% or more peroxide present this is readily detonated by heat or shock.
Hindered phenols are suitable inhibitors to prevent peroxidation.

Storage Incompatibilities: WARNING: Long standing in contact with air and light may result in the formation of potentially explosive peroxides.
Avoid any contamination of this material as it is very reactive and any contamination is potentially hazardous.
Explosion hazard may follow contact with incompatible materials.
Contamination with polymerization catalysts - peroxides, persulfates, oxidizing agents - also strong acids, strong alkalies, will cause polymerization with exotherm - generation of heat. Polymerization of large quantities may be violent - even explosive.
Light or water tend to promote self-polymerization.
Haloalkenes are highly reactive. Some of the more lightly substituted lower members are highly flammable; many members of the group are peroxidizable and polymerizable.
When stored at between -40 and 25 C in the absence of an inhibitor and in the presence of air, vinylidene chloride rapidly absorbs oxygen with the formation of a violently explosive peroxide. This peroxide initiates polymerization to produce an insoluble polymer which adsorbs the peroxide. Separation of the polymer in the dry state must be avoided since if more than 15% of the peroxide is present, the polymer may be detonatable by slight shock or friction.
Hindered phenols have been used to prevent peroxidation. Reaction products with ozone are particularly dangerous.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (rat) LD_{50}: 200 mg/kg
Inhalation (human) TC_{Lo}: 25 ppm
Inhalation (rat) LC_{50}: 6350 ppm/4h

IRRITATION
Nil reported

See NIOSH, *RTECS* KV 9275000, for additional data.

Section 12 - Ecological Information

Environmental Fate: Once in the atmosphere it will degrade rapidly by photooxidation with a half-life of 11 hours in relatively clean air or under 2 hours in polluted air. If spilled on land, part will evaporate and part will leach into the groundwater where its fate is unknown, but degradation is expected to be slow based upon microcosm studies. It would not be expected to bioconcentrate into fish.

Ecotoxicity: LC_{50} Cyprinodon variegatus (sheepshead minnow) 249 mg/l/24 hr, 48 hr, 72 hr, 96 hr in a static bioassay using sea water; EC_{50} Skeletonema costatum (alga) > 712,000 ug/l/96 hr, Toxic effects: Inhibition chlorophyll synthesis; reduced cell counts. /Conditions of bioassay not specified; LC_{50} Lepomis macrochirus (bluegill) 74 mg/l at 24 hr & 96 hr, temp at 21-23 °C, water hardness 32-48 mg/l (calcium carbonate), pH 6.7-7.8, dissolved oxygen concentration 7.0-8.8 mg/l (static bioassay); LC_{50} Mysidopsis bahia (mysid shrimp) > 798 mg/l/24 hr, 48 hr, 72 hr; 224 mg/l/96 hr in a static bioassay using seawater; LC_{50} Menidia beryllina (inland silverside) 250 ppm/96 hr in a static bioassay in synthetic seawater at 23 °C with mild aeration

Henry's Law Constant: 2.61×10^{-2}

BCF: not significant

Octanol/Water Partition Coefficient: log K_{OW} = 1.48

Soil Sorption Partition Coefficient: K_{OC} = estimated at 150

Section 13 - Disposal Considerations

Disposal: Consult manufacturer for recycling options and recycle where possible.
Follow applicable federal, state, and local regulations.
Incinerate residue at an approved site.

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Recycle containers where possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: VINYLIDENE CHLORIDE, INHIBITED

Additional Shipping Information:

Hazard Class: 3.1

ID No.: 1303

Packing Group: I

Label: Flammable Liquid[3]

Section 15 - Regulatory Information

EPA Regulations:

RCRA 40 CFR: Listed U078 Toxic Waste

CERCLA 40 CFR 302.4: Listed per CWA Section 311(b)(4); per RCRA Section 3001; per CWA Section 307(a) 100 lb (45.35 kg)

SARA 40 CFR 372.65: Listed

SARA EHS 40 CFR 355: Not listed

TSCA: Listed

Section 16 - Other Information

Research Date: .....1999-11 **Review Date:** 2000-07

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CAS # 75-35-4

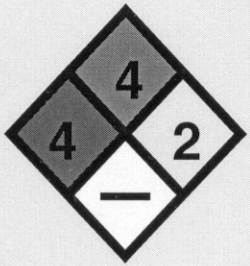
Danger! 1 3

Flammable

Vinylidene Chloride

1,1-DCE; 1,1-dichloroethene; asym-dichloroethylene; VDC; vinylidene dichloride

Colorless liquid; sweet odor. Irritating. Also Causes: narcosis, drunkenness, unconsciousness, conjunctivitis, transient corneal injury, iritis. Chronic: hepatic/renal dysfunction. Flammable. Combustion by-products include phosgene and hydrogen chloride.



Target Organs

3 9 10

Eyes

Skin

Respiratory System

Nervous System

Liver

Kidneys

Personal Protective Equipment

8

Goggles

Gloves

Apron

Check to see is respirator required?

