REMEDIAL DESIGN WORK PLAN

FOR THE
SOIL AND NAPL OPERABLE UNIT
DEL AMO SUPERFUND SITE

LOS ANGELES, CALIFORNIA

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

$\mu g/m^3$	Micrograms per cubic meter
ALTA	American Land Title Association
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirement
As	Arsenic
BaP	Benzo(a)pyrene
BEC	Building Engineering Control
bgs	Below ground surface
BRA	Baseline Risk Assessment
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CEQA	California Environmental Quality Act
CFM	Cubic Feet per Minute
City	City of Los Angeles
COC	Constituent of Concern
CQAPP	Construction Quality Assurance Project Plan
Cr	Chromium
CrVI	Hexavalent Chromium
CR	Cancer Risk
DO	Dissolved Oxygen
DTSC	Department of Toxic Substances Control
EAPC	Exposure Area of Potential Concern
EDR	Environmental Data Resources, Inc.
ERT	Environmental Review Team
°F	Fahrenheit
Fe	Iron
Fe(II)	Ferrous iron
FID	Flame Ionization Detector
FS	Feasibility Study
FSP	Field Sampling Plan
GHG	Green House Gas
GIS	Geographic Information System
gpm	Gallons per minute
GRBMP	Green Remediation Best Management Practices
HASP	Health and Safety Plan
Hg	Mercury
HI	Hazard Index

HVAC	Heating, Ventilation and Air Conditioning
IC	Institutional Control
ICIAP	Institutional Controls Implementation and Assurance Plan
IDW	Investigation-Derived Waste
ISCO	In-Situ Chemical Oxidation
ISO	International Organization for Standardization
JSA	Job Safety Analysis
kg	kilogram
LADWP	Los Angeles Department of Water and Power
Landtec	Landtec GEM2000 Landfill Gas Analyzer and Extraction Monitor
mEq	Milli-equivalents
mg/kg	Milligram per kilogram
MFR	Modified Fenton's Reagent
ml	milliliter
Mn	manganese
MnO_4-	Permanganate ion
NaOH	Sodium hydroxide
NAPL	Non-Aqueous Phase Liquid
NDPA	n-nitrosodiphenylamine
NELAP	National Environmental Laboratory Accreditation Program
NOD	Natural Oxidant Demand
NPL	National Priority List
O_3	Ozone
O&M	Operation and Maintenance
OH	Hydroxyl radical
OH^-	Hydroxide ion
OM&M	Operation, Monitoring and Maintenance
ORP	Oxidation Reduction Potential
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCE	Tetrachloroethene
PID	Photoionization Detector
PM	Project Manager
PMEP	Performance Monitoring and Evaluation Plan
PPE	Personal Protection Equipment
ppmv	Parts per million by volume
PRIMA	PRIMA Environmental, Inc.
psi	Pounds per square inch
QA/QC	Quality Assurance/Quality Control
QAO	Quality Assurance Official
QAPP	Quality Assurance Project Plan

QMS	Quality Management System
RA	Remedial Action
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision
ROI	Radius of Influence
ROST	Rapid Optical Screening Tool
RTO	Regenerative Thermal Oxidation
RWQCB	Regional Water Quality Control Board
SO_4•	Sulfate radical
$S_2O_8^-$	Persulfate ion
SA	Source Area
scfm	Standard cubic feet per minute
SCAQMD	South Coast Air Quality Management District
SESR	Screening Evaluation Summary Report
SF	Square Feet
Site	Del Amo Superfund Site
SMS	Safety Management Standard
SOW	Statement of Work
SLIC	Spills, Leaks Investigation and Cleanup
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
SWMP	Site Wide Management Plan
TCE	Trichloroethene
TIC	Tentatively Identified Compound
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TPH-G	Total Petroleum Hydrocarbons as Gasoline
USA	Underground Service Alert
USEPA	United States Environmental Protection Agency
UVOST	Ultraviolet Optical Screening Tool
VETS	Vapor Extraction Treatment System
VOC	Volatile Organic Compound
VPGAC	Vapor Phase Granular Activated Carbon
ZIMAS	Zoning Information Map Access System

SECTION 1.0
INTRODUCTION

This document presents a Remedial Design (RD) Work Plan for the Soil and Non-Aqueous Phase Liquid (NAPL) Operable Unit (OU-1) at the Del Amo Superfund Site (Site) in Los Angeles, California. The RD Work Plan has been prepared by AECOM Technical Services, Inc. (AECOM) (formerly URS Corporation) pursuant to Consent Decree (CD), Civil Action No. 2:15-cv-07619-R (AGRx), dated September 29, 2015 (U.S. District Court 2015). RD elements of the RD Work Plan are in accordance with the Statement of Work (SOW) attached to the CD and are consistent with USEPA's September 30, 2011 Record of Decision (ROD) (modified July 26, 2013). Additional previously completed supporting documents include the Remedial Investigation (RI) Report (URS 2007), Baseline Risk Assessment (BRA) (URS/Geosyntec 2006) and Feasibility Study (FS) (URS 2010).

1.1 PURPOSE AND SCOPE

The purpose of the RD Work Plan is to describe the elements that make up the RD process and how these elements will be implemented. The principal RD Work Plan objectives are to:

1. Specify the data that need to be collected and evaluated to develop the RD for the Site and describe the methods by which this will be achieved
2. Identify and describe the documents in which the above data and evaluations will be presented, as well as the preliminary, pre-final and final RD deliverables
3. Describe the various institutional controls (IC) and the process by which they will be implemented
4. Present a schedule for the various RD tasks and deliverables

The following deliverables required by the CD and SOW are combined to form this RD Work Plan:

- Pre-Design Investigations Work Plan
- Soil Vapor Extraction (SVE) Pilot Test Work Plan
- In-situ Chemical Oxidation (ISCO) Bench Study Work Plan
- Institutional Controls Implementation and Assurance Plan (ICIAP)
- Field Sampling Plan (FSP)
- Quality Assurance Project Plan (QAPP)
- Cap Survey Plan
- Generic Excavation Plan

- Health and Safety Plan (HASP)

Included in the deliverables are Decision Diagrams that were developed in cooperation with USEPA and DTSC to summarize the process by which the remedy components are implemented and the achievement of performance standards is assessed.

While the CD and SOW specify preparation of an RD Work Plan and separate remedy component work plans as identified above, these work plans are combined in this RD Work Plan to streamline the process to remedy implementation. If revisions to one or more RD elements are required based on results from the Pre-Design Investigations, they will be addressed through technical memoranda that will be submitted to USEPA for review and approval.

1.2 SITE DESCRIPTION AND BACKGROUND

1.2.1 Location and History

The Site is located at the southwest corner of the intersection of the 405 and 110 Freeways in the Harbor Gateway area of Los Angeles, California, adjacent to the cities of Torrance to the west and Carson to the east (Figure 1). The Site comprises approximately 280 acres that were formerly occupied by a synthetic rubber plant.

The plant was constructed in 1942 by the U.S. Government in support of World War II activities and included styrene, butadiene and copolymer plancors. Styrene and butadiene were combined in the copolymer plancor to produce the synthetic rubber. Other chemicals stored and used in the process as either feedstock or intermediary products included ethylbenzene, propane, butylene, butane and lesser amounts of other chemicals. The plant was sold to Shell Chemical in 1955 and continued to operate until 1972 when it was decommissioned and sold to a land development company. Since decommissioning, the Site has been subdivided and gradually redeveloped into the current business park. Environmental investigation of the Site began in the 1980s, revealing past releases from pipelines, storage tanks, processing units and waste pits that impacted underlying soil and groundwater.

1.2.2 Development and Land Use

The Site currently comprises 83 parcels and surface street segments, including Vermont Avenue, Francisco Street, Magellan Drive, Pacific Gateway Drive and Knox Street. Nearly all the parcels have been developed with occupied business buildings and associated parking lots. The Waste Pits Operable Unit (OU-2) occupies two parcels along the southern boundary of the Site that are not addressed in the Soil and NAPL ROD or this RD Work Plan (Figure 2). The two parcels immediately north and immediately west of OU-2 were similarly excluded from the ROD and are also not included in this RD Work Plan but will be addressed separately by USEPA. The remaining Site area that is the subject of this RD Work

Plan is almost entirely covered by buildings, paved parking areas, streets and landscaping. The remaining undeveloped area is limited to an area of approximately 1.1 acres in the southeastern portion of the Site[1].

There are approximately 76 buildings currently on the former plant site. Building footprints range up to approximately 215,000 square feet (SF), although several buildings are multistory structures, and thus may exceed 215,000 SF of floor space. The buildings are typically concrete tilt-up or high-rise structures and are primarily used for warehouse/freight forwarding operations, manufacturing, and office space. All current structures are limited to business use; there are no known full-time residents.

Zoning for the majority of the Site parcels is designated as heavy or light manufacturing/ industrial. One parcel where a hotel is currently located (APN 7351-033-039) has a dual industrial-commercial zoning designation. Two parcels that collectively make up the Los Angeles Department of Water and Power (LADWP) utility corridor near the southern boundary of the Site are zoned as "public facilities". The anticipated future land use at the Site is commercial/industrial, the same as the current land use.

Land use is light industrial and residential to the north of the Site, industrial and commercial to the east, residential, industrial and commercial to the south, and industrial and commercial to the west. An approximately three-block portion of the residential area immediately south of OU-2 was purchased by Shell Oil Company (Shell) and the U.S. Government in 1998 and the associated houses were subsequently razed. The property was conveyed in November 2015 to the Del Amo Neighborhood Park, LLC to be redeveloped into a community park.

1.2.3 Constituents of Concern and Exposure Pathways

Site constituents of concern (COC) that are driving remedy components include volatile organic compounds (VOC) including benzene, ethylbenzene, tetrachloroethene (PCE), and trichloroethene (TCE); polycyclic aromatic hydrocarbons (PAH) including benzo(a)pyrene (BaP), benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(cd)pyrene; and semi-volatile organic compounds (SVOC) including n-nitrosodiphenylamine (NDPA), as identified in the BRA and Feasibility Study (FS). Exposure pathways potentially posing a health risk include shallow soil ingestion/dermal contact and inhalation. The risk-driving chemicals for each property where remedial action (RA) is anticipated are identified and discussed in Section 3.

[1] The undeveloped area consists of current parcel 7351-033-061, which was formerly the western portion of parcel 7351-033-030 (also known as EAPC 10 or Property 10). Parcel 7351-033-030 was subdivided to form 7351-033-061 and 7351-033-062.

1.3 SELECTED REMEDY

Remedial action is required by the ROD to: a) address potential health risks associated with exposure to shallow soil (<15 feet) at selected Site properties; and b) reduce NAPL mass at selected groundwater contamination source areas (SA) and enhance the groundwater remedy. The remedy addresses these concerns through a combination of ICs, engineering controls and treatment technologies. Whereas the remedial objective for shallow soil is to reduce risk by either limiting contact with the COCs or by actively reducing their concentrations to acceptable levels, the remedy for NAPL is not driven by risk and there is therefore no associated quantified value by which mass or concentrations must be reduced.

Remedy components associated with shallow soil apply to portions of selected Site properties that generally consist of individual parcels or street segments and correspond to "Exposure Areas of Potential Concern" (EAPC) in the BRA. The BRA evaluated health risk for each of 37 Site properties (Properties 1 through 37), with risk at the remaining unnumbered properties inferred to be below USEPA's discretionary risk range for a residential setting. While a few properties have been subdivided into multiple parcels since completion of the BRA, the original property numbering system used in the BRA and ROD is retained in this document to avoid confusion and discrepancies between documents.

Remedy components associated with NAPL apply to selected groundwater contamination SAs at the Site where NAPL or NAPL-impacted soil is present. These SAs were originally identified in the Groundwater RI Report (Dames & Moore 1998a). Source areas are not limited by and do not correspond with property boundaries; a single SA can be present on multiple properties. Similarly, since risk was evaluated in the BRA on a property-by-property basis, quantitative health risks are not applicable to SAs. A decision regarding the NAPL remedy was deferred in the ROD for the Groundwater OU (USEPA 1999) and subsequently addressed in the Soil and NAPL ROD (USEPA 2013), where active treatment of NAPL and NAPL-impacted soil was required for SA-3, SA-6, SA-11, and SA-12.

The ROD remedy relies on ICs, engineering controls, and treatment technologies to protect human health and the environment. The remedy consists of the following elements, which are applicable to individual properties or SAs as indicated:

- ICs – all properties
- Capping – Properties 2, 16, 28, and 35
- Building engineering controls (BEC) – Property 16
- SVE for outdoor shallow soil – Properties 6, 11, and 23
- SVE for soil under a building – Property 23
- SVE for deep soil – SA-6

- ISCO/SVE – SA-3, SA-11, and SA-12
- Excavation for areas of impacted shallow soil that may be discovered in the future as a result of redevelopment activities (all properties). In the event that excavation is impractical, one or more of the other remedy components would be considered for implementation.

The properties and SAs associated with each active remedy component in the ROD are indicated on Figure 2 and the ICs application is summarized on Figure 3. The remedy components that apply to each parcel are further summarized in Table 1. Each ROD remedy component is briefly summarized below.

1.3.1 Institutional Controls

ICs are legal and administrative controls designed to minimize the potential for future exposure and protect the remedy. Four layers of ICs (IC-1 through IC-4) are identified which are applied progressively to each Site property depending on the nature and magnitude of the health risks identified in the BRA and FS. Each layer is briefly described below and the properties to which they apply are indicated in Table 1 and Figure 3. A more comprehensive description of each IC layer and details regarding implementation are presented in Section 5.

1.3.1.1 IC-1 – Informational Outreach

This IC layer will be applied to all Site properties and includes mailings, websites, publicly accessible databases and other media to inform the public of environmental conditions and controls and restrictions that are in place to prevent exposure. Informational outreach will be accomplished by the Project Team (Del Amo Parties and contractors), USEPA, and DTSC.

1.3.1.2 IC-2 – Building Permit Review and Landwatch

This layer will be applied to all Site properties and facilitates review of property development projects that involve soil excavation in excess of 18 inches or a change to sensitive land use (school, hospital, etc.). This layer has previously been implemented as part of an ongoing pilot project by USEPA, DTSC, and the Project Team in cooperation with the City of Los Angeles (City) Planning Department and Building and Safety.

1.3.1.3 IC-3 – General Plan Footnote

Implementation of this IC will result in a footnote to the City General Plan indicating that the identified properties are within the Del Amo Superfund Site and are not appropriate for residential use. This IC will be applied to properties where residential health risks are within or greater than USEPA's discretionary risk range and will be implemented by the Project Team, USEPA, and DTSC in cooperation with the City.

1.3.1.4 IC-4 – Restrictive Covenants

Restrictive covenants are legal agreements entered into by property owners and DTSC that are recorded on the property deeds and are binding upon future owners and occupants. The covenants will be selectively applied based on the property-specific health risks, the need for remedial facilities to be present, and whether impacted groundwater underlies the property. Restrictive covenant components identified in the ROD include:

- Restrictions on residential and other sensitive land uses
- A requirement for USEPA review of all development plans involving excavation in excess of 18 inches below ground surface (bgs) or change to a sensitive land use
- A requirement for non-interference with remedial facilities and engineering controls
- A requirement for USEPA and DTSC approval prior to drilling into, and use of, groundwater (18 properties)

Restrictive covenants will be primarily implemented by the Project Team, with DTSC and USEPA providing additional oversight and support as necessary.

1.3.2 Capping

Capping involves covering an area of impacted soil with a suitable material such as concrete, asphalt, clean soil, landscaping or other surface that eliminates the potential for direct contact exposure. Capping will be implemented at Properties 2, 16, 28, and 35, where one or more COCs are present at concentrations in excess of USEPA action levels, and for applicable compounds, above Site background levels. A more detailed description of this remedy element and associated conditions at each property where it will be implemented is presented in Section 3.2.

1.3.3 Building Engineering Controls

Building Engineering Controls (BEC) include floor sealing, ventilation system modifications, building pressurization, passive or active sub-slab venting, or a combination of these controls. This remedy component is under consideration for implementation at the existing building at Property 16. BECs will be implemented in the event that there is a potential for vapor intrusion, as identified based on COCs in indoor air at concentrations in excess of both action levels and background, and a demonstrable correspondence with COCs present under the building. Additional details regarding this remedy component and conditions at the Property 16 building is presented in Section 3.3.

1.3.4 SVE for VOC-impacted Outdoor Shallow Soil

SVE is an active remedial technology that removes VOCs from impacted soil by applying a vacuum to wells screened in the vadose zone. The wells are connected by piping to an aboveground vapor extraction and treatment system (VETS). Various vapor treatment technologies are under consideration, including thermal oxidizers, catalytic oxidizers, vapor-phase carbon adsorption, condensers, and internal combustion engines, as further described in Section 4.2. SVE is being considered for implementation for outdoor shallow soil at Properties 6, 11, and 23. Implementation will occur in the event that Pre-Design Investigations confirm that VOC concentrations in excess of USEPA action levels are present, as described in Section 3.4. Pilot testing for shallow soil SVE will be completed at Property 23 and is described in Section 4.1.

1.3.5 SVE for VOC-impacted Shallow Soil Under a Building

Implementation of SVE under the current building at Property 23 will be assessed to address VOC-impacted shallow soil. Additional Pre-Design Investigations and SVE Pilot Testing are planned for this area, as described in sections 3.5 and 4.1, respectively.

1.3.6 SVE for Deep Soil in NAPL-impacted Source Areas

SVE will additionally be implemented in deep vadose zone soil at SA-6 to remove VOCs. This area overlaps with an area of potential shallow soil SVE at Property 23 so that SVE may be implemented for both shallow and deep vadose zone soil. Additional investigation of conditions in this area is described in Section 3.6 and details regarding associated pilot testing are presented in Section 4.1.

1.3.7 ISCO/SVE for Deep Soil and Groundwater in NAPL-impacted Source Areas

The ROD specifies implementation of ISCO in conjunction with SVE at NAPL-impacted SA-3, SA-11 and SA-12 to remove VOCs from deep vadose zone soil and the saturated zone. ISCO is an active remedial technology that uses chemical injection to oxidize (chemically break down) VOCs in groundwater, converting the VOCs into nontoxic byproducts such as carbon dioxide and water. Injection of certain chemical oxidants (e.g., hydrogen peroxide and ozone) into groundwater will also increase dissolved oxygen (DO) levels in the vicinity of the injection wells, promoting aerobic biodegradation of the dissolved hydrocarbons. Injection of the selected oxidant will be accomplished using permanent injection wells and/or direct-push temporary injection points. SVE will be applied to remove any VOC vapors that volatilize from groundwater during implementation of the ISCO injections. Additional investigation of conditions in NAPL areas where ISCO/SVE will be implemented is described in Section 3.7. Details regarding associated deep soil SVE Pilot Testing, an ISCO Bench Study, and the ISCO implementation approach are presented in Sections 4.1, 5.2 and 5.4, respectively.

1.3.8 Excavation of Future Areas of Shallow Soil Contamination

Due to the developed nature of the Site and associated access limitations, there are inherent uncertainties with respect to areas of shallow soil contamination at the Site. Therefore, the ROD specifies excavation and off-site disposal as the remedy for areas of shallow soil contamination discovered in the future as a result of property redevelopment activities. If excavation is impractical or infeasible, one or more of the previously described remedy components will be assessed and implemented, as appropriate. A generic work plan describing characterization, excavation, and waste disposal activities for this remedy component is presented in Appendix A.

1.4 APPROACH

1.4.1 Overall Approach

The principal components of the RD phase of work include the RD Work Plan, Pre-Design Investigations, IC Implementation, SVE Pilot Studies, ISCO Bench Study, and RD drawings and specifications. A flow chart indicating the sequence of these components is presented in Figure 4. The Pre-Design Investigations will further evaluate the need for the various remedy components and/or the extent of the area where they will be implemented, while also providing additional characterization data to support RD. Existing RI/FS data and the new Pre-Design Investigations data will be taken into account in the subsequent SVE Pilot and ISCO Bench Studies, where the influence of Site-specific soil conditions on these technologies will be evaluated. The knowledge gained from the Pre-Design Investigations and Pilot and Bench Studies will collectively form the basis for development of the RD drawings and specifications.

While the Pre-Design Investigations, Pilot and Bench Studies, and RD drawings and specifications will be completed sequentially, IC Implementation will be performed concurrently with those tasks. The IC remedy component is unique in that it involves administrative controls rather than engineering and construction. Completion of all of the identified RD components is necessary in preparation for the future RA Work Plan, in which the approach for construction, operation and maintenance, and monitoring of the various remedial systems will be presented. Details regarding the Pre-Design Investigations, Pilot and Bench Studies, IC Implementation, and RD tasks are presented in Sections 3 through 6.

1.4.2 Design/Construction

RD and RA can be undertaken following either a design/bid/build strategy, in which a 100% complete design is generated and put out to bid for completion of the construction work, or a design/build approach, in which a single firm completes both the design and the subsequent construction work. USEPA will be notified of the selected approach when the 95% design document is submitted.

1.4.3 Green Remediation Approach During RD/RA

This section outlines the general approach to green remediation during RD/RA and how the USEPA's Superfund Green Remediation Strategy and Sustainability Principles (USEPA 2010) will be implemented. The goal is to make reasonable and appropriate efforts to reduce short-term impacts of remedial activities beyond minimum legal requirements. The USEPA has described the principles of green cleanup in several guidance documents (USEPA 2008, USEPA 2010). As part of the green remediation strategy, efforts will be made to reduce the environmental footprint through the following core green remediation factors identified in the guidance documents:

- Energy – reduce energy use or consider use of renewable energy
- Air – reduce air pollutants and greenhouse gas (GHG) emissions
- Water – reduce water use and negative impacts on water resources
- Land – use technologies that have lower environmental impacts
- Materials – use recycled materials and reuse wastes or spent materials
- Wastes – use technologies that minimize waste generation

Green remediation best management practices (GRBMP) are outlined in USEPA green remediation fact sheets (USEPA 2011) for a range of different field investigation and remedial activities such as site investigation, soil vapor extraction, excavation, and vapor treatment. These GRBMP fact sheets discuss methods to reduce environmental footprint by addressing the core green remedial factors identified above.

The environmental impacts of the RD activities (investigation, bench testing, pilot testing) discussed in the RD Work Plan are small relative to those during the subsequent remedy implementation. RD documents (30%, 95% and 100% design) will include a Green Remediation/Sustainability Plan as required by the SOW, providing details of GRBMPs proposed for the remedy implementation phase. Preliminary GRBMPs are briefly discussed in the Pre-Design Investigations and SVE Pilot Test sections of the RD Work Plan (Sections 3 and 4, respectively), identifying techniques and technologies that are reasonably implementable and reduce environmental impacts. GRBMPs associated with field activities conducted by subcontractors will typically be further refined during and after the subcontractor bidding process, with the final GRBMPs for these activities being presented in a technical memorandum or a progress report to be issued prior to field implementation.

1.4.4 Quality Assurance

AECOM utilizes a proven Quality Management System (QMS) that is certified to the International Organization for Standardization (ISO) 9001:2008 standard, yet is sufficiently

flexible to address project specific requirements. Quality management is central to the project management approach, and the Project Team includes individuals assigned to specific quality roles under the QMS. Quality management components of the QMS are described below. Quality assurance with respect to laboratory data is described separately within the QAPP in Appendix B.

1.4.4.1 Initiating Quality

Quality begins with understanding the project goals and objectives, emphasizing communication with all parties involved, and a thorough knowledge of available project information. The project planning process provides information needed to control the project by defining tasks, assigning technically qualified personnel to produce and review the work, and interpreting and applying applicable QMS procedures to the project.

1.4.4.2 Producing Quality

A project execution plan will be used to define key aspects of the project and guide the work. This plan serves as a roadmap to a successful project, outlining the specific actions to be taken to produce deliverables that are thorough, complete, and consistent with expectations and professional standards. The plan will be discussed at the Project Team kickoff meeting and updated as needed to inform the team of new developments.

1.4.4.3 Confirming Quality

While quality is built into the work as it is performed, formal checking and review are critical QMS activities. Quality checking activities are documented with two-level approvals, and include:

- Checking calculations to verify correctness and completeness of mathematics, methodology, software selection, application of standards and codes, and general approach
- Checking drawings to confirm design layout, dimensions and details. Potential interferences, conflicts and interface issues are resolved through interdisciplinary reviews
- Checking specifications for content and application, compliance with the prescribed format, and consistency
- Checking reports for content, logic, clarity, soundness of recommendations, grammar, punctuation, and format

1.4.4.4 Delivering Quality

All deliverables undergo a final verification check before they are submitted. An independent reviewer evaluates the deliverable for completeness and consistency, adherence to quality

requirements, and resolution of comments. The reviewer then signs a Deliverable Release Form and transmits it to the project manager (PM), who is responsible for the final review, approval and submittal. This final review evaluates the suitability of the document for release to the client or regulatory agency without diminishing PM accountability for the quality of the work. This check-and-balance activity helps AECOM consistently deliver quality and value.

1.4.4.5 Improving Quality

A key component of AECOM's quality program and ISO 9001:2008 is continuous improvement. Continual improvement of the QMS effectiveness is achieved through top-down promotion of the QMS policy, dissemination of the QMS objectives, evaluation of and response to audit results, analysis of objective data, implementation and evaluation of corrective and preventive actions, and management review.

1.5 PROJECT ORGANIZATION AND MANAGEMENT

RD will be managed to meet the objectives described above and complete the Pre-Field Activities, Pre-Design Investigations, SVE Pilot Testing, and ISCO Bench Study, IC Implementation and RD document tasks described in Sections 2 through 6.

1.5.1 Project Organization

The parties and individuals involved in the project and their respective roles and relationships are presented on Figure 5 and described below.

USEPA is the lead regulatory agency with primary oversight responsibility. Dante Rodriguez is the USEPA Remedial Project Manager; although, EPA is in the process of transitioning that role to Anhtu Nguyen.

DTSC will provide project oversight for the state. Safouh Sayed is the DTSC PM.

The Project Team (Shell, AECOM, and NewFields) is responsible for overall compliance with the CD and SOW. Key members of the Project Team include:

- Carol Campagna (Shell), Project Coordinator
- Peter Conwell (Shell), Technical Reviewer
- Julie Doane-Allmon (AECOM), PM
- Patrick Gobb (NewFields), Technical Consultant

Support for implementation of IC Layers 3 and 4 will be obtained independently from other ICs and RD tasks. Additional resources may be hired to provide required support services, as

necessary to obtain information regarding the Site history and background, property ownership and contact information, and details regarding the remedy to be implemented.

SECTION 2.0
PRE-FIELD ACTIVITIES

Pre-Design Investigation activities will require advance planning and coordination with the various stakeholders to ensure that the field work is performed in a safe and efficient manner. Details regarding pre-field activities are discussed below.

2.1 PROPERTY ACCESS AND SUBCONTRACTOR COORDINATION

Access to the following 10 properties may be required for RD/RA field activities:

APN	Property No.	Address
7351-031-020	2	950 W. 190th St.
7351-033-034	11	19901 Hamilton Ave.
7351-033-017	5	20101 Hamilton Ave.
7351-033-022	6	20221 Hamilton Ave.
7351-033-027	9	20280 S. Vermont Ave.
7351-033-900	15	None (LADWP corridor)
7351-034-015, -050, -056	16	19681 Pacific Gateway Dr.
7351-034-057	23	19899 Pacific Gateway Dr.
7351-034-069	28	19780 Pacific Gateway Dr.
Magellan Drive	35	None (street)

Access agreements shall be updated or established to allow for performance of activities identified in the ROD.

Subcontractor quotes will be solicited for work task(s) to be completed. As part of the solicitation process, prospective subcontractors will be evaluated to ensure their historical safety performance metrics meet or exceed AECOM's safety program requirements.

2.2 HEALTH AND SAFETY AND SITE SECURITY

All RD field work will be conducted in accordance with the Site-specific HASP included in Appendix C. The HASP includes the following elements:

- Site background information
- The scope of work to be conducted
- Project personnel responsibilities
- Training requirements
- Emergency contacts and facilities

- Anticipated hazards
- An exposure monitoring program
- Administrative measures, personal protective equipment (PPE), and engineering controls to minimizing potential hazards
- Contingency/emergency response plan
- Job safety analyses (JSA) detailing procedures for each of the field tasks to be implemented
- Safety management standards (SMS) identifying potential hazards and related mitigation measures
- Site control and security measures, decontamination procedures, safe work practices, emergency response measures, training, medical surveillance, Site inspections and recordkeeping requirements

All project field personnel and subcontractors will be required to be familiar with the HASP and be responsible for implementing the protective measures detailed therein.

2.3 UTILITY CLEARANCE AND PERMITTING

Subsurface utilities clearance will be obtained for areas to be investigated prior to commencement of drilling activities or excavation activities. Underground Services Alert (USA) will be notified at least 48 hours prior to initiation of intrusive field tasks. All proposed locations will be clearly marked with white paint or surveyors flagging, as required by USA. Alternate locations will be clearly marked at each proposed boring location. All soil borings will be located a minimum of 5 feet from identified underground utilities.

USA will contact all utility owners of record within the area of proposed work and inform them of the planned subsurface work. All utility owners of record or their designated agents will be expected to clearly mark the position of their utilities on the ground surface throughout the area designated for investigation. Prior to commencing field activities, it will be verified that all utility owners of record have responded to the USA notification by either marking the position of all buried utilities or verbally confirming that they do not maintain or operate subsurface utilities in the areas to be investigated. The current landowner will also be contacted regarding knowledge or records they may have regarding the presence and location of buried utilities or services. Following USA mark-out, a private utility location service will additionally conduct utility clearance using geophysical instruments, which may include the use of ground penetrating radar and/or one or more electromagnetic methods.

Further protection of subsurface utilities will be achieved through mandatory use of an air knife to a minimum depth of 8 feet bgs. If a subsurface object is encountered with the air knife, the hole will be abandoned and relocated to avoid the obstruction. For areas where soil

sampling is required within the upper 8 feet, the samples will be collected manually. If additional deeper samples are required at the same location, an air knife will be used to expand the boring diameter down to 8 feet bgs before completing the remainder of the boring with standard drilling or direct-push techniques such as hollow stem auger, Geoprobe, etc.

Permitting is not anticipated since Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response actions are exempted by law from federal, state and local permitting requirements within the footprint of a Superfund site. However, field activities will be performed in accordance with relevant permit requirements.

2.4 AGENCY NOTIFICATIONS

USEPA will be notified a minimum of 28 days prior to the start of field investigations. USEPA will also be notified at least seven days prior to the scheduled initiation of field work in the event that the field work will be delayed.

SECTION 3.0
PRE-DESIGN INVESTIGATIONS

3.1 OBJECTIVE AND OVERVIEW

The objective of the Pre-Design Investigations is to confirm the need for implementation of the various active remedy elements and/or more accurately delineate their respective implementation areas. The following remedy components will, or may potentially, be implemented:

- ICs – all properties
- Capping – Properties 2, 16, 28, and 35
- BECs – Property 16
- SVE for outdoor shallow soil – Properties 6, 11, and 23
- SVE for soil under a building – Property 23
- SVE for deep soil – SA-6
- ISCO/SVE – SA-3, SA-11 and SA-12
- Excavation of areas of impacted shallow soil that may be discovered in the future as a result of redevelopment activities (all properties)

ICs are a unique remedial component in that they are administrative in nature, and for this reason, their description and implementation plan is presented separately in Section 6. The excavation of future areas of impacted soil that are encountered as a result of redevelopment activities is also a unique remedy component in that it applies to currently unknown areas for which the COCs, concentrations, and physical conditions are also unknown. A separate work plan template applicable to such properties is presented in Appendix A.

The following sections discuss the remaining remedy components, the areas where each component applies, relevant data for the area, and the investigative scope that will generate the additional data needed for detailed remedy design to proceed. The sampling and analytical plan is summarized in Table 2 and overviews of the RD process for each remedy component are presented in the form of Decision Diagrams in Appendix D.

3.2 CAPPING (PROPERTIES 2, 16, 28, AND 35)

3.2.1 Overview

Capping is an engineering control or containment technology used to create a physical horizontal barrier at or near the surface to prevent exposure to contaminants. Appropriate

capping materials identified in the ROD include asphalt, concrete, clean soil or landscaping. Portions of Properties 2, 16, 28, and 35 require capping where PAHs or VOCs exceed USEPA action levels. Capping does not remove or treat soil, so there is no quantitative soil clean-up level.

Site areas where capping will be implemented are indicated on Figure 6 and in more detail on Figures 7 through 10. Caps are considered to already be in place at each of the specified areas since each area is currently either covered by asphalt, concrete, or clean soil/landscaping. Summaries of existing soil data for each of the planned cap areas are presented below. Comprehensive presentation of historical data for each property is included in Appendix D of the RI Report (URS 2007).

3.2.2 Property 2

Property 2 is a large office building currently occupied by Herbalife. COCs at Property 2 are limited to PAHs. In accordance with the ROD, as indicated on Figure 7, a 70-feet by 70-feet cap is proposed and already in place, as shown on the figure.

3.2.3 Property 16

Property 16 is occupied by LSC Communications (formerly R.R. Donnelley) and consists of a commercial printing operation and associated office space. As indicated in the ROD, a 128-feet by 184-feet cap area is already in place, as indicated on Figure 8.

3.2.4 Property 28

The building at Property 28 has previously been used as a warehouse/fulfillment center, although the property was recently observed to be vacant. The text, tables, and figures presented in the ROD are not clear regarding the capping of one or two areas on this property. The area identified on the northwestern portion of the property is driven by soil samples and the area identified on the eastern portion of the property is driven by one soil gas sample; therefore, it does not appear appropriate for a cap to be installed on the eastern portion of the property. However, after discussion with USEPA, both areas will be capped, as indicated on Figure 9. The caps proposed at these areas are already in place and will measure approximately 50-feet by 50-feet (northwestern area) and 50-feet by 15-feet (eastern area).

3.2.5 Property 35

Property 35 consists of Magellan Drive, a public street, where the ROD identifies three areas to receive a cap, as indicated on Figure 10. Three 50-feet by 50-feet cap areas are identified, which are already in place in the form of the asphalt street.

3.2.6 Cap Field Survey Plan

3.2.6.1 Objectives and Overview

No additional characterization sampling is planned for any of the cap areas, as described above. Furthermore, surface materials identified in the ROD as being suitable for capping when maintained in good condition include asphalt, concrete, clean soil, and landscaping, one or more of which are currently present at each of the identified cap areas. RD capping activities will therefore include a field survey to document the nature and condition of the existing surface material at each area, evaluate the suitability of the cap, and identify any necessary modifications or repairs. Design and completion of any modifications and repairs will be subsequently completed.

3.2.6.2 Methods and Documentation

The quality and integrity of the existing caps and immediately surrounding areas will be visually inspected to assess their quality, integrity and ability to meet the remedial cleanup goal. The quality of the existing caps will be evaluated annually and be based on observations of current conditions. Additional soil sampling will be conducted in advance of the 5-year review and risk analysis will be performed to evaluate the continued need for the cap areas. The field survey will include a visual inspection and evaluation of the cap areas and immediately surrounding areas, and recommendations for cap repairs, enhancements or replacements, as necessary. The following observations will be noted during the field reconnaissance and documented on a Cap Survey Field Inspection Form (Appendix E) and documented in a field log book:

- Current type and use of the cap surface material at each area
- Any observed damage to cap surface materials, including cracks, gaps, settlement, or worn or missing areas
- Evidence of animal burrows
- Vegetation growth through paved surfaces
- Deterioration of caulking areas at joint seals (e.g., pavement seams between the foot of building walls and exterior concrete walkways)
- Soil erosion

Findings will be summarized in a Pre-Design Investigation Report specific to cap areas. If cracks, holes, or other forms of disrepair are observed indicating that the existing cap is insufficient to prevent exposures, then repairs, enhancements or replacements of existing surfaces will be proposed in the report. Potential recommendations may include the following:

- Seal or repave to improve the integrity of the existing surface
- Remove and replace damaged surface material in select areas
- Remove existing vegetation growing through surface cracks and seal cracks
- Filling of animal burrows
- Maintain grass/soil landscape cover
- Replacement of damaged or missing caulking at joint seals
- Addition of topsoil/vegetation where erosion has occurred
- Augmentation of existing cap with additional components to create a more durable and effective cap

Required repairs, upgrades or replacements will be proposed in the report, along with design specifications and design drawings, as appropriate.

3.2.7 Monitoring and Maintenance

A draft operation, monitoring and maintenance (OM&M) Plan for the caps describing periodic inspection, monitoring, and maintenance activities for the cap areas will be prepared as part of a Capping Pre-Design Investigation Report. The OM&M Plan will propose a schedule and protocol for inspections, maintenance, planned penetrations, and repairing or replacing the caps.

Restrictive covenants included as part of ICs for cap properties will require that property owners protect the caps and prevent interference with the remedy, as further described in Section 6. A soil investigation and risk analysis will be performed prior to the next 5-year review to evaluate the continued need for the cap areas.

3.3 BUILDING ENGINEERING CONTROLS (PROPERTY 16)

3.3.1 Overview

BECs are planned changes to a building's infrastructure that prevent exposure to contaminants. The potential for implementation of BECs is limited to Property 16 on the western border of the Site, occupied by the LSC Communications (formerly R.R. Donnelley) facility. This facility consists of a large warehouse with printing presses and associated equipment and a smaller area of office space. Multiple truck loading bays are present providing abundant ventilation to the warehouse portion of the property. Historic RI/FS data indicate VOCs were present in sub-slab vapor above USEPA action levels for indoor air after taking into account an attenuation factor of 0.0011 associated with the building floor slab, as previously used in the USEPA-approved BRA. Further investigation and evaluation will be undertaken during RD to determine whether BECs implementation is appropriate, as

described below. BECs that could be implemented include enhancement of natural ventilation, modifications to the heating, ventilation and air conditioning (HVAC) system, floor sealing, and sub-slab venting.

3.3.2 Summary of Existing Data and Investigative Scope

Vapor intrusion is identified as a concern at Property 16 based on concentrations of PCE, TCE and chloroform in sub-slab vapor at the existing building and consideration of USEPA action levels for air and the previously described attenuation factor of 0.0011. PCE, TCE and chloroform concentrations were considered elevated. Benzene was not detected at concentrations of concern in any of the Property 16 sub-slab samples.

Further evaluation of the vapor intrusion pathway and the need for implementation of BECs will be evaluated during RD through indoor air sampling and sub-slab vapor sampling at the building. The field investigation will consist of two air sampling events approximately six months apart to take into account seasonal effects. Each event will include the following tasks:

- A walk-through survey of the building interior to identify indoor VOC sources that could influence the analytical results.
- Collection of indoor air samples at thirteen locations.
- Collection of outdoor (background) air samples at two locations, concurrent with indoor air sampling events.
- Collection of sub-slab vapor samples at seven locations.
- Laboratory analysis of the indoor and outdoor air samples for VOCs.

Existing indoor sources of VOCs that could influence sampling results will be identified prior to each sampling event through Site observations, field screening, interviews with employees, and review of hazardous materials management plans and other information regarding the use and storage of chemicals. A photo-ionization detector (PID) will be used during the walk-through to aid in identifying VOC sources. Indoor VOC sources will be contained or eliminated to the extent possible at least 48-hours prior to sampling. If VOC sources are identified that cannot be adequately contained or removed due to the nature of the ongoing business operations, source-specific sampling and testing may be necessary to account for the contribution of the indoor source. Any identified indoor sources of PCE, TCE or chloroform that cannot be contained or removed will be problematic in that it may not be possible to discriminate between their contribution to indoor air and the potential vapor intrusion contribution.

Air and sub-slab vapor sampling locations are indicated on Figure 11. These locations are approximate and may be revised at the time of the field investigation to take into account

ventilation intakes, obstructions, and conflicts with on-going business operations. The air samples will be collected over a12-hour period using Summa canisters equipped with flow control valves. The outdoor air samples will be collected starting approximately one hour prior to commencement of the indoor air sampling to establish background levels and evaluate its influence on indoor air quality. Outdoor sample collection locations will be along the western (upwind under prevailing conditions) edge of the building or near HVAC intakes, with final locations to be identified in the field. Sub-slab vapor sampling will be conducted upon completion of the indoor and outdoor air sampling.

Sampling will be completed in general accordance with procedures outlined in the DTSC/California Environmental Protection Agency "Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)" (DTSC 2011). Sampling protocols and standard operating procedures are presented in the FSP, Appendix F.

All samples will be analyzed for VOCs by a National Environmental Laboratory Accreditation Program (NELAP) certified laboratory using USEPA Method TO-15 SIM for indoor and outdoor air samples and TO-15 for sub-slab vapor samples. Laboratory analytical procedures will be in accordance with the existing QAPP presented in Appendix B.

3.3.3 Data Evaluation

Indoor air analytical data for each air sampling event will be evaluated with respect to action levels, background, and the existing sub-slab data to assess whether a vapor intrusion hazard exists at the building. Indoor air concentrations that are equal to or less than action levels or background would indicate that there is no significant vapor intrusion risk. Similarly, a lack of correlation between compounds detected in indoor air and those detected in sub-slab vapor would tend to indicate there is no significant vapor intrusion risk. In the event that there is a correlation between the indoor air and sub-slab VOCs and one or more indoor air action levels are exceeded, the data evaluation process presented in the Decision Diagram (DD-3) will be utilized to further assess risk.

3.4 SVE – OUTDOOR SHALLOW SOIL (PROPERTIES 6, 11, AND 23)

3.4.1 Overview

SVE removes VOCs from impacted soil by applying a vacuum to a network of vapor extraction wells and treating the vapor in an aboveground treatment system. The ROD specifies SVE for portions of Properties 6, 11, and 23 to remove VOCs that are present at concentrations in excess of action levels in shallow soil (<15 feet bgs). These properties and their ROD-identified SVE areas are indicated on Figure 12. Soil borings and sampling will be completed at each of the outdoor soil SVE areas during RD to confirm the need for SVE and delineate the area where it will be applied. A description of the associated methods

applicable to all areas is presented below, while area-specific details and proposed sampling locations are presented in subsequent sections.

3.4.2 Soil Borings and Sampling

Shallow soil borings will be completed in each area from ground surface to 15 feet bgs using hand auger and direct-push (Geoprobe) methods. An air knife and hand auger will be utilized for the upper 8 feet bgs of each boring to minimize the potential for damage to buried utilities, and the borings will thereafter be completed to total depth with a Geoprobe rig. The borings will be continuously logged, and two to four soil samples will be collected from each boring to characterize conditions. One sample will be collected from the most impacted interval, as identified by visual observations and PID readings of total organic vapor concentrations. For those locations where there are corresponding shallow soil gas samples from prior investigations, a second soil sample will be collected at the same depth as the shallow gas sample for which maximum VOC concentrations were detected. Additional soil sample locations will be determined at the time of the field investigation to more completely document conditions encountered and will include intervals believed to be impacted and un-impacted. Drilling and sampling procedures will be in accordance with the FSP presented in Appendix F.

All samples will be analyzed for VOCs by a state-certified laboratory using USEPA Method 8260B. Sample handling and analyses will be completed in accordance with the QAPP presented in Appendix B. Additional samples will be analyzed for physical parameters, including porosity, moisture content, grain size distribution, and air permeability to aid in subsequent design of the SVE system where needed, in accordance with Table 2 and as further described below. Physical testing samples will be collected to be representative of the range of soil types present. Soil samples for physical testing will be placed on hold pending receipt of VOC analytical laboratory results. If VOC analytical laboratory results do not exceed action levels, the testing for physical parameters will not be completed.

3.4.3 Property 6

The ROD-identified area for SVE consideration at Property 6 is located within a parking lot along the western side of the California Department of Public Health's Torrance Health Center building. Seven soil borings will be completed in this area, as indicated on Figure 13. Two to four soil samples will be collected from each of the seven borings (14 to 28 samples total) for VOC analysis. Four additional samples will be collected from two of the borings (eight samples total) for physical testing.

3.4.4 Property 11

The ROD-identified area for SVE consideration at Property 11 is located in a paved parking area near the southeast corner of a restaurant supply business. Four soil borings will be

completed in this area, as indicated on Figure 14. Two to four soil samples will be collected from each of the four borings (8 to 16 samples total) for VOC analysis. Four additional samples will be collected from two of the borings (eight samples total) for physical testing.

3.4.5 Property 23

Four separate sub-areas at Property 23 are identified in the ROD for SVE consideration, as shown on Figure 15: an irregular shaped area in the northwestern portion of the property, a rectangular area near the southwestern corner of the main building, a rectangular area along the eastern side of the building, and a square area near the northeastern corner of the building. The main existing building on the property comprises a Coca-Cola distribution warehouse, associated offices, and a truck maintenance facility. COCs at each of the four sub-areas and the proposed shallow soil sampling locations for each sub-area are described below.