Emergency Procedures

First Aid

4

Inhalation: Remove to fresh air and support breathing as needed. Eyes/Skin: Flush with flooding amounts of water for at least 15 minutes. This should prevent any adverse reaction. Ingestion: Consult physician before inducing vomiting.

Fire

5

Flammable. Can form explosive mixtures in the air. Combustion by-products include hydrogen chloride and phosgene. Use dry chemical, alcohol foam, or carbon dioxide. Use water to cool fire-exposed containers.

Spills & Leaks

6

Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Take up with inert material such as sand or vermiculite. Cleanup crew should protect against exposure.

Consult MSDS 0708 for more information

ATTACHMENT D-A-7
DECONTAMINATION PROCEDURES AND EQUIPMENT

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Attachment D-A-7

Decontamination Procedures and Equipment Directory

Included in HASP	*Level of Protection*
☒	Modified Level D
☐	Level C
☐	Level B

Decontamination Procedures and Equipment
– Modified Level D –

Applies to Task: ☒ ① ☒ ② ☒ ③ ☒ ④ ☒ ⑤ ☒ ⑥ ☒ ⑦

Decontamination Solution*:* Alconox

Procedure		***Equipment Needed***
Station 1	Deposit disposable equipment in plastic trash bags	Plastic trash bag
Station 2	Scrub equipment with decontamination solution	Containers (5 gal), decontamination solution, long-handled scrub brushes
Station 3	Rinse off decontamination solution from Station 2 using copious amounts of water	Containers (5 gal), water, long-handled scrub brushes
Station 4	Remove gloves and deposit in plastic trash bag	Plastic trash bags

REFERENCE D-A-1
OSHA AND NIOSH CHEMICALS REQUIRING AIR MONITORING AND MEDICAL SURVELLIENCE

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Reference D-A-1

OSHA and NIOSH Chemicals
Requiring Air Monitoring and Medical Surveillance

OSHA Regulated Chemical	*Regulatory Citation*	*Requires Air Monitoring*	*Requires Medical Surveillance*
2-Acetylaminoazobenzene	29 CFR 1910.1014		✓
Acrylonitrile (AN)	29 CFR 1910.1045	✓	✓
4-Aminodiphenyl	29 CFR 1910.1011		✓
Arsenic	29 CFR 1910.1018	✓	✓
Asbestos	29 CFR 1910.1001	✓	✓
Benzene	29 CFR 1910.1028	✓	✓
Benzidine	29 CFR 1910.1010		✓
Bloodborne Pathogens	29 CFR 1910.1030		✓
Cadmium	29 CFR 1910.1027	✓	✓
Bis-Chloroethyl ether	29 CFR 1910.1008		✓
Coke Oven Emission	29 CFR 1910.1029	✓	✓
Cotton Dust	29 CFR 1910.1043	✓	✓
1,2-Dibromo-3-chloropropane (DBCP)	29 CFR 1910.1044	✓	✓
3,3-Dichlorobenzidine	29 CFR 1910.1007		✓
4-Dimethylaminoazobenzene	29 CFR 1910.1015		✓
Ethylene oxide	29 CFR 1910.1047	✓	✓
Ethyleneimine	29 CFR 1910.1012		✓
Formaldehyde	29 CFR 1910.1048	✓	✓
Lead	29 CFR 1910.1025	✓	✓
Methyl chloromethyl ether	29 CFR 1910.1006		✓
Methylenedianline	29 CFR 1910.1050	✓	✓
Alpha-Naphthylamine	29 CFR 1910.1004		✓
Betha-Naphthylamine	29 CFR 1910.1009		✓
4-Nitrobiphenyl	29 CFR 1910.1003		✓

Reference D-A-1

OSHA and NIOSH Chemicals
Requiring Air Monitoring and Medical Surveillance
(continued)

OSHA Regulated Chemical	*Regulatory Citation*	*Requires Air Monitoring*	*Requires Medical Surveillance*
N-Nitrosodimethylamine	29 CFR 1910.1016		✓
Beta-Propiolactone	29 CFR 1910.1013		✓
Vinyl chloride	29 CFR 1910.1017	✓	✓

NIOSH Recommended Chemical	*Recommended Citation*	*Requires Air Monitoring*	*Requires Medical Surveillance*
Mercury	NIOSH 73-11024	NA	✓
Methyl Parathion	NIOSH 77-106	NA	✓
Polychlorinated biphenyls (PCBs)	NIOSH 77-225	NA	✓

REFERENCE D-A-2
NATIONAL PRIMARY DRINKING WATER REGULATIONS

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Reference D-A-2

National Primary Drinking Water Regulations

Contaminants	*MCLG[1] (mg/L)[4]*	*MCL[2] or TT[3] (mg/L)[4]*	*Potential Health Effects from Ingestion of Water*	*Sources of Contaminant in Drinking Water*
Inorganic Chemicals				
Antimony	0.006	0.006	Increase in blood cholesterol; decrease in blood glucose	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder
Arsenic	None[5]	0.05	Skin damage; circulatory system problems; increased risk of cancer	Discharge from semiconductor manufacturing; petroleum refining; wood preservatives; animal feed additives; herbicides; erosion of natural deposits
Asbestos (fiber 10 micrometers)	7 million fibers per Liter	7 MFL	Increased risk of developing benign intestinal polyps	Decay of asbestos cement in water mains; erosion of natural deposits
Barium	2	2	Increase in blood pressure	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits
Beryllium	0.004	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries
Cadmium	0.005	0.005	Kidney damage	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints

Chromium (total)	0.1	0.1	Some people who use water containing chromium well in excess of the MCL over many years could experience allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits

National Primary Drinking Water Regulations
(continued)

Contaminants	*MCLG[1] (mg/L)[4]*	*MCL[2] or TT[3] (mg/L)[4]*	*Potential Health Effects from Ingestion of Water*	*Sources of Contaminant in Drinking Water*
Inorganic Chemicals ***(continued)***				
Copper	1.3	Action Level=1.3; TT[6]	Short term exposure: Gastrointestinal distress. Long term exposure: Liver or kidney damage. Those with Wilson's Disease should consult their personal doctor if their water systems exceed the copper action level.	Corrosion of household plumbing systems; erosion of natural deposits; leaching from wood preservatives
Cyanide (as free cyanide)	0.2	0.2	Nerve damage or thyroid problems	Discharge from steel/metal factories; discharge from plastic and fertilizer factories
Fluoride	4.0	4.0	Bone disease (pain and tenderness of the bones); Children may get mottled teeth.	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories
Lead	zero	Action Level=0.015; TT[6]	Infants and children: Delays in physical or mental development. Adults: Kidney problems; high blood pressure	Corrosion of household plumbing systems; erosion of natural deposits
Inorganic Mercury	0.002	0.002	Kidney damage	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and cropland
Nitrate (measured as Nitrogen)	10	10	"Blue baby syndrome" in infants under six months - life threatening without immediate medical attention. Symptoms: Infant looks blue and has shortness of breath.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits
Selenium	0.05	0.05	Hair or fingernail loss; numbness in fingers or toes; circulatory problems	Discharge from petroleum refineries; erosion of natural deposits; discharge from mines

National Primary Drinking Water Regulations
(continued)

Contaminants	*MCLG*[1] *(mg/L)*[4]	*MCL*[2] *or TT*[3] *(mg/L)*[4]	*Potential Health Effects from Ingestion of Water*	*Sources of Contaminant in Drinking Water*
Inorganic Chemicals ***(continued)***				
Thallium	0.0005	0.002	Hair loss; changes in blood; kidney, intestine, or liver problems	Leaching from ore-processing sites; discharge from electronics, glass, and pharmaceutical companies
Organic Chemicals				
Acrylamide	zero	TT[7]	Nervous system or blood problems; increased risk of cancer	Added to water during sewage/wastewater treatment
Alachlor	zero	0.002	Eye, liver, kidney or spleen problems; anemia; increased risk of cancer	Runoff from herbicide used on row crops
Atrazine	0.003	0.003	Cardiovascular system problems; reproductive difficulties	Runoff from herbicide used on row crops
Benzene	zero	0.005	Anemia; decrease in blood platelets; increased risk of cancer	Discharge from factories; leaching from gas storage tanks and landfills
Benzo(a)pyrene	zero	0.0002	Reproductive difficulties; increased risk of cancer	Leaching from linings of water storage tanks and distribution lines
Carbofuran	0.04	0.04	Problems with blood or nervous system; reproductive difficulties.	Leaching of soil fumigant used on rice and alfalfa
Carbon tetrachloride	zero	.005	Liver problems; increased risk of cancer	Discharge from chemical plants and other industrial activities
Chlordane	zero	0.002	Liver or nervous system problems; increased risk of cancer	Residue of banned termiticide
Chlorobenzene	0.1	0.1	Liver or kidney problems	Discharger from chemical and agricultural chemical factories

National Primary Drinking Water Regulations
(continued)

Contaminants	*MCLG*[1] *(mg/L)*[4]	*MCL*[2] *or TT*[3] *(mg/L)*[4]	*Potential Health Effects from Ingestion of Water*	*Sources of Contaminant in Drinking Water*
Organic Chemicals ***(continued)***				
2,4-D	0.07	0.07	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops
Dalapon	0.2	0.2	Minor kidney changes	Runoff from herbicide used on rights of way
1,2-Dibromo-3-chloropropane (DBCP)	zero	0.0002	Reproductive difficulties; increased risk of cancer	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards
o-Dichlorobenzene	0.6	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories
p-Dichlorobenzene	0.075	0.075	Anemia; liver, kidney or spleen damage; changes in blood	Discharge from industrial chemical factories
1,2-Dichloroethane	zero	0.005	Increased risk of cancer	Discharge from industrial chemical factories
1-1-Dichloroethylene	0.007	0.007	Liver problems	Discharge from industrial chemical factories
cis-1,2-Dichloroethylene	0.07	0.07	Liver problems	Discharge from industrial chemical factories
trans-1,2-Dichloroethylene	0.1	0.1	Liver problems	Discharge from industrial chemical factories
Dichloromethane	zero	0.005	Liver problems; increased risk of cancer	Discharge from pharmaceutical and chemical factories
1-2-Dichloropropane	zero	0.005	Increased risk of cancer	Discharge from industrial chemical factories
Di(2-ethylhexyl)adipate	0.4	0.4	General toxic effects or reproductive difficulties	Leaching from PVC plumbing systems; discharge from chemical factories
Di(2-ethylhexyl) phthalate	zero	0.006	Reproductive difficulties; liver problems; increased risk of cancer	Discharge from rubber and chemical factories