3.4.5.1 Northwestern Sub-area

Principal COCs in the northwestern sub-area include benzene, ethylbenzene and PCE based on historical shallow soil gas data, and to a lesser extent, shallow soil data. Detected shallow soil gas concentrations for each COC are indicated on Figure 16. RD shallow soil sampling will be completed at 13 soil boring locations as indicated on the figure. These locations are selected to be spatially representative of the area under consideration. Two to four soil samples will be collected from each of the 13 borings (26 to 52 samples total) for VOC analysis. Two additional samples will be collected from three of the borings (six samples total) for physical testing.

3.4.5.2 Southwestern Sub-area

PCE is the principal COC for the southwestern sub-area. Two borings will be completed in this sub-area. Two to four soil samples will be collected from each of the two borings (four to eight samples total) for VOC analysis. Two additional samples will be collected from one of the borings (two samples total) for physical testing.

3.4.5.3 Eastern Sub-area

The shallow soil and soil gas sampling locations, Ultraviolet Optical Screening Tool (UVOST)/ Rapid Optical Screening Tool (ROST) locations and their respective data are indicated on Figure 17. Benzene and ethylbenzene are the COCs in this sub-area. Six soil borings in proximity to these previous shallow soil gas locations will be sampled to characterize COC concentrations with respect to action levels. Two to four soil samples will be collected from each of the six borings (12 to 24 samples total) for VOC analysis. Two additional samples will be collected from two of the borings (four samples total) for physical

testing. Four of the shallow soil borings will be extended and also used for deep soil sampling, as described in Section 3.6.

3.4.5.4 Northeastern Sub-area

Benzene and ethylbenzene are the COCs in this sub-area. One soil boring will be completed coincident with this location to evaluate current soil conditions, as indicated on Figure 15. Two to four soil samples will be collected from the boring for VOC analysis. Two additional samples will be collected from the boring for physical testing.

3.4.6 Data Evaluation

Findings for each area will be presented in a Pre-Design Investigation Report specific to outdoor shallow soil SVE.

3.5 SVE – SHALLOW SOIL UNDER A BUILDING (PROPERTY 23)

3.5.1 Overview

Shallow SVE under a building is limited to the southern portion of the Coca-Cola distribution center building on Property 23 (if needed).

3.5.2 Historical Data Summary and Investigative Scope

Existing sub-slab data for ROD-identified COCs at Property 23 are presented on Figure 18. Based on USEPA action levels for indoor air and taking into account the previously described attenuation factor of 0.0011 associated with the building floor slab, sub-slab VOC concentrations of concern are limited to TCE at SGL0925 [3,600 micrograms per cubic meter ($\mu g/m^3$)], in the southeastern corner of the main building. This area corresponds to an existing truck maintenance facility where chlorinated solvents were/are used. Further investigation and evaluation will be undertaken during RD to determine whether implementation of SVE under the building is appropriate. Additional investigation and evaluation is supported by Section 12.4.2 of the ROD, which states "*Some of the remedial actions will require additional field sampling during the remedial design process, to assist in defining the extent of the remediation. If new analytical data for one or more of the identified areas demonstrate that the described clean-up goal has been met prior to implementation of the remedy through natural attenuation or other mechanisms, the intent of the ROD will have been met and active remediation will not be required".*

The pre-design investigation will include collection of at least five sub-slab vapor samples in the vicinity of the SGL0925 location to further refine the SVE area, as indicated on Figure 18. Two outdoor air samples will additionally be collected to establish background air conditions. The outdoor air samples will be collected from the western, (upwind under

prevailing conditions) side of the building, with final locations identified in the field to account for air intake locations. Sampling locations are approximate, and may be revised at the time of the field investigation to take into account ventilation intakes, obstructions, and conflicts with on-going business operations. Depending upon results, additional sampling at one or more step-out locations may be completed to the west of the maintenance facility.

Sub-slab and outdoor air samples will be collected using Summa canisters in accordance with the procedures outlined in the FSP (Appendix F) and the "Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air" (DTSC 2011). Summa canisters for the outdoor air samples will be equipped with flow regulators allowing sample collection over an 8-hour period. The sub-slab sampling for inside the building will take place during the outdoor air sampling period. The sub-slab and outdoor air samples will be analyzed by a state-certified laboratory for VOCs using USEPA Method TO-15 SIM and TO-15, respectively. Laboratory analytical procedures will be in accordance with the existing QAPP, presented in Appendix B.

3.5.3 Data Evaluation

Investigation findings will be presented in a Pre-Design Investigation Report specific to the SVE under a building remedy component.

3.6 SVE – DEEP SOIL (SA-6)

3.6.1 Overview

SVE will be applied to deep (>15 feet bgs) NAPL-impacted soil at SA-6 on the southeastern portion of Property 23, adjacent to the Coca-Cola distribution center building. Deep SVE is being implemented to remove VOCs to the extent practicable and to enhance the groundwater remedy rather than achieve a quantifiable reduction in risk. Therefore, no concentration based action/cleanup goals associated with deep SVE.

3.6.2 Historical Data Summary and Investigative Scope

The SA-6 area to be evaluated with respect to deep SVE is indicated on Figure 19[2].

RD investigation will include soil sampling at 10 borings at the locations indicated on Figure 19 to further characterize conditions and refine the SVE area. As indicated on the figure, four of the borings will also be used for shallow soil sampling, as previously described in Section

2 The area of deep SVE at SA-6 and the area of shallow SVE along the eastern side of the Coca-Cola building at Property 23 are erroneously swapped on Figure 12-1 of the ROD. The area of deep SVE is the larger of the two areas, extending from the east side of the building eastward to Pacific Gateway, while shallow SVE is limited to the smaller area immediately adjacent to the building, as presented in Appendices D and E of the FS.

3.4.5.3. The borings will be completed using an air knife for the upper 8 feet to minimize the potential for damage to subsurface utilities, and thereafter with a hollow-stem auger rig to the water table. The borings will be continuously logged, and four to six soil samples per boring will be collected for VOC analysis (40 to 60 samples total). The samples will be collected exclusively from deep soil, from 15 to approximately 43 feet bgs (five feet above the water table). Sampling depths will be selected in the field and be representative of intervals of both impacted and un-impacted soil, as identified through visual observation and PID readings of total organic vapor concentrations. Three samples from two of the borings (six total samples) will additionally be collected for physical testing. Drilling and sample collection will be in accordance with the FSP presented in Appendix F.

Sample handling and analyses will be completed in accordance with the QAPP presented in Appendix B. VOC analyses will be completed by a state-certified laboratory using USEPA Method 8260B. Physical testing will consist of tests for porosity, moisture content, grain size distribution, and air permeability to aid in subsequent design of the SVE system.

3.6.3 Data Evaluation

Results of VOC analyses will be evaluated with respect to the distribution of VOC concentrations to refine the SVE treatment area. Findings will be summarized in a Pre-Design Investigation Report specific to the deep soil SVE remedy component.

3.7 ISCO/SVE (SA-11)

3.7.1 Overview

ISCO/SVE will be applied to deep (>15 feet bgs), NAPL-impacted soil at SA-11 during RA, as indicated on Figure 20. ISCO is an active remedial technology that uses chemical injection to oxidize (chemically break down) VOCs in groundwater, converting the VOCs into nontoxic byproducts such as carbon dioxide and water. SVE will be applied to remove VOC vapors that volatilize from groundwater during implementation of the ISCO injections. The anticipated ISCO/SVE approach is further described in Section 5.4.

3.7.2 Investigative Scope

The extent of NAPL at SA-11 has been previously investigated (Dames & Moore 1993 and 1998b; URS/NewFields 2011) and no further delineation is necessary to implement the ISCO/SVE approach. Review of soil boring and CPT logs and soil physical/chemical property data indicate similar lithology and soil characteristics at SA-3, SA-11 and SA-12. Additionally, benzene is the principal COC at each of the three source areas. While the NAPL at SA-12 also includes additional components, benzene is the driver and the oxidant used at SA-11 is expected to be effective at SA-12. After implementation of ISCO/SVE at SA-11, additional testing may be performed at the other source areas, as needed. Pre-Design Investigations at this area are therefore limited to collection of soil samples for physical

testing and collection of additional bulk soil and groundwater samples for use in the ISCO Bench Study described in Section 5.2. Findings from both the physical testing and the bench study will subsequently be used in RD. The physical testing and bench study soil samples will be collected from the same two soil borings, as indicated on Figure 21. Drilling and sampling of the borings will be completed in accordance with the procedures outlined in Section 3.5.3 of the FSP (Appendix F). The ISCO Bench Study samples will consist of one bulk (30 kg minimum) sample collected from the NAPL-impacted area at approximately 46 to 56 feet bgs and an additional un-impacted bulk sample (3 kg minimum) from the same depth interval but outside the NAPL area. The bulk samples will be sent to Prima Environmental Inc. (PRIMA) for ISCO Bench Study testing, as further described in Section 5.2 below.

The physical testing samples will be collected from the same two borings as the bulk samples. Three physical testing samples will be collected from the deep vadose zone and three from the saturated zone for each of the two borings (six samples/boring; 12 samples total) in accordance with Table 2. The deep vadose zone extends from approximately 15 to 44 feet bgs based on September 2015 water level information (URS 2015). The samples to be collected will be representative of the range of soil types present. Physical testing will include analyses for porosity, moisture content, grain size distribution and air permeability.

Impacted and relatively un-impacted bulk groundwater samples for the ISCO Bench Study will be collected from existing wells XMW-01HD and XMW-03HD, respectively, as indicated on Figure 21. Approximately 50 liters of impacted groundwater and three liters of un-impacted groundwater will be collected. Sampling procedures are described in Section 3.6 of the FSP.

3.8 GREEN REMEDIATION BEST MANAGEMENT PRACTICES

The following are preliminary GRBMPs that will be considered for use during Pre-Design Investigations:

- Incorporation of green specifications into solicitations and contracts for environmentally preferred materials, equipment and services, and selection of local subcontractors, vendors, facilities and service providers with green policies and procedures
- Use of alternative fuels such as biodiesel or other low sulfur diesel for vehicles and machinery to reduce fuel consumption and associated air emissions
- Use of equipment retrofitted with emissions controls (e.g., diesel oxidation catalyst, diesel multistage filter, or diesel particulate filter)
- Use of local analytical testing laboratories with sample pickup to reduce fuel consumption and air emissions

- Use of low-flow groundwater sampling and purging techniques to minimize waste water production, energy consumption, and disposal requirements
- Use of direct-push drilling rigs to minimize use of consumable materials and reduce waste production and disposal requirements
- Use of mobile laboratories where appropriate to facilitate real-time decision making, minimize additional site mobilizations, reduce fuel use and emissions of GHG, and eliminate sample packing and shipping
- Prompt restoration of any vegetated areas disrupted by equipment or vehicles to control storm water runoff and avoid transport of sediment to off-site surface water bodies
- Use of PPE, sample containers, and routine working supplies that are made with recycled materials and/or are reusable
- Use of rechargeable batteries in field monitoring instruments
- Shutting down equipment when not in use and institution of idle reduction plans
- Minimization of the number of vehicles deployed to the Site
- Use of electric or hybrid vehicles when possible to minimize energy consumption
- Use of phosphate-free detergents to decontaminate sampling equipment
- Disposal of wastes at the nearest permitted and approved facility
- Containment of decontamination fluids to prevent their entrance into storm drains or the subsurface
- Use of teleconferencing and compressed work schedules when possible to reduce travel

GRBMPs will be further refined during and after the bidding process for subcontractor selection and the final GRBMP list will be communicated to USEPA in a technical memorandum or progress report.

SECTION 4.0
SVE PILOT TESTING AND VAPOR TREATMENT TECHNOLOGY EVALUATION

4.1 SVE PILOT TESTING

4.1.1 Overview

SVE Pilot Testing will be performed for deep soil at NAPL-impacted SA-6. Provided Pre-Design Investigation findings confirm that SVE is required for one or more outdoor shallow soil areas, pilot testing for that remedy component will also be conducted. The purpose of the pilot testing will be to generate data by which the SVE system design parameters for the two remedy components will be determined. The two pilot tests will be completed at Property 23, where a Coca-Cola distribution facility is located. The shallow outdoor soil pilot test will address soil to a depth of 15 feet bgs, while the deep soil testing will address soil from 15 feet bgs to approximately 43 bgs (5 feet above the water table). Findings from the shallow soil pilot testing at Property 23 will additionally be applied to the SVE system designs at Properties 6 and 11, as necessary, and will also be used to develop the RD for the SVE under a building remedy component at Property 23 (if needed). Findings from the deep soil pilot testing at SA-6 will additionally be applied to the ISCO/SVE remedy at SA-11, and potentially SA-3 and SA-12, as discussed in Section 5.4.

The two pilot test areas are shown on Figure 22. Details regarding the pilot test well installations and testing approach are presented below.

Two vapor extraction wells and ten vapor monitoring wells will be installed for both the outdoor shallow soil and the deep soil pilot tests (12 total wells). Extraction well SVE-1A and monitoring wells VM-1A through VM-5A will be screened in shallow soil (≤15 feet bgs), while extraction well SVE-1B and monitoring wells VM-1B through VM-5B will be screened in the deeper NAPL-impacted soil (>15 feet bgs). Each extraction well will have five associated vapor monitoring wells spaced radially around it at varying distances in the respective shallow and deep zones. The vapor monitoring wells will be located approximately 7 feet, 10 feet, 15 feet, 20 feet, and 30 feet from the extraction well for the shallow zone, and 15 feet, 22 feet, 27 feet, 37 feet, and 49 feet from the extraction well for the deep zone. All wells will be single completion wells. The shallow and deep well locations are presented on Figures 23 and 24, respectively. These locations may be modified based on results from the Pre-Design Investigations or limitations attributable to subsurface utilities/obstructions.

4.1.2 Drilling and Well Construction

4.1.2.1 Drilling

A total of 12 vertical soil borings will be drilled and logged in accordance with the methods described in Section 3 (Pre-Design Investigations) and the FSP (Appendix F) for subsequent completion as vapor extraction or vapor monitoring wells. Subcontractor coordination, utility clearance, and property access will be conducted prior to initiation of drilling in accordance with Section 2 (Pre-Field Activities) and the FSP. Associated Health and Safety procedures are detailed in Appendix C.

Soil boring/well locations are indicated on Figures 23 (shallow outdoor wells) and 24 (deep outdoor wells). Borings for extraction wells SVE-1A and SVE-2, outdoor monitoring wells VM-1A through VM-5A will be drilled to a total depth of approximately 16 feet, while those for the deep wells (extraction well SVE-1B and monitoring wells VM-1B through VM-5B) will be drilled to approximately 44 feet bgs. Equipment decontamination and investigation derived waste (IDW) procedures will be in accordance with those described in the FSP (Appendix F). Characterization of shallow and deep soil COCs will have been previously completed as part of the Pre-Design Investigations (see Sections 3.4 and 3.6) and soil sampling for laboratory analyses is therefore not proposed as part of the pilot testing drilling program. Copies of waste manifests will be included in the SVE Pilot Testing report. Offsite shipment of waste material shall be performed in accordance with Section 15 of the CD.

4.1.2.2 Shallow Outdoor Soil Well Installations

For SVE Pilot Testing in shallow outdoor soil, extraction well SVE-1A and associated monitoring wells VM-1A through VM-5A will be constructed of 2-inch diameter Schedule 40 PVC casing. Well screens consisting of 0.020-inch slots will be placed from 7 to 15 feet bgs. The screened interval will not extend above 7 feet bgs due to the potential for leakage from the ground surface associated with anticipated high applied vacuum levels required during the pilot test to address the low permeability soil. The annulus between the borehole and the well casing and screen will be backfilled with #2/12 Monterey sand from total depth to approximately two feet above the top of the well screen, followed by a hydrated bentonite chip seal to one foot below ground surface, and finished with concrete to the surface. A locking cap will be placed on each wellhead, and the wellhead will be enclosed in a flush-mounted, traffic-rated vault encased in concrete. A well construction diagram for the outdoor shallow soil SVE and vapor monitoring wells is shown on Figure 25. Well construction details may be modified based on data collected during the Pre-Design Investigations.

4.1.2.3 Deep Soil Well Installations

For deep soil SVE Pilot Testing, extraction well SVE-1B and associated monitoring wells VM-1B through VM-5B will be constructed similarly to the shallow wells except that the

screen interval will span the impacted deep soil interval. The top of the well screen and top of the sand pack will not extend above 20 and 18 feet bgs, respectively, to avoid interference with the shallow SVE system. The bottom of the screen will be placed no deeper than five feet above the water table (approximately 43 feet bgs) to minimize the potential of groundwater entering the well. Three feet of hydrated bentonite chips will be placed above the sand and cement bentonite grout will be used above the bentonite chips to create the well seal. A well construction diagram for the deep SVE and vapor monitoring wells is shown on Figure 26. Well construction may be modified based on data generated as part of the Pre-Design Investigations.

4.1.3 Equipment

Pilot testing will require temporary aboveground pipe and hose, vapor abatement equipment, a power generator, and a security fence, with the equipment placed in close proximity to the extraction wells. Temporary fencing to create an equipment compound will be installed around the remediation equipment, extraction wells, and generator. Traffic cones and barricades will be placed around the monitoring wells to provide continual safe access for pilot test readings. The location of the temporary equipment compound and the details of the planned field activities will be coordinated with Coca-Cola facility management to minimize impacts to their operation.

Thermal oxidation will be used for vapor treatment during the SVE pilot tests due to expected high VOC concentrations at the SA6 deep well. Thermal oxidation is a standard, industry-accepted method for treatment of high concentration vapor streams that is routinely used for SVE remediation across the Los Angeles area, and is currently in use by commercial operators on the Site (LSC Communications). Carbon adsorption was not selected because of additional logistical complexity, including carbon change-outs and higher costs. It may also increase the potential for exposure due to breakthrough and waste handling. While carbon adsorption is used at the Waste Pits, flow rates there are low (~5 scfm) relative to the anticipated flow rates during SA6 deep well pilot testing (50 to 100 scfm).

Thermal/catalytic oxidation will serve as the vapor treatment technology for the shallow outdoor soil and deep soil SVE pilot tests. The oxidizer is expected to run in catalytic mode for the shallow outdoor soil test based on existing shallow soil gas data indicating relatively low total VOC concentrations. The system is expected to run in thermal mode during the deep soil test based on the presence of NAPL-impacted soil and deep soil gas data indicating benzene vapor concentrations exceeding 15,000 ppmv at SA-6.

The pilot testing equipment will be trailer-mounted and powered by a diesel generator. The equipment will consist of a control panel, variable speed controller, air-liquid separator, dilution valve, air filter, blower and associated motor, a vapor abatement device [thermal/catalytic oxidizer or vapor phase granular activated carbon (VPGAC) vessel], and

miscellaneous gauges, ports, and other instrumentation. The combined blower and motor equipment will be capable of a flow of 250 cubic feet per minute (CFM) and have a vacuum rating of 16 to 22 inches of mercury (Hg). Typical operating vacuum levels are expected to range from 5 to 14 inches of Hg depending on the vapor flow rates observed at the extraction wells. The blower selection for either of the SVE pilot tests may be revised following review and evaluation of soil data collected during the Pre-Design Investigations.

The SVE equipment will be connected to the appropriate extraction well during each test procedure using 2-inch diameter, above-ground vacuum hose and Camlock fittings. A process and instrumentation diagram is presented as Figure 27.

4.1.4 Equipment Instrumentation

Instrumentation consisting of flow sensors, differential pressure gauges, vacuum gauges, temperature gauges, relative humidity meters, and associated sample ports will be installed on the remedial test equipment to collect the necessary data to evaluate remedial performance. Instrument specifications are provided below:

- Dwyer Series In-Line Flow Sensors (DS-300) will be used in conjunction with Dwyer Series 2000 Magnehelic® Differential Pressure Gauges (model numbers 2002 [0 to 2 inches of water] and 2005 [0 to 5 inches of water]) on the well field line, the dilution line, and the system influent line to calculate flow rates.
- Vacuum and pressure gauges measuring in inches of mercury (Hg) or pounds per square inch (psi) will be used across the remedial system (well field line, dilution line, and influent line). Gauges will be liquid-filled, with a range of 0 to 30 inches of Hg or psi (either is sufficient) and will be calibrated by the National Institute of Standards and Technology.
- Temperature gauges with a range of 0 to 200 degrees Fahrenheit will be installed on the well field line, dilution line, and system influent. A Dwyer Model 485B Thermo-Hygrometer will be used to measure relative humidity from ambient air, the well field line, and system influent.
- Sample ports will be installed on the well field, system influent and effluent lines to collect vapor samples.

The following monitoring and sampling equipment will be used to collect field data during each pilot test:

- A RAE Systems MiniRae 2000, or equivalent, PID with a 10.6 eV bulb will be used to monitor soil vapor concentrations in ppmv from the individual vapor extraction wells and across the remedial system. The PID will be calibrated to 100 ppmv hexane to evaluate compliance with South Coast Air Quality Management District (SCAQMD)

requirements. A moisture trap will be used to mitigate the potential for moisture influence.

- A Photovac MicroFID, or equivalent, flame ionization detector (FID) will be used to monitor organic vapor concentrations, including methane, from the individual vapor extraction wells and across the remedial system. The FID will be calibrated to 100 ppmv methane gas. A moisture trap will be used to mitigate the potential for moisture influence. A carbon filter will be used to isolate methane from other VOCs and allow separate quantification of its concentration.
- A Landtec GEM2000 Landfill Gas Analyzer and Extraction Monitor (Landtec), or equivalent, will be used to measure fixed gases (oxygen, carbon dioxide, and methane) from the individual vapor extraction wells and system influent as percent volume. The Landtec will be calibrated daily. A carbon filter will be used to obtain methane readings.
- Vapor samples will be collected in 1-liter Tedlar® bags using a vacuum sampling box.
- A GAST vacuum pump capable of up to 25 inches of Hg will be used in conjunction with the vacuum box for sample collection.
- Dwyer 477-5-FM (0 to 20 psi) and 477-0-FM (0 to 10 inches of water) manometers will be used to measure vacuum at the vapor monitoring wells.
- Dwyer Series 2000 Magnehelic® differential pressure gauges, model numbers 2000-0 (0 to 0.5 inches of water), 2001 (0 to 1 inches of water), 2010 (0 to 10 inches of water), and 2100 (0 to 100 inches of water) will be used to measure vacuum at the extraction and monitoring wells.
- A Dwyer Model HP hand pump will be used to calibrate and check all on-site gauges.
- Brass ball valves with barbed fittings and tubing will be used on all vapor monitoring wells to collect vacuum readings.

4.1.5 Pilot Testing Procedures

Separate pilot tests for shallow outdoor soil and deep soil will be completed consisting of initial baseline measurements followed by a step test and a constant rate test. The pilot testing analytical program is summarized in Table 3. Each test is anticipated to take up to one week to complete assuming 24 hours per day operations. A minimum 24 hour equilibration period will be observed between test events. Equilibrium will be considered achieved once pressure readings are within +/- 0.1 inches of water of the initial baseline conditions.

While local permits are not required under CERCLA, the pilot test equipment will be operated in accordance with the terms of a Various Locations Permit from the SCAQMD with compliance sampling and monitoring being conducted during pilot testing.

All pilot testing field data will be documented on field sheets. Example field sheets are included in Appendix G and additional details are provided in the FSP (Appendix F).

4.1.5.1 Baseline Measurements

Baseline pressure readings and soil vapor samples will be collected from the pilot test wells prior to operation of the SVE test equipment as follows:

- Baseline pressure readings will be collected from applicable extraction and vapor monitoring wells prior to each test procedure. These include extraction well SVE-1A and monitoring wells VM-1A through VM-5A for the outdoor shallow soil test, and extraction well SVE-1B and monitoring wells VM-1B through VM-5B for the deep test. Baseline pressure readings will be recorded on a field sheet with a plus symbol ("+") indicating positive pressure and a negative symbol ("-") indicating negative pressure or vacuum.
- Vapor samples will be collected from the applicable extraction well (SVE-1A for the shallow outdoor soil test and SVE-1B for the deep soil test) to evaluate concentrations in the subsurface and select appropriate dilution rates for vapors entering the abatement system. Samples will be collected using a portable sample pump connected to the well head using air-tight sample fittings. A minimum of three purge volumes of vapor will be removed prior to sample collection.
- Vapor samples will be submitted to a state-certified laboratory for analysis under chain-of-custody procedures. Samples will be tested for total petroleum hydrocarbons as gasoline (TPH-G) using USEPA Method TO-3; VOCs using USEPA Method TO-15M; Fixed Gas Analysis using ASTM Method D-1946; and methane using SCAQMD 25.1.

4.1.5.2 Step Testing

The primary goal of step testing is to determine the relationship between the vacuum applied to the extraction wells and the vapor flow rate. Each step test will be conducted by incrementally applying a vacuum to the applicable extraction well (SVE-1A for the shallow outdoor soil test and SVE-1B for the deep soil test) in four consecutive steps, with each step lasting approximately 60 minutes (four hours total for each test). Vacuum is expected to range from 4 to 12 inches of Hg for the shallow tests and 4 to 10 inches of Hg for the deep test due to the higher permeability of the deep soil. The exact vacuum for each step will be determined in the field once the initial vacuum required to induce vapor flow in the subsurface is determined. Table 4 summarizes the anticipated test step vacuums and the associated measurements that will be made. A system schematic showing measurement locations is presented on Figure 27.

The following tasks will be performed during the SVE step tests:

- Flow rates, temperature and applied vacuum will be documented every 30 minutes for the applicable extraction well (SVE-1A for the shallow outdoor soil test and SVE-1B for the deep soil test), dilution line, and influent line.
- The dilution configuration will be recorded every 30 minutes.
- PID, FID and Landtec readings for the applicable extraction well and treatment system influent line will be documented every 30 minutes.
- Vapor treatment system temperature readings will be recorded every 30 minutes.
- Vacuum influence measurements will be recorded at the end of each step for the applicable vapor monitoring wells (VM-1A through VM-5A for the shallow outdoor soil test and VM-1B through VM-5B for the deep soil test). Instrumentation to be used is previously described in Section 4.1.4.
- Vapor samples will be collected from the applicable extraction well and the abatement system influent line at the beginning of each step interval and at the end of the last step interval using a vacuum box and Tedlar® bags.
- The soil vapor samples will be submitted to a state-certified laboratory under chain-of-custody procedures. The samples will be analyzed for TPH-G using EPA Method TO-3; VOCs using USEPA Method TO-15M; Fixed Gas Analysis using ASTM Method D-1946; and methane using SCAQMD 25.1.

4.1.5.3 Constant Rate Testing

A constant vacuum will be applied to the applicable extraction well (SVE-1A for the shallow outdoor soil test and SVE-1B for the deep soil test) during constant rate testing to allow evaluation of system influent concentrations, radius of influence (ROI) and mass removal rates. Each test will run for up to four days, with the vacuum/flow rate to be determined based on results from the step test. Table 5 summarizes the anticipated constant rate test measurements and frequencies. A system schematic showing measurement locations is presented on Figure 27.

The following tasks will be performed during the constant rate test:

- Vacuum influence measurements will be recorded at applicable vapor monitoring wells (VM-1A through VM-5A for the shallow outdoor soil test and VM-1B through VM-5B for the deep soil test) gauge at 0 hours, 4 hours, 8 hours, and 24 hours into the constant rate test and every 24 hours thereafter. Instrumentation to be used is previously described in Section 4.1.4.
- Flow rates, temperature, applied vacuum, and relative humidity will be documented every 60 to 120 minutes for the applicable extraction well (SVE-1A for the shallow outdoor soil test and SVE-1B for the deep soil test), dilution line, and influent line.

- The dilution configuration will be recorded every 60 to 120 minutes.
- Vapor treatment system temperature readings will be recorded every 60 to 120 minutes.
- PID and FID readings for the extraction well, influent line, and effluent line will be documented every 60 to 120 minutes.
- Landtec readings for the extraction well and influent line will be documented every 60 to 120 minutes.
- Vapor samples will be collected at the beginning, mid-point, and end of the constant rate test from the extraction well, influent line and effluent line using a vacuum box and Tedlar sample bags, or as otherwise specified in the Various Locations Permit.
- The soil vapor samples will be submitted to a state-certified laboratory under chain-of-custody procedures for analysis. All vapor samples will be analyzed for TPH-G using USEPA Method TO-3 and VOCs using USEPA Method TO-15M. Only samples collected from the extraction well and influent line will be tested for fixed gases by ASTM Method D-1946 and methane by SCAQMD 25.1.

4.1.5.4 Dioxin/Furan Compound Sampling and Analyses

Additional vapor sampling and testing will be conducted during the constant rate testing (Section 4.1.5.3) to assess the potential for polychlorinated dibenzodioxin and polychlorinated dibenzofuran (dioxin and furan) compound formation as byproducts while using a thermal oxidizer for emission control at source areas within OU1. The objective of vapor sampling and analyses will be to detect the potential production of dioxin and furan compounds in soil vapor in the thermal oxidizer. Background or ambient air sampling and testing will also be conducted for dioxin / furan compounds during the SVE pilot test.

A minimum of 6 background ambient air samples will be collected and 6 SVE emission sampling runs shall be performed for dioxin/furan compounds, and will be conducted during constant rate testing of SVE-1A and SVE-1B. During each sampling run, the thermal oxidizer system will be operating at nominal capacity. Background or ambient air sampling for dioxin / furan compounds will also be conducted daily during the constant rate testing of SVE-1A and SVE-1B. Sample collection and testing for dioxins/furans will be conducted by an independent source testing contractor that is approved by the SCAQMD through the Lab Approval Program (Source Testing) to conduct the sampling and test methods required for dioxin and furan compound sampling and monitoring.

USEPA Method TO-9A will be used to perform background or ambient air sampling to assess potential dioxin / furan concentrations in ambient air. Method TO-9A uses a high volume air sampler equipped with a filter and adsorbent for sampling ambient air over a 24-hour sampling period. The air sampling equipment will be placed (based on prevailing wind patterns) at a location that is generally up-wind of the SVE Pilot Test equipment.

At the post-thermal oxidizer sample location, the following parameters will be collected during each of the daily emission sampling runs:

- Concentrations of dioxins and furans – CARB Method 428
- Sample Traverse Points – SCAQMD Method 1
- Stack Gas Flow Rate – SCAQMD Method 2
- Stack Gas Molecular Weight – SCAQMD Method 3
- Stack Gas Moisture Content – SCAQMD Method 4

The above pollutants and parameters will be tested in accordance with procedures recommended in the SCAQMD Source Test Manual and CARB Stationary Source Test Manual.

The results of the test runs will be reported in a source test report prepared by the independent source testing contractor.

4.1.6 Data Evaluation and Reporting

Following completion of field activities and receipt of analytical results, a SVE Pilot Testing Report will be prepared. The report will describe the procedures, equipment and results associated with the pilot tests and will identify any variances from the Work Plan. The report will document the SVE and monitoring well installation, the system operation and monitoring measurements collected during the tests, sampling activities, and analytical results. Maps with well locations, boring logs/well construction details, tabulated field monitoring and analytical results, laboratory analytical reports and chain-of-custody documentation will be included in the report.

Pilot testing data will be evaluated in the report with respect to the following:

- The relationship between applied vacuum and the vapor flow rate
- ROI
- Well field permeability
- Average VOC system influent concentrations
- Mass removal rates for benzene and other identified COCs
- Selection of an appropriate vapor treatment technology for full scale SVE during RA operations
- Compliance with substantive requirements of SCAQMD emission regulations, which are applicable or relevant and appropriate requirements (ARAR)

Evaluation of the vacuum/flow rate relationship will aid in subsequent selection of appropriate sized blowers for the SVE systems at the various SVE implementation areas. Separate ROIs for the shallow outdoor soil and deep soil areas will be estimated using the observed vacuum influence data from the constant rate tests and the distance from the applicable extraction well to each monitoring well. The data will be plotted on a semi-logarithmic chart with distance from the extraction well on the x-axis, measured vacuum on the y-axis (logarithmic), and a trend line between the data points. The ROI will be estimated as the distance from the extraction well to the point where the observed vacuum is 1 percent of the applied vacuum. Only vacuum readings above 0.1 inches of water will be used for determining the ROI. An alternate approach to ROI estimation based on flow (Gustafson et al. 1994) will also be considered if it is deemed better suited for the Site lithology than conventional vacuum-based ROI methods. The ROI data will be used during RD to determine the appropriate number, size, spacing and screened intervals of SVE wells and soil vapor monitoring points to remediate the impacted area. The vapor stream influent VOC concentrations and flow rates, field permeability, and applied system vacuum/flow rates will similarly be used to develop the SVE system design.

Lastly, the report will summarize the respective findings from the pilot tests and present recommendations for full-scale implementation. If efficient and effective, the findings and recommendations will be subsequently applied to all SVE remedy areas at the Site.

4.1.7 Green Remediation Best Management Practices

Preliminary GRBMPs for SVE Pilot Testing include all the GRBMPs listed in Section 3.8 for the Pre-Design Investigations as well as the following additional GRBMPs:

- Use of variable frequency drive motors to adjust energy use to meet SVE blower demand
- Installation of sound proofing and acoustic barriers on noise-generating remedial equipment to the extent practicable
- Establishment of threshold influent concentrations for switching the vapor treatment system from thermal to catalytic oxidation mode

The final list of GRBMPs will be communicated to the USEPA in a technical memorandum or within a progress report.

4.2 VAPOR TREATMENT TECHNOLOGY EVALUATION

This section provides a preliminary evaluation of vapor treatment technology options to support future SVE remedial design activities at Properties 6, 11 and 23, SA-11, and potentially SA-3 and SA-12. Various treatment technologies have been screened and preliminary recommendations are presented based on historical soil vapor concentrations at the Site. The vapor treatment technology selection will be updated after the Pre-Design

Investigation and SVE pilot tests are completed and finalized in the 100% Remedial Design document.

4.2.1 Technology Screening

A variety of technologies are capable of treating extracted vapors from SVE systems prior to discharge to the atmosphere. The most common of these are thermal oxidation-based technologies wherein COCs are destroyed on-site, and adsorption-based technologies wherein COCs are adsorbed onto permeable media (e.g. VPGAC) and typically recycled or disposed offsite.

Table 6 summarizes the screening evaluation, and is organized by technology type, including thermal oxidation, adsorption, compression/condensation, biological treatment, and two combination technologies. The technologies were evaluated based on multiple site-specific factors, including contaminant type, vapor concentrations, flow rates, air emission regulatory requirements, and the anticipated duration of system operation. The screening evaluation takes into account these factors and rates each technology with respect to four criteria: 1) effectiveness in treating site COCs; 2) implementability; 3) cost; and 4) sustainability. Each technology is rated on a 5-point scale for the four criteria, where "good" is 5 points, "moderate to good" is 4 points, "moderate" is 3 points, "poor to moderate" is 2 points, and "poor" is 1 point. Technologies with combined overall scores of 13 or higher were retained for further consideration.

All the thermal oxidation technologies except internal combustion engines were retained for further evaluation. For adsorption technologies, only VPGAC was retained. The two combination technology options (Thermal Oxidizer with Cat-Ox Polishing and Thermal Oxidizer with VPGAC Polishing) were additionally retained. The screened out technologies generally have technical limitations, higher cost, are difficult to implement, or lack maturity as a commercially available option for environmental remediation. The retained technologies and their benefits and limitations are discussed further below.

4.2.1.1 Thermal Oxidation

Thermal oxidation technologies for vapor treatment are readily available in the industry and are sold by a variety of manufacturers. There are two main groups of thermal oxidation technologies: those that operate at a high temperature (1,400°F or greater) where the contaminant destruction occurs in the gas phase; and those that operate at a lower temperature (around 700°F) that involve destruction of contaminants on a catalyst surface. Examples of the higher temperature thermal oxidation equipment include the direct flame thermal oxidizer, the flameless thermal oxidizer and the regenerative thermal oxidizer. These oxidizers heat the soil vapor in a combustion chamber using natural gas or propane as fuel, with temperatures being maintained at or above 1,400°F. The inlet vapors are often pre-heated with a heat exchanger prior to entering the combustion chamber. High temperature

oxidizers can achieve destruction efficiencies of up to 99.95 percent depending on the specific oxidizer design and contaminant. These oxidizers provide cost-effective treatment of VOC concentrations between 3,000 and 10,000 ppmv. For lower concentrations (<3,000 ppmv), catalytic thermal oxidizers that operate at a lower temperature range of 600°F to 800°F are more cost effective. Hybrid thermal/catalytic oxidizers are also available that can operate at a higher temperature (thermal mode) when concentrations are above 3,000 ppmv and at a lower temperature (catalytic mode) when concentrations decrease below 3,000 ppmv. The equipment for all of these thermal oxidation technologies generally come in standard sizes but can also be customized to meet site-specific design requirements.

Conventional direct-flame thermal oxidizers or hybrid thermal/catalytic oxidizers are the most applicable technologies for initial Site SVE operations, when influent concentrations are highest. A wide range of such oxidizers are available on the market that are well suited for the relatively low SVE flow rates [100 to 500 standard cubic feet per minute (scfm)] that are expected due to the low permeability soils at the Site. Flameless thermal oxidizers are retained but are considered less applicable than conventional thermal oxidizers because of higher capital cost. Catalytic oxidizers are retained as they can be more cost-effective when vapor concentrations are below 3,000 ppmv. Regenerative thermal oxidizers (RTO), while more energy efficient, have a very high capital cost and are typically used for larger SVE systems in the 1,000 to 20,000 scfm range operating over long durations (>10 years). RTO is retained in the event multiple SVE areas at the Site can be combined for treatment in a single vapor treatment system.

Thermal oxidation performance can be limited by low oxygen concentrations and elevated carbon dioxide concentrations. These conditions are common at sites where natural biodegradation of hydrocarbon contaminants is occurring in the subsurface and can affect system performance at startup, but can be effectively managed by using dilution air from the atmosphere or by limiting operation to wells located away from the most impacted area until oxygen levels increase.

Formation of undesirable byproducts that require additional exhaust gas treatment are also possible with thermal oxidation. For example, acid gases such as hydrogen chloride are formed when chlorinated VOCs are combusted. An acid gas wet scrubbing system is then necessary to remove the hydrogen chloride from the system exhaust prior to discharge to atmosphere. A recirculating water spray in a tower is used in these scrubbing systems to rapidly cool the combustion gases to below 200°F and remove the acid gas by water phase absorption. The operational complexity of the thermal oxidizer is increased by the scrubber because the spray water often requires pH control using sodium hydroxide (NaOH) and periodic off-site waste disposal. The potential presence of chlorinated solvent vapors in the vapor stream and associated combustion by-products in treatment system exhaust will be further evaluated during the pilot test.

In spite of the limitations described above, thermal oxidation is a highly effective, proven, and readily implementable technology for treatment of VOC influent concentrations ranging from 250 ppmv to 10,000 ppmv and has been retained for further consideration.

4.2.1.2 Thermal Oxidation with Catalytic Oxidation Polishing

Thermal oxidation with catalytic oxidation polishing treats the vapor stream in two steps prior to discharge to the atmosphere. The inlet vapor stream initially enters a thermal oxidizer operating at a high temperature (1,400°F or greater) where contaminant destruction occurs in the gas phase. Upon discharge from the thermal oxidizer, the vapor enters a heat exchanger that cools the vapor to 800°F prior to entry to the catalytic oxidizer for further destruction of residual contaminants before discharge to the atmosphere. This approach is considered when a higher destruction efficiency (99.99 percent) compared to thermal oxidation alone is desired to comply with system emission standards.

Thermal oxidation with catalytic oxidation polishing is not routinely used in remediation applications, and may involve additional implementation challenges and operational complexities compared to other thermal oxidation technologies. Although not the most cost effective option, thermal oxidation with catalytic polishing is retained in the event higher destruction efficiency is desired.

4.2.1.3 Vapor Phase Granular Activated Carbon Adsorption

VPGAC treatment consists of passing vapor phase contaminants through two or more VPGAC vessels in series, where contaminants are adsorbed to the carbon. VPGAC can typically adsorb between 10 and 25 percent of its own weight in COC mass depending on the specific contaminant and concentrations, vapor temperature and relative humidity. Unlike thermal oxidation systems, VPGAC is not affected by low oxygen or the presence of carbon dioxide, and the media will readily adsorb most chlorinated VOCs. VPGAC treatment equipment is readily available and sold by a variety of vendors. Equipment components include media, vessels, and blowers, and are customized to meet site-specific design requirements.

While VPGAC is well suited for treatment of low vapor concentrations (<250 ppmv), higher vapor concentrations result in frequent carbon change-out that needs to be transported off-site for regeneration or disposal. This technology therefore does not rate well with respect to sustainability and there are significant environmental impacts and risks associated with frequent trucking of the spent carbon. There are also safety concerns associated with high vapor concentrations because adsorption is an exothermic process that releases heat and can raise bed temperatures. Temperatures above 120°F will significantly reduce the carbon adsorption capacity and can potentially cause bed hot spots or fires. The technology is additionally sensitive to relative humidity and does not treat methane (a greenhouse gas), which is commonly present at sites where biodegradation is occurring in the subsurface.

VPGAC is retained for potential SVE applications where influent concentrations have decreased to less than 250 ppmv and it is anticipated that operation of the treatment system will continue for six months or more. VPGAC is deemed cost effective under these conditions. VPGAC is also retained for SVE applications that involve primarily chlorinated solvents, which adsorb well to activated carbon.

4.2.1.4 Thermal Oxidation with VPGAC Polishing

Under thermal oxidation with VPGAC, the inlet vapor stream first enters a high temperature (1,400°F or greater) thermal oxidizer where contaminant destruction occurs in the gas phase. The vapor stream subsequently enters a series of heat exchangers where the temperature is decreased from approximately 1,400°F to 100°F prior to entering the VPGAC where residual VOCs are adsorbed before discharge to the atmosphere. This combination technology is not widely used, and will likely involve significantly higher capital and operation and maintenance costs compared to the simpler thermal oxidation-only technologies.

While thermal oxidation with VPGAC is not the most cost effective technology, it is retained in the event that a higher treatment efficiency is desired and combustion byproducts in the system exhaust are of concern.

4.2.2 Preliminary Recommendations

The retained vapor treatment technologies discussed above were preliminarily evaluated in terms of their applicability for shallow soil SVE (< 15 feet bgs) at Properties 6, 11 and 23 and deep soil SVE (>15 feet bgs) at SA-3, SA-6, SA-11, and SA-12. Preliminary recommendations for vapor treatment technologies are presented below and summarized in Table 7 based on the range of historical benzene concentrations in shallow and deep soil gas for each SVE area:

- Thermal oxidation is the most appropriate primary vapor treatment option for all areas based on the range of benzene vapor concentrations in shallow and deep soil and the destruction efficiencies required to meet regulatory air emission limits. Thermal oxidation combined with either catalytic or VPGAC polishing are additionally retained in the event higher treatment efficiencies are desired.
- Thermal oxidation is additionally recommended during shallow and deep SVE Pilot Testing at Property 23/SA-6. High benzene concentrations are anticipated during the deep pilot testing and thermal oxidation will provide the high destruction efficiency required while avoiding system shutdowns for carbon change outs. By using thermal oxidation for both the shallow and deep soil pilot tests, costs for design work, mobilization and operation will be minimized, the potential for delays reduced, and pilot testing execution simplified.

- A thermal oxidation unit that begins operating in thermal mode and is switched over to catalytic mode as concentrations decline over time is recommended for shallow soil at Properties 6, 11, and 23, deep soil at SA-3 and SA-6, and likely SA-11 and SA-12. VPGAC adsorption is retained only for potential use in shallow soil areas in the event influent concentrations decrease further and operation in catalytic mode is not cost effective.
- The potential need for acid gas scrubber treatment downstream of the thermal oxidizer will be further evaluated during RD for Property 23/SA-3 based on the presence of chlorinated VOCs in shallow and deep soil.
- VPGAC is applicable for SVE at the two small areas of shallow outdoor soil adjacent to the northwest and southwest corners of the building at Property 23.

SECTION 5.0
ISCO BENCH STUDY AND CONCEPTUAL ISCO/ SVE IMPLEMENTATION APPROACH

ISCO is an active remedial technology that uses chemical injection to oxidize (chemically break down) VOCs in groundwater, converting the VOCs into nontoxic byproducts such as carbon dioxide and water. Saturated soil and groundwater collected from SA-11 will undergo a series of tests in the ISCO Bench Study, with the results being used to develop a plan for phased ISCO implementation. The objective of the ISCO Bench Study is to select the oxidant, injection approach and dosage for field implementation. More specifically, the study will:

- Determine the natural oxidant demand (NOD) of saturated zone soil and groundwater
- Evaluate oxidant and activator persistence (longevity) in saturated zone soil and groundwater
- Test the effectiveness of the oxidants over a range of dosages
- Evaluate potential deleterious effects such as formation of detrimental daughter products, significant changes in groundwater pH, and metals formation and mobilization in groundwater
- Select the most effective and efficient oxidant for field implementation based on multiple factors, including COC destruction effectiveness, persistence, safety, and anticipated effectiveness

Bench testing is being conducted to samples from SA11 since the lithology and soil characteristics at SA3, SA11 and SA12 are similar based on review of soil boring logs, CPT logs and physical/chemical data. Benzene is the principal COC at each of the three source areas and while the NAPL at SA12 includes additional components, it is expected that the selected oxidant will be appropriate for all three source areas. After implementation of ISCO/SVE at SA11, additional oxidant testing of samples from SA12 may be conducted prior to implementation as needed to account for oxidant demand.

5.1 OXIDANT TYPES AND INITIAL SCREENING

Principal oxidant types and variants are described below along with an initial screening based on literature and experience (desktop study) to select those oxidant types appropriate for the laboratory bench study. Additional information regarding various oxidants and vendors is provided in Appendix H.

5.1.1 Permanganates

Permanganates are highly soluble crystalline solids that yield the permanganate ion (MnO_4^-) when dissolved in water. Permanganate has a particular affinity for oxidizing organic compounds that contain carbon-carbon double bonds (alkenes), and its effectiveness is well-documented for chlorinated solvents. However, permanganate has a low reactivity with benzene, and is therefore not retained for further evaluation.

5.1.2 Persulfates

Persulfates are crystalline solids that yield the persulfate ion ($S_2O_8^{2-}$) when dissolved in water. This ion can be catalyzed with various compounds to form the SO_4• sulfate radical, a more powerful oxidant. Persulfates are relatively new in the environmental remediation field, but they have been used extensively as oxidants in chemical manufacturing, surface preparation and etching in electronics manufacturing, and as a "shock treatment" for disinfecting swimming pools. Sodium persulfate is the most commonly used persulfate due to its relatively higher solubility and decreased potential for undesirable by-products. Though persulfate injection is potentially effective and implementable, cost would be relatively high due to anticipated high oxidant consumption (45 gram of persulfate per gram of benzene).

Klozur® by PeroxyChem is the only sodium persulfate product licensed for use in environmental remediation applications. Persulfate is a strong and stable oxidant, but needs to be activated to be effective for hydrocarbon remediation. Activation is traditionally achieved through iron, hydrogen peroxide, an alkaline pH (pH >11), or heat, as further described below.

5.1.2.1 Iron Activation

Iron activation is achieved through addition of soluble ferrous iron (Fe[II]) to the sodium persulfate solution to initiate the formation of sulfate radicals. While typically very successful in bench-scale studies, use of ferrous iron alone has limited field applications due to significant precipitation of ferric iron at pH values above 4. Chelating agents such as ethylenediaminetetraacetic acid, citrate, polyphosphate, glycolic acid, catechol, and nitrotriacetic acid are typically added to increase iron solubility. Persulfate with a chelated iron activator, which is available as Klozur by PeroxyChem, is retained for additional evaluation in the bench study.

5.1.2.2 Hydrogen Peroxide Activation

When hydrogen peroxide is added to the sodium persulfate solution, hydrogen peroxide exothermically decomposes yielding heat and hydroxyl radicals that result in the formation of sulfate radicals. This activation is short-lived however, and typically performs better in bench-scale applications than in the field. Additional implementation challenges are created

by the rapid production of oxygen gas, which can result in surfacing of the oxidant. As a result of these concerns, persulfate with hydrogen peroxide is not retained for bench study evaluation.

5.1.2.3 Alkaline pH Activation

Activation can also be achieved by adding an alkaline compound (e.g. NaOH, aka caustic) to the sodium persulfate solution to maintain a pH above 11. Under these pH conditions, persulfate forms sulfate radicals, which react with hydroxide ions to form hydroxyl radicals, which then propagate the activation by forming new sulfate radicals. The primary concern with this activation method is delivering enough alkaline activator to overcome the pH buffering capacity of the soil. However, this activation method is considered better than others with respect to injection implementation for low permeability soils such as exist at the Site. Persulfate with alkaline pH activation is additionally produced under the Klozur product name and is retained for bench study evaluation.

5.1.2.4 Thermal Activation

Persulfate activation and breakdown into sulfate radicals can additionally be achieved through heat that is delivered to the targeted area using steam injection, electrical resistance, or radio frequency heating. The primary limitation of this activation technology is the high energy consumption and associated cost. As a result, this type of activation has not been widely used, and is not retained for further evaluation.

5.1.2.5 Klozur CR® and PersulfOx®

In addition to using Klozur and one of the traditional activation methods described above, Klozur CR® by PeroxyChem and PersulfOx® by Regenesis provide additional options. Klozur CR® is a self-activated product containing sodium persulfate and calcium peroxide. The calcium peroxide provides initial activation via the high-pH mechanism previously described, and continues to release oxygen to support aerobic biodegradation after the solution is injected. This product is not retained for further evaluation due to the low solubility of calcium peroxide and associated difficulties with injection in low permeability soils.

PersulfOx® combines elements of traditional alkaline pH activation and a novel silica catalyst that extends the longevity of activated persulfate in the subsurface. This is a relatively new product that has not been widely used. PersulfOx® is a powder that is mixed with water on-site to produce an alkaline (pH >11) solution. The pH gradually declines below effective levels as the base is consumed, resulting in formation of a silica precipitate that continues to catalyze the formation of sulfate radicals. However, the silica catalyst is injected as a slurry, resulting in dispersal challenges in low permeability formations compared to alkaline pH activation. Also, PersulfOx is a relatively new product that has not been widely used in high

concentration source area remediation. For these reasons, PersulfOx is not retained for bench study evaluation.

5.1.3 Peroxides

Peroxides are typically used in combination with an iron catalyst to initiate formation of hydroxyl radicals through Fenton's reaction. The hydroxyl radical is the primary oxidizing species and has the highest oxidation potential compared to other oxidants. Traditional Fenton's chemistry is often difficult to implement in the field due to the low pH (2.5 to 3.5) required to sustain the reaction, the short lifespan of the oxidant in the subsurface and the potential for surfacing of the oxidant due to formation of oxygen gas. A modified Fenton's reagent (MFR) using hydrogen peroxide and chelated iron as an activator is therefore commonly employed to simplify field application and maximize the longevity of the oxidation reaction. MFR is retained for further bench study evaluation, while challenges with field implementability will be discussed in the bench study report (Section 5.3)

Another MFR approach is the RegenOx® product by Regenesis, consisting of a solid, sodium percarbonate-based alkaline oxidant with a liquid mixture of sodium silicates, silica gel and ferrous sulfate. Sodium percarbonate is safer to store and transport than hydrogen peroxide, yet produces hydrogen peroxide almost immediately when mixed with water. RegenOx® has been demonstrated to be effective on benzene and a wide range of other hydrocarbon contaminants, but is difficult to inject in low permeability formations and not proven for high concentration SAs; hence, it is consequently not retained for further evaluation.

5.1.4 Ozone and Peroxone

Ozone (O_3) can oxidize contaminants directly or through the hydroxyl radical (OH^-), which is formed when ozone reacts with water and is a stronger oxidizer than ozone. Ozone has an additional benefit of increasing DO, thereby enhancing biodegradation. Ozone is typically applied as a gas, has a short half-life, and is only slightly soluble in water. For these reasons it must be generated on-site and continually injected through wells during implementation.

Peroxone is a generic name for a modified ozone injection approach that uses a combination of hydrogen peroxide and ozone, resulting in more rapid production of hydroxyl radicals. Peroxone also increases DO, stimulating biodegradation. Peroxone is typically applied by alternating injection of hydrogen peroxide and ozone at nested injection points, with the ozone injection occurring at a lower well screen interval and the hydrogen peroxide at the upper interval. The ozone gas then migrates upward to interact with the hydrogen peroxide.

There are no proprietary restrictions on the use of ozone or peroxone for environmental remediation and a number of vendors supply these services (H_2O Engineering, Applied Process Technology, Kerfoot Technologies) under various process names (PulseOx, C-Sparger® etc.). Both ozone and peroxone are retained for bench study evaluation. It should be

noted that ozone and peroxone may face implementability challenges in the low permeability formation at this site resulting from rapid degassing of hydrogen peroxide and/or ozone gas injection. The implementability criterion will be further evaluated (see Oxidant selection criteria in Section 5.3) after the bench study prior to selection of the appropriate oxidant for the field study.

5.1.5 Selection of Bench Study Oxidants

Information regarding persulfate, peroxide and ozone oxidant technologies and their variants is summarized in Table 8. Based on the available information, the following five oxidants are retained for evaluation in the laboratory bench study:

- Persulfate with chelated iron activation (Klozur® by PeroxyChem)
- Persulfate with alkaline pH activation (Klozur® by PeroxyChem)
- Peroxide with chelated iron catalyst (multiple vendors)
- Ozone (multiple vendors)
- Peroxone (multiple vendors)

5.2 BENCH STUDY PROCEDURES

The bench study will be conducted by PRIMA, under the supervision of AECOM. PRIMA specializes in treatability testing, technology evaluation, custom laboratory work and scientific consulting services for the environmental community.

Soil and groundwater for the bench testing will be collected from SA-11 as part of the Pre-Design Investigations (Section 3.7) and as described in the FSP. The QAPP is not applicable to ISCO bench study data, as these data will not be used for Site characterization or risk analysis purposes. The following quantities of sample material will be generated from that work and provided to PRIMA:

- 30 kilograms (kg) of NAPL-impacted, saturated zone soil
- 3 kg of un-impacted or minimally impacted saturated zone soil (NAPL not present and reduced benzene concentrations)
- 50 liters of impacted groundwater (high benzene concentration but no NAPL)
- 3 liters of un-impacted groundwater

PRIMA will homogenize and screen the soil with a #4 mesh to form single-volume samples of impacted and un-impacted soil. Similarly, multiple groundwater containers will be composited to form single-volume samples of impacted and un-impacted groundwater samples for use in bench testing.

The bench testing will consist of baseline, oxidant screening, and oxidant effectiveness tests. A schematic presentation of the program is presented on Figure 28, with each type of testing further described below.

5.2.1 Baseline Testing

Baseline testing of the impacted and un-impacted soil and groundwater will be completed to evaluate dosing requirements for subsequent oxidant screening testing. The baseline testing program is summarized below and on Table 9:

- Un-impacted Soil:
  - VOCs including Tentatively Identified Compounds (TIC) by USEPA Method 8260B
  - TPH carbon chain ($C_6 – C_{44}$) by USEPA Method 8015B
  - Total organic carbon (TOC) by USEPA Method 9060
- Impacted Soil:
  - VOCs including TICs by USEPA Method 8260B
  - TPH carbon chain by USEPA Method 8015B
  - Hexavalent chromium [Cr(VI)] by USEPA Method 7199
  - Total metals [(Cr, Fe, arsenic (As), manganese (Mn)] by USEPA Method 6020
  - TOC by USEPA Method 9060
  - pH by USEPA Method 9045
- Groundwater (impacted and un-impacted):
  - VOCs and TICs using USEPA Method 8260B
  - TPH carbon chain using USEPA Method 8015B
  - Cr(VI) by USEPA Method 7199
  - Total dissolved metals (Cr, Fe, Mn, As) by USEPA Method 6020
  - Ferrous iron by method SM 3500-Fe B
  - Alkalinity by USEPA Method 310.1
  - Anions (Sulfate, Nitrate, Chloride) by USEPA Method 300.0
  - Total dissolved solids by method SM 2540C
  - DO by direct reading instrument
  - Oxidation reduction potential (ORP) by direct reading instrument

- pH by direct reading instrument
- Conductivity by direct reading instrument

The groundwater tests using direct reading instruments will be completed by PRIMA, and the remaining tests will be subcontracted by PRIMA to an outside laboratory.

The bench study laboratory work will include homogenization of bulk soil samples and up to 28 days between sample treatment and post-treatment testing (see Table 10). Standard QA/QC criteria, including sample holding times from the time of sample collection, are not applicable since the bench study data are not being used for health risk analysis or comparison to action levels/cleanup levels. The bench study data will be used to select an appropriate oxidant and dosage, which will be done by comparing COC concentrations immediately before and after sample treatment with the various oxidants. VOC losses associated with initial sample homogenization and the elapsed time since sample collection will therefore not impact the outcome of the oxidant testing and selection process. For the purposes of the bench study, holding times that apply will begin when specific bench testing activities are completed, e.g. after sample homogenization, or at Day 28 for the sample from the activated persulfate reactor.

5.2.2 Oxidant Screening Tests

Oxidant screening tests are ancillary to the effectiveness tests discussed in the following section and include caustic dosage, NOD, and pH buffering capacity for persulfate, and hydrogen peroxide longevity and ozone demand tests for the peroxide and ozone oxidants. The purpose and approach for these tests are further described below.

5.2.2.1 Caustic Dosage

Caustic dosage testing will be completed to determine how much caustic is required to maintain a pH greater than 11, which is the required condition for effective oxidation with pH-activated persulfate. This testing will be accomplished through titration of a slurry of impacted soil and groundwater using NaOH while monitoring pH with a direct reading instrument probe.

5.2.2.2 Persulfate Natural Oxidant Demand

NOD refers to oxidant consumption by soil or water that is unrelated to degradation of the COCs. Natural organic matter consumes oxidant, and for highly organic soils, chemical oxidation may not be economically feasible. NOD testing will be completed using three reactors containing un-impacted soil and groundwater in a 1:1 soil to liquid ratio. The reactors will contain low, medium and high doses of sodium persulfate, with the dosages selected based on typical NOD values for the soil type. All reactors will additionally contain

the amount of NaOH (caustic) needed to achieve a pH greater than 11, plus an additional 2:1 mole ratio of caustic to sodium persulfate. After seven days, the water in each reactor will be sampled and tested for residual persulfate. The NOD will be calculated as the total amount of persulfate added to the reactors, less the residual amount remaining. Data for reactors where there is no residual persulfate will be rejected since the NOD for these samples may be higher than amount of oxidant added to the reactor.

5.2.2.3 pH Buffering Capacity

Buffering capacity is a measure of the ability of a sample media to resist changes in pH, and is expressed as the ratio of acid or base added to the media to the change in pH produced (e.g., mEq./pH). Buffering capacity is a key parameter since persulfate oxidation requires activators that affect pH and therefore the oxidant effectiveness. If the pH buffering capacity of the media is poor for acid (i.e., the aqueous pH remains low after acid addition), then the performance of iron-activated Klozur® will be commensurately lower since this product is more effective in a neutral pH environment. If the pH buffering capacity of the soil/groundwater is good for caustic (i.e., pH returns to neutral conditions after the addition of caustic), this would be unfavorable for pH-activated Klozur® because multiple additions of caustic would be necessary to achieve and maintain the high pH necessary for the persulfate to remain active.

Testing will be accomplished by combining impacted soil/groundwater with dilute NaOH to create a series of high pH samples (pH = 11, 12 and 13), and with dilute sulfuric acid to create an additional series of low pH samples (pH = 1, 2, 3). The water pH will be periodically measured until it stabilizes, or for up to 14 days.

5.2.2.4 Hydrogen Peroxide Persistence

Hydrogen peroxide persistence testing will be completed to establish the duration over which it can be expected to remain present in the media. This will be tested by combining impacted soil and groundwater in a 2:1 ratio and adding hydrogen peroxide at low (up to 4 percent) and high (up to 6 percent) doses. Residual hydrogen peroxide will be monitored for up to two days using test strips to evaluate oxidant persistence. Gas production from the samples will additionally be monitored, with the total duration of gas production inferred to be another measure of oxidant persistence.

5.2.2.5 Ozone Demand

The purpose of ozone demand testing is to measure ozone consumption by the sample media that is unrelated to oxidation of COCs. Ozone demand will be estimated by adding a small amount of un-impacted soil and groundwater to ozone-saturated water, then measuring the concentration of ozone in the water at multiple time points (e.g. 15, 30, 45, 60, and 90 minutes) for up to two hours using the indigo method (SM 4500-O_3). A control sample in

which no soil or groundwater is added will also be monitored. The ozone demand will be calculated as the difference in ozone consumption between the sample in which the soil and groundwater was present and the sample in which they were absent. This test will be conducted in duplicate.

5.2.3 Oxidant Effectiveness Testing

While the screening tests are completed largely to establish the conditions under which each oxidant product would be most effective, the effectiveness testing will evaluate the relative ability of each product to treat the COCs present. The general approach for effectiveness testing is described below, followed by details specific to each oxidant type.

Nineteen 1-liter reactor jars will be prepared with a combination of impacted soil and groundwater from the Site for testing. Figure 28 shows the reactors for each oxidant effectiveness test, including an initial sample (t=0) reactor, the primary oxidant test reactors, and process and sterile control reactors. Each oxidant reactor will include approximately 300 grams of soil, with the remainder filled with approximately 800 milliliters (ml) of groundwater and 100 ml of oxidant to leave approximately 100 ml of head space in each reactor. The initial t=0 sample and the process and sterile control reactors will receive deionized water rather than oxidant. The initial t=0 sample testing will serve to document contaminant concentrations in soil and groundwater at the initiation of the effectiveness testing. A duplicate soil sample will be collected from the t=0 reactor to confirm the sample is relatively homogeneous. Testing of process control samples will allow evaluation of contaminant degradation unrelated to the oxidants being tested, including natural biodegradation, mechanical agitation and soil-groundwater chemical interactions. Testing of the sterile control samples will be used for the longer duration (7 and 28 day) tests to quantify degradation unrelated to both the oxidants being tested and natural biodegradation processes. The sterile control samples will be sterilized using sodium azide.

Each reactor will be periodically agitated during the testing period to ensure adequate contact between the oxidant and soil and groundwater, and will remain sealed except when sample collection and testing is necessary. The reactors will additionally be maintained in a dark setting and at a temperature consistent with the media's natural environment.

Each reactor will be sampled only once; there will be no repeated sampling of the same reactor to minimize the potential for outside influences on results. A chemical mass balance calculation will additionally be completed for each oxidant effectiveness test as a check that the tests were properly implemented and the results are defensible. Additional details regarding the testing procedures for each oxidant product are presented below and the analytical program is summarized in Table 10.

5.2.3.1 Iron-activated and pH-activated Persulfate

Ten reactors will be prepared to test persulfate effectiveness, including four using iron-activated Klozur® (two low dose, two high dose), four using pH-activated Klozur® (two low dose and two high dose; all adjusted to pH >11), and one each for process and sterile controls. The amount of sodium persulfate added to the reactors will be determined based results of the NOD screening test. This effectiveness test will be relatively longer due to the slower reaction of the persulfate oxidant, with a duration of approximately 28 days. Two of both the iron-activated and pH-activated reactors will be held in reserve to allow for testing beyond 28 days, if needed.

After 28 days, soil and aqueous phase samples will be collected from one iron-activated and one pH-activated reactor, as well as both control reactors and analyzed for TPH carbon chain and VOCs plus TICs. The aqueous phase samples will also be analyzed for Cr(VI), dissolved metals (Cr, Fe, Mn, As), sulfate, ORP, DO, pH, and persulfate (see Table 10). No headspace gas analyses will be conducted since persulfate reactions are not anticipated to generate significant vapors.

5.2.3.2 Iron-activated Hydrogen Peroxide (Modified Fenton's Reagent)

Higher concentrations of hydrogen peroxide often decompose faster than lower concentrations, without improving contaminant destruction. Therefore, the effectiveness of this oxidant at destroying COCs will be evaluated for single high and low doses, as well as for a low dose applied three separate times. Two primary reactors containing low and high doses of hydrogen peroxide with chelated iron will be used in the approximately 7-day test. A third primary reactor will have a low dose of "hydrogen peroxide and iron" applied daily for three days. After 7 days, soil and aqueous phase samples will be collected from each primary reactor and the two control reactors and analyzed for VOCs plus TICs and TPH carbon chain. The aqueous samples from the primary reactors will additionally be analyzed for Cr(VI), dissolved metals (Cr, Fe, Mn, As), hydrogen peroxide, ORP, DO, and pH. Gas samples will be additionally collected from the primary reactors and analyzed for VOCs plus TICs and TPH-G) (see Table 10).

5.2.3.3 Ozone/Ozone-hydrogen Peroxide

Three reactors will be used to test the effectiveness of ozone and ozone plus hydrogen peroxide: one with ozone, one with ozone and hydrogen peroxide, and one process control (no oxidant) reactor. This will be a 24-hour test, with soil, aqueous phase, and gas samples collected at the end for VOCs plus TICs and TPH carbon chain analysis. The aqueous phase samples will also be analyzed for Cr(VI), dissolved metals (Cr, Fe, Mn, As), hydrogen peroxide (only for reactor with hydrogen peroxide added), ozone, ORP, DO, and pH. Gas samples will be additionally collected from the primary reactors and analyzed for VOCs (plus TICs) and TPH-G (see Table 10).

5.3 DATA EVALUATION AND REPORTING

An ISCO Bench Study Report will be prepared upon completion of the bench study summarizing the testing procedures, identifying variances from the work plan, and presenting the findings and conclusions. Results of the screening and effectiveness tests will be presented in data tables and charts. Independent reports from the bench study laboratory and analytical laboratory will be included as report appendices.

Based on the bench study findings and other factors, the following RD parameters will be presented in the report:

- The chemical oxidant most suitable for use in ISCO implementation at the Site
- An estimate of the appropriate injection dosage (concentration, rate, and volume) for the oxidant, and as appropriate, its associated activator
- The selected approach to injection (direct-push injection versus injection through wells)

Oxidant selection will be based on:

- Oxidant effectiveness in reducing COC concentrations
- The potential for negative effects such as metals mobilization, formation of toxic daughter products, deleterious pH changes and excessive gas production
- Implementability under Site conditions
- The potential impact of dissolved chlorinated solvents on effectiveness
- The potential impact on future treatment or monitored natural attenuation
- Implementation cost

5.4 CONCEPTUAL ISCO/SVE IMPLEMENTATION APPROACH

5.4.1 Overview

ISCO/SVE will be implemented at SA-11. Rather than achieving a quantifiable reduction in risk, the remedial goal is to enhance the groundwater remedy by removing as much VOC NAPL mass as practicable through ISCO. SVE will be used to remove VOC vapors that volatilize from groundwater during ISCO injections.

ISCO/SVE will be implemented where NAPL mass is most concentrated at SA-11. Implementation will be phased to allow for changes in design or procedures based on findings from the initial/previous phase. The Phase 1 area will include 9 to 12 injection points placed in a grid, with a spacing of approximately 15 feet on center. The conceptual

Phase 1 area is indicated on Figure 29 along with anticipated or existing monitoring well locations for the area. The general implementation approach is described below:

- Step 1 – Pre-injection planning/sampling:
  - Locate 9 to 12 injection points in the phase area.
  - Identify existing groundwater monitoring wells or install new wells as necessary in the phase area. For the Phase 1 area, at least two wells will be required to establish groundwater conditions with more certainty, while a single well is appropriate for subsequent phases.
- Collect and analyze groundwater samples from the wells to establish baseline conditions prior to the injection event.
- Step 2 – Injection:
  - Perform the ISCO injection event.
  - Assess the ability to inject without creating any adverse conditions.
- Step 3 – Monitoring and scalability:
  - Collect and analyze groundwater samples at one, two, three and six months after the injection event to assess changes in dissolved-phase COC concentrations and the active life of the oxidant.
  - Evaluate the groundwater data to confirm that:
    - An injection point spacing of 15 feet or greater is sufficient.
    - NAPL mass reduction is occurring.
    - The volume of oxidant required is reasonable.
    - NAPL has not been mobilized and there is no significant creation of adverse daughter products.
    - Additional injection events and/or phases will result in meaningful reductions in NAPL mass.
- Step 4 – Proceed with implementation at next phase area or source area, as appropriate.

A summary of the conceptual approach for oxidant injection, SVE, groundwater monitoring and data evaluation is presented below. Details of the ISCO/SVE RD and implementation will be presented in the 30%, 95% and 100% RD Reports and the approach may be revised based on findings from the ISCO Bench Study and SVE Pilot Studies.

5.4.2 Oxidant Injection

Oxidant injection will proceed using either a direct push rig or semi-permanent injection wells, depending upon the specific oxidant selected from the completed bench study. Injection locations will be installed in a grid pattern. For the Phase 1 injections, a spacing of approximately 15 feet on center is assumed. Injection well spacing may be modified for subsequent phases depending on results from the initial Phase 1 injection. For the direct push method, injection will occur in approximately two-foot vertical increments over the NAPL-impacted interval zone, as determined from previous source area-specific NAPL investigations using a Rapid Optical Screening Tool (ROST) and the Ultra-Violet Optical Screening Tool (UVOST) technologies (Dames & Moore 1998b; URS 2003; URS/NewFields 2011). For areas where sufficient NAPL data exist, the injection interval may vary between individual injection points. If injection wells are used, injection will be through a well screen that coincides with the NAPL-impacted interval. Injections will begin at the hydraulically up-gradient edge of the phase area and proceed hydraulically down-gradient to allow any potentially displaced contaminated groundwater to be addressed during subsequent injection events. Injection will additionally be staggered (adjacent points will not be injected simultaneously) to reduce the potential for groundwater mounding.

It is preliminarily anticipated that injection will occur at rates of approximately 1 to 5 gallons per minute (gpm) and pressures of up to 70 to 80 psi, resulting in an estimated ROI of approximately 10 feet. The oxidant delivery rate and target injection volume may be adjusted during implementation based on observed field conditions. The oxidant injection volume will be determined based on the results of the bench study results and the selected oxidant. Total oxidant injection volume for the entire treatment area will be limited to mitigate the potential for NAPL and dissolved VOCs to migrate outside the treatment zone. Injection volume limits will be discussed in subsequent RD documents. Injection performance will initially be evaluated with respect to whether relatively uniform distribution is achieved using appropriate injection pressures and oxidant volumes, and whether any adverse conditions occur as a result of injection.

5.4.3 SVE

An SVE system will be installed to remove VOC vapors that volatilize from groundwater during ISCO injections. It is anticipated that the SVE wells will be installed in a grid pattern within each phased treatment area. The spacing of the wells will be determined based on findings from the deep SVE pilot study described in Section 4, but is preliminarily anticipated to be approximately 60 feet on center. The SVE wells will be screened from approximately 20 to 40 feet bgs (five feet above the top of the local water table) to cover the entire deep vadose zone.

Operation and monitoring of the SVE system will begin shortly before an injection event occurs to establish a baseline, and will continue for approximately one month after injection is completed to allow for capture of all VOC vapor generated as a result of the injection event while also capturing additional VOC vapor already present in the deep vadose zone. SVE may be terminated prior to one month after completion of injection if VOC concentrations reach asymptotic conditions.

A thermal/catalytic oxidizer will be used as the vapor treatment technology for the SVE remedial component for the reasons previously outlined in Section 4.1.3. The oxidizer is expected to run in thermal mode to accommodate the high benzene vapor concentrations (~15,000 ppmv) that are expected. The SVE system will incorporate temporary, above-ground pipe/hose, and a compound will be created around the equipment with temporary fencing. The equipment will consist of a positive displacement blower, an associated motor, a direct-fired thermal/catalytic oxidizer, and miscellaneous gauges, ports, and other instrumentation. A temporary power pole will be installed to provide electricity for the oxidizer. The equipment is expected to be sized for a flow of 500 CFM and have a vacuum rating of 22 inches of Hg. Operating vacuum levels are expected to range from 5 to 14 inches of Hg depending on the vapor flow rates observed at the extraction wells. The blower and oxidizer selection will be finalized after completion of SVE Pilot Testing during remedial design.

While operation permits are not required under CERCLA, the vapor treatment equipment will be operated in accordance with the terms of a Various Locations Permit from the SCAQMD with associated compliance sampling and monitoring. It is anticipated that vapor influent concentrations will be monitored daily with PID and FID instruments and sampling and analysis for TPH-G using USEPA Method TO-3, VOCs using EPA Method TO-15M and Fixed Gases using ASTM Method D-1946 will be completed weekly after steady state conditions have been reached. Similar monitoring and sample collection and analysis will occur at individual vapor wells on a weekly and monthly basis, respectively.

5.4.4 Groundwater Monitoring

Groundwater monitoring data will be collected from monitoring wells located within each treatment phase area, as well as hydrologically up-gradient and down-gradient from the treatment area. At least two wells will be within the Phase 1 treatment area to allow for greater certainty in evaluating groundwater conditions and remedial effectiveness, while a single well will likely be adequate for subsequent phases. The monitoring wells will be screened from approximately five feet above the water table to a depth at which the vast majority of the NAPL mass lies above, as known from previous source-area specific NAPL investigations. For SA-11, this interval is approximately 35 to 60 feet bgs.

Groundwater levels will be monitored during injection events and injection will be terminated if levels rise above 15 feet bgs. Field monitoring of the wells for temperature, pH, specific conductance, DO, and oxygen reduction potential (ORP) will also be completed during injection events to assess oxidant distribution. Additional groundwater level gauging, sampling and laboratory analysis for the central, up-gradient and down-gradient wells will be completed immediately before an injection event (a baseline event) and repeated at approximately one, two, three and six months after the injection event. Laboratory testing for the baseline and post-injection monitoring events will include analyses for TPH carbon chain, VOCs, alkalinity, As, ammonia, carbon dioxide, chlorides, chromium, hexavalent chromium, total and ferrous iron, manganese, methane, nitrate, and sulfate.

5.4.5 Data Evaluation

Further details regarding data evaluation will be presented in the Performance Monitoring and Evaluation Plan (PMEP). As appropriate, the ISCO/SVE designs for SA-3 and SA-12 will be presented to USEPA for review in future technical memoranda.

SECTION 6.0
INSTITUTIONAL CONTROLS IMPLEMENTATION AND ASSURANCE PLAN

6.1 OVERVIEW AND OBJECTIVES

ICs are legal and administrative controls applied to properties to minimize the potential for human exposure to contamination and to protect the integrity of the remedy. This ICIAP serves to:

- Identify and describe the various ICs to be implemented
- Specify how the ICs will be implemented, monitored, and enforced
- Identify the various parties involved and their roles and responsibilities

ICs work by controlling land or resource use and providing information that helps guide human behavior at properties where the presence of contaminants prevents unrestricted land use. General categories of ICs include governmental controls, proprietary controls, enforcement tools, informational tools and long-term stewardship tools.

The ROD for the Soil and NAPL OU (USEPA 2011) included ICs as an element of the Site remedy. Four IC layers were identified:

- IC-1 – Informational Outreach
- IC-2 – Building Permit Review and Landwatch
- IC-3 – General Plan Footnote
- IC-4 – Restrictive Covenants

Figure 3 illustrates which IC Layers apply to each Site property, and their application is further detailed in Table 11. Each IC layer is additionally summarized in Table 12.

The ICs are layered so that they can be used conjunctively and reinforce each other. By design, properties where higher numbered layers are applicable are also subject to all the lower numbered layers. In this way, where Layer 2 applies, Layer 1 also applies, and likewise, where Layer 3 applies, Layers 1 and 2 also apply, etc.

ICs will be in effect until requested for revision or termination by the property owner or Project Team, upon approval by USEPA. Additional requirements apply for revision/termination of IC-3 General Plan Footnote and IC-4 Restrictive Covenants, as provided in Sections 6.4 and 6.5.

ICs monitoring will be conducted by the Project Team to confirm that the various IC instruments remain in place and are operating effectively.

Each IC layer is discussed in detail below, including a description of the nature of the IC, the properties where they are applicable, the implementing parties and their responsibilities, the implementation process and its components, and monitoring and enforcement requirements, where applicable. USEPA and DTSC will provide review and oversight for all IC layers, and discussion of their roles below is therefore limited to specific additional responsibilities they may have.

6.2 IC LAYER 1 – INFORMATIONAL OUTREACH

6.2.1 Description and Applicability

The informational outreach IC is a tool to inform the public about the environmental condition of the Site and associated land use restrictions that are in place. The target audience includes property owners, prospective owners, developers and their contractors, and the adjacent community. Property owners will be encouraged to pass on information regarding environmental conditions and associated remedial design elements to their tenants.

Informational outreach will be applied to all Site properties. There are no legal requirements associated with IC-1 and therefore enforcement is not applicable. Monitoring of websites will be conducted periodically to ensure the site-related information is still present.

6.2.2 Process and Components

Informational outreach components include document repositories, federal and state registries, websites, and direct communications including public meetings, fact sheets, informational flyers and individual communications. Details regarding these components are presented below.

6.2.2.1 Document Repositories

Document repositories are publicly accessible locations maintained by USEPA where the various work plans, reports, data, records of decision, and other documents pertaining to site investigations can be reviewed to help the public better understand the site. The most complete collection of documents for the Site is the official USEPA site file maintained at the Superfund Records Center. The Superfund Records Center, as well as other repositories are provided below:

- Superfund Records Center
  Mail Stop SFD-7C
  95 Hawthorne Street, Room 403
  San Francisco, CA 94105
  (415) 820-4700
- Carson Public Library
  151 East Carson Street
  Carson, CA 9074
  (310) 830-0901
- Katy Geissert Civic Center Library
  3301 Torrance Boulevard
  Torrance, CA
  (310) 618-5959

6.2.2.2 Federal/State Site Registries

The Site is known to be included on various federal and state lists and databases including, but not limited to, the National Priority List (NPL) and Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) that are national lists maintained by USEPA; and on the state level, DTSC's Hazardous Waste and Substances Sites (Cortese List) and the Regional Water Quality Control Board (RWQCB) Spills, Leaks Investigation and Cleanup (SLIC) list. Registries such as these are available to the public through the internet and comprehensively through third party environmental research companies such as Environmental Data Resources Inc. (EDR). The various lists are routinely checked as part of typical Phase I Environmental Site Assessments to satisfy a buyer's due diligence responsibilities prior to property transactions.

Responsibility for the various registries is limited to the various regulatory agencies that maintain and update them. The Project Team will monitor the registries cited above annually to ensure that site-related information is still present and accurate and will notify the appropriate government agency in the event that it is not present or is inaccurate.

6.2.2.3 Websites

A publicly accessible webpage for the Site exists on USEPA's webpage that includes detailed project information and technical documents. Available information includes the involved parties, a site description and history, contaminants and risks, investigation and cleanup activities, cleanup results to date; community involvement (including a Community Involvement Plan and Fact Sheets); and various technical documents and reports. This website can be accessed at http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/ViewByEPAID/CAD029544731.

USEPA is responsible for maintaining this webpage. The Project Team will continue to provide documents and coordinate with USEPA for posting documents to the website.

The Project Team will review and recommend a website to replace www.delamo.info, or recommend improvements for an upgrade. Website shall store Site and parcel-specific data.

The Site is also included in DTSC's EnviroStor database, an online and Geographic Information System (GIS) tool for identifying sites that have known contamination, sites for which there may be reasons to investigate further, and facilities that are authorized to treat, store, dispose or transfer hazardous waste. Public access to EnviroStor is available via the DTSC Web Page located at: http://www.envirostor.dtsc.ca.gov. The EnviroStor webpage for the Site includes a brief site history, cleanup status and regulatory profile; digital copies of recorded covenants; documents pertaining to completed, current and future activities, sub-area descriptions and an interactive map. DTSC is responsible for maintaining this webpage.

6.2.2.4 Direct Communications

Direct communications include fact sheets, flyers, public meetings, and individual communications. Through these mechanisms, regular updates will be provided to the community, introduce the public to significant new activities, and inform the public of major milestones. Fact sheets and flyers will be distributed through postal and electronic mailing lists and will additionally be posted online on the previously described website. Public meetings will be conducted on an as-needed basis to inform the public and provide a forum for public comment when applicable. USEPA is primarily responsible for these direct communications.

In accordance with Section 29 of the CD, the Project Team shall participate in community involvement activities, including but not limited to preparation of fact sheets, flyers, letters, final editing, production and distribution. The Project Team will support USEPA's efforts as has been done throughout the years on this project.

Annually, the Project Team shall produce and distribute to all property owners within the former rubber plant property a letter that provides an update on site activities and reminds them of site land and groundwater use restrictions, any restriction associated with protecting remedial or monitoring components on their property, and continued need to coordinate with the site team regarding construction or redevelopment work.

6.3 IC LAYER 2 – PERMIT REVIEW AND LANDWATCH

6.3.1 Description and Applicability

Permit review and Landwatch is a system by which proposed construction projects for Site properties are reviewed to identify whether there is a potential for exposure to contaminants. The system is currently operating effectively as a pilot program described in USEPA's June 27, 2007 Work Plan Supplement, and will continue to be implemented under the ROD in a similar fashion. This IC is partly an informational tool facilitating communication between a property developer and an environmental review team, but additionally acts as a long-term stewardship tool through land use monitoring.

This IC can lead to additional sampling, field monitoring, and a remedial action pursuant to the "Future Areas" component of the ROD, if conditions specified in the ROD are met. Appendix A provides a Work Plan for such remedial activities.

The permit review and Landwatch IC is applicable to all Site properties. It is primarily implemented by the Project Team, with USEPA having an oversight and approval role. The Project Team, DTSC and USEPA collectively comprise the Environmental Review Team (ERT) for IC-2. There are no legal requirements for IC-2 and therefore no standardized enforcement actions, although property owner cooperation in the permit review process and cooperation in any recommendations for further investigation or remedial actions will be strongly encouraged by the ERT. However, independent enforcement action can be taken by USEPA directly with a property owner in certain circumstances to compel cooperation.

6.3.2 Process and Components

6.3.2.1 Permit Review

The ERT has previously worked with the City to flag Site parcels in the City's Planning's Zone Information Map Access System (ZIMAS), which is accessed by City employees whenever building and grading permits are applied for by owners and developers. The flag identifies the subject property as being part of the Del Amo Superfund Site, instructs the City Department of Building and Safety to inform the applicant that additional environmental review is required, and provides ERT contact information.

Initial ERT contact by the applicant is typically with the Project Team. Through discussion and review of available planning documents, the Project Team conducts an initial screening of the project. If the project does not involve excavation in excess of 18 inches bgs, or a change from the current industrial/commercial land use to a sensitive use (i.e., residential use, a hospital for humans, a school for persons under 21 years of age, or a day care center for children), no further review is necessary and the project can proceed with notification by the Project Team.

In the event that excavation in excess of 18 inches or an identified land use change is planned, additional review of the proposed project and existing environmental data, historical rubber plant facilities, and BRA findings for the property is completed by the Project Team. This process culminates in the preparation of a Screening Evaluation Summary Report (SESR) that includes the following:

1. A description of the proposed project
2. A summary of the calculated risks to commercial/industrial and construction worker receptors, as identified in the BRA (URS/Geosyntec 2006) and FS[3] (URS 2010) at the project location
3. Any institutional and/or engineering controls applicable to the project location, including any restricted uses
4. A summary of existing environmental data and sampling locations on the property, particularly in proximity to planned excavation/grading areas
5. A map indicating the location of former rubber plant site facilities and sample locations relative to proposed excavations and construction work
6. Recommendations for additional monitoring, evaluation, sampling, testing or remediation

Upon completion, the SESR is reviewed by USEPA and revised and finalized by the Project Team, as necessary. USEPA then issues the SESR and an accompanying cover letter to the applicant that reviews the SESR findings and recommends follow-up actions where appropriate. The letter also identifies the parties responsible for implementing any follow-up actions.

A generic work plan for excavation, if required, including information regarding soil sampling and soil management is presented in Appendix A. This template will serve as the basis for future Site development projects in which sampling, and potentially excavation and disposal, of impacted soil is expected.

For any field work conducted that involves site-related contamination, a Technical Memorandum summarizing the activities and findings shall be prepared and submitted to USEPA by the Project Team.

6.3.2.2 Landwatch

Landwatch is an additional tool by which Site development projects or other construction, maintenance or repair activities that could result in exposures are identified and reviewed.

[3] Some revisions to BRA calculations were made in the FS.

Landwatch is accomplished through a third party service (Terradex) that is subscribed to and is part of the previously described ICs pilot program.

Types of development activities to be monitored by Terradex, the information sources, and the frequency at which the information is available are indicated below:

Development Type	Information Source	Availability/ Monitoring Frequency
Excavation	Underground Service Alert (USA)	Daily
Building Permits	Construction Monitor (third-party source)	Weekly
Grading Permits	LA City Department of Building and Safety	Monthly
Zoning Changes	LA City Planning agendas; California Environmental Quality Act (CEQA) filings	Monthly
Change to Sensitive Land Use	California Community Care Licensing Division; California Public Schools database; Medicaid database	Monthly
Ownership Changes	Los Angeles County Tax Assessor	Quarterly
Environmental Releases	Geotracker; California Emergency Management Agency and National Response Center	Quarterly
Water Well Permits	LA County Environmental Health	Monthly
Soil Boring Permits	LA County Environmental Health	Monthly

When identified, alerts for all development categories are communicated by email to at least two of the Project Team members.

The Terradex service provides redundancy and an independent check on the previously described permit review process, since in this case the development projects are identified by a third party when the building permit is pending or issued rather than through notification by the building permit applicant when the permit is applied for. The service also routinely identifies smaller projects such as utility installation or repair work where a building or grading permit may not have been applied for but USA has been notified.

6.3.2.3 Public Street Work Advisories

The Del Amo Parties will work with City representatives to place a flag in this database for Site streets that will serve a similar purpose to the previously described flags placed in ZIMAS for private property development projects. The flag will identify the street segment as being within the Superfund Site, inform the reviewer that additional environmental review is necessary, and provide ERT contact information. Upon notification, the Project Team will

complete the environmental review process as previously described for the permit review process, including preparation and USEPA review of a SESR where appropriate.

6.3.3 Monitoring

Monitoring activities for IC-2 will consist of annual confirmation by the Project Team that Site properties are flagged for ERT permit review at the City Building and Planning Department and maintaining the described Terradex Landwatch service or an equivalent. Confirmation of the permit review process will be accomplished through viewing ZIMAS via the internet and communications with the City Planning Department and Department of Building and Safety. In the event that flags are identified as having been mistakenly omitted from one or more properties, a request to reinstate the flag will be submitted to the City. The City had voluntarily participated in this IC, so there is no enforcement mechanism to compel the City if they withdraw either the flags or their participation overall.

6.4 IC LAYER 3 - GENERAL PLAN FOOTNOTE

6.4.1 Description and Applicability

The General Plan Footnote IC consists of amending the General Plan Land Use Map in the City's Harbor Gateway Community Plan ("General Plan") to identify the existence and location of the Site and further indicate that selected Site properties are not appropriate for residential use. This IC is categorized as a governmental control, wherein land use restrictions are placed on properties under the jurisdiction of a government agency. While all Site properties are currently zoned for industrial or commercial use, this IC will further reinforce the existing restriction and serve as a reminder to City planners in the event that an owner or developer applies for a zoning change. The IC therefore decreases the likelihood of a change to residential land use.

The General Plan Footnote will apply to Site properties identified in the ROD. City requirements specify that implementation of the IC must be initiated and directed by the City, although the Project Team will begin the process through submittal of application materials and other informational services. Given that the General Plan Footnote pertains to City zoning restrictions, enforcement of the IC will be the responsibility of the City.

6.4.2 Process and Components

6.4.2.1 Application Process

Coordination and communication with the Planning Director will occur prior to and during submittal of a formal application.

The following information is required as part of the application process according to the City's checklist for General Plan Amendment Applications. Actual application materials and submittal requirements may change per City recommendations after a project management level preview meeting:

1. Application Form:

   - Project size and location
   - Project description
   - A clear, complete and accurate request clause
   - Owner applicant status
   - Owner affidavit signed

2. Application materials:

   - Master application
   - Radius map
   - Mailing list
   - Plot plan
   - Photographs
   - Additional information
   - Environmental clearance (note: City staff to determine what will be required for CEQA compliance)

The Project Team will submit the formal application and associated materials for the proposed amendment, as well as prepare a draft General Plan Footnote for USEPA review and approval prior to submittal of the formal application to the Development Services Center. The City may later wish to revise the draft language, which would be coordinated between the Project Team, the City, USEPA, and DTSC.

General Plan amendments must be initiated by the City Council, the City Planning Commission or the Director of Planning (LAMC 11.5.6 B) by majority vote. It is transmitted to the Planning Director for report and recommendation to the Planning Commission.

The City Planning Commission will then conduct a public hearing.

After the public hearing and receipt of any report from the Planning Director, the Planning Commission will make a recommendation to the Mayor and the City Council for approval or disapproval either in whole or in part.