National Primary Drinking Water Regulations
(continued)

Contaminants	*MCLG*[1] *(mg/L)*[4]	*MCL*[2] *or TT*[3] *(mg/L)*[4]	*Potential Health Effects from Ingestion of Water*	*Sources of Contaminant in Drinking Water*
Organic Chemicals ***(continued)***				
Dinoseb	0.007	0.007	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables
Dioxin (2,3,7,8-TCDD)	zero	0.00000003	Reproductive difficulties; increased risk of cancer	Emissions from waste incineration and other combustion; discharge from chemical factories
Diquat	0.02	0.02	Cataracts	Runoff from herbicide use
Endothall	0.1	0.1	Stomach and intestinal problems	Runoff from herbicide use
Endrin	0.002	0.002	Nervous system effects	Residue of banned insecticide
Epichlorohydrin	zero	TT[7]	Stomach problems; reproductive difficulties; increased risk of cancer	Discharge from industrial chemical factories; added to water during treatment process
Ethylbenzene	0.7	0.7	Liver or kidney problems	Discharge from petroleum refineries
Ethelyne dibromide	zero	0.00005	Stomach problems; reproductive difficulties; increased risk of cancer	Discharge from petroleum refineries
Glyphosate	0.7	0.7	Kidney problems; reproductive difficulties	Runoff from herbicide use
Heptachlor	zero	0.0004	Liver damage; increased risk of cancer	Residue of banned termiticide
Heptachlor epoxide	zero	0.0002	Liver damage; increased risk of cancer	Breakdown of hepatachlor
Hexachlorobenzene	zero	0.001	Liver or kidney problems; reproductive difficulties; increased risk of cancer	Discharge from metal refineries and agricultural chemical factories
Hexachlorocyclopenta-diene	0.05	0.05	Kidney or stomach problems	Discharge from chemical factories

National Primary Drinking Water Regulations
(continued)

Contaminants	*MCLG*[1] *(mg/L)*[4]	*MCL*[2] *or TT*[3] *(mg/L)*[4]	*Potential Health Effects from Ingestion of Water*	*Sources of Contaminant in Drinking Water*
Organic Chemicals ***(continued)***				
Lindane	0.0002	0.0002	Liver or kidney problems	Runoff/leaching from insecticide used on cattle, lumber, gardens
Methoxychlor	0.04	0.04	Reproductive difficulties	Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, livestock
Oxamyl (Vydate)	0.2	0.2	Slight nervous system effects	Runoff/leaching from insecticide used on apples, potatoes, and tomatoes
Polychlorinated biphenyls (PCBs)	zero	0.0005	Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer	Runoff from landfills; discharge of waste chemicals
Pentachlorophenol	zero	0.001	Liver or kidney problems; increased risk of cancer	Discharge from wood preserving factories
Picloram	0.5	0.5	Liver problems	Herbicide runoff
Simazine	0.004	0.004	Problems with blood	Herbicide runoff
Styrene	0.1	0.1	Liver, kidney, and circulatory problems	Discharge from rubber and plastic factories; leaching from landfills
Tetrachloroethylene	zero	0.005	Liver problems; increased risk of cancer	Discharge from factories and dry cleaners
Toluene	1	1	Nervous system, kidney, or liver problems	Discharge from petroleum factories
Total Trihalomethanes (TTHMs)	None[5]	0.10	Liver, kidney or central nervous system problems; increased risk of cancer	Byproduct of drinking water disinfection
Toxaphene	Zero	0.003	Kidney, liver, or thyroid problems; increased risk of cancer	Runoff/leaching from insecticide used on cotton and cattle

National Primary Drinking Water Regulations
(continued)

Contaminants	*MCLG*[1] *(mg/L)*[4]	*MCL*[2] *or TT*[3] *(mg/L)*[4]	*Potential Health Effects from Ingestion of Water*	*Sources of Contaminant in Drinking Water*
Organic Chemicals ***(continued)***				
2,4,5-TP (Silvex)	0.05	0.05	Liver problems	Residue of banned herbicide
1,2,4-Trichlorobenzene	0.07	0.07	Changes in adrenal glands	Discharge from textile finishing factories
1,1,1-Trichloroethane	0.20	0.2	Liver, nervous system, or circulatory problems	Discharge from metal degreasing sites and other factories
1,1,2-Trichloroethane	0.003	0.005	Liver, kidney, or immune system problems	Discharge from industrial chemical factories
Trichloroethylene	Zero	0.005	Liver problems; increased risk of cancer	Discharge from petroleum refineries
Vinyl chloride	Zero	0.002	Increased risk of cancer	Leaching from PVC pipes; discharge from plastic factories
Xylenes (total)	10	10	Nervous system damage	Discharge from petroleum factories; discharge from chemical factories
Radionuclides				
Beta particles and photon emitters	None[5]	4 millirems per year	Increased risk of cancer	Decay of natural and man-made deposits
Gross alpha particle activity	none[5]	15 picocuries per Liter (pCi/L)	Increased risk of cancer	Erosion of natural deposits
Radium 226 and Radium 228 (combined)	none[5]	5 pCi/L	Increased risk of cancer	Erosion of natural deposits
Microorganisms				
Giardia lamblia	zero	TT[8]	Giardiasis, a gastroenteric disease	Human and animal fecal waste