Within 30 days after receipt of the Planning Commission recommendation, the Mayor will make a recommendation to the City Council on the proposed amendment. If the Mayor does not act within the 30-day period, the inaction will be deemed a recommendation for approval of the General Plan amendment.

The City Council will hold a public hearing on the proposed amendment.

Then the City Council may adopt the amendment by a majority vote. Depending upon the vote and any proposed changes, the process could continue for some time prior to final approval.

6.4.3 Modification or Termination

Modification or termination of a General Plan Footnote that has been previously implemented would be considered an amendment to the General Plan and would therefore follow the same procedures as described above for the original footnote.

6.4.4 Monitoring

Monitoring of the General Plan footnote IC will be undertaken by the Project Team and consist of the following elements:

- Confirmation that zoning has not changed to permit residential or any other sensitive land use at applicable properties per the Terradex Landwatch monitoring described above.

USEPA will be notified of any discrepancies. USEPA would not have enforcement authority over the City in this regard.

6.5 IC LAYER 4 – RESTRICTIVE COVENANTS

6.5.1 Description and Applicability

Restrictive covenants are legal agreements entered into by the property owner and DTSC that run with the land and are binding upon all future owners and occupants. Restrictive covenants are categorized as proprietary controls in that they are based on property law and involve legal instruments placed in the chain of title with the property that are binding on subsequent purchasers of the property.

Covenants will be applied to the properties designated in the ROD. The covenants will consist of the following land use restrictions, as identified in the ROD:

- Restrictions on residential and other sensitive land uses
- A requirement for USEPA review of all development plans involving excavation in excess of 18 inches bgs or change to a sensitive land use

- A requirement for non-interference with remedial facilities and engineering controls
- A requirement for USEPA and DTSC approval prior to drilling into, and use of, groundwater

Residual COC concentrations will likely remain in the restricted areas after remedy implementation. COC concentrations will generally be reduced after completion of remedial activities. Any residual COCs remaining after completion of the remedial action that exceeds the remedial goal and has a potential pathway for exposure will be managed through the use of institutional controls.

The ROD-identified restrictive covenants applicable to each property are identified on Figure 30 and Table 11. A DTSC template for a generic restrictive covenant agreement from the CD indicating the general form of the agreement and specifying additional restrictive covenant elements that are required for all properties where restrictive covenants are applied is provided in Appendix I.

6.5.2 Process and Components

Implementation of restrictive covenants involves the following steps:

- Title reports (includes legal descriptions). Legal descriptions and a map of the boundaries of the areas covered by the restrictive covenants were submitted as a separate addendum on November 7, 2016.
- Identification of existing liens and encumbrances that could potentially impact the remedy and enforcement of the restrictive covenants
- Review and approval of the covenants by the regulatory agencies and property owners
- Execution and filing of the covenants with County of Los Angeles Assessor and Recorder Office, with a copy to the City

The schedule for implementation of restrictive covenants is summarized in the CD and included in Figure 31.

Property owner consent is required to allow restrictive covenants to be recorded. In the event that negotiations are unsuccessful and one or more owners refuse to provide their consent, USEPA will be notified. A title report will be issued for each property, including the identity and address of the property owner, a legal description of the property, and a listing of existing easements, liens and other encumbrances. The title report shall meet the requirements of a title insurance commitment, come from a title company, and be in the form of the ALTA Commitment form – 1982 (as amended).

The Project Team shall evaluate liens and encumbrances associated with each property from the title reports for their impact on remedy implementation compliance with the restrictive

covenants. For any encumbrances that will impact the remedy and cannot be avoided, DTSC and USEPA will be notified, and the Project Team shall request the release or subordination of the encumbrance with the third party encumbrance holder.

For those properties where semi-permanent outdoor remedial facilities will be located (caps, vapor wells, monitoring wells, treatment systems, pumps, utilities etc.), easements will be recorded as necessary. Once RD has been completed and the location of the facilities has been finalized, the remedial areas will be surveyed and a legal description of the area will be prepared in accordance with survey guidelines. The legal description and associated survey maps will be included as part of the underlying documentation for the restrictive covenants.

For those properties where no remedial facilities will be located but restrictive covenants are required, a description of the restricted area(s) including maps and GIS information, legal description and final survey maps will be prepared in accordance with survey guidelines. The legal description and associated survey maps will be included as part of the underlying documentation for the restrictive covenants as described above.

6.5.3 Monitoring

Monitoring associated with the restrictive covenants will include the following:

- Title reports to be updated every 5 years
- Landwatch monitoring (Terradex)
- Annual inspection of remedial facilities
- Inspections for engineering controls at those properties where they are in place to be performed every 5 years to confirm their satisfactory condition and effectiveness

Enforcement of the restrictive covenants would rest with DTSC, per State law governing these types of covenants, and with USEPA as a third-party beneficiary.

6.6 REPORTING

An annual ICs monitoring report that evaluates the status of the ICs will be prepared and submitted to USEPA and DTSC. USEPA will review and approve the annual reports. The report will summarize the monitoring IC Layers as described above and will include:

- Description of monitoring conducted
- Certification by the Project Team that ICs remain in place and are effective
- Documentation of any non-compliance and resulting enforcement or corrective action

- Update of title commitment at least once every 5 years, to identify all current ownership interests
- Any recommendation for reducing and/or removing ICs

SECTION 7.0
REMEDIAL DESIGN AND PERFORMANCE GOALS

A description of the Preliminary Design (30%), Pre-Final Design (95%) and Final Design (100%) process and deliverables for the active remedy components is presented below. ICs are described in Section 6 but excluded from discussion in this section because they are administrative in nature and do not have a physical design element.

7.1 PRELIMINARY (30%) DESIGN

A Preliminary Design Report will be submitted to USEPA when the design effort is approximately 30% complete and within 120 days after USEPA approval of the Final RD Work Plan, Pilot Study Report, or the completion of additional characterization activities, whichever comes later. The 30% Design Report will include the following elements:

- Pre-Design Investigation data
- Conditions affecting the design, including land use and ownership, development, site topography, and surface paving or vegetation conditions
- A description of the selected remedies, remedial objectives, and performance standards
- Preliminary design criteria, drawings, and a list of specifications for the selected final remedy
- A preliminary cost estimate for remedial system construction and operation and maintenance
- Design assumptions and parameters, including uncertainties, design restrictions, expected construction disturbances, process performance criteria, treatment unit processes, and expected removal or treatment efficiencies (concentration and volume)
- A summary of ISCO bench study and SVE pilot testing results
- A description of necessary construction/demolition, engineering controls, treatment system layouts, design calculations, equipment specifications, instrumentation and controls, support facilities, and utility requirements
- A summary of applicable specifications, codes and standards
- Permit requirements (e.g., drilling, building, planning, fire, electrical, natural gas, demolition, source area treatment, earthwork, grading, injection, waste discharge, traffic control, etc.). While no permits are required for the Work under CERCLA, all activities will be performed in compliance with requirements of permits that would otherwise be applicable

- A description of remedy implementation processes, logistics, health and safety monitoring, surveying, system construction/installation, remedial system operation and monitoring procedures, permit compliance sampling, and long-term operation and maintenance requirements
- Proposed clean-up verification methods, including compliance with ARAR
- A summary of methods for minimizing public and environmental impacts from the remedy through engineering controls and operational/functional monitoring
- A description of the project delivery strategy (design/bid/build or design/build)
- A Green Remediation/Sustainability Plan that describes how RA will be performed in accordance with USEPA's Superfund Green Remediation Strategy
- A preliminary construction schedule, including permit requirements
- Access agreements for implementation of the RA
- A Value Engineering Screening or Study

The 30% Design Report will be refined to add additional details and address comments through the 95% pre-final and 100% final design stages. However, if the 30% design for any proposed remedial response action meets the USEPA's design requirements, it may be approved for implementation and would not be carried forward to the 95% pre-final design or 100% final design stages.

Additional details regarding the development and scope of the Preliminary Design Report with respect to each active remedy component is presented below.

7.1.1 Capping

As previously discussed in Section 3, caps are already in place at each cap area and their adequacy will be further evaluated in accordance with the Cap Survey Plan during the Pre-Design Investigation phase. Any minor cap repairs that do not require formal design (e.g., asphalt patching and/or slurry seal) will be described in the Pre-Design Investigation Report and finalized in the Preliminary Design Report. For caps with more significant deficiencies, preliminary designs for their repair or replacement will be presented in the Preliminary Design Report. The cap designs will include assumptions, construction details, cap materials, thickness specifications, allowable traffic loads based on current and future site use, limitations associated with cap constructability, and a draft operations and maintenance (O&M) plan describing required periodic inspection, monitoring and maintenance activities.

7.1.2 BECs

Implementation of BECs is limited to Property 16 and will be contingent on results of air monitoring conducted during the Pre-Design Investigation, as described in Section 3.3. BECs implementation will be accomplished in incremental steps, beginning with modifications to the passive ventilation system. The nature of the modifications and an associated monitoring program to evaluate its effectiveness will be presented in the Preliminary (30%) Design document. Implementation of any additional BECs, such as HVAC modification, floor sealing, and sub-slab venting will only be pursued as necessary, as determined through multiple intervening air monitoring events. For this reason, BECs implementation may proceed on a different schedule than other remedy components, and involve multiple work plans and technical memoranda to describe the various air monitoring events, present results, and evaluate the success of the incrementally applied BECs.

7.1.3 SVE in Outdoor Shallow Soil

Implementation of SVE in outdoor shallow soil will be contingent on results of soil sampling conducted during the Pre-Design Investigation, as described in Section 3.4. The preliminary SVE system design for outdoor shallow soil areas (Properties 6, 11, and 23) will be developed based on results from the Pre-Design Investigations and the SVE shallow soil pilot testing. Information presented in the Preliminary Design Report will include preliminary equipment specifications, utilities, number of wells, subsurface conveyance pipe layout, well spacing, and the equipment compound location. The equipment specifications will include the size and type of vacuum blowers and vapor treatment equipment to treat the VOC influent stream and meet SCAQMD emission limits. The number of extraction and monitoring wells and well construction details will be based on the lateral and vertical extent of the treatment areas, as determined from the Pre-Design Investigation, and the ROI, as determined from SVE Pilot Testing. The sizing of the blowers will be based on expected well flow rates, applied vacuum, and mass removal rates developed from the pilot test results. The potential for combining SVE systems for cost effectiveness will also be evaluated when multiple treatment areas are in close proximity to each other such as for Property 23/SA-3/SA-6. The Preliminary Design Report will additionally address any data gaps or implementation challenges identified during SVE Pilot Testing.

7.1.4 SVE Under a Building

Implementation of SVE under a building will be contingent on results of sub-slab vapor samples conducted during the Pre-Design Investigation, as described in Section 3.5. In accordance with Section 12.4.2 of the ROD, if new analytical data demonstrates that the described clean-up goal has been met prior to implementation of the remedy, the intent of the ROD will have been met. The preliminary SVE system design for SVE under a building (Property 23) will be developed based on results from the associated Pre-Design

Investigations and SVE outdoor shallow soil pilot testing. Design information presented in the Preliminary Design Report will include the same elements identified in Section 7.1.3 above for SVE in outdoor shallow soil. Opportunities for achieving cost efficiencies through combining the SVE under a building treatment system and the system for one or more of the adjacent outdoor shallow soil areas and/or the deep soil SVE system at Property 23 will be evaluated, as appropriate.

7.1.5 SVE in Deep Soil at a NAPL-impacted Source Area

The preliminary SVE system design for deep soil at SA-6 will be developed based on results from the associated Pre-Design Investigations and deep soil SVE Pilot Testing. Design information presented in the Preliminary Design Report will include the same elements identified in Section 7.1.3 above for SVE in outdoor shallow soil. Opportunities for achieving cost efficiencies through combining the deep soil SVE treatment system and the system for one or more of the adjacent outdoor shallow soil areas and/or the SVE under a building system at Property 23 will be evaluated, as appropriate.

7.1.6 ISCO/SVE

The preliminary ISCO/SVE remediation design for SA-11 will be based on the ISCO Bench Study and SVE Pilot Study results and the phased implementation approach outlined in Section 5.4. The preliminary design will include the preferred oxidant(s), the preliminary number of injection locations, and injection approach (temporary, direct push locations versus longer term wells), dosage and intervals. Injection approach selection will be based on the selected oxidant, local soil conditions, and logistical considerations. A ROI will be inferred based on subsurface lithology to determine the number and spacing of injection points, which will be revised as appropriate based on initial results. The design will also present preliminary monitoring well locations and a sampling plan for monitoring ISCO performance. If a direct push injection approach is selected, the injection procedure will be described, including details of the injection rig and chemical storage location. If injection wells will be used, the preliminary design will present well locations and construction details, piping layout, oxidant injection equipment, and the location of the oxidant chemical storage tanks and treatment compound.

7.2 PRE-FINAL (95%) DESIGN

The 95% design will incorporate agreed upon agency comments from the 30% design and present engineering plans and drawings, specifications, and equipment lists suitable for bid solicitation. The remedial system layout for each remedy will additionally be finalized based on a comprehensive review of subsurface conditions to identify buried utilities and building structure components that could affect placement of remedial equipment. Subsurface investigation will include review of existing as-built drawings (to be provided by each property owner), utilities in the public right-of-way, and a geophysical investigation. All

subsurface and overhead utilities as well as buried structures will be mapped to aid with the final placement of the remedy components. This activity will help manage construction costs and the installation schedule by eliminating unknowns prior to bid solicitation and field implementation.

The Pre-Final Design Report will be submitted when the design effort is approximately 95% complete, within 120 days after receipt of USEPA comments on the Preliminary Design Report. This report will be a continuation and expansion of the Preliminary Design Report and will address USEPA comments regarding the Preliminary Design. The Pre-Final Design will serve as the Final Design if USEPA has no further comments and approves the Pre-Final Design.

The Pre-Final Design Report will include all the elements described for the Preliminary Design Report plus the following additional elements:

- Highlights of changes from the 30% to the 95% design
- Updated or additional data, detailed design criteria, and relevant calculations
- Final engineering plans and drawings, specifications, and equipment list suitable for bid solicitation
- Survey work necessary for securing property easements or licenses and design completion
- A final cost estimate for remedial system construction and operation and maintenance
- A proposed project schedule for construction and RA implementation
- A schedule for startup and long-term O&M activities
- Final methods for selection and procurement of remedial construction contractor(s)
- An implementation plan for construction and construction oversight
- A photographic documentation plan for remedial construction work
- A plan for remedial action system operation and injection activities to achieve the performance standards
- A description of efforts made to secure access, institutional controls, and any other approval needed from property owners or tenants, and the results of those efforts
- Legal descriptions of any property or easements or licenses to be acquired

The report will include drawings/specifications for the following items:

- Title sheet including the project title, key maps with north arrow and scale, name of the designer, date prepared, and sheet index listing the sheet titles, sheet numbers and the person responsible for preparing each sheet
- All properties within 200 feet of the Site including the name and address of the owners of record
- A survey including the distance and bearing of all property lines that identify and define the project area
- All recorded easements, licenses, right-of-ways, and reservations
- Location and delineation of all significant natural features
- A topographic survey, including existing and proposed contours and spot elevations for all areas that will be affected by the remedial activities, based on U.S. Coast and Geodetic Survey data
- Flood hazard data and 100-year and 500-year flood plain delineation
- Existing surface conditions
- Wells, facilities, and equipment to be constructed or installed
- Proposed building, equipment and piping layouts and/or cross section views
- BEC/SVE/ISCO remediation systems process, instrumentation and electrical/control panel diagrams
- Detailed design drawings of all proposed equipment, improvements, construction and installation items in accordance with the current standards and California guidelines
- All utilities, existing (on file with the local municipality and as identified under the available dig alert notification systems) and proposed
- Electrical, mechanical, and/or structural plans for work, as required
- Decontamination areas, staging areas, borrow areas and stockpiling areas
- A specification for a sign to be placed at work areas at the Site describing the project, identifying the name of the main contractor performing the Work, stating that the project is being performed under USEPA oversight, and providing contact information
- Security measures for areas of active construction/operation
- Roadways
- Definitions of all symbols and abbreviations

Drawings will be submitted in both standard D and standard B size. Drawings and specifications will be certified by a Professional Engineer registered in the State of California

and will be of reproducible quality suitable for bid advertisement. Example design sheet templates are provided in Appendix J. Additional details regarding the Pre-Final Report with respect to each active remedy component are presented below.

7.2.1 Capping

For any caps that are identified to be deficient or in need of more significant repair or replacement, the Pre-Final Design will expand on the preliminary design documents to reflect design changes and present the final design engineering plans, drawings and specifications suitable for solicitation of bids to repair, upgrade or replace the existing cap.

7.2.2 BECs

Any BECs identified in the Preliminary Design will be revised in the Pre-Final Design to address any associated comments received on the preliminary design. If the BECs remedy requires steps beyond modification of the passive ventilation system, then additional evaluation and design will be required and will likely be provided in separate work plans and technical memoranda.

7.2.3 SVE in Outdoor Shallow Soil

The Pre-Final Design Report will include engineering plans and drawings, specifications, and equipment lists suitable for bid solicitation for SVE in outdoor shallow soil. It will present the final location and design of the extraction and monitoring wells, the size and selected manufacturer of the vacuum blower, the layout of conveyance piping and the recommended vapor treatment equipment for each shallow soil SVE area. The design will include approximate placement of the treatment compound and the layout of the equipment in the treatment compound. The design will additionally identify remedial areas that will be combined for service by a single vapor treatment system, as appropriate.

7.2.4 SVE for Soil Under a Building

Elements of the Pre-Final Design Report associated with SVE for soil under a building will be consistent with those identified for SVE in outdoor shallow soil in Section 7.2.3 above.

7.2.5 SVE in Deep Soil at a NAPL-impacted Source Area

Elements of the Pre-Final Design Report associated with SVE in deep soil will be consistent with those identified for SVE in outdoor shallow soil in Section 7.2.3 above.

7.2.6 ISCO/SVE

The 95% design will include final injection locations, injection dosage, and injection intervals. It will specify the oxidant manufacturer, oxidant concentration for injection,

oxidant preparation or mixing instructions from the manufacturer and oxidant storage location. The design will present the final number and location of performance monitoring wells and an associated sampling plan indicating the frequency of sampling and testing procedures to be performed. If an ISCO approach with injection wells and piping is selected then well locations and construction details, piping layout, injection equipment, chemical storage tanks and the treatment compound location will also be included in the Pre-Final Design Report.

7.3 FINAL (100%) DESIGN

If USEPA does not approve the Pre-Final Design Report, it will be revised to address comments and re-submitted as the Final Design Report within 60 days after receipt of the comments. The Final Design Report will provide final versions of all elements from the Preliminary Design Report and Pre-Final Design Report. If USEPA approves the Pre-Final Design Report, it will be considered to be the Final Design Report. Subsequently, the Draft Operation and Maintenance (O&M) Plan and Draft Construction Quality Assurance Project Plan (CQAPP) will be submitted to USEPA within 120 days after receipt of USEPA approval of the Pre-Final or Final Design Report. Details of the Draft O&M Plan and Draft CQAPP are described below.

7.3.1 Draft O&M Plan

The Draft O&M Plan will describe long-term operation and maintenance for RA, including all elements of the Site Wide Management Plan (SWMP). The Draft O&M Plan will be prepared in accordance with applicable federal, state and local laws and regulations, and policy/guidance documents. The Draft O&M Plan will include the following elements:

- Description of and schedule for each O&M task
- Description of and schedule for periodic inspections of equipment and remedial components
- Description of instrumentation and equipment monitoring
- Example inspection and monitoring checklists and descriptions of periodic reports
- HASP including descriptions of field activities, JSAs, health and safety monitoring, necessary PPE, shut down procedures, etc.
- Description of common equipment troubleshooting and common and/or anticipated remedies
- Description of routine monitoring, data collection and laboratory testing; schedule and procedures for monitoring; and anticipated interpretation of the data

- A FSP and the existing QAPP for field sample collection including routine monitoring, data collection and laboratory testing
- Description and specifications of field monitoring equipment including maintenance, calibration, and replacement requirements and frequency
- Description of field and administrative procedures for systems failure, including procedures to prevent release of waste material which may endanger public health and the environment and proper notification and reporting requirements should O&M systems fail or be in danger of imminent failure
- Description of records and reports, including daily operating logs, laboratory records, waste characterization for off-site disposal in accordance with Section 15 of the CD, reports regarding emergencies, personnel and maintenance records and monthly and annual reports to state agencies

Guidance regarding how to proceed in the event that performance goals are not met despite the proper design and operation of the remedial system will be presented in the PMEP, which will be part of the RA Work Plan. The PMEP will additionally describe how the RA performance standards will be measured and evaluated.

7.3.2 CQAPP

The draft CQAPP will detail the procedures to be followed during remedy construction activities to ensure that the completed project meets or exceeds all design criteria, plans, and specifications. The CQAPP will address all sampling, analysis, and monitoring to be performed during the remedial construction phase of the Work. Quality assurance items to be addressed in the plan include the following:

- Identification of a quality assurance official (QAO) independent of the RA Contractor to conduct a quality assurance program during the RA phase of the project
- Qualifications of the QAO to demonstrate that he or she possesses the training and experience necessary to fulfill his or her identified responsibilities
- Responsibilities and authorities of all organizations and key personnel involved in the design and construction of the RA
- Specific construction quality assurance systems to be used, if any
- Monitoring, measurement, sampling, testing and daily logging to be conducted to establish whether the RA construction is performed in compliance with design specifications, ARARs, and performance standards, including identification of sample size, locations, frequency of testing, acceptance and rejection data sheets, problem identification and corrective measures reports, evaluation reports, acceptance reports, and final documentation

- Protocols for monitoring, measurement, sampling and testing
- Inspection and certification of the Work
- A detailed description of reporting requirements for CQAPP activities, including daily summary reports, inspection data sheets, problem identification and corrective measures reports, design acceptance reports, and final documentation
- Post-construction "as-built" drawings

The Final O&M Plan and Final CQAPP will be completed as part of the subsequent RA Work Plan.

7.4 PERFORMANCE GOALS

Development of performance goals to include more specific or quantitative criteria will be presented in the PMEP. The PMEP will be submitted as part of the RA Work Plan and is further described below.

7.5 PERFORMANCE MONITORING EVALUATION PLAN

The PMEP will be prepared as part of the RA Work Plan and will describe the performance goals and how they will be measured and evaluated. The PMEP will include the following elements:

- The performance goals for each remedy element
- A description of how each performance goal will be met
- A description of how progress toward achieving the goals will be evaluated and reported
- A FSP and QAPP for any proposed sampling (if any modifications to existing)

The PMEP will be supported by remedy-specific Decision Diagrams that summarize the key decisions and actions from the Pre-Design Investigations through RA and eventual remedy termination. Decision Diagrams are included in Appendix D and were developed in cooperation with USEPA and DTSC. The PMEP will also address conditions where the performance goals are not met despite proper design and operation of the remedial system by presenting approaches for continued operation, modification, or termination of the remedial system.

SECTION 8.0
SCHEDULE AND PROGRESS REPORTING

8.1 SCHEDULE

The RD schedule was developed based on the CD SOW and is presented in Figure 31. The schedule breaks down RD into nine task categories:

- Administration
- RD Work Plan
- Pre-Design Investigations
- ICs
- Cap Survey Plan
- ISCO Bench Study/SVE Pilot Testing
- Remedial Design
- RA Work Plan
- O&M Plan

These categories are further subdivided into tasks with individual durations, deliverable due dates, and milestones, as appropriate. RA activities are not included in the schedule at this time. The total estimated duration of RD is shown to be approximately 5.5 years: however, submittal of many sections of this RD WP earlier than requested in the CD SOW should reduce overall time.

The schedule was developed with the following considerations:

- Durations for the Pre-Design Investigations, ISCO Bench Study and SVE Pilot Testing are based on typical experience at other sites and can vary depending on site-specific constraints
- The duration of ICs implementation and property access activities are influenced by the actions of other stakeholders and subject to delay
- Design documents for the remedy components will be submitted after Pre-Design Investigations, ISCO Bench Study and SVE Pilot Testing activities are completed
- Durations for USEPA review and approval of documents are assumed and vary by the anticipated length and complexity of the document
- Changes to the SVE Pilot Testing and ISCO Bench Study may be necessary based on findings from the Pre-Design Investigation. As necessary, these changes will be

accommodated in technical memoranda that will be submitted to USEPA for review and approval

8.2 PROGRESS REPORTING

Written progress reports are being submitted to USEPA and DTSC on the tenth day of every reporting period in accordance with the CD. The progress reports will continue to be submitted monthly (or less frequently if agreed to by the Parties) while design or construction activities are occurring, and quarterly (or less frequently if agreed to by the Parties) during other periods of Work. The progress reports:

- Describe actions that have been taken toward achieving compliance with the CD during the previous reporting period
- Identify plans, reports, and other deliverables required by the CD completed and submitted during the previous reporting period
- Describe actions, including, but not limited to, data collection and implementation of work plans, that are scheduled for the next two reporting periods.
- Include information regarding completion, unresolved delays encountered or anticipated that may affect the future schedule for implementation of the Work, and a description of efforts made to mitigate those delays or anticipated delays
- Include any modifications to the work plans or other schedules proposed to USEPA or that have been approved by USEPA

SECTION 9.0
REFERENCES

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2007. Work Plan Supplement, AOC for RI/FS, Del Amo Superfund Site, Pilot Project, Environmental Review Institutional Control. April 24.

1999. Record of Decision for Dual Site Groundwater Operable Unit, Montrose Chemical and Del Amo Superfund Sites. March.

TABLES

Property No.	Institutional Control Layers							Active Remedy Components					
	IC-1	IC-2	IC-3	IC-4[1]				Shallow Soil				NAPL-Impacted Source Areas	
	Informational Outreach	Permit Review and Landwatch	General Plan Footnote	Residential use restriction	USEPA review of development plans	Non-interference with remedial facilities/engineering controls	USEPA approval prior to drilling into or use of groundwater	Cap	BECs	SVE - Outdoor Soil	SVE - Under Building	SVE - Deep Soil	ISCO
1	X	X											
2	X	X	X	X	X	X		X					
3	X	X											
4	X	X	X	X	X		X						
5	X	X	X	X	X	X	X					X (SA12)	X (SA12)
6	X	X	X	X	X	X	X			X		X (SA11)	X (SA11)
7	X	X	X	X	X								
8	X	X	X	X	X		X						
9	X	X	X	X	X	X	X					X (SA11)	X (SA11)
10	X	X	X	X	X								
11	X	X	X	X	X	X	X			X			
12	X	X	X	X	X								
13	X	X	X	X	X								
14	X	X	X	X	X								
15	X	X	X	X	X	X	X					X (SA11)	X (SA11)
16	X	X	X	X	X	X	X	X	X			X (SA3)	X (SA3)
17	X	X	X	X	X		X						
18	X	X											
19	X	X	X	X	X		X						
20	X	X	X	X	X		X						
21	X	X											
22	X	X	X	X	X		X						
23	X	X	X	X	X	X	X			X	X	X (SA3, SA6)	X (SA3)
24	X	X	X	X	X		X						
25	X	X											
26	X	X											
27	X	X											
28	X	X	X	X	X	X	X	X					
29	Excluded from remedy												
30	X	X	X	X	X								
31	X	X											
32	X	X	X	X	X		X						
33	X	X	X	X	X		X						
34	Excluded from remedy												
35	X	X	X	X	X	X	X	X					
36	X	X	X	X	X								
37	X	X											
Unnumbered Properties	X	X											

Notes:

1) Identified restrictive covenants are consistent with those presented in the ROD. A generic DTSC restrictive covenant agreement template is provided in Appendix I and includes additional requirements applicable to all properties with restrictive covenants.

TABLE 2
PRE-DESIGN INVESTIGATIONS SAMPLING AND ANALYTICAL PLAN

Work Phase	Remedy Component	Property Number	APN	Area	Media	Locations or Borings	Samples Per Location	Total Number of Samples	Total Number of Field Duplicates[2]	Total Number of MS/MSD Samples[3]	Frequency	Laboratory Analyses			
												Analysis	Method	Sample Container Type and Number	Laboratory
Pre-Design Investigations	Cap	2	7351-031-020	West	--	--	--	--	--	--	--	--	--	--	--
		16	7351-034-015, -050, -056	Northwest	--	--	--	--	--	--	--	--	--	--	--
		28	7351-034-069	Northwest	--	--	--	--	--	--	--	--	--	--	--
				East	--	--	--	--	--	--	--	--	--	--	--
		35	Magellan Drive	North	--	--	--	--	--	--	--	--	--	--	--
				Central	--	--	--	--	--	--	--	--	--	--	--
				South	--	--	--	--	--	--	--	--	--	--	--
	BECs	16	7351-034-015, -050, -056	Building interior	Indoor Air	13	1-2	17	3	--	Two events, 6 months apart	VOCs	TO-15 SIM	1 Summa	Calscience
				West side of building	Outdoor Air	2	1	2			Two events, 6 months apart	VOCs	TO-15 SIM	1 Summa	Calscience
				Interior	Subslab Soil Vapor	7	1	7			Two events, 6 months apart	VOCs + MTBE	TO-15	1 Summa	Calscience
	SVE – Outdoor Shallow Soil	6	7351-033-022	West	Shallow Soil	7	2-4	14-28	2-3	2-3	one time	VOCs	8260B	Three Encore	Calscience
						2	2	4	--	--	one time	Physical Testing[1]	API RP 40	Two 6" SS Rings	To be determined
		11	7351-033-034	South	Shallow Soil	4	2-4	8-16	1-2	1-2	one time	VOCs	8260B	Three Encore	Calscience
						2	2	4	--	--	one time	Physical Testing[1]	API RP 40	Two 6" SS Rings	To be determined
		23	7351-034-057	Northwest	Shallow Soil	13	2-4	26-52	3-5	3-5	one time	VOCs	8260B	Three Encore	Calscience
						3	2	6	--	--	one time	Physical Testing[1]	API RP 40	Two 6" SS Rings	To be determined
				Southwest	Shallow Soil	2	2-4	4-8	1	1	one time	VOCs	8260B	Three Encore	Calscience
						1	2	2	--	--	one time	Physical Testing[1]	API RP40	Two 6" SS Rings	To be determined
				East	Shallow Soil	6	2-4	12-24	2-3	2-3	one time	VOCs	8260B	Three Encore	Calscience
						2	2	4	--	--	one time	Physical Testing[1]	API RP40	Two 6" SS Rings	To be determined
				Northeast	Shallow Soil	1	2-4	2-4	1	1	one time	VOCs	8260B	Three Encore	Calscience
						1	2	2	--	--	one time	Physical Testing[1]	API RP40	Two 6" SS Rings	To be determined
	SVE – Under Building	23	7351-034-057	SE Corner of Main Building	Subslab Soil Vapor	5	1	5	1	--	one time	VOCs + MTBE	TO-15	1 Summa	Calscience
					Outdoor Air	2	1	2			one time	VOCs	TO-15 SIM	1 Summa	Calscience
	SVE – Deep Soil	23	7351-034-057	SA-6	Deep Soil	10	4-6	40-60	4-6	4-6	one time	VOCs	8260B	Three Encore	Calscience
						2	3	6	--	--	one time	Physical Testing[1]	API RP40	Two 6" SS Rings	To be determined
	ISCO/SVE	6 9 15	7351-033-022 7351-033-027 7351-033-900	SA-11	Deep Vadose Zone Soil[5]	2	3	6	--	--	one time	Physical Testing[1]	API RP40	Two 6" SS Rings	To be determined
					Saturated Zone Soil[5]	2	3	6	--	--	one time	Physical Testing[1]	API RP40	Two 6" SS Rings	To be determined
												Hydraulic Conductivity Package[4]	API RP40, EPA 9100, mod. ASTM D425	Two 6" SS Rings	To be determined
	ISCO Bench Study Baseline Sampling	6 9	7351-033-022 7351-033-027	SA-11	Unimpacted Soil	1	1	1	--	--	one time	ISCO Bench Study testing program (see Tables 7 and 8)	ISCO Bench Study testing program (see Tables 7 and 8)	One 2.5 gallon bucket	Prima Environmental
					Impacted Soil	1	1	1	--	--	one time	ISCO Bench Study testing program (see Tables 7 and 8)	ISCO Bench Study testing program (see Tables 7 and 8)	Two 2.5 gallon buckets	
					Unimpacted Groundwater	1 (XMW-03HD)	1	1	--	--	one time	ISCO Bench Study testing program (see Tables 7 and 8)	ISCO Bench Study testing program (see Tables 7 and 8)	Six 1-Liter Amber Glass	
					Impacted Groundwater	1 (XMW-01HD)	1	1	--	--	one time	ISCO Bench Study testing program (see Tables 7 and 8)	ISCO Bench Study testing program (see Tables 7 and 8)	Fifty 1-liter amber glass	

Notes:

1) Physical Testing includes porosity, moisture content, grain size distribution, and air permeability
2) Field Duplicate is counted as a discrete sample at a 10% frequency
3) Matrix Spike/Matrix Spike Duplicate is not a discrete sample but triples the amount of sample and containers collected. This is collected at a 10% frequency.
4) Hydraulic conductivity package includes tests for hydraulic conductivity, grain density, dry bulk density, total porosity, air filled porosity, moisture content, and total pore fluid saturation
5) Deep vadose zone and saturated zone samples may originate from the same boring location

SVE Remedy Component	Test	Location	Sampling Frequency	Total Number of Samples	Laboratory Analyses (Calscience)		
					Analysis	Method	Sample Container Type and Number
Shallow Soil	Baseline	SVE-1A	one time	1	TPH-g	TO-3	2 Tedlar Bags
					VOCs	TO-15	
					Fixed Gases	ASTM D-1946	
					Methane	SCAQMD 25.1	
	Step	SVE-1A	Beginning of each step and end of last step (five times total)	5	TPH-g	TO-3	2 Tedlar Bags
					VOCs	TO-15	
					Fixed Gases	ASTM D-1946	
					Methane	SCAQMD 25.1	
		Influent line[1]	Beginning of each step and end of last step (five times total)	5	TPH-g	TO-3	2 Tedlar Bags
					VOCs	TO-15	
					Fixed Gases	ASTM D-1946	
					Methane	SCAQMD 25.1	
	Constant Rate	SVE-1A	Beginning, midpoint and end of test (three times total)	3	TPH-g	TO-3	2 Tedlar Bags
					VOCs	TO-15	
					Fixed Gases	ASTM D-1946	
					Methane	SCAQMD 25.1	
		Influent line[1]	Beginning, midpoint and end of test (three times total)	3	TPH-g	TO-3	2 Tedlar Bags
					VOCs	TO-15	
					Fixed Gases	ASTM D-1946	
					Methane	SCAQMD 25.1	
		Effluent line	Beginning, midpoint and end of test (three times total)	3	TPH-g	TO-3	1 Tedlar Bag
					VOCs	TO-15	

SVE Remedy Component	Test	Location	Sampling Frequency	Total Number of Samples	Laboratory Analyses (Calscience)		
					Analysis	Method	Sample Container Type and Number
Deep Soil	Baseline	Well SVE-1B	one time	1	TPH-g	TO-3	2 Tedlar Bags
					VOCs	TO-15	
					Fixed Gases	ASTM D-1946	
					Methane	SCAQMD 25.1	
	Step	Well SVE-1B	Beginning of each step and end of last step (five times total)	5	TPH-g	TO-3	2 Tedlar Bags
					VOCs	TO-15	
					Fixed Gases	ASTM D-1946	
					Methane	SCAQMD 25.1	
		Influent line[1]	Beginning of each step and end of last step (five times total)	5	TPH-g	TO-3	2 Tedlar Bags
					VOCs	TO-15	
					Fixed Gases	ASTM D-1946	
					Methane	SCAQMD 25.1	
	Constant Rate	SVE-1B	Beginning, midpoint and end of test (three times total)	3	TPH-g	TO-3	2 Tedlar Bags
					VOCs	TO-15	
					Fixed Gases	ASTM D-1946	
					Methane	SCAQMD 25.1	
		Influent line[1]	Beginning, midpoint and end of test (three times total)	3	TPH-g	TO-3	2 Tedlar Bags
					VOCs	TO-15	
					Fixed Gases	ASTM D-1946	
					Methane	SCAQMD 25.1	
		Effluent line	Beginning, midpoint and end of test (three times total)	3	TPH-g	TO-3	1 Tedlar Bag
					VOCs	TO-15	

1) If no dilution is used, no influent sample will be collected because it is equivalent to the sample from the extraction well that is already being collected.

TABLE 4
SVE PILOT TESTING STEP TEST MEASUREMENTS

Step Number[1]	Applied Vacuum[3] (inches Hg)		Measurements	Measurement Locations		Frequency
	Shallow Test	Deep Test		Shallow Test	Deep Test	
0	0	0	Baseline Vacuum	Extraction Well and Vapor Monitoring Wells (SVE-1A, VM-1A, VM-2A, VM-3A, VM-4A, VM-5A)	Extraction Well and vapor Monitoring Wells (SVE-1B, VM-1B, VM-2B, VM-3B, VM-4B, VM-5B)	Prior to test start
1	4	3	Flow rate[2], Temperature, Vacuum	-Well SVE-1A - Dilution - Influent	- Well SVE-1B - Dilution - Influent	Every 30 Minutes
			PID, FID and Lantec	-Well SVE-1A - Influent	-Well SVE-1B - Influent	
			Temperature	- Combustion chamber or catalyst bed - Stack	- Combustion chamber or catalyst bed - Stack	
			Vacuum	Wells VM-1A, VM-2A, VM-3A, VM-4A, VM-5A	Wells VM-1B, VM-2B, VM-3B, VM-4B, VM-5B	End of Step
2	7	5	Flow rate[2], Temperature, Vacuum	- Well Field (SVE-1A) - Dilution - Influent	- Well Field (SVE-1B) - Dilution - Influent	Every 30 Minutes
			PID, FID and Lantec	-Well SVE-1A - Influent	-Well SVE-1B - Influent	
			System Temperature	- Combustion chamber or catalyst bed - Stack	- Combustion chamber or catalyst bed - Stack	
			Vacuum Readings	Wells VM-1A, VM-2A, VM-3A, VM-4A, VM-5A	Wells VM-1B, VM-2B, VM-3B, VM-4B, VM-5B	End of step
3	10	7	Flow rate[2], Temperature, Vacuum	- Well SVE-1A - Dilution - Influent	- Well SVE-1B - Dilution - Influent	Every 30 Minutes
			PID, FID and Lantec	Wellfield and Influent	Wellfield and Influent	
			System Temperature	- Combustion chamber or catalyst bed - Stack	- Combustion chamber or catalyst bed - Stack	
			Vacuum Readings	Wells VM-1A, VM-2A, VM-3A, VM-4A, VM-5A	Wells VM-1B, VM-2B, VM-3B, VM-4B, VM-5B	End of Step
4	12	10	Flow rate[2], Temperature, Vacuum	- Well SVE-1A - Dilution - Influent	- Well SVE-1B - Dilution - Influent	Every 30 Minutes
			PID, FID and Lantec	- Well SVE-1A - Influent	- Well SVE-1B - Influent	
			Temperature	- Combustion chamber or catalyst bed - Stack	- Combustion chamber or catalyst bed - Stack	
			Vacuum	Wells VM-1A, VM-2A, VM-3A, VM-4A, VM-5A	Wells VM-1B, VM-2B, VM-3B, VM-4B, VM-5B	End of Step

Notes:

1) Each step will be approximately 60 minutes

2) Flow rate will be calculated using differential pressure

3) Approximate; actual applied vacuum be determined in the field

TABLE 5
SVE PILOT TESTING CONSTANT RATE TEST MEASUREMENTS

Measurement / Instrument	Test and Measurement Locations		Frequency (time since test start)
	Shallow Test	Deep Test	
Vacuum	Vapor Monitoring Wells (VM-1A, -2A, -3A, -4A, -5A)	Vapor Monitoring Wells (VM-1B, VM-2B, VM-3B, VM-4B, VM-5B)	0 hrs (before test start) 4 hrs 8 hrs 24 hrs every 24 hrs thereafter
	Extraction Well (SVE-1A)	Extraction Well (SVE-1B)	
Flow Rate[1], Temperature, Applied Vacuum, and Relative Humidity	- Extraction Well (SVE-1A) - Dilution - Influent	- Extraction Well (SVE-1B) - Dilution - Influent	Every 1-2 hours
Temperature	- Combustion chamber or catalyst bed - Stack	- Combustion chamber or catalyst bed - Stack	
PID and FID	- Extraction Well (SVE-1A) - Influent - Effluent	- Extraction Well (SVE-1B) - Influent - Effluent	
Landtec	- Extraction Well (SVE-1A) - Influent	- Extraction Well (SVE-1B) - Influent	

Notes:

1) Flow rate will be calculated using differential pressure

TECHNOLOGY TYPE	DESCRIPTION	TYPICAL CONTAMINANTS, CONCENTRATIONS & FLOW	SCREENING CRITERIA								SCREENING RESULTS	
			EFFECTIVENESS	SCORE	IMPLEMENTABILITY	SCORE	COST	SCORE	SUSTAINABILITY	SCORE	COMMENTS	OVERALL SCORE
Thermal Oxidation												
Direct Flame Thermal Oxidizer (DFTO)	Treatment of extracted VOC vapors by thermal destruction at high temperatures (1,200 °F to 1,800 °F) in oxidizers that burn fuels such as natural gas or propane. Off-gases enter a reaction chamber where an open flame burns the vapors and additional fuel.	Broad range of fuel hydrocarbons and VOCs If chlorinated VOCs are present in soil vapor, post-oxidation treatment using an acid scrubber may be required to remove acid vapors; Thermal: 1,000 to 10,000 ppmv; Catalytic: 250 to 3,000 ppmv; Wide range of flow rates.	Good. Technologies are well proven for achieving high VOC destruction (95% to 99.95%). Technologies are sensitive to oxygen concentrations below 14% and carbon dioxide above 2% and require dilution air to complete oxidation of contaminants. If chlorinated VOCs are present in the vapors, then acid scrubber treatment of the vapors would be required.	**5**	Moderate to Good. Systems are more complex to start up and operate than adsorption systems. May require discharges into sewer or batch treatment/off-site disposal of liquid waste stream if scrubber is used for chlorinated VOCs.	**4**	Moderate to Good. More cost- effective when vapor stream contains sufficient VOC concentrations to sustain the high operating temperatures without auxiliary fuel.	**4**	Moderate. Though this technology involves fuel combustion, it is proposed only where vapor concentrations are high so that fuel use will be low.	**3**	Retained. Highly effective and proven mature technologies for treatment of high VOC concentrations in the vapor phase. Technology is robust, well understood and readily implementable at SVE sites when influent concentrations are in the higher range (250 ppmv to 10,000 ppmv). Conventional DFTOs (100 to 500 cfm) or hybrid thermal/catalytic oxidizers are the most applicable for the anticipated SVE application at this site.	**16**
Flameless Thermal Oxidizer (FTO)	VOC vapors are treated on heated ceramic media (1400°F) without direct contact with a flame using natural gas or propane. The SVE off-gas is typically pre-heated in a separate ceramic heat exchanger bed.						Moderate. FTO requires higher capital costs, but can provide greater destruction efficiencies than DFTO.	**3**				**15**
Catalytic Oxidizer (Cat-Ox)	Treatment of vapors using a catalyst and heat to oxidize contaminants at lower temperatures (600 °F to 800 °F); also used as concentrations decrease from initial highs. Electric Cat-Ox units use electricity to heat the extracted vapor rather than gas-fired units for off-gas treatment.						Good. Cat-Ox treatment often costs less than DFTO and FTO due to lower oxidation temperatures and energy requirements.	**5**				**17**
Hybrid Thermal/Catalytic Oxidizer	A thermal oxidizer (1400 °F) that can easily be converted to a catalytic oxidizer (700 °F) by inserting a catalyst in the exhaust chamber when SVE concentrations decrease with time.											**17**
Regenerative Thermal Oxidizer (RTO)	RTOs are more complex, energy-efficient oxidizers that use two parallel, alternately heated (1400 °F) ceramic beds. Inlet gas passes through the hot bed and gets pre-heated while cooling the bed and the gas is combusted in the combustion chamber. The heated vapors exit through the other bed heating the bed prior to discharge to the stack.						Moderate. RTOs are typically more cost effective only for large high volume systems (1,000 to 20,000 cfm) and are typically used in large refinery SVE systems.	**3**			Retained. RTOs are typically high volume systems that more cost effective in larger SVE applications; however, the technology is retained in the event multiple areas are combined.	**15**
Internal Combustion Engine (ICE)	An internal combustion engine is used to treat contaminated vapors by mixing the off-gas in the carburetor of the engine with air and, if necessary, additional fuel. Concentrations in excess of 30,000 to 40,000 ppmv are generally required to sustain the engine speed without the need for supplemental fuel. More common at sites for short term SVE operations with high fuel hydrocarbon concentrations.	Petroleum Hydrocarbons. Exhaust gases from ICE can be passed through a standard automobile catalytic converter or activated carbon before discharge to the atmosphere. Not normally used to treat vapors with chlorinated VOCs. >3,000 ppmv; 50 to 200 cfm.	Moderate. Destruction efficiency may not be high enough for treating pure benzene vapors. Can achieve destruction/removal efficiencies between 90% and 98%. System flow rates are typically low (<200 cfm) and multiple units may be needed to handle higher flows.	**2**	Moderate. ICE units are complex systems that require skilled technicians to maintain. Typically used for short term remedial applications such as pilot testing, when concentrations are very high. Maintenance can be intensive for long term applications. Implementation opportunities at this site are low.	**3**	Moderate. Fuel costs are low because it is typically used with high concentration applications; however, capital costs tend to be higher because they are used in short term applications.	**3**	Moderate. Though this technology involves fuel combustion, it is rated moderate because it is proposed for use only where vapor concentrations are high so that fuel use will be low.	**3**	Not retained. May not provide adequate destruction efficiency for pure benzene vapor and has limited implementability, typically only for short durations like pilot testing.	**11**
Combined Thermal Oxidizer and Cat-Ox Polishing												
Thermal Oxidizer with Cat-Ox Polishing	Treatment of high influent vapor concentrations using thermal oxidizers followed by vapor polishing with a Cat-Ox in series. This technology requires a heat exchanger to cool the TO exhaust from approximately 1,450 to 800 °F prior to entering the catalytic bed. Rarely used and only considered when a destruction/removal efficiency of 99.99% is needed to comply with emission standards.	Broad range of non-chlorinated and chlorinated VOCs; <10 to 10,000 ppmv; Wide range of flow rates	Good. Both technologies (Thermal oxidation and Cat-Ox) are well proven for VOCs including chlorinated VOCs. Can achieve high >99.99% removal efficiency.	**5**	Moderate. Technical challenges with operation of complex system required to cool the vapor.	**3**	Moderate. Higher capital and O&M costs associated with additional equipment required to cool the vapor.	**3**	Moderate. Similar to thermal oxidizers.	**3**	Retained. Though having high costs, retained in the event higher destruction efficiency and vapor polishing is considered necessary.	**14**

TECHNOLOGY TYPE	DESCRIPTION	TYPICAL CONTAMINANTS, CONCENTRATIONS & FLOW	SCREENING CRITERIA								SCREENING RESULTS	
			EFFECTIVENESS	SCORE	IMPLEMENTABILITY	SCORE	COST	SCORE	SUSTAINABILITY	SCORE	COMMENTS	OVERALL SCORE
Adsorption												
Vapor Phase Granular Activated Carbon (VPGAC)	Treatment of extracted vapors by adsorption of hydrocarbons or VOCs in activated carbon media. Often used in SVE applications after initial use of thermal oxidizers have reduced influent concentrations. Activated carbon typically adsorbs 10-25% of its own weight in contaminants. Used/spent carbon is taken offsite for recycling/reuse.	Broad range of VOCs and chlorinated VOCs in extracted vapor. Not effective for some VOCs such as vinyl chloride, methylene chloride. Does not remove methane. Typically used for <250 ppmv but can be used for higher concentrations with more frequent carbon changes. Wide range of flow rates	Good. Technology is well proven for VOCs including chlorinated VOCs. Can achieve >98% removal efficiency. GAC systems are robust in that they are not sensitive to rapid changes in extracted vapor concentrations. GAC is sensitive to high relative humidity (> 50%) and high temperatures (> 120 ^{o}F) which can significantly reduce its adsorption capacity. GAC is not affected by low oxygen or CO_2.	**5**	Moderate to Good. A widely used vapor treatment technology to treat waste streams with lower vapor concentrations below 250 ppmv. Desorption of adsorbed VOCs can occur if influent vapor temperatures exceed 125ºF.	**4**	Moderate to Good. Relatively low initial capital cost. Cost-effective technology for SVE with low VOC concentrations (< 250 ppmv). Carbon usage (cost) increases with higher concentrations or high flow rates. Sustained high vapor concentrations result in faster carbon breakthrough and high O&M cost associated with adsorbent replacement or regeneration.	**4**	Poor to Moderate. Offsite treatment required involving frequent shipment of spent carbon, truck emissions, risk and liability.	**2**	Retained. Potential for use with shallow SVE as a secondary technology after initial implementation of an initial technology. Effective and proven mature technology for treatment of low VOC concentrations. Technology is robust, well understood and readily implementable.	**15**
VPGAC and Steam Regeneration	Treatment of extracted vapors by adsorption of hydrocarbons or VOCs in activated carbon media with onsite steam regeneration. Often used in refinery SVE applications due to ready availability of steam.				Poor to Moderate. Steam is not readily available at the site. Regeneration waste stream and NAPL will need to be disposed off-site or treated onsite.	**2**	Poor. Very high onsite steam regeneration cost. Steam is not available onsite.	**1**	Moderate. Technology is only used at sites with high concentrations with low fuel consumption. COCs are destroyed on site.	**3**	Not retained. Not cost effective for sites that don't already have available steam. Offsite VPGAC regeneration is more cost effective.	**11**
Zeolites	Treatment of extracted vapors by adsorption of hydrocarbons or VOCs in Zeolites (naturally occurring crystalline aluminosilicate minerals with uniform and regularly spaced pores). Zeolites may be synthesized to have specific properties (made hydrophobic for affinity to non-polar compounds or chemically-enhanced to target specific contaminants) . Spent media is taken offsite for recycling/reuse.	Highly polar and volatile VOC degradation products, NOx emissions, high boiling point solvents. Generally used to treat high-flow, (3,000 to 30,000 cfm), very-low concentration (20 - 150 ppmv) vapor streams.	Moderate. Effectiveness for benzene is uncertain. Adsorptive capacities are not as affected by high humidity levels or high temperatures. It is not useful in treating vapor streams with a wide assortment of contaminants.	**3**	Poor to Moderate. Zeolites are primarily used in industrial applications and have limited use in soil and groundwater remediation.	**2**	Poor. Zeolite costs are significantly higher than VPGAC costs. Contaminants tend to polymerize on this adsorbent, making desorption difficult without very high temperatures.	**1**	Poor to Moderate. Involves frequent shipment of spent zeolite; COCs are shipped offsite rather than treated onsite.	**2**	Not retained. Poor applicability in SVE remediation applications and poor cost effectiveness.	**8**
Polymeric Resin	Treatment of extracted vapors by adsorption of hydrocarbons or VOCs in synthetic polymeric resins. Polymeric adsorbents have manufactured pores ranging in size from macro-pores to molecular size. Polymeric adsorption is non-selective in nature. Spent resin is taken offsite for recycling/reuse or regenerated onsite.	Wide range of VOCs. Typically 100-1,000 ppmv Wide range of vapor flow rates: 100 to 10,000 scfm.	Moderate to Good. Capable of achieving destruction/removal efficiency > 95% but not as high as oxidizers and limited capacity at low VOC concentrations. Usually hydrophobic, much less sensitive to humidity than GAC, applicable to off-gas streams with relative humidity > 90% without loss of adsorption efficiency. Polymer bed capacity is typically lower than zeolites but higher than carbon.	**4**	Moderate. Adsorption capacity at low concentrations is orders of magnitude below GAC and zeolites, severely limiting the value of synthetic polymers in environmental remediation applications.	**3**	Poor. High costs of polymer adsorbents is in the range of zeolites. Generally not cost-effective for streams with VOC concentrations of less than 100 ppmv.	**1**	Poor to Moderate. Involves frequent offsite shipment of spent resin for treatment	**2**	Not retained. Resin adsorption was tested at the Waste Pits OU and not used because of poor cost effectiveness and challenges.	**10**
Combined Thermal Oxidizer and Carbon Adsorption Polishing												
Thermal Oxidizer with Vapor Phase Granular Activated Carbon (VPGAC) polishing	Treatment of high influent vapor concentrations using thermal oxidizers followed by vapor polishing using carbon adsorption in series. This technology requires a heat exchanger to cool the TO exhaust from approximately 1,450 to 800 ^{o}F prior to entering the vapor phase carbon. This approach is rarely used and only considered where dioxin in the exhaust vapors is a concern.	Broad range of chlorinated and non-chlorinated VOCs; <10 to 10,000 ppmv Wide range of flow rates	Good. Both technologies (Thermal oxidation and VPGAC) are well proven for non-chlorinated and chlorinated VOCs. Can achieve high (>99%) removal efficiency.	**5**	Moderate. Technical challenges associated with operation of a more complex system required to cool the vapor.	**3**	Poor to Moderate. Significantly higher capital and O&M costs associated with additional equipment required to cool the vapor	**2**	Moderate. Similar to thermal oxidizers assuming that carbon usage is low with carbon only being used for polishing.	**3**	Retained. Though this combined technology is considered high in costs, it is retained in the event higher removal efficiency and vapor polishing is necessary.	**13**
Vapor Compression/Condensation												
Cryogenic-Compression and Condensation (C3)	Treatment of extracted vapors containing VOCs by cooling and compressing to condense VOCs combined with regenerative adsorption. Efficiently recovers VOCs from the SVE off-gas. Temperatures required for condensation may be extremely low (-40 ^{o}C). Condensed contaminant is recovered as non-aqueous phase liquids for recycling or offsite disposal.	All VOCs, including halogenated compounds. > 5,000 ppmv Standard units available for 100, 200, 300 and 500 scfm.	Good. May achieve high removal efficiency (>99%) at > 5,000 ppmv with no upper limit of VOC influent concentration and no dilution.	**5**	Poor to Moderate. Technology has been implemented at high concentrations that exceed LELs but recovered product requires disposal as a RCRA hazardous waste. Typically used only for short term applications.	**2**	Poor. O&M costs are much higher than oxidizers and adsorption alternatives. Used only for short term (few months) remedial activities like pilot tests for high vapor concentrations.	**1**	Poor to Moderate. Relatively high electricity usage for compression and condensation in refrigeration systems.	**2**	Not retained. Very high operational costs and is typically suitable only for short term high vapor concentration treatment (e.g. pilot tests)	**10**

TECHNOLOGY TYPE	DESCRIPTION	TYPICAL CONTAMINANTS, CONCENTRATIONS & FLOW	SCREENING CRITERIA								SCREENING RESULTS	
			EFFECTIVENESS	SCORE	IMPLEMENTABILITY	SCORE	COST	SCORE	SUSTAINABILITY	SCORE	COMMENTS	OVERALL SCORE
Biological Treatment												
Biofiltration	Biofiltration uses microorganisms attached to a fixed media support to sorb and biologically degrade VOCs present in air streams flowing through the filter. Specific strains of bacteria may be introduced into the filter and optimal conditions can be maintained to preferentially degrade specific compounds.	Readily biodegradable non-halogenated VOCs and fuel hydrocarbons (mono-aromatic hydrocarbons, alcohols, aldehydes, and ketones). < 1,500 ppmv 100 to 1,500 scfm	Poor to Moderate. May achieve > 90% to 95% destruction efficiency under optimum conditions. Requires up to 30-day initial acclimation period. Contaminants are destroyed not just separated as with adsorbent technologies. System interruptions lower efficiency so may not be appropriate for SVE pulsing cycle. Not effective for chlorinated solvents.	**2**	Poor. Biofiltration requires pre-treatment for particulate removal to prevent clogging, flow equalization to minimize "shocks" from spikes in VOC concentrations. Technology is highly sensitive to variations in operating parameters. Not effective for high initial concentrations. Not often used in SVE applications.	**1**	Moderate. Typically a lower cost technology though frequent shutdowns and high labor costs can be anticipated.	**3**	Moderate. Relatively low environmental impacts with biofilter treatment with limited need for filter media replacement if technology is appropriate for the application.	**3**	Not retained. Relatively minor fluctuations of process parameters and deviations from optimum ranges can significantly affect performance and result in system upset. Significant engineering effort is required to specify, design and operate a proper biofilter for a site-specific application.	**9**
Emerging Technologies												
Non-Thermal Plasma; Photolytic and Photocatalytic; Membrane Separation; Absorption	Emerging technologies are more in the research and testing stage and use is limited in SVE. - Non-Thermal Plasma uses electric power and a flow through reactor vessel to treat SVE off-gas. - Photolytic/Photocatalytic use light energy in the UV wavelength spectrum to oxidize or break down organics in the off-gas. - Membrane Separation removes VOCs by passing off-gas stream through a membrane up to 100 times more permeable to organic molecules than to air. -Absorption removes VOCs by dissolving vapors into a liquid solution (scrubbing).	Broad range of VOCs; 1 to 3,000 ppmv; Generally used for low flow rates	Moderate. Destruction /removal efficiencies are contaminant specific but generally >95%.	**3**	Poor. These technologies are used for industrial treatment but are not commercially available for environmental remediation applications.	**1**	Poor. Not commercially available for environmental remediation applications.	**1**	Poor. Unknown sustainability. Technologies not well developed.	**1**	Not retained. Technologies have not been commercialized.	**6**

Sustainability is rated good for technologies with low environmental impacts and rated poor for those with high environmental impacts

Retained technologies are identified as shaded rows.

Scores are based on a 5-point scale where “good” is 5 points, “moderate to good” is 4 points, “moderate” is 3 points, “poor to moderate” is 2 points, and “poor ” is 1 point .

TABLE 7
PRELIMINARY VAPOR TREATMENT TECHNOLOGY RECOMMENDATIONS

Remedy Component	Location	Treatment Interval (feet bgs)	Primary COCs	Total VOC Vapor Concentration Range (ppmv)	Primary Vapor Treatment Technology[6]	Potential Secondary Vapor Treatment Technology[6]
SVE Shallow outdoor soil	Property 23[1] - NW	5-15	Benzene	ND-1,500	Thermal Oxidation[5]	VPGAC
	Property 23[1] - NE	5-15	Benzene, Ethylbenzene	ND-2,000	Thermal Oxidation[5]	VPGAC
	Property 23[1] - E	5-15	Benzene, Ethylbenzene	ND-12,000	Thermal Oxidation[5]	VPGAC
	Property 23[1] – NW, SW	5-15	PCE	ND-20	Thermal Oxidation[5]	-
	Property 6	5-15	Benzene	ND-4,100	VPGAC Adsorption	-
	Property 11	5-15	Benzene	ND-2,000	Thermal Oxidation	VPGAC Adsorption
SVE deep soil	SA-6[2]	15-40	Benzene, Ethylbenzene	15,800	Thermal Oxidation/ Thermal Oxidation + catalytic oxidation or VPGAC Adsorption	-
ISCO/SVE	SA-3	15 - 40	Benzene	7,500- 30,800	Thermal Oxidation/ Thermal Oxidation + catalytic oxidation or VPGAC Adsorption	-
	SA-11	15 - 40	Benzene	NA[3]	Thermal Oxidation/ Thermal Oxidation + Catalytic Oxidation or VPGAC Adsorption	-
	SA-12	15 - 30	Benzene, Toluene, Ethylbenzene, Xylenes, Styrene	NA[4]	Thermal Oxidation/ Thermal Oxidation + Catalytic Oxidation or VPGAC Adsorption	-

Notes:

1) Property 23: Location of Shallow Soil SVE Pilot Test

2) SA-6: Location of Deep Soil SVE Pilot Test

3) Deep soil gas data is not available. Shallow soil gas benzene concentrations range from 31 to 4,100 ppmv. Deep soil gas concentrations are expected to be similar to SA-3 and SA-6.

4) Deep soil gas data is not available. Shallow soil gas benzene concentrations range from 32 to 380 ppmv. Deep soil gas concentrations are expected to be similar to SA-3 and SA-6

5) Thermal oxidation includes hybrid thermal/catalytic oxidizers operating in thermal or catalytic modes depending on the influent concentrations.

6) "Primary vapor treatment technology" refers to the technology used during startup and the initial phase when concentrations are high. "Potential secondary vapor treatment technology" refers to the technology that may be used after SVE influent concentrations have decreased appropriately.

TABLE 8
ISCO BENCH STUDY OXIDANT COMPARISON SUMMARY

Oxidant Type	Reactive Species	Electrode Potential (volts)	Chemical Reactions	Product	Manufacturer	Primary Component	Activator	Commercial Form	Persistence	BTEX/TPH Treatability	Stoichiometric Demand (lbs. Oxidant/ lbs. Benzene)	Retained?	Rationale
Persulfates	$\cdot SO_4^-$	2.1 ($S_2O_8^{2-}$) 2.6 ($\cdot SO_4^-$)	**General** $S_2O_8^{2-} + 2e- \rightarrow 2SO_4^{2-}$ $\cdot SO_4^- + e- \rightarrow SO_4^{2-}$ **Benzene Oxidation** $15Na_2S_2O_8 + C_6H_6 + 12H_2O \rightarrow$ $6CO_2 + 30SO_4^{2-} + 30Na^+ + 30H^+$	Klozur	PeroxyChem	Sodium Persulfate	Fe(II)	Powder	Hours - Days	Good	45	No	Low persistence and iron precipitation
							Chelated Fe(II)	Powder	Days - Weeks	Good	45	**Yes**	Better persistence than both peroxide oxidants and persulfate oxidants with non-chelated Fe(II) activator
							Hydrogen peroxide	Powder (persulfate) + Liquid (hydrogen peroxide)	Days	Good	45	No	Low persistence; potential injection difficulties in low permeability soils due to gas formation
							Alkaline pH (>11)	Powder (persulfate) + Liquid (caustic)	Days - Weeks	Good	45	**Yes**	Best option with respect to injection in low permeability soil; good persistence
							Heat	Powder	Days - Weeks	Good	45	No	High energy and cost requirements; not widely implemented
				Klozur CR	PeroxyChem	Sodium Persulfate	Calcium peroxide	Powder	Weeks - Months	Moderate	45	No	Injected as a slurry due to low solubility of calcium peroxide and therefore difficult to inject in low permeability soils
				PersulfOx	Regenesis	Sodium Persulfate	Alkaline pH Amorphous silica	Powder + Liquid	Weeks - Months	Good	45	No	New product, not widely used; injection difficulties in low permeability soils due to injection as a slurry
Peroxides	$\cdot OH$ $\cdot O^{2-}$ HO_2 HO^{2-}	2.8 ($\cdot OH$) -2.4 ($\cdot O2-$) 1.7 ($\cdot HO_2$) -0.88 (HO^{2-})	**General** $H_2O_2 + 2H^+ + 2e- \rightarrow 2H_2O$ $2\cdot OH + 2H^+ + 2e- \rightarrow 2H_2O$ $\cdot HO_2 + 2H^+ + 2e- \rightarrow 2H_2O$ $\cdot O^{2-} + 4H^+ + 3e- \rightarrow 2H_2O$ $HO_2^- + H_2O + 2e- \rightarrow 3OH-$ **Benzene Oxidation** $15H_2O_2 + C_6H_6 \rightarrow$ $6CO_2 + 18H_2O$	Catalyzed Hydrogen Peroxide (MFR)	Multiple Vendors	Hydrogen Peroxide	Chelated Fe(II)	Liquid	Minutes - Hours	Good	6.5	**Yes**	Well developed technology; oxygen production enhances biodegradation after oxidation; potential implementation challenges due to gas production in low permeability soil
				RegenOx	Regenesis	Sodium Percarbonate	Sodium Silicates, Silica Gel, Ferrous Sulfate	Powder	Days - Weeks	Good	20.1	No	Injected as a slurry due to low solubility of sodium percarbonate and therefore difficult to inject in low permeability soils
Ozone	O_3 $\cdot OH$	2.1 (O_3) 2.8 ($\cdot OH$)	**General** $O_3 + 2H^+ + 2e- \rightarrow O_2 + H_2O$ $2O_3 + 3H_2O_2 \rightarrow$ $4O_2 + 2\cdot OH + 2H_2O$ **Benzene Oxidation** $15O_3 + C_6H_6 \rightarrow$ $6CO_2 + 15O_2 + 3H_2O$	Ozone	Multiple Vendors	Ozone	None	Gas	Minutes - Hours	Good	9.2	**Yes**	Well developed technology; oxygen production enhances biodegradation after oxidation; injection rates likely to be low compared to demand
				Peroxone	Multiple Vendors	Ozone, Hydrogen Peroxide	Ozone	Gas (ozone) + Liquid (hydrogen peroxide)	Minutes - Hours	Good	6.5 (HP) 9.2 (O_3)	**Yes**	Well developed technology; potentially more effective than ozone alone in addressing hydrocarbon due to production of hydroxyl radicals; oxygen production enhances biodegradation after oxidation; potential implementation challenges due to gas production in low permeability soil

Notes:

Persistence of the oxidant varies depending on site-specific conditions. Durations specified here are based on general observations.

MFR - Modified Fenton's Reagent

TABLE 9
ISCO BENCH STUDY BASELINE AND OXIDANT SCREENING TESTING PROGRAM

Media	Impacted / Unimpacted	Analysis	Test Method	Baseline Testing (no oxidant)	Oxidant Screening Testing														Total Samples Analyzed
					Persulfate										Hydrogen Peroxide Persistence		Ozone Demand		
					Caustic Dosage	Natural Oxidant Demand			pH Buffering Capacity										
									Low pH			High pH							
						Low NaOH Dose	Med NaOH Dose	High NaOH Dose	pH 1	pH 2	pH 3	pH 11	pH 12	pH 13	Low (<4%)	High (<6%)	Ozone	Process Control	
					1 Hr.	Day 7	Day 7	Day 7	14 Day	14 Day	14 Day	14 Day	14 Day	14 Day	2 Day	2 Day	2 Hrs.	2 Hrs.	
Soil	Unimpacted	VOCs + TICs	EPA 8260	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		$TPH_{carbon\ chain}$	EPA 8015	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		TOC	EPA 9060	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	Impacted	VOCs + TICs	EPA 8260	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		$TPH_{carbon\ chain}$	EPA 8015	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Cr(VI)	EPA 7199	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Metals (Cr, Fe, Mn, As)	EPA 6020	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		TOC	EPA 9060	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		pH	EPA 9045	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Water	Unimpacted	VOCs + TICs	EPA 8260	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		$TPH_{carbon\ chain}$	EPA 8015	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Cr(VI)	EPA 7199	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Metals (Cr, Fe, Mn, As)	EPA 6020	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Ferrous Iron	SM 3500-Fe B	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Alkalinity	EPA 310.1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Anions (Sulfate, Nitrate, Chloride)	EPA 300.0	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		TDS	SM 2540C	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Persulfate	Titration FAS/KMnO4	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	3
		Ozone	Indigo method SW 4500-O_3	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	NA
		ORP	Probe	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		DO	Probe	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		pH	Probe	1	-	1	1	1	-	-	-	-	-	-	-	-	-	-	1
	Impacted	VOCs + TICs	EPA 8260	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
		$TPH_{carbon\ chain}$	EPA 8015	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Hydrogen Peroxide	Test Strips	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	2
		Cr(VI)	EPA 7199	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Metals (Cr, Fe, Mn, As)	EPA 6020	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Ferrous Iron	SM 3500-Fe B	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Alkalinity	EPA 310.1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Anions (Sulfate, Nitrate, chloride)	EPA 300.0	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		TDS	SM 2540C	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		ORP	Probe	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		DO	Probe	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		pH	Probe	1	X	-	-	-	X	X	X	X	X	X	-	-	-	-	NA
Gas	Not Applicable	Gas Volume	Volume Measurement	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	NA

NOTES

X	Parameter will be monitored multiple times over duration of test period		
HP	Hydrogen Peroxide	FAS	Ferrous Ammonium Sulfate
Cr(VI)	Hexavalent Chromium	ORP	Oxidation Reduction Potential
Cr	Chromium	DO	Dissolved Oxygen
Fe	Iron	TICs	Tentatively Identified Compounds

TABLE 10
ISCO BENCH STUDY OXIDANT EFFECTIVENESS TESTING PROGRAM

Media	Analysis	Test Method	Oxidant, Reactor and Sampling Time															Total Samples Analyzed
			Initial Sample (no oxidant)	Persulfate with Iron-activation and pH-activation						Catalyzed Hydrogen Peroxide with Chelated Iron (MFR)					Ozone and Ozone + Hydrogen Peroxide			
				Sterile Control	Process Control	Fe-activated		pH-Activated		Sterile Control	Process Control	Low Dose	3x Low Dose	High Dose	Process Control	Ozone	Ozone + Hydrogen Peroxide	
						Low Dose	High Dose	Low Dose	High Dose									
			0	Day 28	Day 28	Day 28	Day 28	Day 28	Day 28	Day 7	Day 7	Day 7	Day 7	Day 7	24 Hrs.	24 Hrs.	24 Hrs.	
Soil	VOCs + TICs	EPA 8260	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
	$TPH_{carbon\ chain}$	EPA 8015	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
Water	VOCs + TICs	EPA 8260	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
	$TPH_{carbon\ chain}$	EPA 8015	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
	Cr(VI)	EPA 7199	1	-	1	1	1	1	1	-	1	1	1	1	1	1	1	13
	Metals (Cr, Fe, Mn, As)	EPA 6020	1	-	1	1	1	1	1	-	1	1	1	1	1	1	1	13
	Persulfate	Titration FAS/KMnO4	-	-	-	1	1	1	1	-	-	-	-	-	-	-	-	4
	Sulfate	EPA 300	1	-	1	1	1	1	1	-	-	-	-	-	-	-	-	6
	Hydrogen Peroxide	Test Strips	-	-	-	-	-	-	-	-	-	1	1	1	-	-	1	4
	Ozone	Indigo method SM 4500-O_3	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2
	ORP	Probe	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	14
	DO	Probe	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	14
	pH	Probe	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	14
Gas	VOCs + TICs	EPA 8260	-	-	-	-	-	-	-	-	-	1	1	1	-	1	1	5
	TPH-g	EPA 8015	-	-	-	-	-	-	-	-	-	1	1	1	-	1	1	5

Notes

Cr(VI) Hexavalent Chromium
Cr Chromium
Fe Iron
FAS Ferrous Ammonium Sulfate
ORP Oxidation Reduction Potential
DO Dissolved Oxygen
TICs Tentatively Identified Compounds

APN	Property Number	IC LAYERS						
		IC-1 Informational Outreach	IC-2 Permit Review and Landwatch	IC-3 General Plan Footnote	IC-4 Restrictive Covenants[1]			
					Residential Use Restriction	USEPA Review of Development Plans	Non-Interference With Remedial Facilities / Engineering Controls	USEPA Approval Prior to Drilling Into or Use of Groundwater
7351-031-007	4	✓	✓	✓	✓	✓		✓
7351-031-008	none	✓	✓					
7351-031-012	none	✓	✓					
7351-031-017	none	✓	✓					
7351-031-018	1	✓	✓					
7351-031-020	2	✓	✓	✓	✓	✓	✓	
7351-031-021	none	✓	✓					
7351-031-027	none	✓	✓					
7351-031-028	none	✓	✓					
7351-031-029	none	✓	✓					
7351-031-030	none	✓	✓					
7351-031-031	3	✓	✓					
7351-033-009	14	✓	✓	✓	✓	✓		
7351-033-015	none	✓	✓					
7351-033-017	5	✓	✓	✓	✓	✓	✓	✓
7351-033-020	none	✓	✓					
7351-033-022	6	✓	✓	✓	✓	✓	✓	✓
7351-033-023	none	✓	✓					
7351-033-024	7	✓	✓	✓	✓	✓		
7351-033-026	8	✓	✓	✓	✓	✓		✓
7351-033-027	9	✓	✓	✓	✓	✓	✓	✓
7351-033-030	10	✓	✓	✓	✓	✓		
7351-033-031	none	✓	✓					
7351-033-034	11	✓	✓	✓	✓	✓	✓	✓
7351-033-039	none	✓	✓					
7351-033-040	12	✓	✓	✓	✓	✓		
7351-033-045	13	✓	✓	✓	✓	✓		
7351-033-900	15	✓	✓	✓	✓	✓	✓	✓
7351-034-015, 050, 056	16	✓	✓	✓	✓	✓	✓	✓
7351-034-021	none	✓	✓					
7351-034-023	none	✓	✓					
7351-034-024	none	✓	✓					
7351-034-025	none	✓	✓					
7351-034-039	17	✓	✓	✓	✓	✓		✓
7351-034-041	18	✓	✓					
7351-034-043	19	✓	✓	✓	✓	✓		✓
7351-034-045	20	✓	✓	✓	✓	✓		✓
7351-034-047	21	✓	✓					
7351-034-049	none	✓	✓					
7351-034-052	22	✓	✓	✓	✓	✓		✓
7351-034-057	23	✓	✓	✓	✓	✓	✓	✓

APN	Property Number	IC LAYERS						
		IC-1 Informational Outreach	IC-2 Permit Review and Landwatch	IC-3 General Plan Footnote	IC-4 Restrictive Covenants[1]			
					Residential Use Restriction	USEPA Review of Development Plans	Non-Interference With Remedial Facilities / Engineering Controls	USEPA Approval Prior to Drilling Into or Use of Groundwater
7351-034-058	24	✓	✓	✓	✓	✓		✓
7351-034-061	none	✓	✓					
7351-034-062	none	✓	✓					
7351-034-063	none	✓	✓					
7351-034-064	none	✓	✓					
7351-034-065	none	✓	✓					
7351-034-066	25	✓	✓					
7351-034-067	26	✓	✓					
7351-034-068	27	✓	✓					
7351-034-069	28	✓	✓	✓	✓	✓	✓	✓
7351-034-070	29	Excluded From Soil & NAPL Remedy						
7351-034-072	30	✓	✓	✓	✓	✓		
7351-034-073	31	✓	✓					
7351-034-074	none	✓	✓					
7351-034-075	none	✓	✓					
7351-034-076	32	✓	✓	✓	✓	✓		✓
7351-034-079	none	✓	✓					
7351-034-080	none	✓	✓					
7351-034-800	none	✓	✓					
7351-034-803	33	✓	✓	✓	✓	✓		✓
7351-034-804	none	✓	✓					
7351-034-901	34	Excluded From Soil & NAPL Remedy						
Francisco St	none	✓	✓					
Knox St	none	✓	✓					
Magellan Dr	35	✓	✓	✓	✓	✓	✓	✓
Pacific Gateway (northern segment)	36	✓	✓	✓	✓	✓		
Pacific Gateway (southern segment)	37	✓	✓					
Vermont Avenue	none	✓	✓					

Notes:

1) Identified restrictive covenants are consistent with those presented in the ROD. A generic DTSC restrictive covenant agreement template is provided in Appendix I and includes additional requirements applicable to all properties with restrictive covenants.

TABLE 12
IC SUMMARY

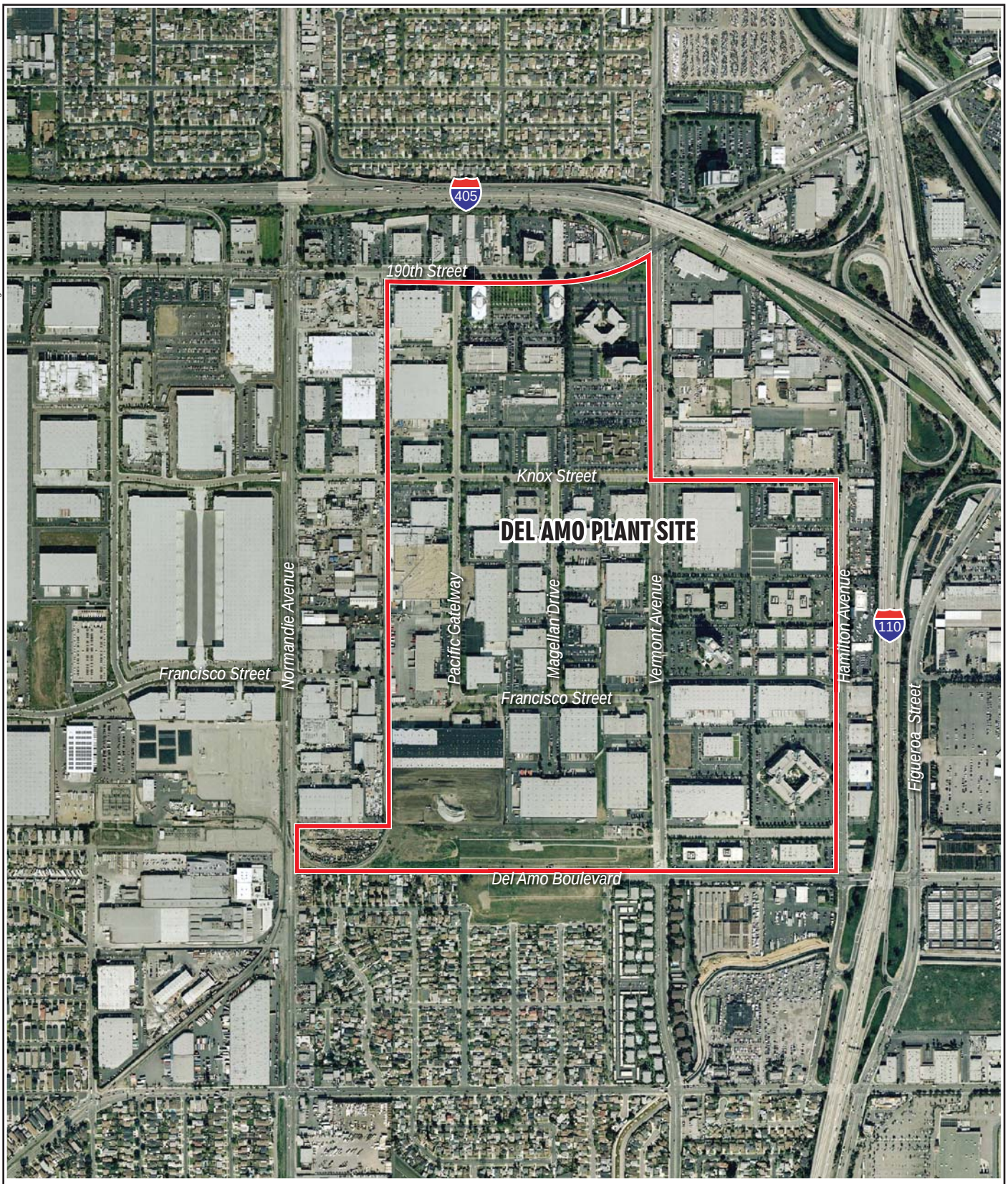
Category	IC Layer						
	IC-1	IC-2	IC-3	IC-4			
				Restrictive Covenants			
	Informational Outreach	**Building Permit Review/ Landwatch**	**General Plan Footnote**	**Residential Use Restriction**	**EPA Review of Development Plans**	**Non-Interference With Remedial Facilities / Engineering Controls**	**USEPA Approval Prior to Drilling into or Use of Groundwater**
Instrument Type	Informational Device	Informational / Long-term stewardship tool	Government Control	Proprietary Control	Proprietary Control	Proprietary Control	Proprietary Control
Goal	Inform public about Site environmental conditions and controls and restrictions in place.	Identify construction activities with potential to result in exposures	Reduce potential for change to residential land use	Prohibit residential land use	Identify construction activities with potential to result in exposures	Prohibit interference with remedial activities within the property and residential use	Reduce potential for exposure through groundwater
Applicable Properties	All Site Properties	All Site Properties	2, 4-17, 19, 20, 22-24, 28, 30, 32, 33, 35, 36	2, 4-17, 19, 20, 22-24, 28, 30, 32, 33, 35, 36	2, 4-17, 19, 20, 22-24, 28, 30, 32, 33, 35, 36	2, 5, 6, 9, 11, 15, 16, 23, 28, 35[1]	4, 5, 6, 8, 9, 11, 15, 16, 17, 19, 20, 22, 23, 24, 28, 32, 33, 35
Implementation Prerequisites	Development of communication plan, schedule and web page	Already in place as a pilot program	Initiation of General Plan Amendment by City Council, Planning Commission or Planning Director	USEPA/DTSC approval; filing with county registrar-recorder/clerk	USEPA/DTSC approval; filing with county registrar-recorder/clerk	USEPA/DTSC approval; filing with county registrar-recorder/clerk	USEPA/DTSC approval; filing with county registrar-recorder/clerk
Implementation Completion	Ongoing periodic updating of websites/ repositories; public outreach coincident with project milestones and schedule	Already in place as a pilot program	Approval of General Plan Amendment	Legal recording by County	Legal recording by County	Legal recording by County	Legal recording by County
Potential Implementation Barriers	None anticipated	None anticipated	City of Los Angeles and owner approval	Property owner approval	Property owner approval	Property owner approval	Property owner approval
Implementation Responsibility	USEPA/DTSC/ Respondents	ERT/ City of Los Angeles/Respondents	City of Los Angeles/Respondents	USEPA/DTSC/ Respondents	USEPA/DTSC/ Respondents	USEPA/DTSC/ Respondents	USEPA/DTSC/ Respondents
Monitoring Frequency	Annual	Annual	Annual	Annual	Annual	Annual	Annual

Notes

1) Properties where remedial facilities will be located may decrease based on results from Pre-Design Investigations

FIGURES

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\615-047



N

0 1,000 2,000

Scale in Feet

Source: AirPhotoUSA dated February 2006

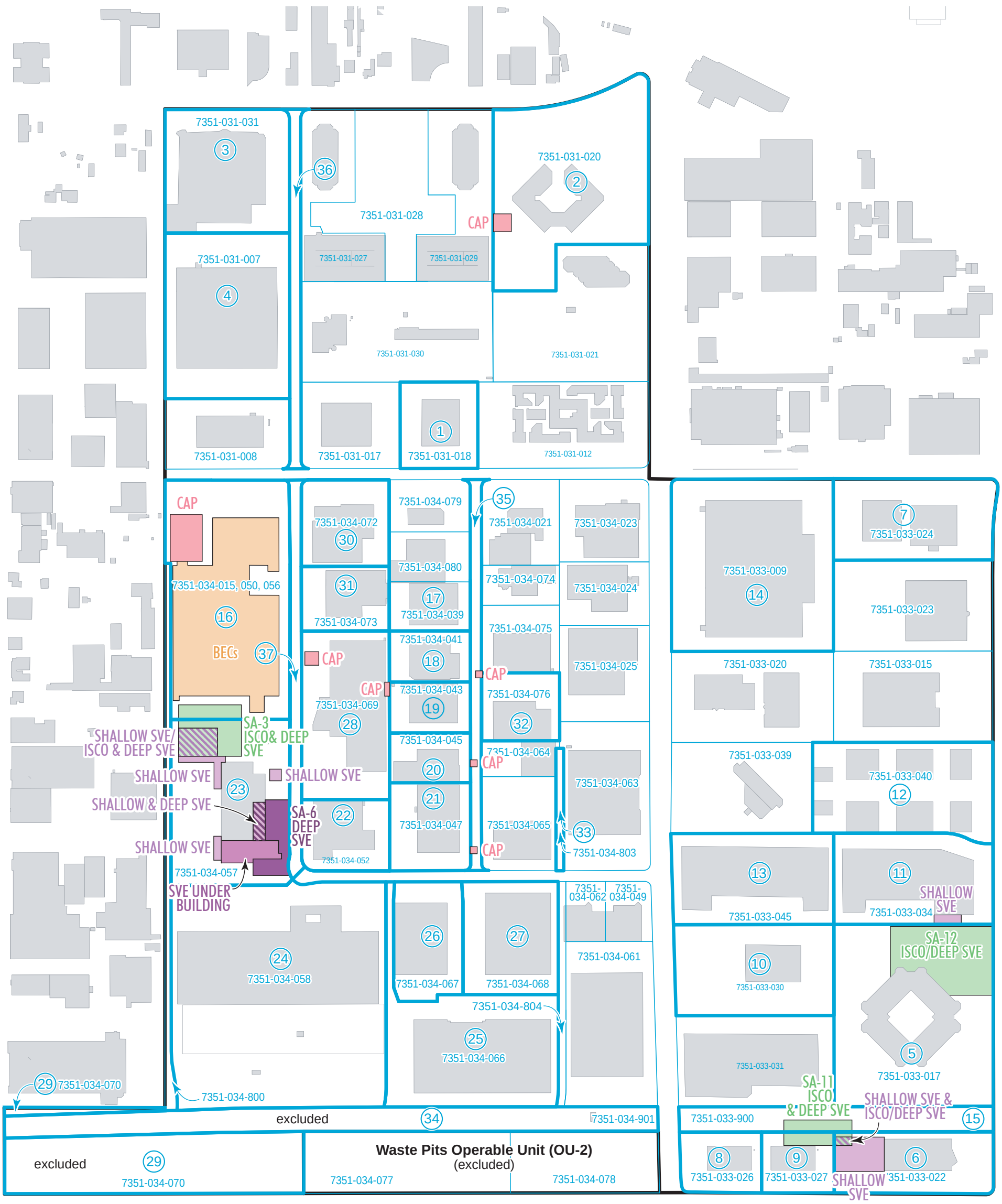
FIGURE 1

SITE LOCATION MAP

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\615-050A



Legend

Current building footprint

29 — Property and number (corresponds with Exposure Area of Potential Concern (EAPC) identified in the Baseline Risk Assessment)

7351-034-070 — Assessor's parcel number

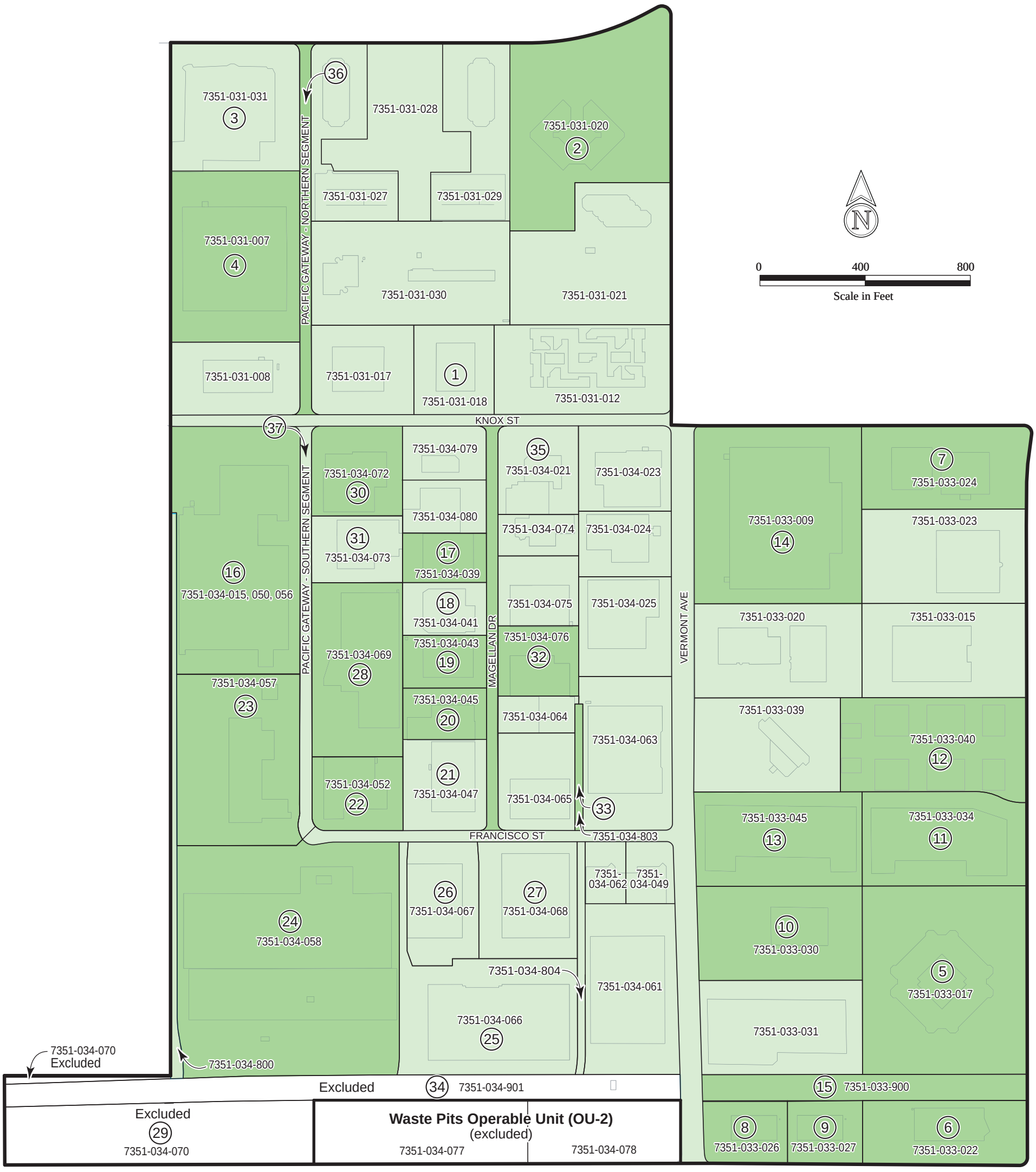
FIGURE 2

ROD REMEDIATION AREAS

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\607-140G



Legend

- *IC Layers 1 and 2 (68 properties)*
- *IC Layers 1 - 4 (26 properties)*
- 7351-034-066 *Assessor's parcel number*
- (25) *EAPC/Property Number*

IC Layer No.	Description
1	Informational Outreach
2	Permit Review/Landwatch
3	General Plan Footnote
4	Restrictive Covenants

Notes:

1. See Table 1 and Figure 29 for the specific restrictive covenants applicable to each property
2. Streets such as Pacific Gateway, Francisco, Knox, Magellan and Vermont do not have parcel numbers but have proposed institutional controls.