National Primary Drinking Water Regulations
(continued)

Contaminants	***MCLG[1] (mg/L)[4]***	***MCL[2] or TT[3] (mg/L)[4]***	***Potential Health Effects from Ingestion of Water***	***Sources of Contaminant in Drinking Water***
Microorganisms ***(continued)***				
Heterotrophic plate count	N/A	TT[8]	HPC has no health effects, but can indicate how effective treatment is at controlling microorganisms.	N/A
Legionella	zero	TT[8]	Legionnaire's Disease, commonly known as pneumonia	Found naturally in water; multiplies in heating systems
Total Coliforms (including fecal coliform and *E. Coli*)	zero	5.0%[9]	Used as an indicator that other potentially harmful bacteria may be present[10]	Human and animal fecal waste
Turbidity	N/A	TT[8]	Turbidity has no health effects but can interfere with disinfection and provide a medium for microbial growth. It may indicate the presence of microbes.	Soil runoff
Viruses (enteric)	zero	TT[8]	Gastroenteric disease	Human and animal fecal waste

Table 1

National Secondary Drinking Water Regulations

National Secondary Drinking Water Regulations (NSDWRs or secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, states may choose to adopt them as enforceable standards. See Table 2.

Contaminant	*Secondary Standard*
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	noncorrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
PH	6.5-8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

Table 2

Notes

[1] Maximum Contaminant Level Goal (MCLG) - The maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health effect of persons would occur, and which allows for an adequate margin of safety. MCLGs are non-enforceable public health goals.

[2] Maximum Contaminant Level (MCL) - The maximum permissible level of a contaminant in water which is delivered to any user of a public water system. MCLs are enforceable standards. The margins of safety in MCLGs ensure that exceeding the MCL slightly does not pose significant risk to public health.

[3] Treatment Technique - An enforceable procedure or level of technical performance which public water systems must follow to ensure control of a contaminant.

[4] Units are in milligrams per Liter (mg/L) unless otherwise noted.

[5] MCLGs were not established before the 1986 Amendments to the Safe Drinking Water Act. Therefore, there is no MCLG for this contaminant.

[6] Lead and copper are regulated in a Treatment Technique which requires systems to take tap water samples at sites with lead pipes or copper pipes that have lead solder and/or are served by lead service lines. The action level, which triggers water systems into taking treatment steps if exceeded in more than 10% of tap water samples, for copper is 1.3 mg/L, and for lead is 0.015 mg/L.

[7] Each water system must certify, in writing, to the state (using third-party or manufacturer's certification) that when acrylamide and epichlorohydrin are used in drinking water systems, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows:

- **Acrylamide** = 0.05% dosed at 1 mg/L (or equivalent)
- **Epichlorohydrin** = 0.01% dosed at 20 mg/L (or equivalent)

[8] The Surface Water Treatment Rule requires systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

- ***Giardia lamblia****:* 99.9% killed/inactivated
  Viruses: 99.99% killed/inactivated

- ***Legionella****:* No limit, but EPA believes that if *Giardia* and viruses are inactivated, *Legionella* will also be controlled.

- **Turbidity**: At no time can turbidity (cloudiness of water) go above 5 nephelolometric turbidity units (NTU); systems that filter must ensure that the turbidity go no higher than 1 NTU (0.5 NTU for conventional or direct filtration) in at least 95% of the daily samples in any month.

- **HPC**: NO more than 500 bacterial colonies per milliliter.

[9] No more than 5.0% samples total coliform-positive in a month. (For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive). Every sample that has total coliforms must be analyzed for fecal coliforms. There cannot be any fecal coliforms.

[10] Fecal coliform and *E. coli* are bacteria whose presence indicates that the water may be contaminated with human animal wastes. Microbes in these wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms.