FIGURE 3

IC APPLICATION

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\1115-076

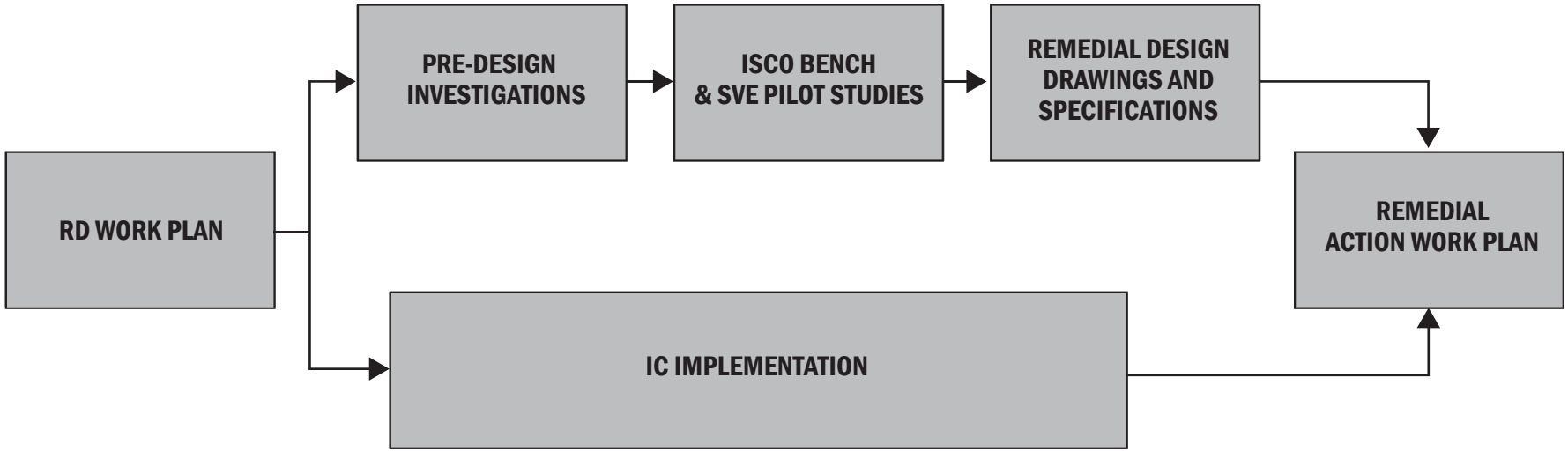


FIGURE 4

PROJECT FLOW CHART

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\615-045

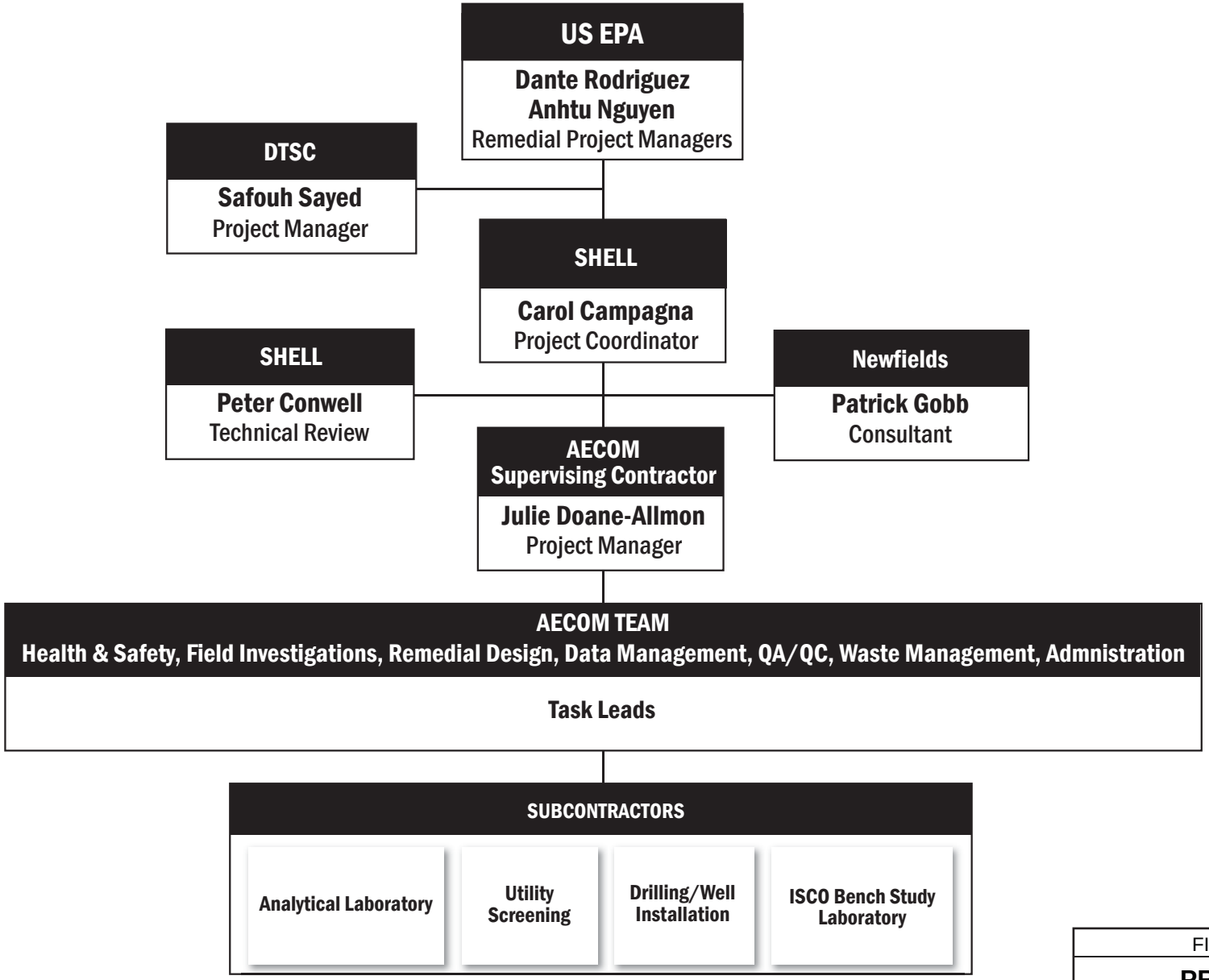


FIGURE 5

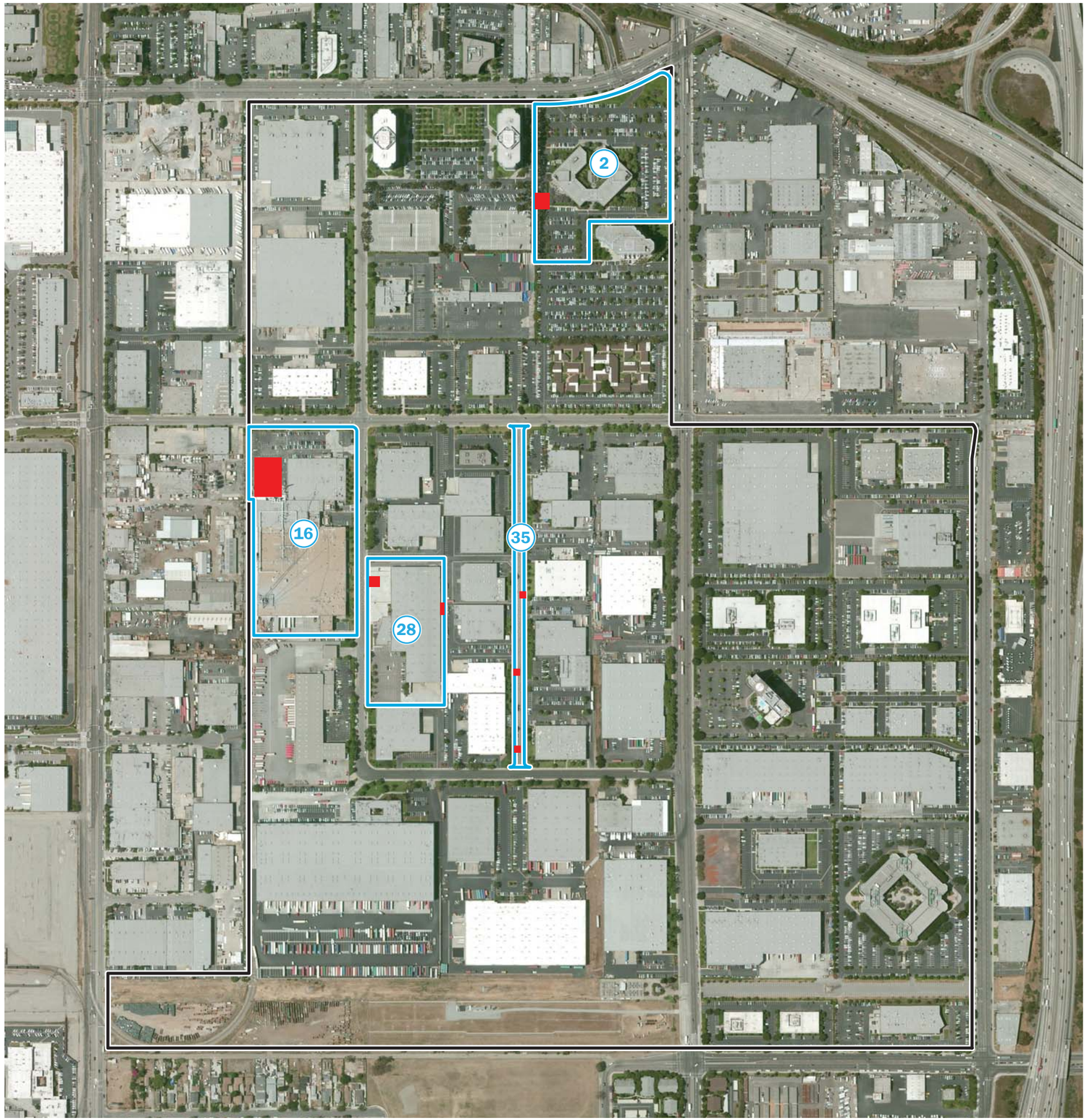
PROJECT ORGANIZATION CHART

RD Work Plan

Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\515-040A



N

0 500 1000

Scale in Feet

Legend

- Proposed cap areas
- Property boundaries
- 35 Property number
- Del Amo Superfund Site boundary

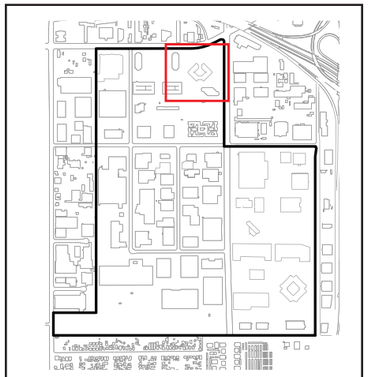
FIGURE 6

CAP AREAS

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\714-118C



Area shown in this map

Legend

● SBL0340 BaP 0.442	Shallow soil sampling location with maximum benzo(a)pyrene equivalent concentration (mg/kg)
▬	Property boundary
▭	Proposed cap area
7351-031-020	Assessor's parcel number
(2)	Property number

Note:

USEPA accepted background concentration for benzo(a)pyrene equivalent is 0.9 mg/kg.

N

0 40 80 160

Scale in Feet

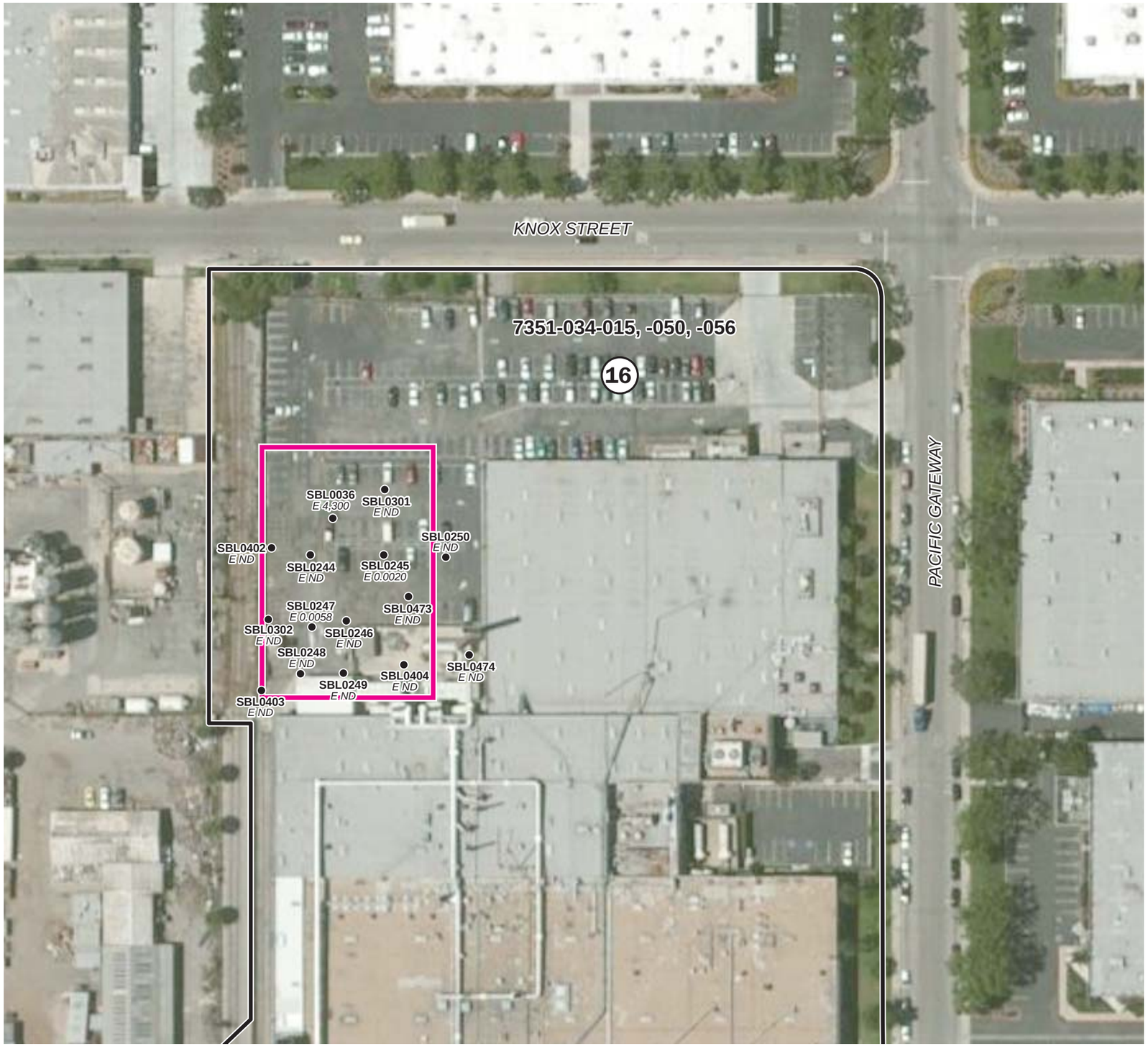
FIGURE 7

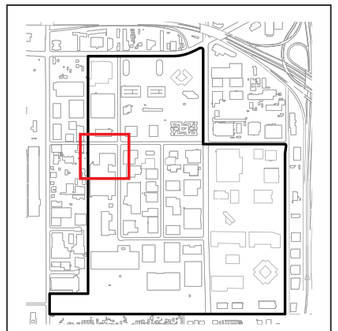
CAP AREA
Property 2

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\714-124A2





Area shown in this map

Legend

SBL0247 E 0.0058	Shallow soil sampling location with maximum ethylbenzene concentration (mg/kg)
	Property boundary
	Cap area
7351-034-015, -050, -056	Assessor's parcel number
16	Property number
E	Ethylbenzene

N

0 40 80 160

Scale in Feet

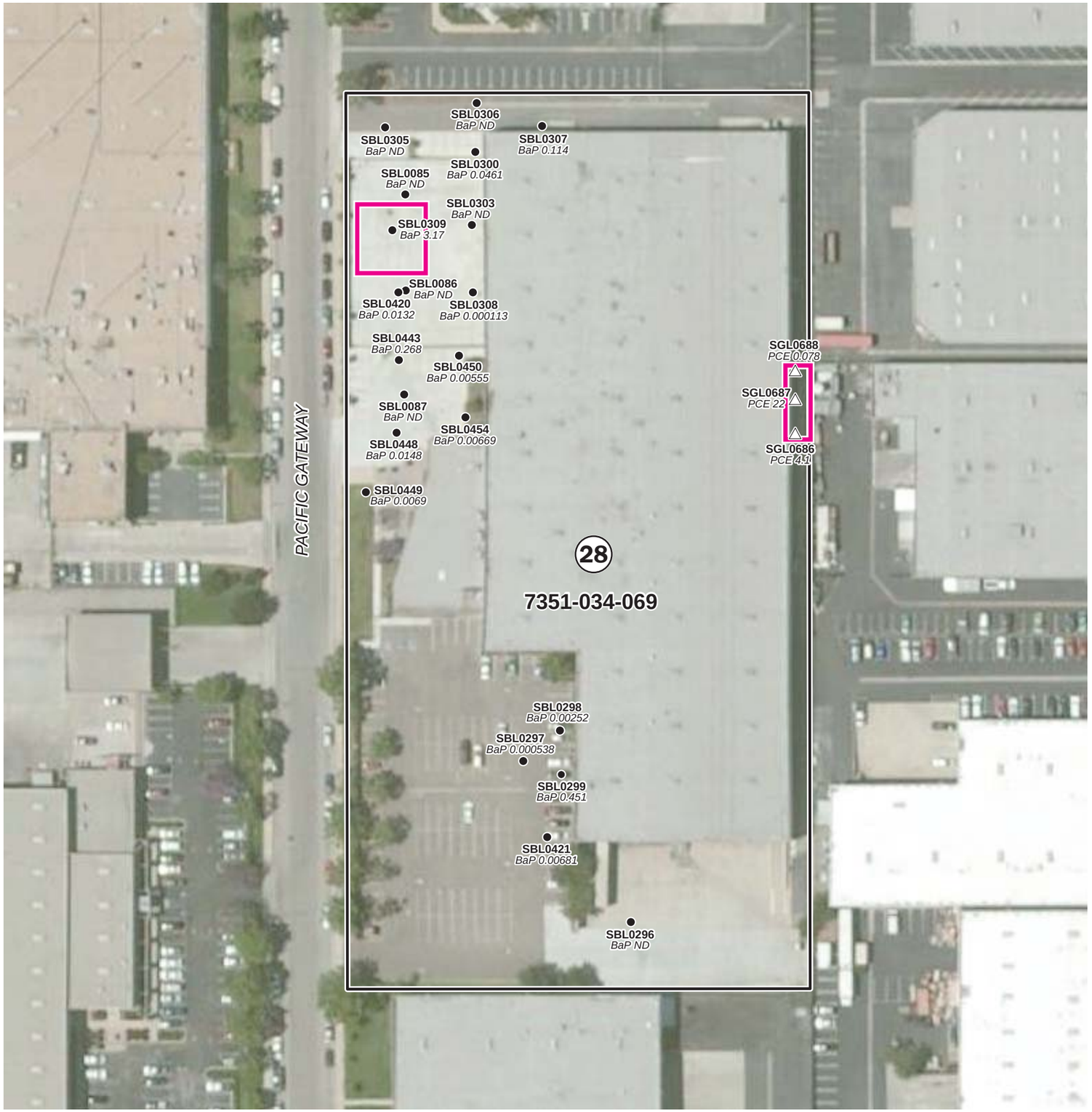
FIGURE 8

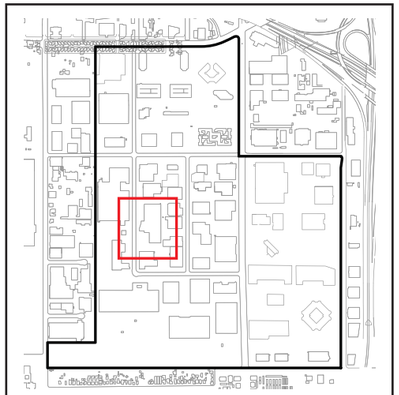
CAP AREA
Property 16

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\794-227D





Area shown in this map

Legend

● SBL0300 BaP 0.0461	Shallow soil sampling location with maximum benzo(a)pyrene equivalent concentration (mg/kg)
△ SGL0687 PCE 22	Shallow soil gas sampling location with PCE concentration (ppmv)
▬	Property boundary
▭	Proposed cap area
7351-034-069	Assessor's parcel number
(28)	Property number

Note:
USEPA accepted background concentration for benzo(a)pyrene equivalent in soil is 0.9 mg/kg.

N

0 40 80 160
Scale in Feet

FIGURE 9

CAP AREA
Property 28

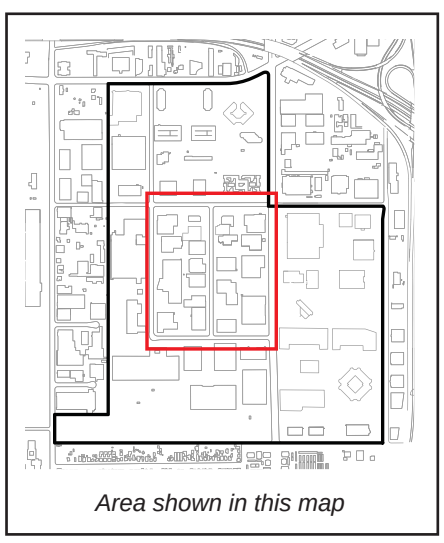
RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\714-121C

Legend

● SBL0323 B 0.0088 E 0.0024 BaP 0.0054	Shallow soil sampling location with maximum concentrations of constituents of concern (mg/kg)
	Property boundary
▭	Proposed cap area
35	Property number
B	Benzene
E	Ethylbenzene
BaP	Benzo(a)pyrene
ND	Not detected
NA	Not analyzed
*	16 ft bgs



Area shown in this map

N

0 100 200 400

Scale in Feet

FIGURE 10

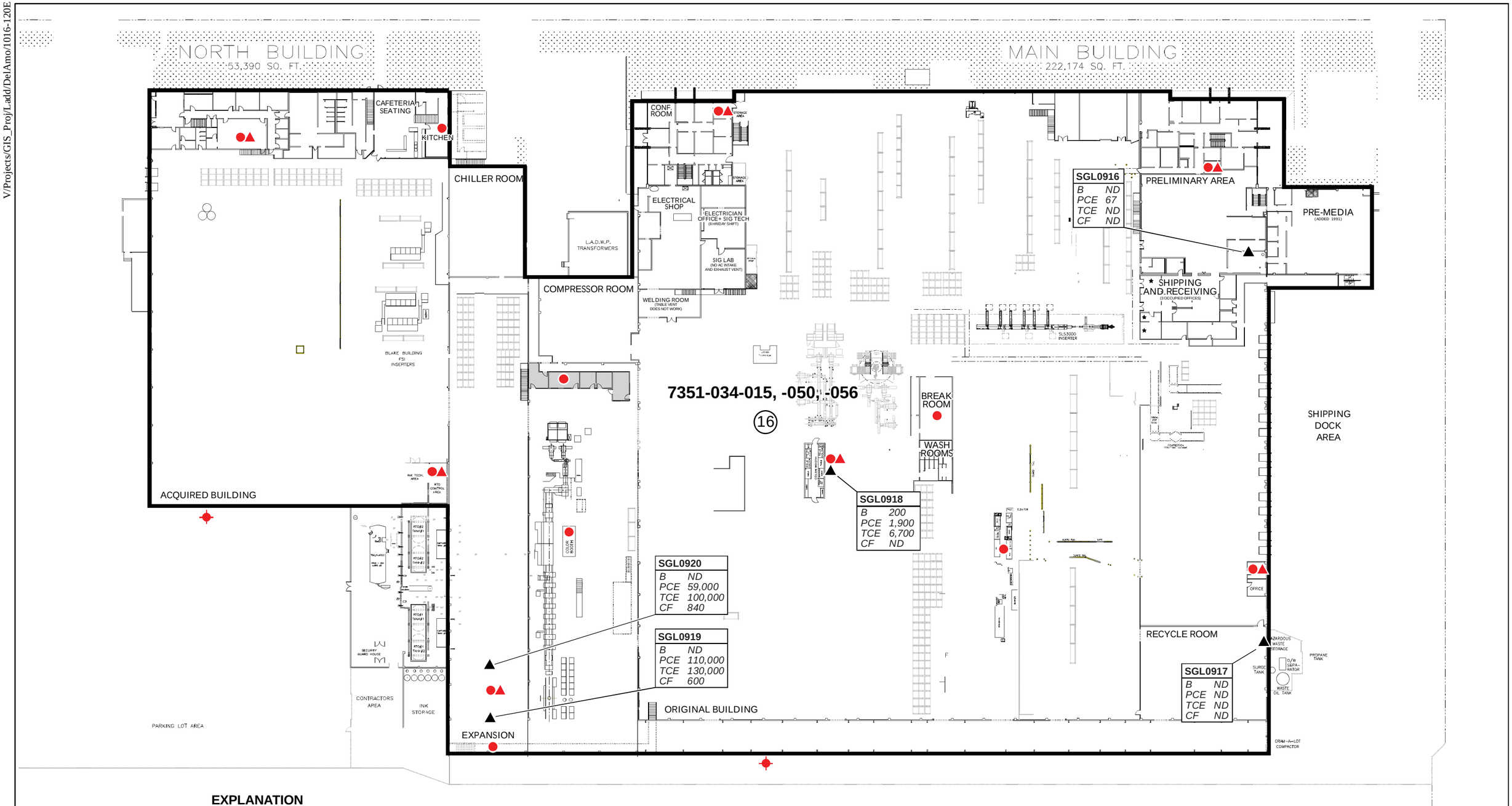
CAP AREAS
Property 35

RD Work Plan
Del Amo Superfund Site

AECOM

Note:
USEPA accepted background level for benzo(a)pyrene is 0.9 mg/kg.

V/Projects/GIS_Proj/Ladd/DelAmo/1016-120E



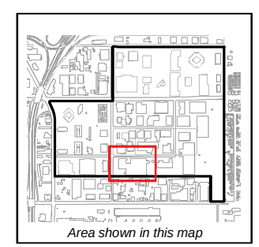
EXPLANATION

- ● PROPOSED INDOOR AIR SAMPLING LOCATION
- ✦ PROPOSED OUTDOOR AIR SAMPLING LOCATION PROPOSED
- ▲ PROPOSED SUB-SLAB VAPOR SAMPLING LOCATION
- ▲ SGL0917 (B ND, PCE ND, TCE ND, CF ND) — 2009 SUB-SLAB VAPOR SAMPLING LOCATION WITH DETECTED CONCENTRATIONS OF CONTAMINANTS OF CONCERN (mg/m^3)
- **7351-034-056** ASSESSOR'S PARCEL NUMBER
- (16) PROPERTY NUMBER

N

0' 30' 60' 90' 120'

Total area = 285,000 ft^2



Area shown in this map

FIGURE 11

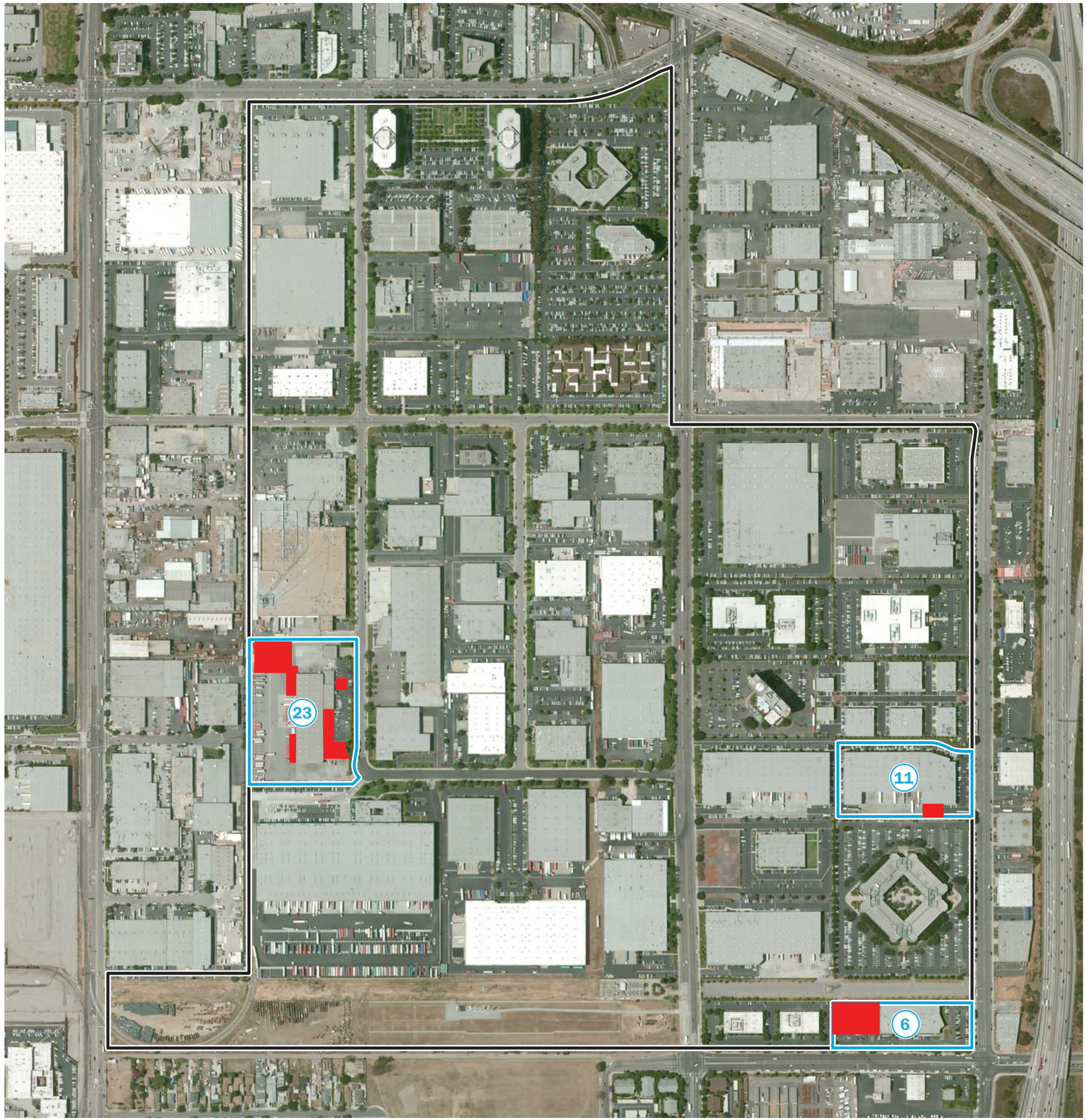
INDOOR AIR AND SUB-SLAB VAPOR SAMPLING LOCATIONS

Property 16

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\515-040B



N

0 500 1000

Scale in Feet

Legend

- Potential shallow soil SVE areas
- Property boundaries
- 23 Property number
- Del Amo Superfund Site boundary

FIGURE 12

SHALLOW SOIL SVE AREAS

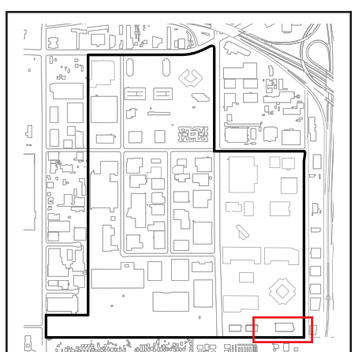
RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\714-120C2

Legend

△ SG-11 B 2.0	Shallow soil gas/subslab vapor sampling location with maximum benzene concentration (ppmv)
●	Proposed shallow soil sampling location
▬	Property boundary
▭	Proposed shallow SVE area
7351-033-022	Assessor's parcel number
6	Property number
B	Benzene
ND	Not detected



Area shown in this map

N

0 30 60 120

Scale in Feet

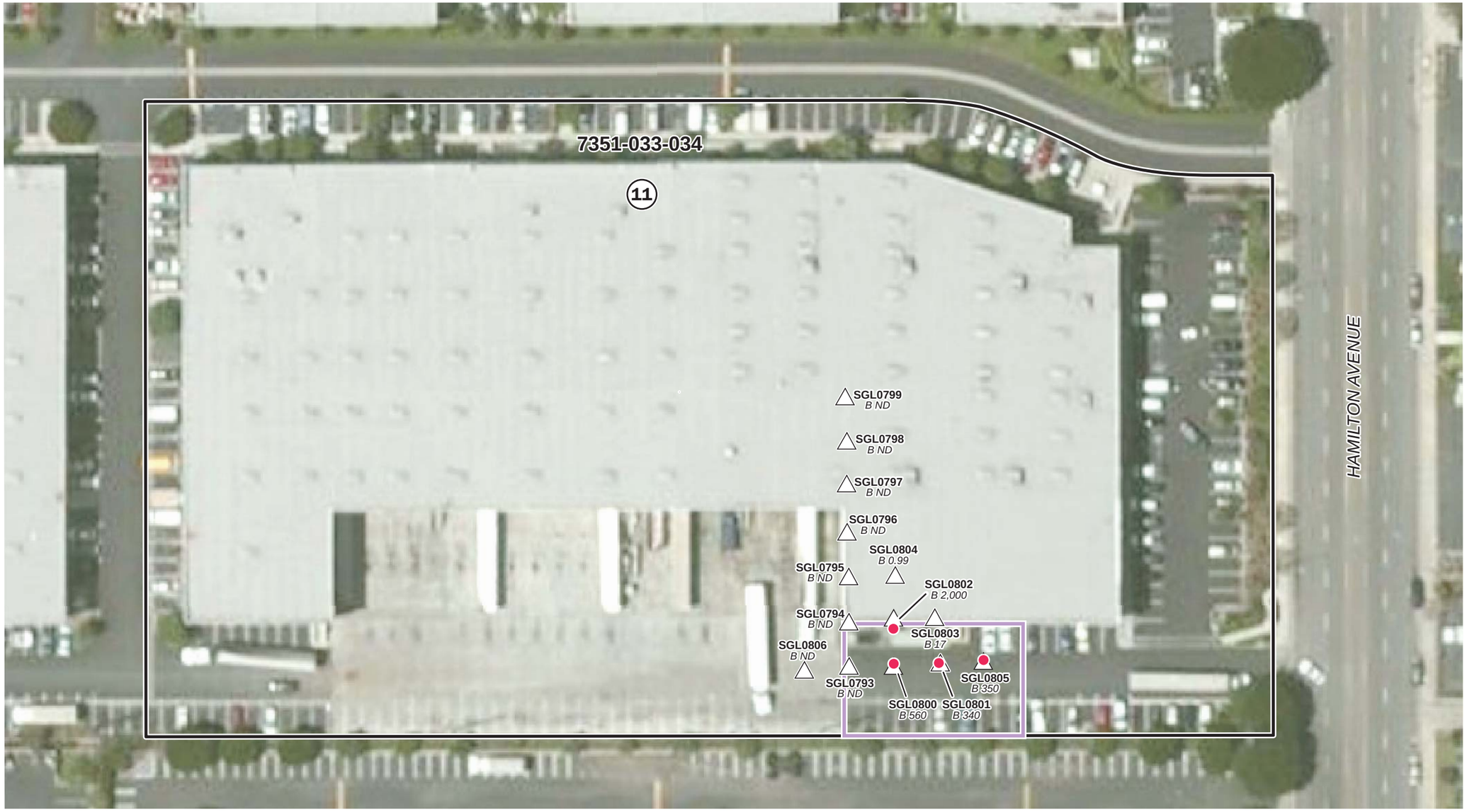
FIGURE 13

SHALLOW SOIL SAMPLING LOCATIONS
Property 6

RD Work Plan
Del Amo Superfund Site

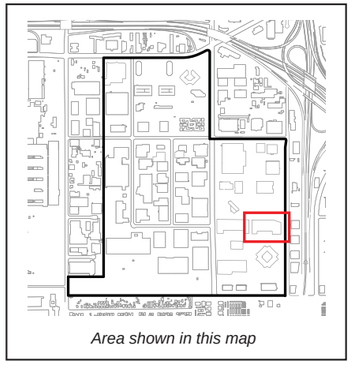
AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\694-121A2



Legend

△ SGL0803 B 17	Shallow soil gas sampling location with maximum benzene concentration (ppmv)
●	Proposed shallow soil sampling location
▬	Property boundary
▭	Proposed shallow SVE area
7351-033-034	Assessor's parcel number
(11)	Property number
B	Benzene
ND	Not detected



Area shown in this map

N

0 30 60 120

Scale in Feet

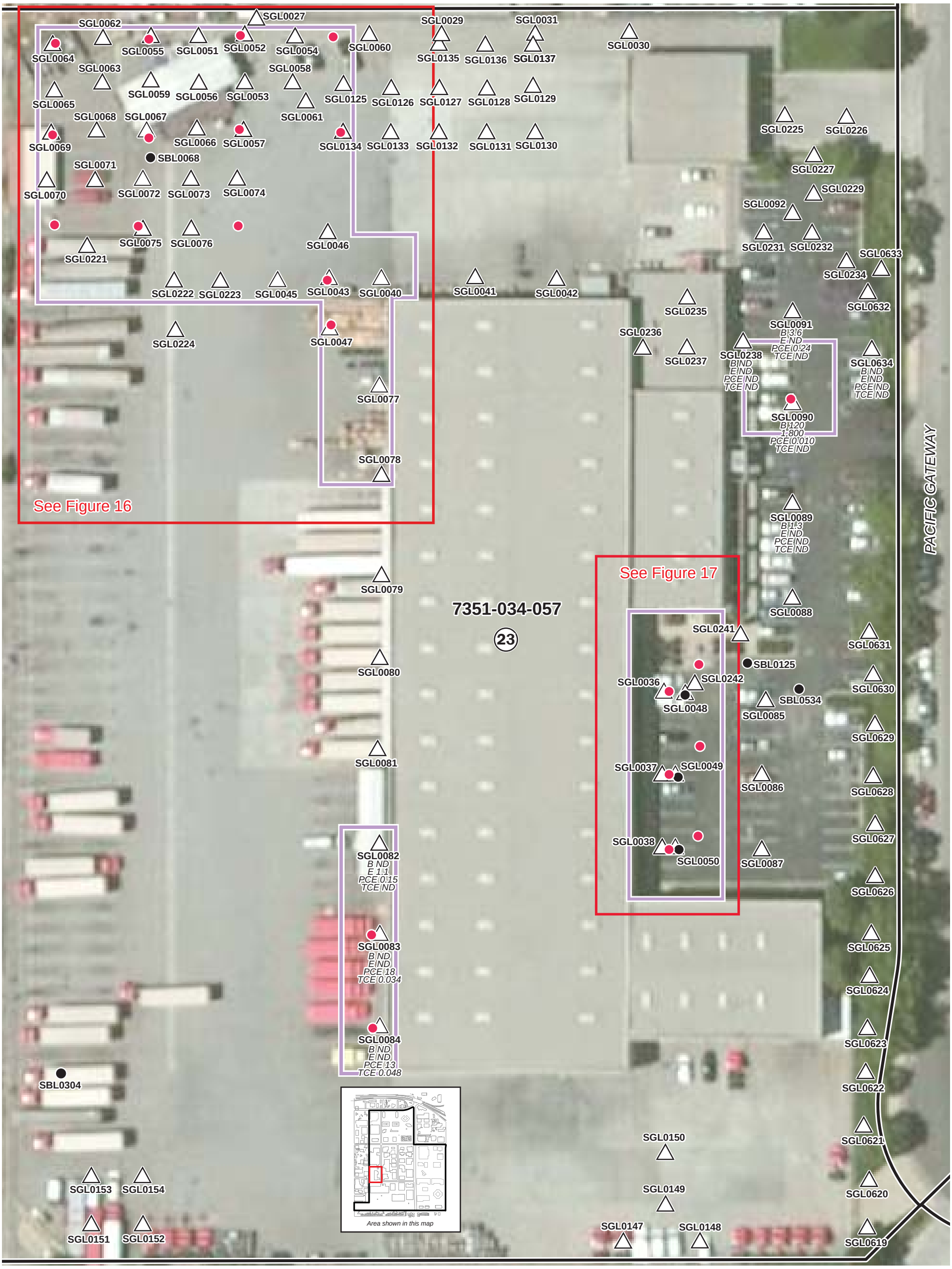
FIGURE 14

SHALLOW SOIL SAMPLING LOCATIONS
Property 11

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\714-124A2



Legend

△ SGL0082 B ND E 1.1 PCE 0.15 TCE ND	*Shallow soil gas sampling location with maximum concentrations of constituents of concern (ppmv)*	**7351-034-057**	*Assessor's parcel number*
		(23)	*Property number*
		B	*Benzene*
● SBL0304	*Shallow soil sampling location with maximum concentrations of constituents of concern (mg/kg)*	E	*Ethylbenzene*
		PCE	*Tetrachloroethene*
●	*Proposed shallow soil sampling location*	TCE	*Trichloroethene*
▬	*Property boundary*	ND	*Not detected*
▭	*Proposed shallow SVE area*		

Note:
Concentrations for constituents of concern in shallow soil and shallow gas are displayed for samples near areas proposed for SVE.

N

0 50 100
Scale in Feet

FIGURE 15

SHALLOW SOIL SAMPLING LOCATIONS
Property 23

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\714-124A3

Legend

△ SGL0075 B ND E 0.22 PCE 0.27 TCE 0.017	Shallow soil gas sampling location with maximum concentrations of constituents of concern (ppmv)
● SBL0068 B ND E 1,200 PCE ND TCE ND	Shallow soil sampling location with maximum concentrations of constituents of concern (mg/kg)
●	Proposed shallow soil sampling location
▬	Property boundary
▭	Area proposed for shallow SVE
7351-034-057	Assessor's parcel number
23	Property number
B	Benzene
E	Ethylbenzene
PCE	Tetrachloroethene
TCE	Trichloroethene
ND	Not detected

N

0 40 80 160

Scale in Feet

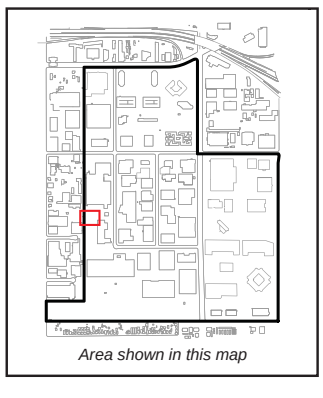


FIGURE 16

SHALLOW SOIL SAMPLING LOCATIONS
Property 23
Northwestern Sub-area

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\714-124A3

Legend

△ SGL0242 B 2.3 E 33 PCE ND TCE ND	Shallow soil gas sampling location with maximum concentrations of constituents of concern (ppmv)
● SGL0049 B 0.55 E 0.40 PCE ND TCE ND	Shallow soil sampling location with maximum concentrations of constituents of concern (mg/kg)
CPL0114	Previously completed UVOST/CPT location
CPL0059	Previously completed ROST/CPT location
●	Proposed shallow soil sampling location
◉	Proposed shallow and deep soil sampling location
▬	Property boundary
▭	Area proposed for shallow SVE
7351-034-057	Assessor's parcel number
23	Property number
B	Benzene
E	Ethylbenzene
PCE	Tetrachloroethene
TCE	Trichloroethene
ND	Not Detected

N

0 50 100

Scale in Feet

Area shown in this map

FIGURE 17

SHALLOW SOIL SAMPLING LOCATIONS
Property 23
Eastern Sub-area

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\714-124A4

Legend

△ SGL0926 B 6.9 PCE 210 TCE ND CF ND	Sub-slab vapor sampling location with concentrations of constituents of concern (µg/m³)
▲	Proposed sub-slab vapor sampling location
⊹	Proposed outdoor air sampling locations
▬	Property boundary
▭	Proposed SVE area
7351-034-057	Assessor's parcel number
23	Property number

B	Benzene
PCE	Tetrachlorethene
TCE	Trichlorethene
CF	Chloroform
ND	Not detected

N

0 50 100
Scale in Feet

FIGURE 18

SUB-SLAB VAPOR AND OUTDOOR AIR SAMPLING LOCATIONS
Property 23

RD Work Plan
Del Amo Superfund Site

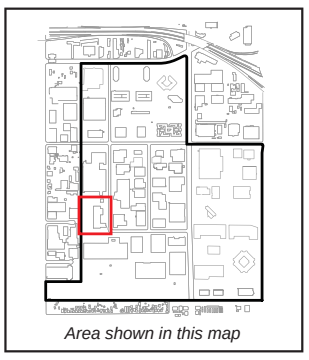
AECOM

V:\Projects\GIS_Proj\Ladd\DelAmo\RDWorkPlan\714-125

Legend

SGL0034 B 15,600 E 240 PCE ND TCE 0.068 CF 0.068	*Deep soil gas sampling location with maximum concentrations of constituent of concern (ppmv)*
SBL0354 B 15 E 21 PCE ND TCE ND CF ND	*Previously completed UVOST/CPT/soil boring location with maximum concentrations of contaminants of concern (mg/kg)*
CPL0115	*Previously completed UVOST/CPT location*
CPL0064	*Previously completed ROST/CPT location*
	Proposed deep soil sampling location
	Proposed shallow and deep soil sampling location
	Property boundary
	Area proposed for deep SVE
7351-034-057	*Assessor's parcel number*
23	*Property number*
	Approximate extent of LNAPL-impacted soil based on ROST/UVOST; queried where uncertain

B	*Benzene*
E	*Ethylbenzene*
PCE	*Tetrachloroethene*
TCE	*Trichloroethene*
CF	*Chloroform*
ND	*Not detected*



N

0 50 100 150

Scale in Feet

FIGURE 19

DEEP SOIL SAMPLING LOCATIONS PROPERTY 23

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\515-040B

N

0 500 1000

Scale in Feet

Legend

- Source area where ISCO/SVE will be implemented
- Source area where ISCO/SVE may potentially be implemented
- Del Amo Superfund Site boundary

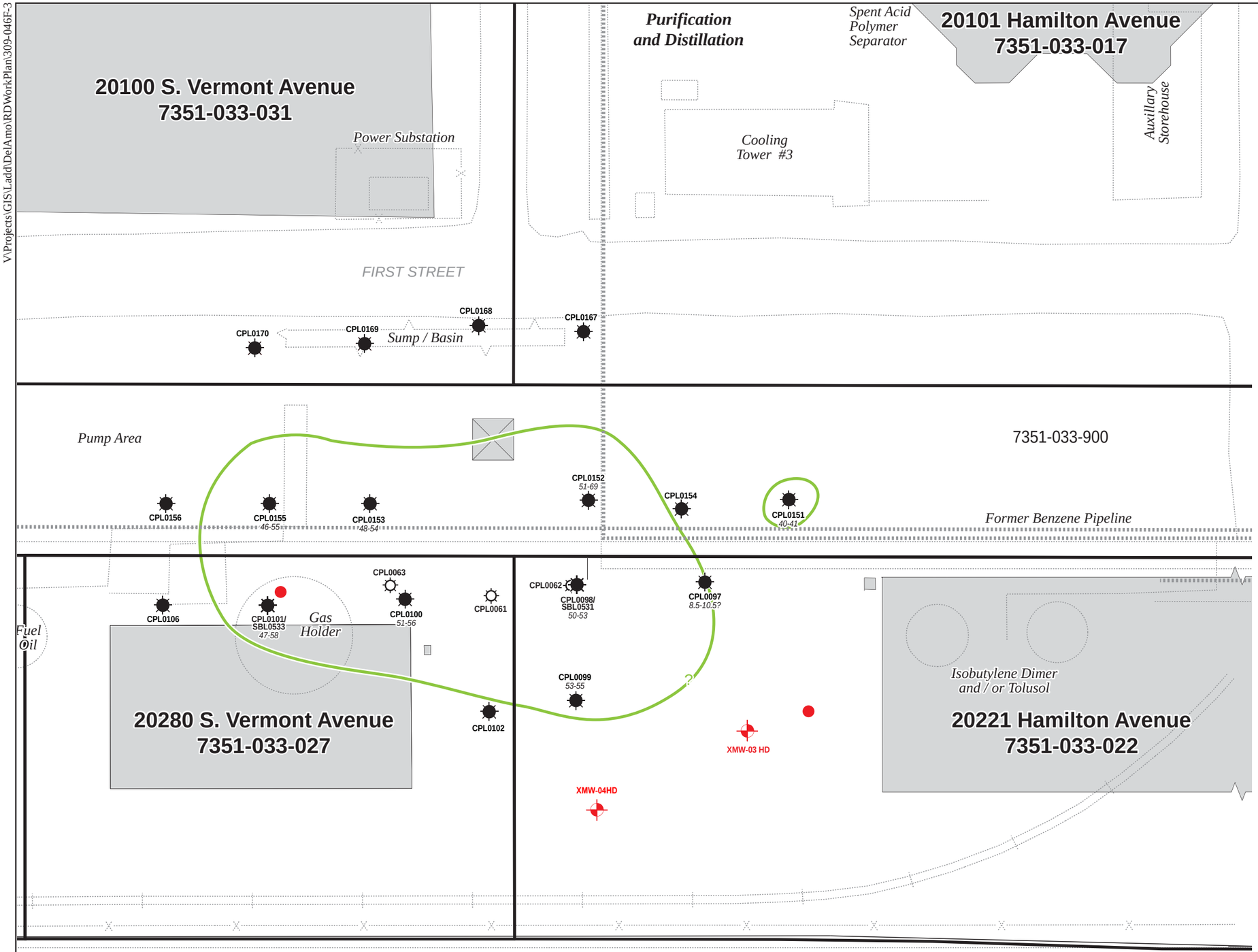
FIGURE 20

ISCO/SVE AREAS

RD Work Plan
Del Amo Superfund Site

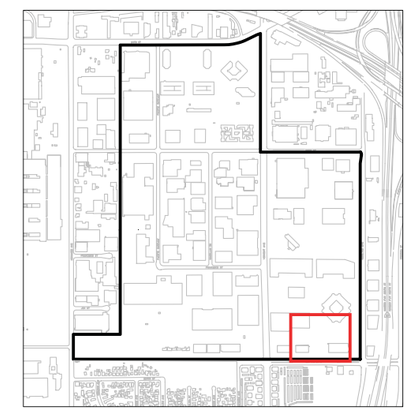
AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\309-046F-3



Legend

- Proposed soil boring location for ISCO/SVE bulk soil and physical testing samples
- Proposed groundwater sampling location
- CPL0099 53-55 — UVOST/CPT location showing depth interval of LNAPL-impacted soil (ft bgs)
- CPL0061 — Previously completed ROST location
- Cooling Tower #3 — Outlines of historical features with use/ contents indicated
- Location of historical pipeline that may have transported VOC solutions
- Property boundary
- Approximate extent of LNAPL-impacted soil based on ROST/UVOST; queried where uncertain



Area shown on this map

N

0 60 120

Scale in Feet

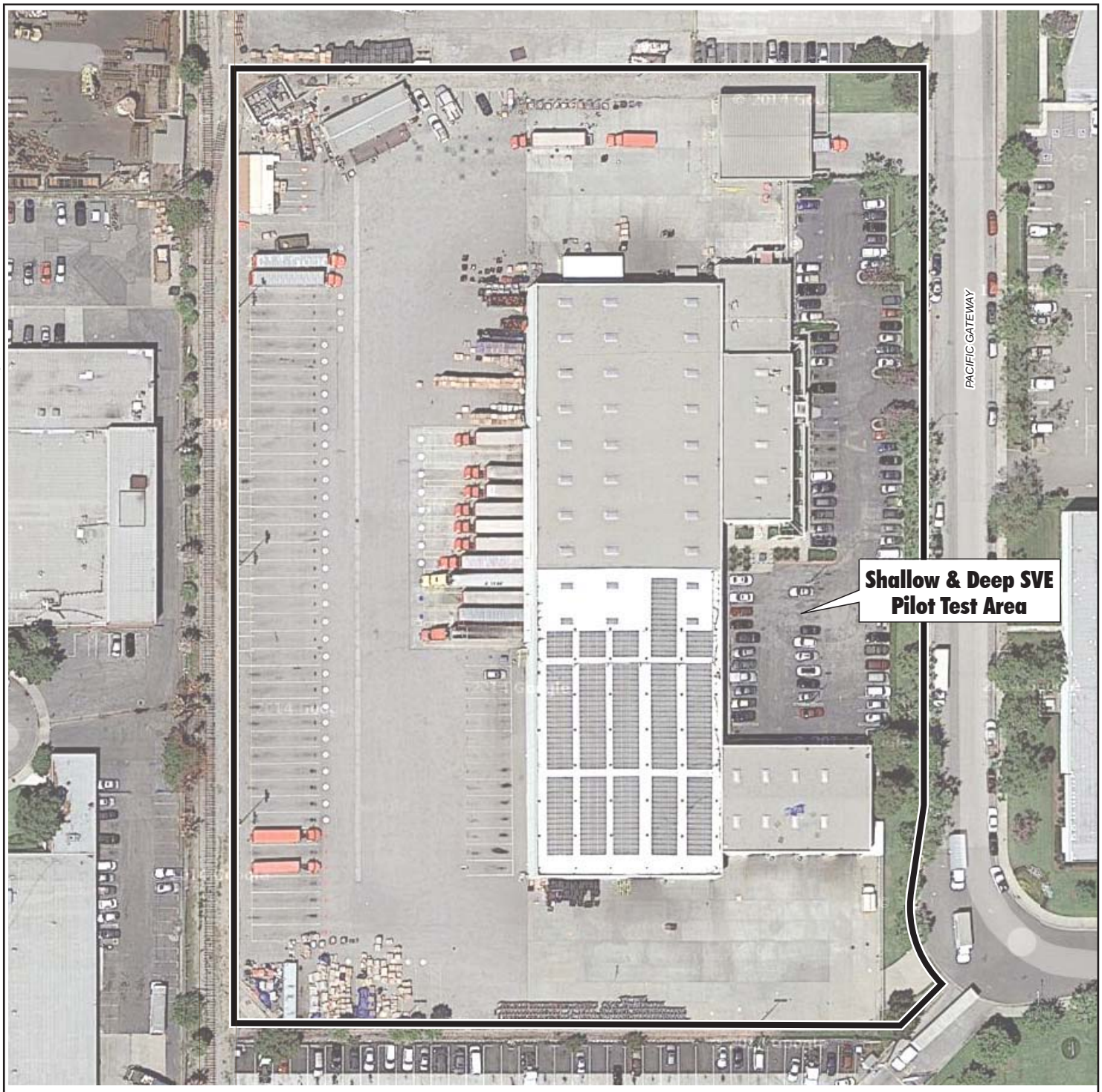
FIGURE 21

SOIL AND GROUNDWATER SAMPLING LOCATIONS
Source Area 11

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\1014-156A-Aerial



N

0 50 100 200

Scale in Feet

Legend

Property boundary

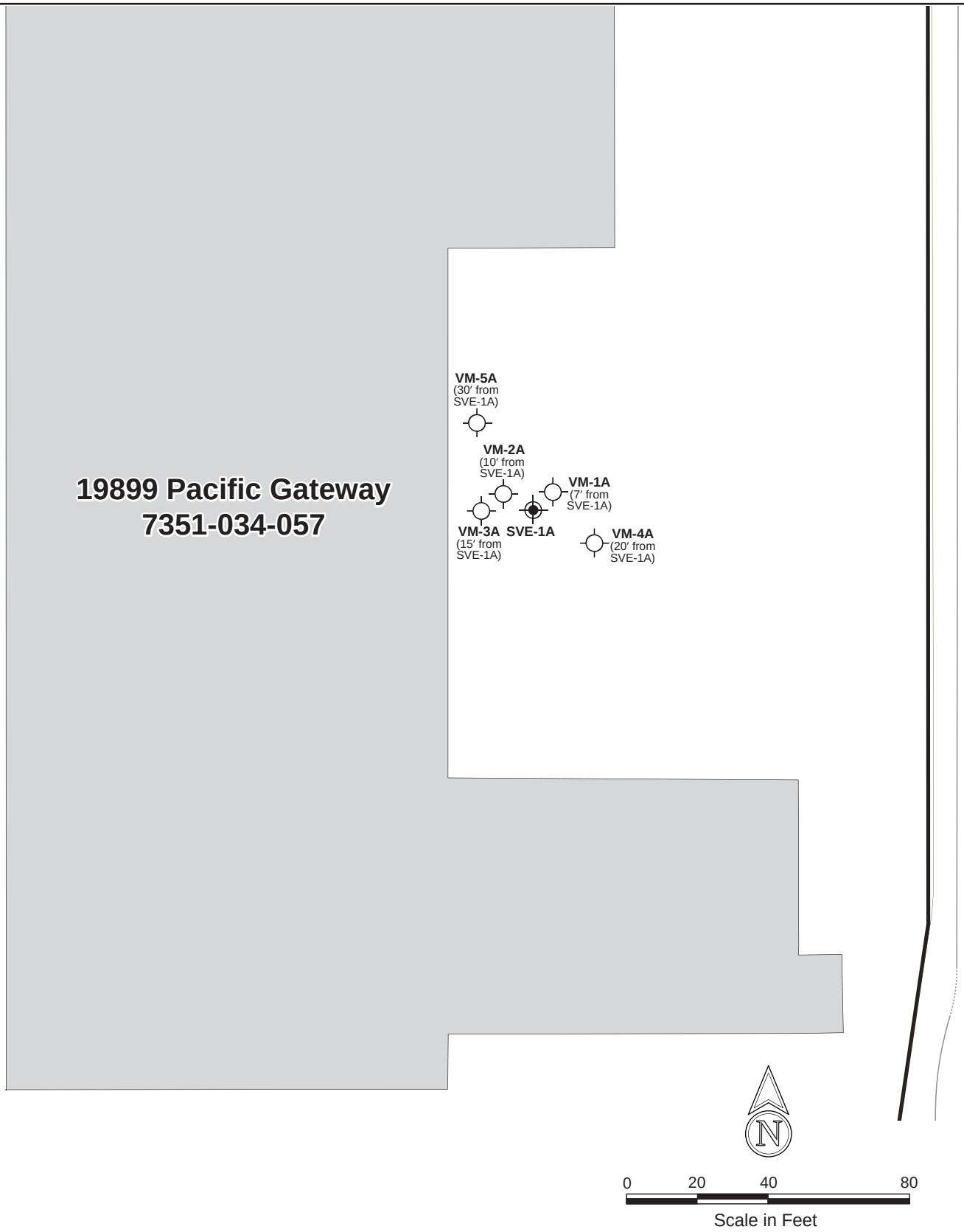
Source:
Imagery @ 2015 DigitalGlobe U.S. Geological Survey,
Maps data ©2015 Google

FIGURE 22

SVE PILOT TEST AREA
Property 23/
Source Area 6
RD Work Plan
Del Amo Superfund Site

AECOM

V\Projects\GIS\Ladd\DelAmo\RDWorkPlan\1014-157A



Legend

- *Property boundary*
- SVE-1A — *Proposed shallow SVE well*
- VM-4A — *Proposed shallow vapor monitoring well*
- *Existing building footprint*

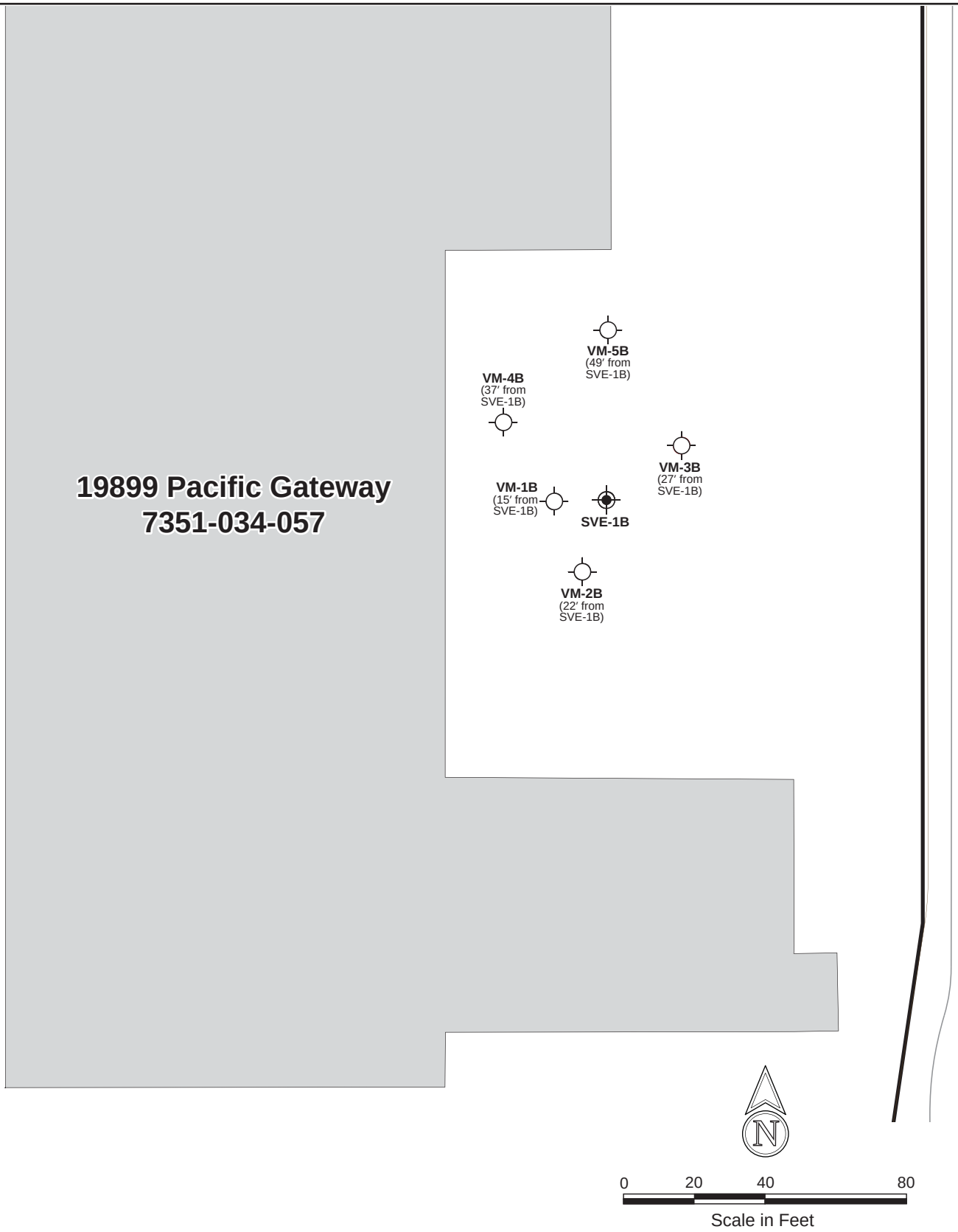
Note:
Pilot test and well locations are contingent upon sampling results

FIGURE 23

WELL LOCATIONS
SHALLOW SVE PILOT TEST
Property 23
RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\1014-158A



Legend

- *Property boundary*
- **SVE-1B** *Proposed deep SVE well*
- **VM-4B** *Proposed deep vapor monitoring well*
- *Existing building footprint*

FIGURE 24

WELL LOCATIONS
DEEP SVE PILOT TEST
Source Area 6
RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\1014-161

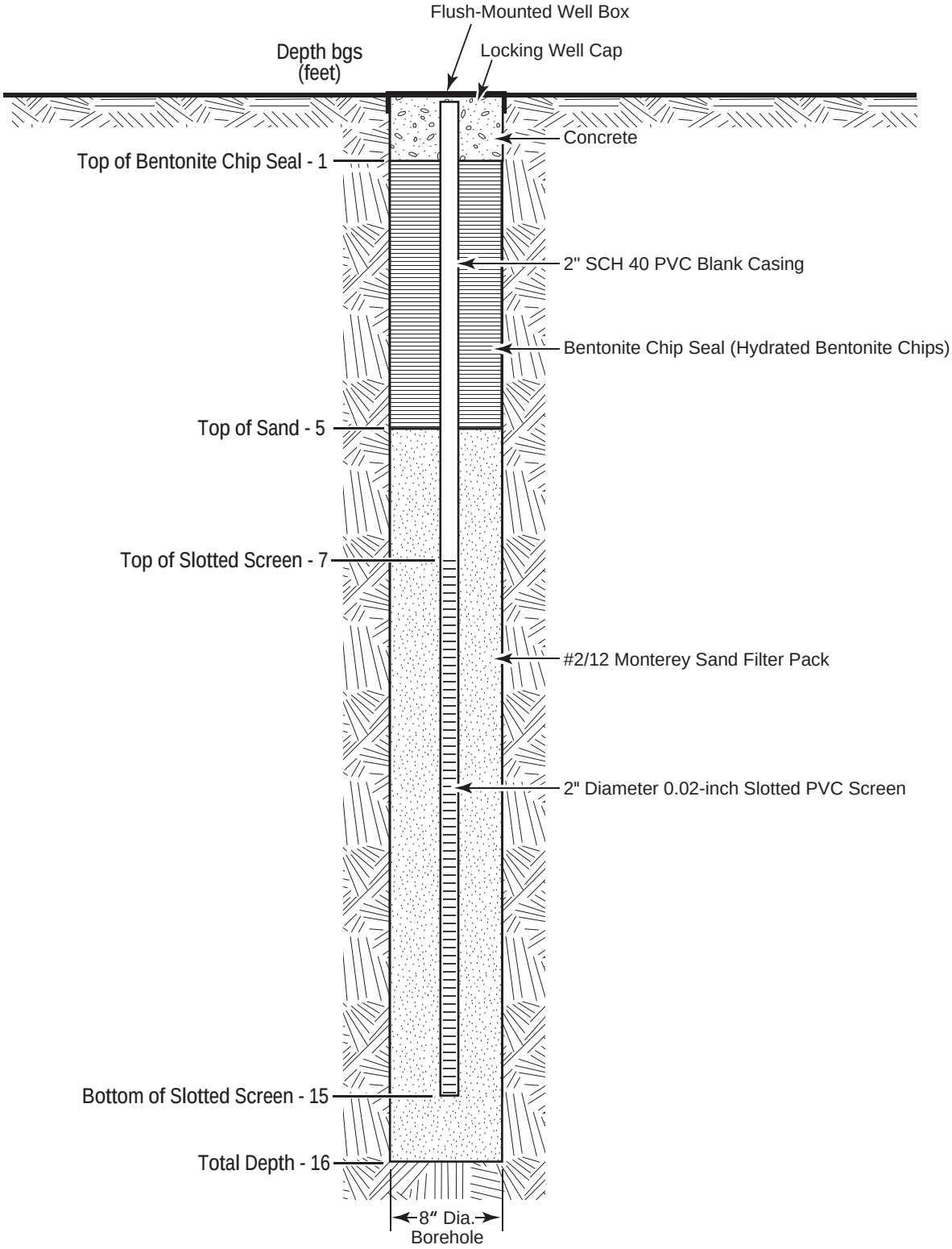


FIGURE 25

CONSTRUCTION DIAGRAM SHALLOW SVE AND VAPOR MONITORING WELLS

RD Work Plan

Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\1014-162

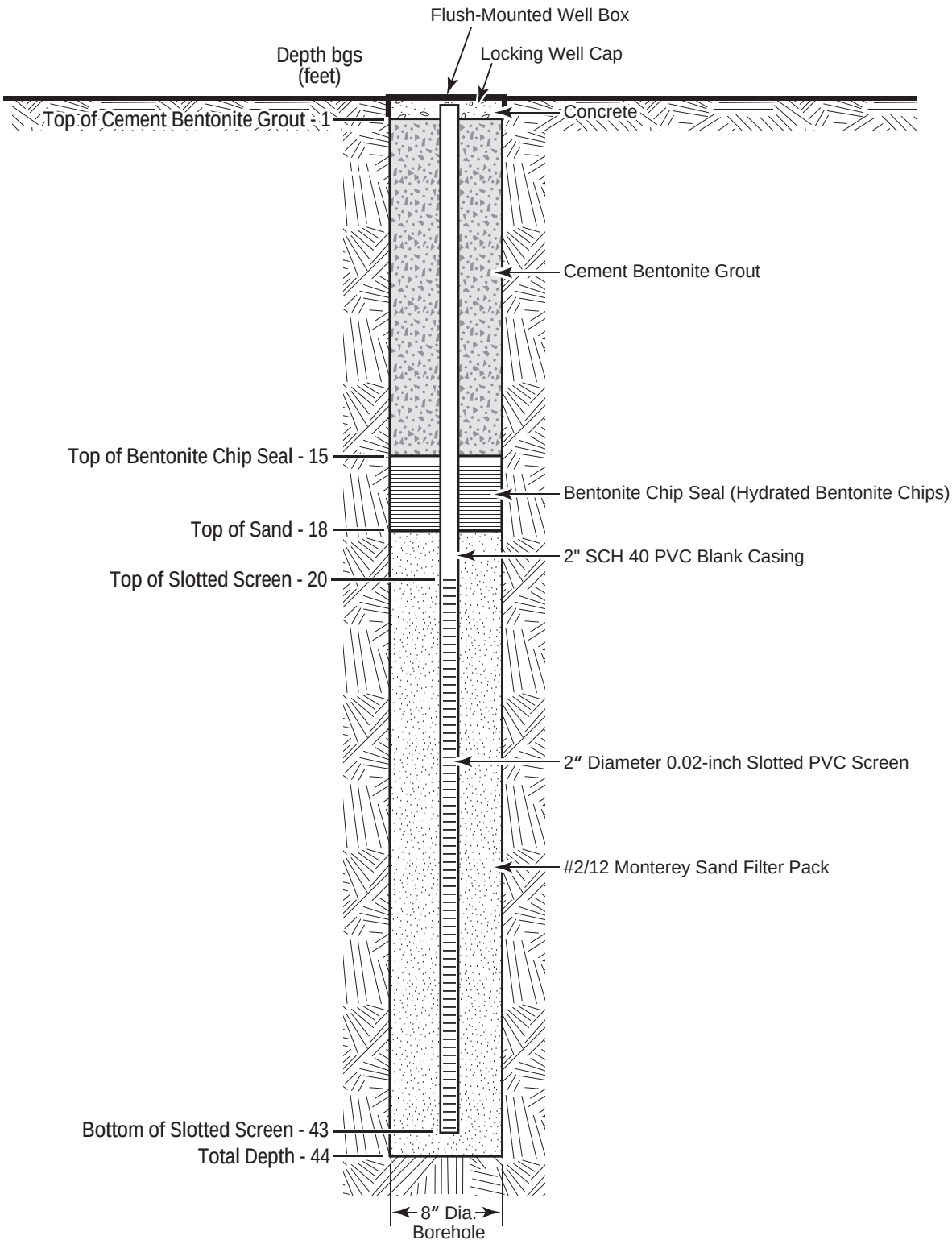


FIGURE 26

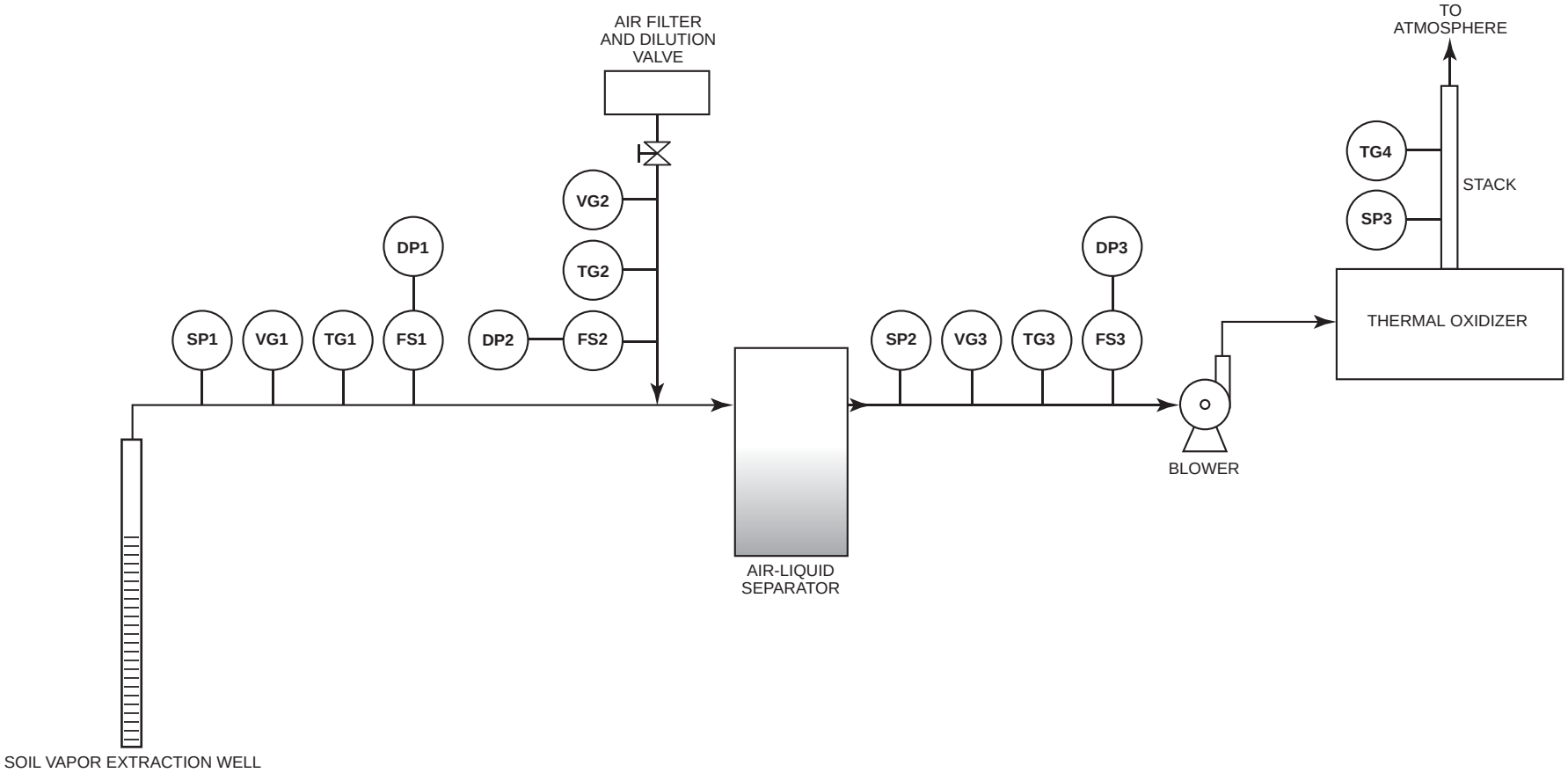
CONSTRUCTION DIAGRAM DEEP SVE AND VAPOR MONITORING WELLS

RD Work Plan
Del Amo Superfund Site

AECOM

Note:
Top of sand and top of screen are minimum depths.
Bottom of screen and total depth are maximum depths.
Well screen will be placed to span the actual impacted interval between the mimimum and maximum depths.

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\1014-159B



Legend

SP1	*Well field sample port*	**DP2**	*Dilution differential pressure gauge*
VG1	*Well field vacuum gauge*	**SP2**	*Influent sample port*
TG1	*Well field temperature gauge*	**VG3**	*Influent vacuum gauge*
FS1	*Well field flow sensor*	**TG3**	*Influent temperature gauge*
DP1	*Well field differential pressure gauge*	**FS3**	*Influent flow sensor*
VG2	*Dilution vacuum gauge*	**DP3**	*Influent differential pressure gauge*
TG2	*Dilution temperature gauge*	**SP3**	*Effluent sample port*
FS2	*Dilution flow sensor*	**TG4**	*Effluent temperature gauge (combustion chamber only)*

Note: Relative humidity, PID, and Landtec readings will be obtained at the sample port
Process & Instrumentation diagram is shown for vapor treatment with either thermal oxider or vapor phase granular activated carbon (VPGAC) vessels. VPGAC vessels are typically 2 or 3 vessels in series.

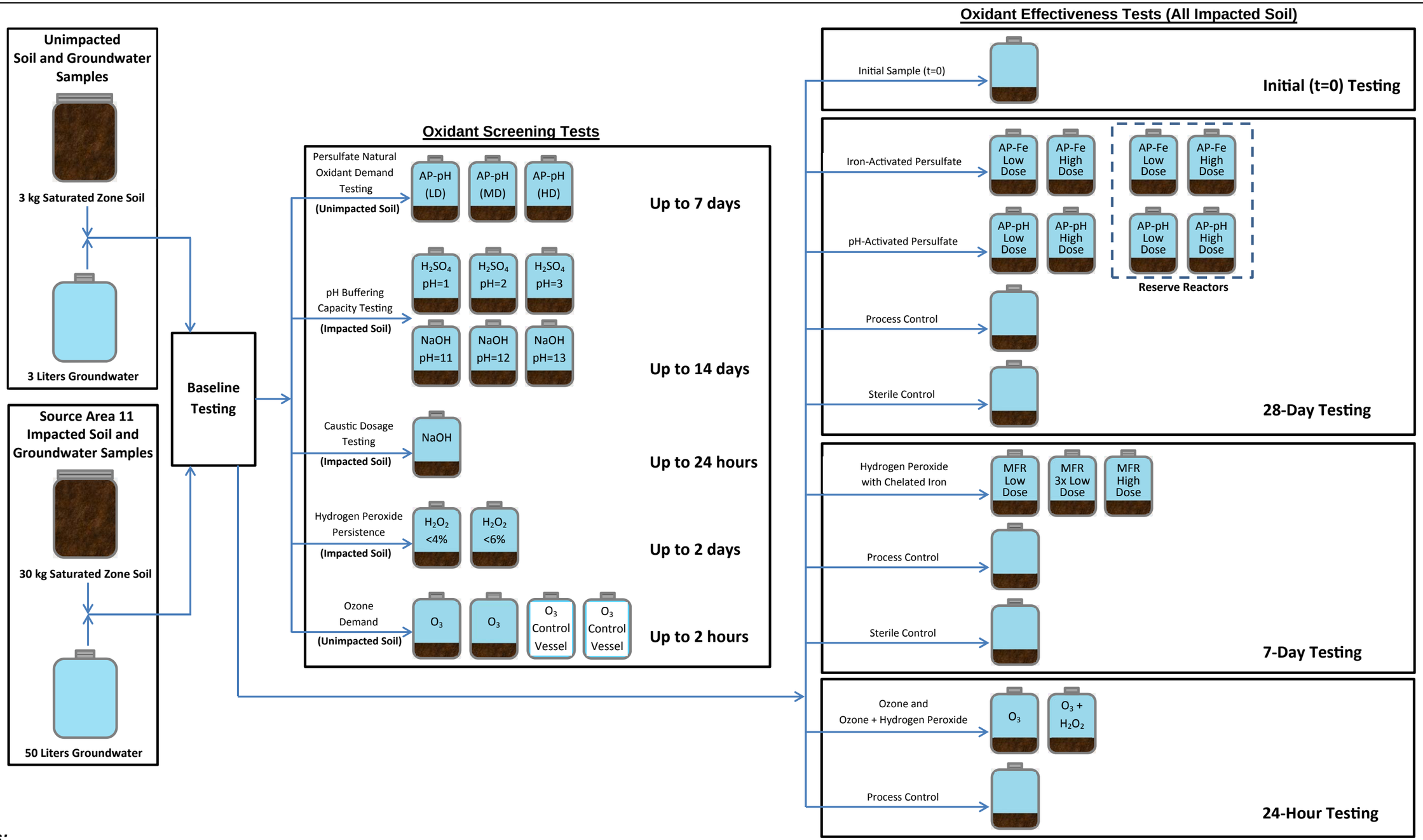
FIGURE 27

SVE PILOT TESTING PROCESS & INSTRUMENTATION DIAGRAM

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\1115-077



Notes:

AP-pH: pH-activated persulfate (pH > 11)
AP-Fe: ferrous iron-activated persulfate
H_2O_2: hydrogen peroxide
H_2SO_4: sulfuric acid
O_3: ozone
NaOH: sodium hydroxide (caustic)
MFR: modified Fenton's reagent
kg: kilogram

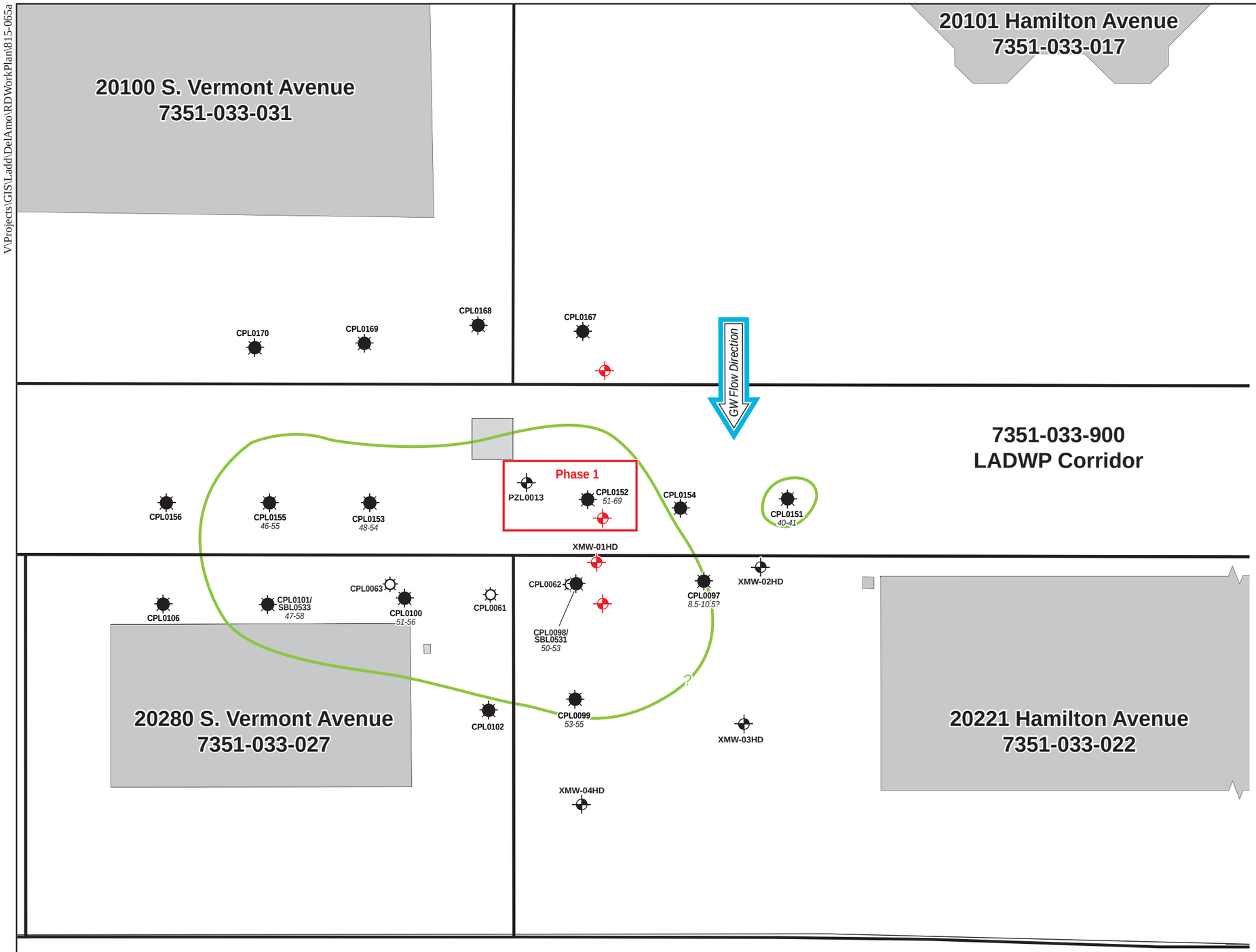
FIGURE 28

ISCO BENCH STUDY SCHEMATIC

RD Work Plan
Del Amo Superfund Site

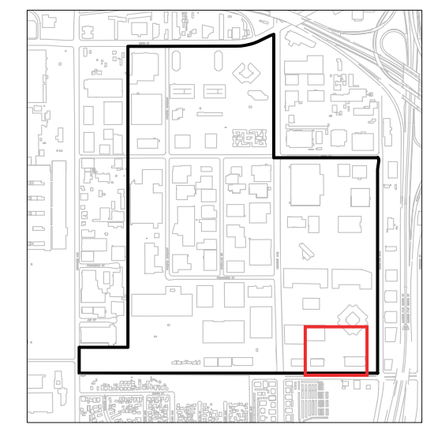
AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\815-065a



Legend

- Anticipated or existing monitoring well for ISCO implementation
- XMW-02HD — Existing monitoring well not included in ISCO program
- CPL0154 — UVOST location showing depth interval of LNAPL-impacted soil (ft bgs)
- CPL0061 — ROST location showing depth interval of LNAPL-impacted soil (ft bgs)
- Parcel boundary
- Approximate extent of LNAPL-impacted soil based on ROST/UVOST; queried where uncertain
- ISCO phased implementation area



Area shown on this map

N

0 60 120

Scale in Feet

FIGURE 29

CONCEPTUAL ISCO/SVE APPROACH Source Area 11

RD Work Plan
Del Amo Superfund Site

AECOM

V:\Projects\GIS\Ladd\DelAmo\RDWorkPlan\607-140E

Restrictive Coventants

- No restrictive covenants
- Residential use restriction; USEPA review of development plans
- Residential use restriction; USEPA review of development plans; non-interference with remedial facilities/engineering controls
- Residential use restriction; USEPA review of development plans; USEPA approval prior to drilling into or use of groundwater
- Residential use restriction; USEPA review of development plans; non-interference with remedial facilities/engineering controls; USEPA approval prior to drilling into or use of groundwater

7351-034-066 *Assessor's parcel number*

Notes:

1. Identified restrictive covenants are consistent with those presented in the ROD. A generic DTSC restrictive covenant agreement template is presented in Appendix I and includes addtional requirements applicable to all properties with restrictive covenants.
2. Streets such as Pacific Gateway, Francisco, Knox, Magellan and Vermont do not have parcel numbers but in some cases do have restricted covenants.