APPENDIX E
INVESTIGATION DERIVED WASTE PLAN

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APPENDIX E
Final Investigation-Derived Waste Plan

INSTALLATION RESTORATION SITE 70
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

March 2008

Department of the Navy
Naval Facilities Engineering Command Southwest
San Diego, CA 92132

Environmental Multiple Award Contract
Contract Number N68711-04-D-1106, CTO 003
Document Control Number ECC-1106-0003-0002

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APPENDIX E

Final Investigation Derived Waste Plan

INSTALLATION RESTORATION PROGRAM SITE 70
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

March 2008

Prepared for:

Department of the Navy
Naval Facilities Engineering Command Southwest
San Diego, CA 92132

Prepared by:

ECC
1240 Bayshore Highway
Burlingame, CA 94010

In association with:

2100 Main Street, Suite 150
Huntington Beach, CA 92648

Prepared under:
Environmental Multiple Award Contract
Contract Number N68711-04-D-1106, CTO 003
Document Control Number ECC-1106-0003-0002

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ACRONYMS AND ABBREVIATIONS

Cal EPA	California Environmental Protection Agency
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DHS	Department of Health Services
DON	Department of the Navy
DOT	Department of Transportation
EVO	emulsified vegetable oil
gal	gallon
HASP	Health and Safety Plan
IR	Installation Restoration
KB-1™	mixed consortia of dehalorespiring bacteria
LDR	Land Disposal Restriction
NAVWPNSTA	Naval Weapons Station
PPE	personal protective equipment
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
ROICC	Resident Office on Charge of Construction
RWQCB	Regional Water Quality Control Board
SHSO	Site Health and Safety Officer
TCLP	Toxicity Characteristic Leaching Procedure
TSDF	treatment, storage, and disposal facility
U.S. EPA	United States Environmental Protection Agency
WET	Waste Extraction Test

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1. WASTE MANAGEMENT

1.1 WASTE CHARACTERIZATION

State and federal regulations require waste generators to determine if a waste is hazardous. Soil cuttings and development water generated during drilling operations at Installation Restoration (IR) Site 70 may potentially be classified as hazardous or California non-Resource Conservation and Recovery Act (RCRA) hazardous waste.

Waste generated during the field operations will be representatively sampled and analyzed to determine the hazard classification prior to transport off site. Analytical testing will be conducted at a Department of Health Services (DHS)-certified and Naval Facilities Engineering Service Center-evaluated analytical laboratory. The waste profiling (waste classification determination) will be based on the results of the soil sample analyses. Analytical methods used for waste classification may include total metals, Toxicity Characteristic Leaching Procedure (TCLP), and Waste Extraction Test (WET).

1.2 WASTE STREAMS

There are several waste streams that may result from the well installation and associated remediation activities. A description of potential waste streams is presented below:

- Waste soil cuttings and drilling mud from monitoring well and injection well installation;
- Decontamination wastewater from drilling, well development, and groundwater sampling equipment cleaning, purge water and development water from groundwater monitoring wells;
- Used disposable sampling equipment and personal protective equipment (PPE);
- Liquids and solids, including well material debris generated during well installation;
- Residual Emulsified Vegetable Oil (EVO) from totes and decontamination of injection equipment, decontamination water from a mixed consortia of dehalorespiring bacteria (KB-1$^{TM)}$, and any spills from these items; and
- Inert or non-hazardous solid waste (refuse).

1.2.1 Decontamination Wastewater/Purge and Development Water

Additional wastewater will be generated from development and purging of injection and monitoring wells. Wastewater will be generated from equipment and personnel decontamination. Liquid waste will be placed in temporary storage containers [Baker tanks or Department of Transportation (DOT) 17H 55-gallon (gal) drums] on site until their disposal. Upon completion of field activities, the wastewater will be sampled to determine if it is a hazardous waste. If drums are used, the drums of decontamination water will be labeled with respect to contents and will be staged in a predetermined secured area with secondary containment and spill control equipment. Weekly inspections of the drum storage area will be conducted and documented to ensure that drums are properly labeled, sealed, and in good condition. Following completion of the project, the wastewater will be treated on site and disposed of on site in compliance with a general waste discharge permit from the Regional Water Quality Control Board ((RWQCB) (as permitted), or properly transported to an appropriately permitted facility for treatment or disposal.

1.2.1.1 EXCESS/UNUSED EVO, KB-1™ AND BLEND-WATER

These excess liquids will either be reused, if not compromised; or will be disposed of in the necessary ways. The EVO and KB-1™ will need to go through a decontamination process. The blend-water will need to be filtered to remove non-water original components from water.

1.2.2 Contaminated Drill Cuttings

Solid waste (soil) generated from well installation will be placed in covered portable roll-off bins lined with plastic sheeting or in DOT 17H 55-gal drums. Solid waste stored in roll-off bins or drums will be temporarily staged on site and transported off site to a permitted disposal facility following characterization and profiling.

Drill cuttings will be transported to an appropriately permitted, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) off-site rule-approved Class I hazardous waste facility or other appropriate facility as determined by waste characterization.

Use of any disposal facility is subject to approval under subcontractor qualification procedures. All manifests and final disposal decisions will be at the direction of the Department of Navy (DON) on site representative.

1.2.3 Used Personal Protection Equipment

All used PPE and disposable sampling equipment will be placed in DOT-approved 17H 55-gal drums or waste storage and later disposed of at an appropriate landfill. Construction activities will be performed in Level D or modified Level D. Depending upon air monitoring results, protection level may be upgraded to Level C. Management of the drums of PPE will be similar to management of the drums of decontamination wastewater described above.

1.2.4 Miscellaneous Debris

Clean miscellaneous debris such as concrete and asphalt resulting from coring operations, polyvinyl chloride (PVC) pipe sections, and others will be transported to an appropriate licensed landfill for disposal. Use of any disposal facility is subject to approval under subcontractor qualification procedures.

Mixing regular trash and/or non-hazardous solid waste with potentially contaminated waste will be avoided.

1.3 WASTE CONTAINERIZATION

Potential hazardous waste (soil cuttings, wastewater, and PPE) will be placed in containers on site. DOT-trained personnel will perform container selection based on type and quantity of waste to be generated. Containers may include DOT-specification drums or roll-off bins for regulated hazardous material. DOT-specification containers are not required for non-hazardous material that does not meet a DOT hazard class. An inventory of hazardous and non-hazardous waste containers and quantities will be maintained for future reporting and inspection.

All containerized hazardous waste will be stored in DOT-approved containers at designated temporary accumulation area(s). These areas shall be clearly marked on pre-mobilization site maps. The temporary accumulation area will be equipped with spill containment and a spill kit. Where appropriate and feasible,

these areas will include secondary containment. The temporary accumulation area and containers will be inspected weekly. Any deficiencies found during the inspection that require corrective action (unlocked gates, missing or damaged labels, leakage, or missing containers) will be recorded and documented. Containers approaching the 90-day accumulation limit will also be noted.

Containerized hazardous waste must be accumulated in accordance with 22 California Code of Regulations (CCR), Sections 66264.170 through 177 (Use and Management of Containers). Containers of hazardous waste and portable tanks will be inspected and logged weekly while the fieldwork is in progress. Inspections will include an evaluation for proper labeling, secure closure, the condition of each container/tank, number of containers/tanks, and condition of the accumulation area(s). Any signs of deterioration, leaking, or dents will be noted, and containers will be immediately re-packed or the tanks will be drained, if necessary. Standing water will be removed from the containment area within 24 hours. Inspection results will be provided upon request to Naval Weapons Station (NAVWPNSTA) Seal Beach. All containers will be checked to ensure labels and markings are in good condition. DOT information for hazardous materials, including proper shipping descriptions and hazard class labels, will be added to containers prior to shipping. Hazardous waste may be accumulated on site in containers for a maximum of 90 days. Hazardous waste may be accumulated on site in portable tanks for a maximum of 60 days. The 60 and 90 days begin on the date that the waste is first generated and containerized or stockpiled.

1.3.1 Labeling

At the time of generation, all disposable waste containers will be labeled, using indelible ink, with the following information:

- Source and location;
- Contents and quantity of material in the container;
- Potential health, safety, and environmental hazards;
- Accumulation start date (the date the material was first put in the container);
- Date container sampled;
- Parameters used for analysis; and
- “ANALYSIS PENDING - POTENTIALLY HAZARDOUS”.

The same information shall be recorded in field logs for non-disposable containers. Upon the determination that the material in the waste container is hazardous, the container will immediately be labeled with a completed commercial EPA “HAZARDOUS WASTE” label. The label will include the accumulation start date and other requested information and managed as defined in 22 CCR, Sections 66262.30 through 66262.34, Pre-Transport Requirements.

1.4 WASTE SAMPLING

All waste shall be sampled and profiled prior to arrangements being made for disposal off site. The DON shall be the generator for all waste produced during the course of the work. The DON shall make the final decision as to the hazardous waste facility contracted to accept waste generated during this project.

1.5 WASTE TRANSPORTATION

Hazardous material will be transported by a subcontractor approved under subcontractor qualification procedures. The transporter will have appropriate licenses, including an EPA identification number. Hazardous material including hazardous waste will be properly classified, described, packaged, marked, and labeled for shipment as required by applicable sections of 49 Code of Federal Relations (CFR), Parts 171, 172, 173, 178, and 179, and 22 CCR, Sections 66262.10 through 66262.45. Properly DOT-trained personnel will perform DOT functions.

- **Shipping Description** – Material that does not exhibit one of the nine DOT hazard classes (explosive, flammable, poison, combustible, and so forth) is not regulated under DOT rules for the transportation of hazardous material. The Compliance Officer or the DOT Coordinator will confirm this description prior to shipment. The applicable DOT shipping description, EPA hazardous waste number, and the California waste code will be selected based on the results of the waste characterization.
- **Marking and Labeling** – The shipping name, hazard class, identification number, technical names, EPA markings and waste code numbers, and consignee/consignor designations must be marked on packages for shipment in accordance with 49 CFR, Part 172. This information will be marked on each roll-off bin after consultation with the Compliance Officer or DOT Coordinator.
- **Placarding** – Vehicles will be appropriately placarded in accordance with 49 CFR, Part 172.
- **Manifest** – Hazardous materials shipped off site must be properly manifested. Manifests will be completed by and require DON signature before the waste leaves the site. Copies of all manifests will be retained in the project files; original copies are sent with the transporter. All loads will be weighed at the base weigh station prior to a DON Representative signing the manifest.
- **LDR (Land Disposal Restriction) Certification** – LDR Certification will be prepared and will accompany the manifest if applicable. Copies of all LDR Certifications will be retained in the project files with copies of the signed manifest received from the disposal facility. All original waste disposal paperwork will be maintained by the Environmental office at NAVWPNSTA Seal Beach.

1.6 WASTE DISPOSAL

This section describes the disposal methods for the waste materials generated at the site including solid waste, EVO wastewater material or excess, wastewater, contaminated soil, and uncontaminated soil and debris.

1.6.1 Solid Waste and Wastewater Disposal

All discarded materials, waste materials, or other objects will be handled in such a manner to control the potential for spreading contamination, creating a sanitary hazard, or causing litter to be left on site. All used PPE materials will be temporarily stored in 55-gal drums and later disposed at a CERCLA-approved and permitted landfill or treatment, storage, and disposal facility (TSDF). The wastewater generated from personnel and equipment decontamination will be stored in 55-gal drums or Baker tanks. A sample of the wastewater will be collected and analyzed to determine if it is a hazardous waste, and then appropriately transported to an off-site disposal and/or treatment facility. Any leftover EVO solution will be removed from the site by an appropriate vendor for recycling.

1.6.2 Contaminated Waste Transportation and Disposal

Following waste classification, all waste material will be disposed of according to the final waste classification. Disposal may be a combination of options determined by the hazardous classifications as follows:

- Soil and debris classified as RCRA hazardous waste will be transported to an appropriately permitted and CERCLA-approved hazardous waste landfill for treatment, if necessary, and disposal.
- Soil and debris classified as non-RCRA hazardous waste will be transported to an appropriately permitted and CERCLA-approved hazardous waste landfill for disposal.

Contaminated drill cuttings will be transported to an appropriate off-site disposal facility. A hazardous waste manifest will be filled out for each load and submitted to the DON to sign as generator. Original copies of the manifest will be provided to the transporter for shipment.

Trucks hauling contaminated waste material for off-site disposal will use Gate Number 9 located on Westminster Avenue to exit NAVWPNSTA Seal Beach. The trucks will travel east on Westminster Avenue to Bolsa Chica Road, then go north on Bolsa Chica Road to enter the 405 Freeway. Trucks hauling contaminated waste for off-site disposal will not be allowed to travel on Seal Beach Boulevard.

1.7 RELEASE PREVENTION

1.7.1 Spill Prevention

Vehicle fueling, generator fueling, and management of decontamination waste are the three primary activities that may result in a spill. Spill prevention practices are described below for these three activities.

- **Fueling** – All vehicles will be fueled and serviced prior to moving onto the site. Any on-site fueling of equipment will be conducted within a designated controlled area. If generators will be required at remote locations for power, they will be parked on a double layer of visqueen which will be bermed to provide temporary containment. A fuel spill response kit with absorbent material will be staged at the active fueling locations. No bulk quantities of fuel will be stored on site.
- **Wastewater** – Wastewater will be containerized in 55-gal drums or a Baker tank (or equivalent). A secondary containment will be constructed for the drums or the Baker tank within areas where a release would impact buildings and structures. All wastewater will have secondary containment until waste profiling is complete. After profiling, all hazardous wastewater will have secondary containment. Therefore, any spills from the drums or the tank will be contained and will not be released to the surrounding areas.
- **EVO** – Any emulsified vegetable oil solution spilled during project activities will be cleaned and containerized in 55-gal drum(s) or other appropriate containers, and hauled off-site for disposal.

1.7.2 Spill Response

In the event of a release of hazardous material into the environment, field personnel will initiate action, as specified in the Health and Safety Plan (HASP), to contain or control the release or evacuate the area if the spill is significant or represents an immediate health threat.

Absorbent pads, shovels, and 55-gal drums will be kept at the site to address the possibility of spills.

1.7.3 Spill/Release Reporting

The steps below outline the chain of communications to be followed if a significant spill of any hazardous substance occurs.

1. Internal Contact:

   Site personnel involved in the spill should immediately contact the Site Health and Safety Office (SHSO), who will notify the Project Manager. The Field Manager or the Project Manager will contact the NAVWPNSTA IR Program Coordinator and the Resident Office in Charge of Construction (ROICC) identified below:

NAVWPNSTA IR Program Coordinator:	Pei-Fen Tamashiro (562) 626-7897
ROICC:	David Crawley (562) 626-7964

2. If a release of a waste or hazardous substance, regardless of quantity, could threaten human health or the environment outside the facility, the Project Manager will verify that the following have been notified by the DON:
   - DHS at (800) 852-7550.
   - National Response Center at (800) 424-8802.
   - Local Emergency Response Coordinator (Fire Department, if necessary).
   - Report releases and submit written follow-up emergency notice under Superfund Act and Reauthorization Amendments, Title II requirements.

1.8 INVESTIGATION-DERIVED WASTE DISPOSAL

Investigation-derived waste (*i.e.*, drill cuttings, drilling mud, and well development, and purge water) will be stored in D.O.T.-approved containers or rolloff bins, sampled and analyzed to determine the appropriate method for disposal. Hazardous materials, if any, will be manifested by a Navy representative and delivered to an appropriate licensed facility for disposal. Navy or base personnel will determine the disposal action based on the generator's knowledge of the waste characteristics. Any hazardous waste will be shipped under the NAVWPNSTA Seal Beach generator Number of 36-060072.

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