FIGURE 30

RESTRICTIVE COVENANT APPLICATION

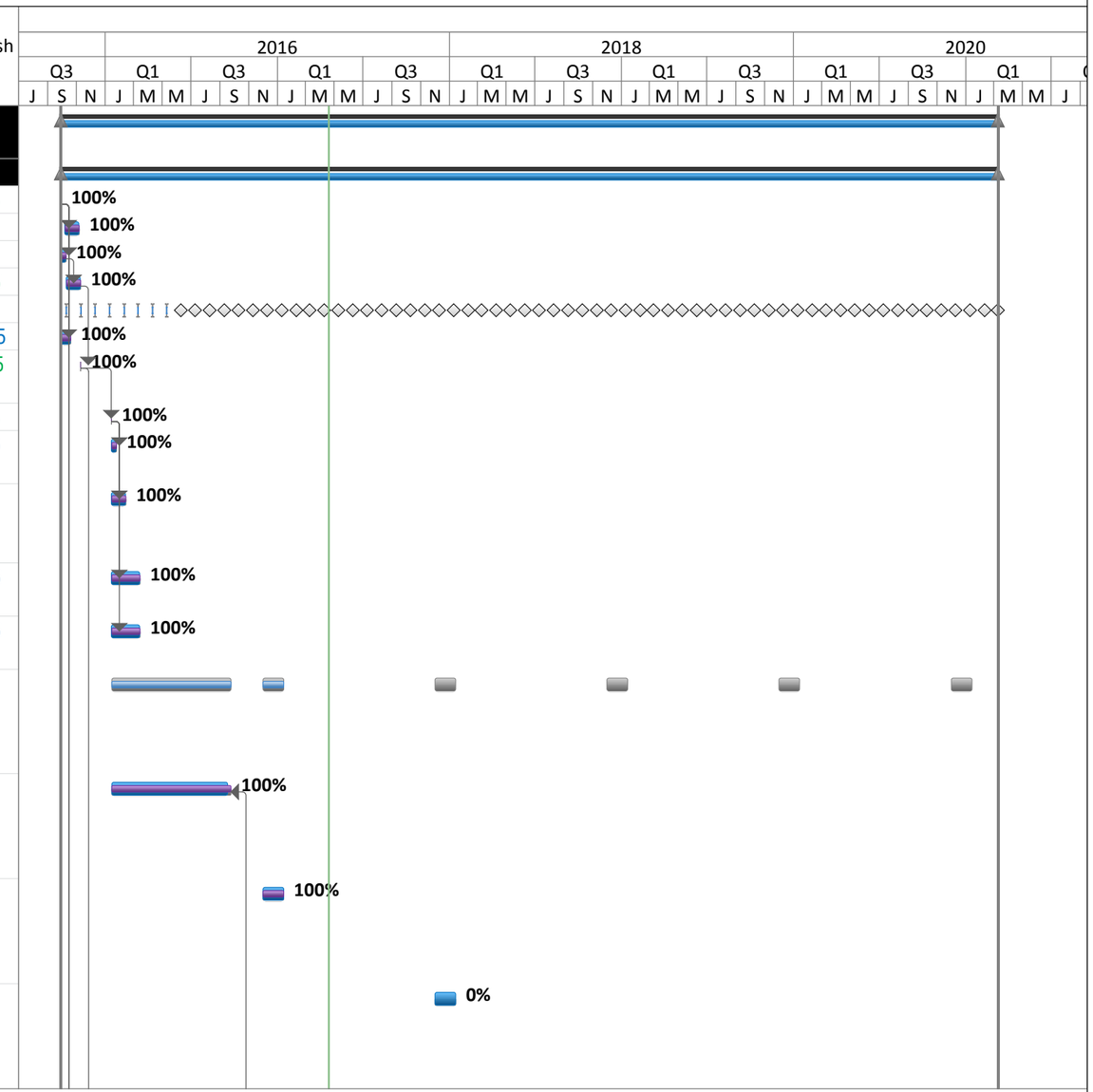
RD Work Plan
Del Amo Superfund Site

AECOM

FIGURE 31
DEL AMO SUPERFUND SITE, REMEDIAL DESIGN SCHEDULE
Soil and NAPL Operable Unit (OU1)

Del Amo Parties = Blue
EPA = Green

ID	Task Mo	Task Name	Contingent Task	CD Schedule Start	CD Schedule Finish	CD Schedule Duration	Project Schedule Start	Project Schedule Finish
0		Del Amo Superfund OU1 - Remedial Design Schedule		Tue 9/29/15	Wed 3/10/21	5967d	Tue 9/29/15	NA
1		Administration		Tue 9/29/15	Wed 3/10/21	5967d	Tue 9/29/15	NA
2		Lodging of Consent Decree		Tue 9/29/15	Tue 9/29/15	0ed	Tue 9/29/15	Tue 9/29/15
3		30-Day Public Comment Period	2FS+8ed	Wed 10/7/15	Fri 11/6/15	30ed	Wed 10/7/15	Fri 11/6/15
4		Contractor Notification/QMP	2	Tue 9/29/15	Fri 10/9/15	10ed	Tue 9/29/15	Fri 10/9/15
5		Review/Approval	4FS+1ed	Sat 10/10/15	Mon 11/9/15	30ed	Sat 10/10/15	Mon 11/9/15
6		Progress Reports		Sat 10/10/15	Wed 3/10/21	5934d	Sat 10/10/15	NA
73		Name Project Coordinators	2	Tue 9/29/15	Mon 10/19/15	20ed	Tue 9/29/15	Mon 10/19/15
74		Notice of Authorization to Proceed	5FS+1ed	Tue 11/10/15	Tue 11/10/15	0ed	Tue 11/10/15	Tue 11/10/15
75		Effective Date	74FS+65ed	Thu 1/14/16	Thu 1/14/16	0ed	Thu 1/14/16	Thu 1/14/16
76		Executed/finalized performance guarantee documents	75	Thu 1/14/16	Sun 1/24/16	10ed	Thu 1/14/16	Sun 1/24/16
77		Submit copies of executed/finalized performance guarantee documents	75	Thu 1/14/16	Sat 2/13/16	30ed	Thu 1/14/16	Sat 2/13/16
78		Pay EPA $1.2M for Past Response Costs	75	Thu 1/14/16	Mon 3/14/16	60ed	Thu 1/14/16	Mon 3/14/16
79		Pay DTSC $63,933.81 for Past Response Costs	75	Thu 1/14/16	Mon 3/14/16	60ed	Thu 1/14/16	Mon 3/14/16
80		Provide COIs and copy of each contractor and subcontractor to EPA and DTSC (annually)		Fri 1/15/16	Thu 1/14/21	5478d	Fri 1/15/16	NA
81		Provide COIs and copy of each contractor and subcontractor to EPA and DTSC (annually) 1	96SF-15ed	Fri 1/15/16	Fri 9/16/16	234ed	Fri 1/15/16	Fri 9/23/16
82		Provide COIs and copy of each contractor and subcontractor to EPA and DTSC (annually) 2		Thu 12/1/16	Sat 1/14/17	44ed	Thu 12/1/16	Fri 1/13/17
83		Provide COIs and copy of each contractor and subcontractor to EPA and DTSC (annually) 3		Fri 12/1/17	Sun 1/14/18	44ed	NA	NA



Project Schedule | Project Milestone | Deadline | CD Milestone | Progress
Split | Summary | CD Schedule | CD Summary

Note: Baseline Duration calculated in elapsed days (ed). Rolled up tasks are displayed in work days (d).

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Figure 31 - RD Schedule_Actual Dates_4.19.2017.mpp

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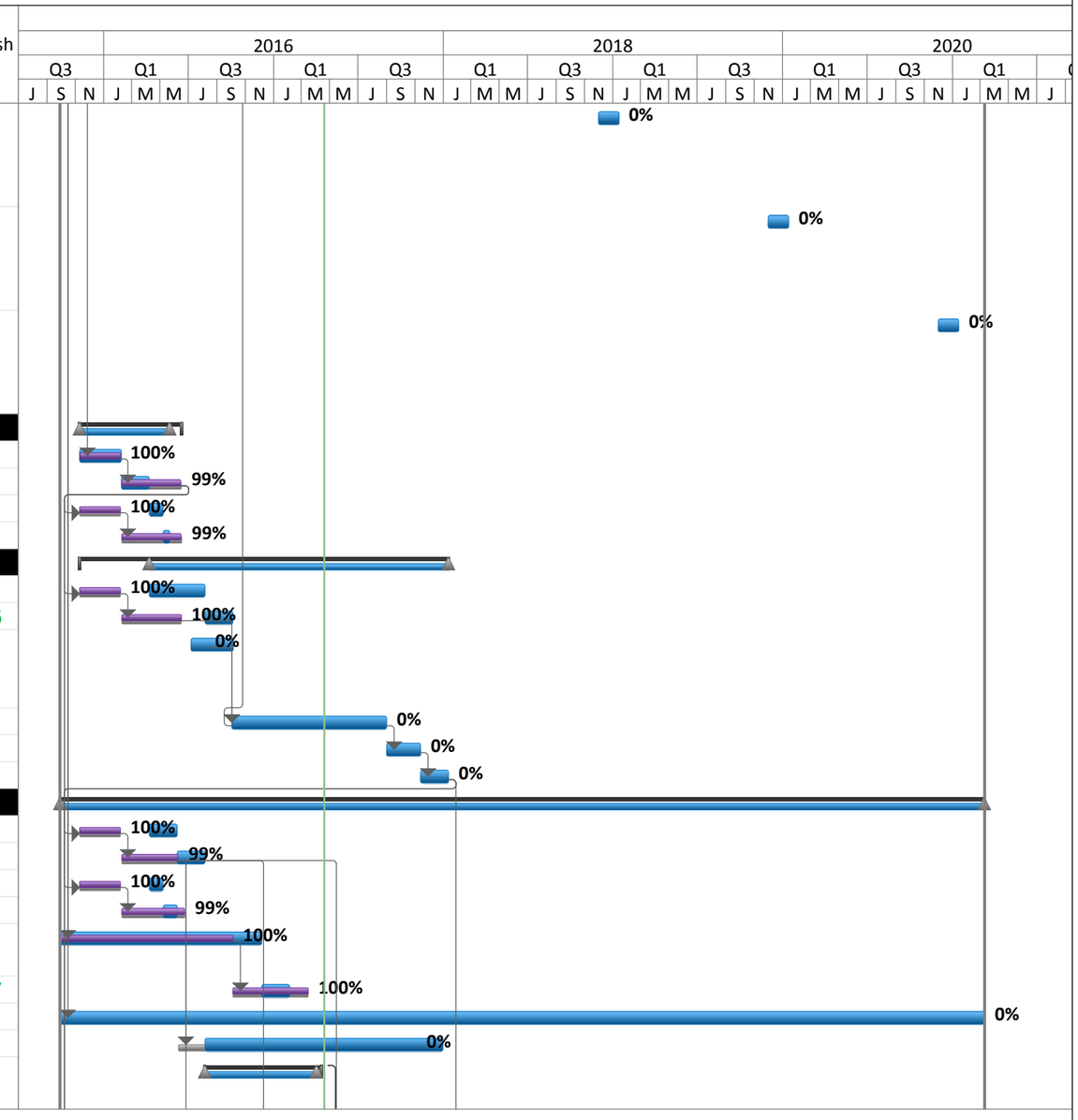
FIGURE 31
DEL AMO SUPERFUND SITE, REMEDIAL DESIGN SCHEDULE
Soil and NAPL Operable Unit (OU1)

Del Amo Parties = Blue
EPA = Green

ID	Task Mo	Task Name	Contingent Task	CD Schedule Start	CD Schedule Finish	CD Schedule Duration	Project Schedule Start	Project Schedule Finish
84		Provide COIs and copy of each contractor and subcontractor to EPA and DTSC (annually) 4		Sat 12/1/18	Mon 1/14/19	44ed	NA	NA
85		Provide COIs and copy of each contractor and subcontractor to EPA and DTSC (annually) 5		Sun 12/1/19	Tue 1/14/20	44ed	NA	NA
86		Provide COIs and copy of each contractor and subcontractor to EPA and DTSC (annually) 6		Tue 12/1/20	Thu 1/14/21	44ed	NA	NA
87		RD Work Plan		Tue 11/10/15	Sun 5/22/16	582d	Tue 11/10/15	NA
88		Work Plan	74	Tue 11/10/15	Mon 2/8/16	90ed	Tue 11/10/15	Fri 2/5/16
89		Review/Approval	88	Mon 2/8/16	Fri 4/8/16	60ed	Mon 2/8/16	NA
90		HASP/Contingency Plan	89	Fri 4/8/16	Sun 5/8/16	30ed	Tue 11/10/15	Fri 2/5/16
91		Review/Approval	90	Sun 5/8/16	Sun 5/22/16	14ed	Mon 2/8/16	NA
92		Pre-Design Work Plan		Fri 4/8/16	Thu 1/11/18	1930d	Tue 11/10/15	NA
93		Work Plan	89	Fri 4/8/16	Sat 8/6/16	120ed	Tue 11/10/15	Fri 2/5/16
94		Work Plan Review/Approval	93	Sat 8/6/16	Wed 10/5/16	60ed	Mon 2/8/16	Wed 6/15/16
95		Site access coordination, subcontractor procurement, field preparation and logistics		Thu 7/7/16	Wed 10/5/16	90ed	Thu 7/7/16	NA
96		Field Investigations	94,95	Mon 10/3/16	Thu 8/31/17	332ed	Mon 10/3/16	NA
97		Report	96	Thu 8/31/17	Sun 11/12/17	73ed	NA	NA
98		Report Review/Approval	97	Sun 11/12/17	Thu 1/11/18	60ed	NA	NA
99		ICs		Tue 9/29/15	Wed 3/10/21	5967d	Tue 9/29/15	NA
100		ICIAP	89	Fri 4/8/16	Tue 6/7/16	60ed	Tue 11/10/15	Fri 2/5/16
101		Review/Approval	100	Tue 6/7/16	Sat 8/6/16	60ed	Mon 2/8/16	NA
102		Generic Excavation Work Plan	89	Fri 4/8/16	Sun 5/8/16	30ed	Tue 11/10/15	Fri 2/5/16
103		Review/Approval	102	Sun 5/8/16	Tue 6/7/16	30ed	Mon 2/8/16	NA
104		Legal Description/Surveying - 26 Rest. Cov. Properties	2	Tue 9/29/15	Tue 12/6/16	434ed	Tue 9/29/15	Tue 10/4/16
105		Review/Approval	104	Tue 12/6/16	Sat 2/4/17	60ed	Tue 10/4/16	Wed 3/15/17
106		Layers 1-2 Implementation	2	Tue 9/29/15	Wed 3/10/21	1989ed	Tue 9/29/15	NA
107		Layer 3 Implementation	101	Sat 8/6/16	Sun 12/31/17	512ed	NA	NA
108		Restrictive Covenants (Layer 4)		Sat 8/6/16	Mon 4/3/17	720d	Sat 8/6/16	NA



Project Schedule — Project Milestone — Deadline — CD Milestone — Progress
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FIGURE 31
DEL AMO SUPERFUND SITE, REMEDIAL DESIGN SCHEDULE
Soil and NAPL Operable Unit (OU1)

Del Amo Parties = Blue
EPA = Green

ID	Task Mo	Task Name	Contingent Task	CD Schedule Start	CD Schedule Finish	CD Schedule Duration	Project Schedule Start	Project Schedule Finish
109		Release or subordination of prior liens and encumbrances; current title insurance commitments or other evidence of title	101FF+240ed	Sat 8/6/16	Mon 4/3/17	240ed	Sat 8/6/16	Mon 11/7/16
110		Executed by property owner	101FF+240ed	Sat 8/6/16	Mon 4/3/17	240ed	NA	NA
111		EPA Review/Approval	108	Mon 4/3/17	Wed 5/3/17	30ed	NA	NA
112		Execution by DTSC	108	Mon 4/3/17	Fri 6/2/17	60ed	NA	NA
113		Update Title Search	112,111	Fri 6/2/17	Thu 8/31/17	90ed	NA	NA
114		Recordation of Rest. Cov. with clerk recording stamp	112	Fri 6/2/17	Tue 8/1/17	60ed	NA	NA
115		Provide EPA with final title policy, survey, or other evidence	112	Fri 6/2/17	Sun 7/2/17	30ed	NA	NA
116		EPA notification of no access or Rest. Cov., or lack of releases, or subordination of liens and encumbrances	101	Sat 8/6/16	Sun 12/4/16	120ed	NA	NA
117		CAP Survey Plan		Tue 11/10/15	Tue 10/17/17	2121d	Tue 11/10/15	Wed 6/15/16
118		Work Plan	98	Tue 11/10/15	Fri 2/5/16	87ed	Tue 11/10/15	Fri 2/5/16
119		Work Plan Review/Approval	118	Sun 9/17/17	Tue 10/17/17	30ed	Mon 2/8/16	Wed 6/15/16
120		ISCO Bench Study/SVE Pilot Testing		Tue 11/10/15	Sat 7/14/18	2932d	Tue 11/10/15	NA
121		ISCO Bench Work Plan	98	Tue 11/10/15	Fri 2/5/16	87ed	Tue 11/10/15	Fri 2/5/16
122		Work Plan Review/Approval	121	Sun 9/17/17	Thu 11/16/17	60ed	Mon 2/8/16	Thu 6/16/16
123		SVE Pilot Test Work Plan	98	Tue 11/10/15	Fri 2/5/16	87ed	Tue 11/10/15	Fri 2/5/16
124		Work Plan Review/Approval	123	Sun 9/17/17	Thu 11/16/17	60ed	Mon 2/8/16	NA
125		Field Event to Collect Soil and Groundwater Samples for Bench Study	122	Thu 11/16/17	Sat 12/16/17	30ed	Sat 11/19/16	Sun 11/20/16
126		Implementation ISCO Bench Study	125	Sat 12/16/17	Fri 3/16/18	90ed	Fri 1/20/17	NA
127		ISCO Bench Study Report	126	Fri 3/16/18	Tue 5/15/18	60ed	NA	NA
128		Report Review/Approval	127	Tue 5/15/18	Sat 7/14/18	60ed	NA	NA
129		Implementation SVE Pilot Test	124	Thu 11/16/17	Mon 2/19/18	95ed	NA	NA
130		SVE Pilot Test Report	129	Mon 2/19/18	Fri 4/20/18	60ed	NA	NA
131		Report Review/Approval	130	Fri 4/20/18	Tue 6/19/18	60ed	NA	NA
132		Remedial Design		Tue 6/19/18	Sat 10/12/19	1440d	NA	NA
133		Preliminary Design (30%)	98,131	Tue 6/19/18	Wed 10/17/18	120ed	NA	NA
134		Preliminary Design Comments	133	Wed 10/17/18	Sun 12/16/18	60ed	NA	NA

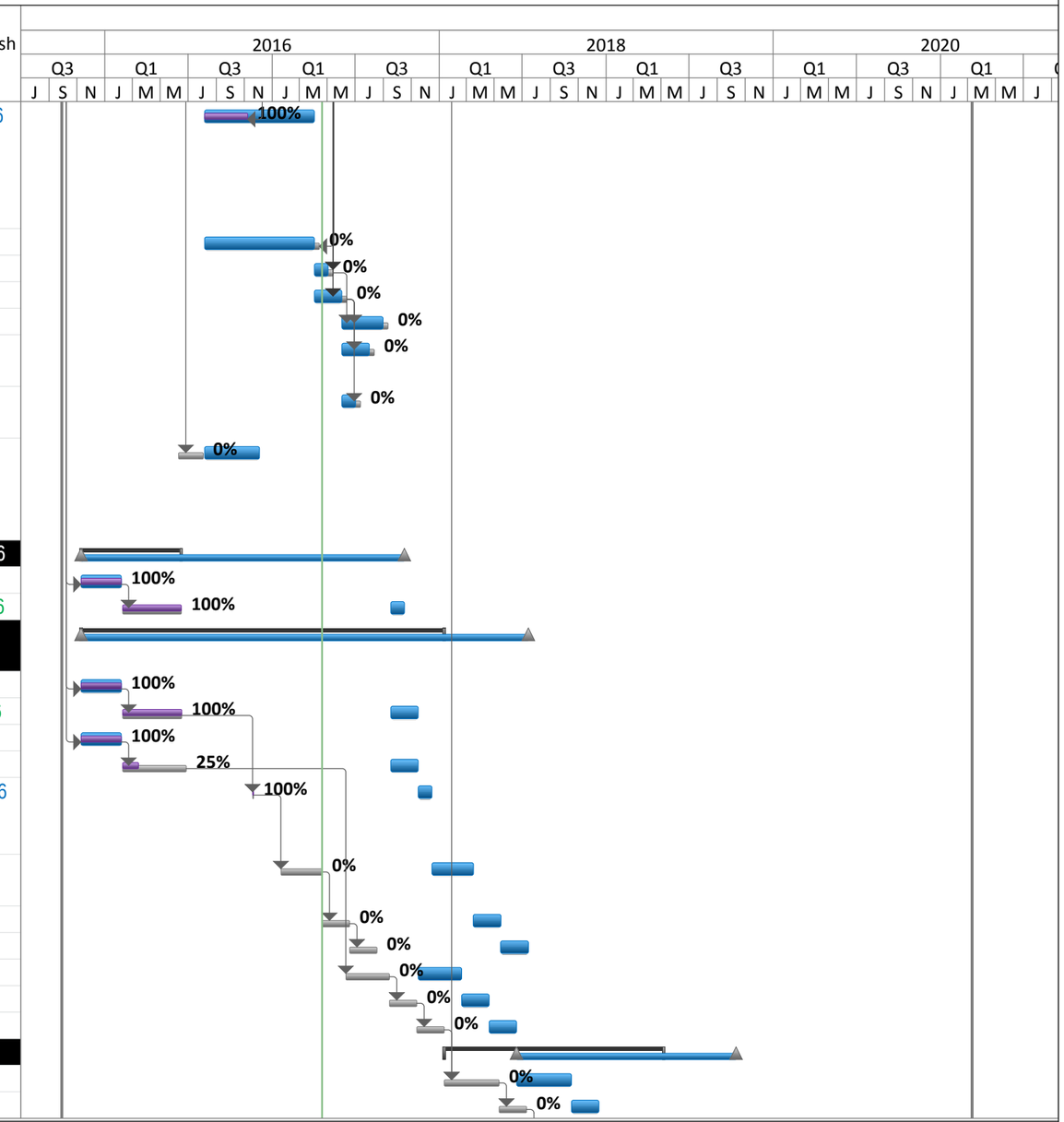

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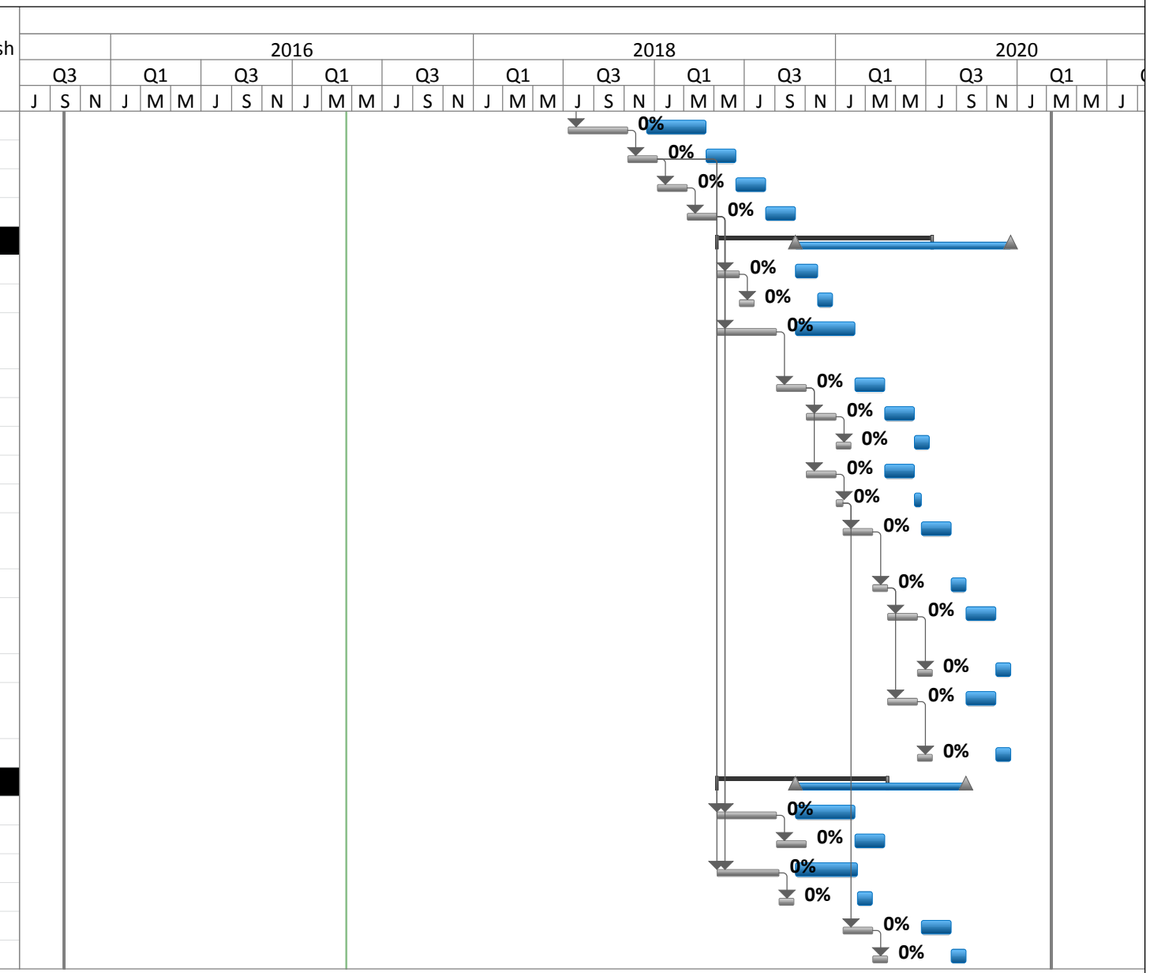
FIGURE 31
DEL AMO SUPERFUND SITE, REMEDIAL DESIGN SCHEDULE
Soil and NAPL Operable Unit (OU1)

Del Amo Parties = Blue
EPA = Green

ID	Task Mo	Task Name	Contingent Task	CD Schedule Start	CD Schedule Finish	CD Schedule Duration	Project Schedule Start	Project Schedule Finish
135		Pre-Final Design (95%)	134	Sun 12/16/18	Mon 4/15/19	120ed	NA	NA
136		Pre-Final Design Comments	135	Mon 4/15/19	Fri 6/14/19	60ed	NA	NA
137		Final Design (100%)	136	Fri 6/14/19	Tue 8/13/19	60ed	NA	NA
138		Final Design Review/Approval	137	Tue 8/13/19	Sat 10/12/19	60ed	NA	NA
139		RA Work Plan		Sat 10/12/19	Sat 12/19/20	1302d	NA	NA
140		Notification/QMP for Contractor	138	Sat 10/12/19	Tue 11/26/19	45ed	NA	NA
141		Review/Approval	140	Tue 11/26/19	Thu 12/26/19	30ed	NA	NA
142		Work Plan (includes Generic Excavation Work Plan)	138	Sat 10/12/19	Sun 2/9/20	120ed	NA	NA
143		Work Plan Review/Approval	142	Sun 2/9/20	Thu 4/9/20	60ed	NA	NA
144		Site-wide Management Plan	143	Thu 4/9/20	Mon 6/8/20	60ed	NA	NA
145		Review/Approval	144	Mon 6/8/20	Wed 7/8/20	30ed	NA	NA
146		HASP/Contingency Plan	143	Thu 4/9/20	Mon 6/8/20	60ed	NA	NA
147		Review/Approval	146	Mon 6/8/20	Mon 6/22/20	14ed	NA	NA
148		Performance Monitoring and Evaluation Form	147	Mon 6/22/20	Fri 8/21/20	60ed	NA	NA
149		Review/Approval	148	Fri 8/21/20	Sun 9/20/20	30ed	NA	NA
150		Waste Transportation and Offsite Disposal Plan	149	Sun 9/20/20	Thu 11/19/20	60ed	NA	NA
151		Review/Approval	150	Thu 11/19/20	Sat 12/19/20	30ed	NA	NA
152		Final Construction Quality Assurance Plan	149	Sun 9/20/20	Thu 11/19/20	60ed	NA	NA
153		Review/Approval	152	Thu 11/19/20	Sat 12/19/20	30ed	NA	NA
154		O&M Plan		Sat 10/12/19	Sun 9/20/20	1032d	NA	NA
155		Draft Plan	136,138	Sat 10/12/19	Sun 2/9/20	120ed	NA	NA
156		Plan Review/Approval	155	Sun 2/9/20	Thu 4/9/20	60ed	NA	NA
157		Draft Construction QAPP	136,138	Sat 10/12/19	Fri 2/14/20	125ed	NA	NA
158		QAPP Review/Approval	157	Fri 2/14/20	Sun 3/15/20	30ed	NA	NA
159		Final O&M Plan	147	Mon 6/22/20	Fri 8/21/20	60ed	NA	NA
160		Review/Approval	159	Fri 8/21/20	Sun 9/20/20	30ed	NA	NA



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Prepared by AECOM

APPENDIX A
WORK PLAN TEMPLATE, EXCAVATION OF FUTURE AREAS OF IMPACTED SOIL

WORK PLAN
EXCAVATION OF IMPACTED SOIL
APN 7351-XXX-XXX
DEL AMO SUPERFUND SITE

INTRODUCTION AND BACKGROUND

Presented in this document is a Work Plan for excavation of impacted soil at Assessor's Parcel Number (APN) 7351-xxx-xxx on the Del Amo Superfund Site (Site). This parcel is located within the former synthetic rubber plant at insert address, in Los Angeles, California (Figure 1). The property is currently occupied by insert description of building/business and is being redeveloped to insert redevelopment description. The potential for exposures to contamination consistent with former rubber plant and related operations identified during redevelopment were previously evaluated in the Site Evaluation Summary Report (SESR) dated xx/xx/20xx.

Redevelopment activities are being conducted by insert name of contractor for insert owner name, the property owner.

FIELD ACTIVITIES

Excavation of Impacted Soil

Excavation of impacted soil will be completed by insert name of subcontractor of insert name of city, California. Excavation, not exceeding a depth of 15 feet bgs, will be conducted using HAZWOPER trained personnel. Excavated soil will be monitored for total organic vapors using a calibrated photoionization detector (PID). The environmental consultant on site will determine their screening method to be used to segregate impacted soil from clean, both stockpiles subject to additional testing. Impacted soil may be placed directly into roll-off bins, or alternatively into temporary stockpiles on the property for subsequent loading onto trucks and transport to the disposal facility. Soil stockpiles will be lined with plastic sheeting, and covered when not in use. Impacted soils having differing waste characteristics that will require different disposal facilities or methods will be segregated and transported separately.

Confirmation Sampling

Confirmation samples will be collected from the excavation floor and sidewalls to document conditions in the soil remaining in place. For larger excavations (in excess of 500 cubic feet), at least one sample will be collected from the excavation floor and each sidewall. A minimum of two samples will be collected from smaller excavations based on PID readings and field observations.

Sample handling (quality control and documentation) will be in accordance with procedures presented in the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (Appendices B and F of the RD Work Plan, respectively). All excavation and sampling

activities will be undertaken in accordance with the Health and Safety Plan (Appendix C of the RD Work Plan).

Waste Profile Sampling

Following completion of impacted soil excavation, composite soil samples from the associated stockpiles or roll-off bins will be collected and analyzed for waste profiling purposes and determination of whether the waste will be classified as hazardous or non-hazardous. Each composite sample will consist of up to four discrete samples of approximately equal size from the different stockpiles or bins, or from different locations within the same stockpile or bin. In the event that there are more than four soil stockpiles or bins, additional composite samples will be created. The waste profile samples will be collected and handled as previously described and submitted for analysis as described in Section 3 of the RD Work Plan.

Waste Transport and Disposal

Upon receipt and evaluation of waste profiling results, the excavated soil will be classified as either non-hazardous or hazardous, and an appropriately licensed and approved landfill or other disposal facility will be selected. Upon acceptance by the disposal facility, USEPA concurrence with respect to the waste classification and disposal facility, and completion of waste manifests, the waste will be trucked to the disposal facility. Transport of the waste will be coordinated by insert name of subcontractor of insert business location.

LABORATORY ANALYSES

Laboratory analyses will be completed by Eurofins Calscience of Garden Grove, California, or other approved laboratory selected by the environmental consultant performing site work (to be named in the final work plan). The analyses will be expedited as necessary to minimize delays to the construction project.

- "Insert Analytical Laboratory Testing Details"

Confirmation Samples

Confirmation sample testing will be analyses of the key indicator and risk-driving compounds identified from the initial characterization sample testing results

- "Insert Analytical Laboratory Testing Details"

Waste Profile Samples

Waste profile sample testing will include analyses as required by the disposal facility, and typically include VOCs by USEPA Method 8260B, TPH-carbon chain by USEPA Method 8015M and Title 22 metals by USEPA methods 6010 and 7474 (mercury only). Depending upon

the disposal facilities under consideration, additional tests may be required prior to the waste being accepted for disposal.

REPORTING

A technical memorandum for submittal to USEPA will be completed following completion of the field activities. The memorandum will summarize the field activities, describe the nature and volume of the impacted soil removed, evaluate the laboratory analytical results, summary of soil disposal activities, and conclusions. Evaluation of the analytical results will include data validation in accordance with the RD Work Plan QAPP. As appropriate, the nature and location of any residual impacted soil will be described in the report. Figures presenting the property location, property layout, and confirmation sampling locations will be presented; and analytical results will be summarized in tables. Copies of laboratory reports with sample chain of custody forms and waste manifests will be included as attachments to the memorandum.

ATTACHMENT A
ENCORE SAMPLING EQUIPMENT AND METHODS

Disposable En Core® Sampler

En Novative Technologies, Inc.
1795 Industrial Drive
Green Bay, WI 54302
Phone: 920-465-3960 • Fax: 920-465-3963
Toll Free: 888-411-0757
www.ennovativetech.com

Sampling Procedures

NOTE:

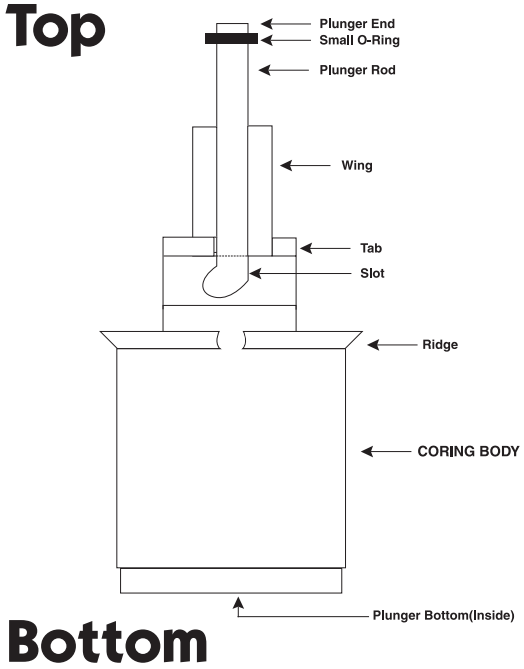
1. En Core® Sampler is a SINGLE USE device. It cannot be cleaned and/or reused.

2. En Core® Sampler is designed to store soil. Do not use En Core Sampler to store solvent or free product!

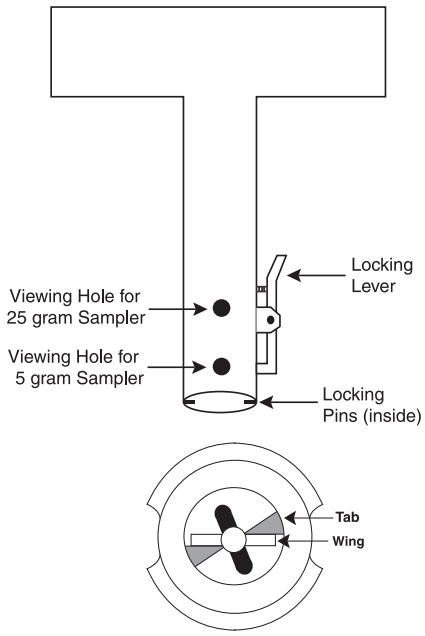
3. En Core® Sampler must be used with En Core® T-Handle and/or En Core® Extrusion Tool exclusively. (These items are sold separately.)

Using The En Core® T-Handle

En Core®

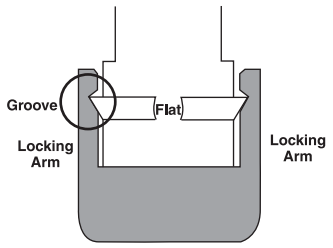


En Core® T-Handle



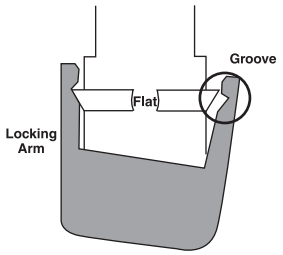
Sampler Correctly Capped

(Locking arm grooves seated over coring body ridge.)



Sampler Incorrectly Capped

(Cap appears crooked; locking arm grooves not fully seated over coring body ridge.)



BEFORE TAKING SAMPLE:

1. Hold **coring body** and push **plunger rod** down until **small o-ring** rests against **tabs**. This will assure that plunger moves freely.

2. Depress **locking lever** on En Core T-Handle. Place coring body, **plunger end first,** into open end of T-Handle, *aligning the (2)* ***slots*** *on the coring body with the (2)* ***locking pins*** *in the T-Handle*. Twist coring body clockwise to lock pins in slots. Check to ensure Sampler is locked in place. Sampler is ready for use.

TAKING SAMPLE:

3. Turn T-Handle with T-up and coring body down. This positions plunger bottom flush with bottom of coring body (ensure that plunger bottom is in position). Using T-Handle, push Sampler into soil until coring body is completely full. When full, small o-ring will be centered in T-Handle **viewing hole**. Remove Sampler from soil. Wipe excess soil from coring body exterior.

4. Cap coring body while it is still on T-handle. *Push* **cap** over **flat** area of **ridge** *and twist* to lock **cap** in place. **CAP MUST BE SEATED TO SEAL SAMPLER (see diagram)**.

PREPARING SAMPLER FOR SHIPMENT:

5. Remove the capped Sampler by depressing locking lever on T-Handle while twisting and pulling Sampler from T-Handle.

6. Lock plunger by rotating extended plunger rod fully counter-clockwise until **wings** rest firmly against tabs (see plunger diagram).

7. Attach completed tear-off label (from En Core Sampler bag) to cap on coring body.

8. Return full En Core Sampler to zipper bag. Seal bag and put on ice.

Disposable En Core® Sampler

EXTRUSION PROCEDURES

USING THE En Core® EXTRUSION TOOL

CAUTION! Always use the Extrusion Tool to extrude soil from the En Core Sampler. If the Extrusion Tool is not used, the Sampler may fragment, causing injury.

1. To attach En Core Sampler to En Core Extrusion Tool: Depress locking lever on Extrusion Tool and place Sampler, plunger end first, into open end of Extrusion Tool, aligning slots on coring body with pins in Extrusion Tool. Turn coring body clockwise until it locks into place. Release locking lever.

2. Rotate and gently push Extrusion Tool plunger knob clockwise until plunger slides over wings of coring body. (When properly positioned plunger will not rotate further.)

3. Hold Extrusion Tool with capped Sampler pointed upward so soil does not fall out when cap is removed. Remove cap from Sampler by rotating cap until locking arms are aligned with the flat area of ridge and pull cap off. To release soil core push down on plunger knob of En Core Extrusion Tool. Remove and properly dispose of En Core Sampler.

Warranty and Disclaimers

IMPORTANT: FAILURE TO USE THE EN CORE® SAMPLER IN COMPLIANCE WITH THE WRITTEN INSTRUCTIONS PROVIDED HEREIN VOIDS ALL EXPRESS AND IMPLIED WARRANTIES, INCLUDING WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

PRINCIPLE OF USE. The En Core Sampler Cartridge System is a volumetric sampling system designed to collect, store and deliver a soil sample. The En Core Sampler comes in two sizes for sample volumes of approximately 25 or 5 grams. There are four components: the cartridge with a movable plunger; a cap with two locking arms; a T-handle (purchased separately); and an extrusion handle (purchased separately). NOTE: The En Core Sampler is designed to store soil. It is not designed to store solvent or free product.

The soil is stored in a sealed headspace-free state. The seals are achieved by three special Viton® * o-rings, two located on the plunger and one on the cap of the Sampler. At no time and under no condition should these o-rings be removed or disturbed.

QUALITY CONTROL. The cartridge is sealed in an airtight package to prevent contamination prior to use. Due to the stringent quality control requirements associated with the use of this system, the disposable cartridge is designed to be used only once.

WARRANTY. En Novative Technologies, Inc. ("En Novative Technologies") warrants that the En Core Sampler shall perform consistent with the research conducted under En Novative Technologies' approval, within thirty (30) days from the date of delivery, provided that the Customer gives En Novative Technologies prompt notice of any defect or failure to perform and satisfactory proof thereof. THIS WARRANTY DOES NOT APPLY TO THE FOLLOWING, AS SOLELY DETERMINED BY EN NOVATIVE TECHNOLOGIES: (a) Damage caused by accident, abuse, mishandling or dropping; (b)Samplers that have been opened, taken apart or mishandled; (c)Samplers not used in accordance with the directions; and (d)Damages exceeding the cost of the sampler. Seller warrants that all En Core Samplers shall be free from defects in title. THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, WHETHER ORAL, WRITTEN, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING ANY INFORMATION PROVIDED BY SALES REPRESENTATIVES OR IN MARKETING LITERATURE. IMPLIED WARRANTIES OF FITNESS AND MERCHANTABILITY SHALL NOT APPLY. En Novative Technologies' warranty obligations and Customer's remedies, except as to title, are solely and exclusively as stated herein.

LIMITATION OF LIABILITY. IN NO EVENT SHALL EN NOVATIVE TECHNOLOGIES BE LIABLE FOR ANTICIPATED PROFITS, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES, INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR LOSS OF REVENUE, DOWN TIME, REMEDIATION ACTIVITIES, REMOBILIZATION OR RESAMPLING, COST OF CAPITAL, SERVICE INTERRUPTION OR FAILURE OF SUPPLY, LIABILITY OF CUSTOMER TO A THIRD PARTY, OR FOR LABOR, OVERHEAD, TRANSPORTATION, SUBSTITUTE SUPPLY SOURCES OR ANY OTHER EXPENSE, DAMAGE OR LOSS, INCLUDING PERSONAL INJURY OR PROPERTY DAMAGE. En Novative Technologies' liability on any claim of any kind shall be replacement of the En Core Sampler or refund of the purchase price. En Novative Technologies shall not be liable for penalties of any description whatsoever. In the event the En Core Sampler will be utilized by Customer on behalf of a third party, such third party shall not occupy the position of a third-party beneficiary of the obligation or warranty provided by En Novative Technologies, and no such third party shall have the right to enforce same. All claims must be brought within one (1) year of shipment, regardless of their nature.

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The En Core™ Sampler is covered by One or More of the Following U.S. Patents: 5,343,771; 5,505,098; 5,517,868; 5,522,271. Other U.S. and Foreign Patents Pending.

* Viton® is a registered trademark of DuPont Dow Elastomers.

APPENDIX B
QUALITY ASSURANCE PROJECT PLAN

QUALITY ASSURANCE PROJECT PLAN

SOIL AND NAPL OPERABLE UNIT
DEL AMO SUPERFUND SITE
LOS ANGELES, CALIFORNIA

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November 30, 2017 – Revised

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Appendix D: TestAmerica Laboratories, Inc. Standard Operating Procedures

ACRONYMS

C	Centigrade
CalEPA	California Environmental Protection Agency
CDPH	California Department of Public Health
DQO	Data Quality Objective
ELAP	Environmental Laboratory Accreditation Program
FSP	Field Sampling Plan
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MDL	Method Detection Limit
NAPL	Non-Aqueous Phase Liquid
NIST	National Institute of Standards and Technology
OU	Operable Unit
PE	Performance Evaluation
PCE	Tetrachloroethene
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
R	Recovery
RPD	Relative Percent Difference
SOP	Standard Operating Procedures
SVE	Soil Vapor Extraction
TCE	Trichloroethene
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

SECTION 1.0
INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared by AECOM to address quality assurance (QA) and quality control (QC) policies associated with the collection of environmental data under the Remedial Design (RD) Work Plan for the Soil and Non-aqueous Phase Liquid (NAPL) Operable Unit (OU-1) at the Del Amo Superfund Site, located in Los Angeles, California (Site). The purpose of this QAPP is to identify the methods to be employed to establish the technical accuracy, precision, and validity of data that will be generated. Together with the Field Sampling Plan (FSP), this QAPP presents the plan for sampling and analysis under the direction of U.S. Environmental Protection Agency (USEPA). USEPA policy requires a QAPP for all environmental data collection projects mandated or supported by the USEPA through regulations or other formalized means (USEPA 2001a). This QAPP is applicable to pre-design investigations and the Soil Vapor Extraction (SVE) pilot study being conducted as part of the OU-1 remedial design as well as the excavation of future areas of impacted soil. This QAPP is not applicable to ISCO bench study data, as these data will not be used for Site characterization or risk analysis purposes. The QAPP is similarly not applicable to physical testing data generated as part of the pre-design investigations, as there are no accepted QA/QC standards for such data.

The sampling program is formally described in the FSP. This QAPP contains general and specific details regarding field sampling, laboratory, and analytical procedures that apply to activities described in the FSP. These instructions will ensure data collected for use in project decisions will be of the type and quality needed and expected for their intended purpose. The QAPP will be updated every five years at a minimum.

Guidelines followed in the preparation of this QAPP are described in USEPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, USEPA QA/R-5 (USEPA March 2001) and USEPA Guidance for Quality Assurance Project Plans, USEPA QA/G-5 (USEPA December 2002). Other documents that have been referenced in this plan include: Guidance for the Data Quality Objectives Process, USEPA QA/G-4 (USEPA 2006) and Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (USEPA SW-846 Third Edition 1996, 2008).

1.1 SITE LOCATION AND HISTORY

The Site is located in the Harbor Gateway portion of the city of Los Angeles, near Torrance, California, and consists of approximately 280 acres that were formerly occupied by a synthetic rubber plant. The plant was present between 1942 and 1972 and included styrene, butadiene and copolymer plancors. The plant was owned by the United States government until 1955, when it was sold to Shell Oil Company, who continued to operate the plant until 1972. The Site was subsequently sold and redeveloped into its current use as a business park.

Releases of volatile organic compounds (VOC) and semi-volatile organic compounds (SVOC) to soil and groundwater are known to have occurred during the operational period of the former synthetic rubber plant. The primary contaminants include benzene and ethylbenzene. NAPL composed of benzene and other hydrocarbons are present in some areas of the Site. Tetrachloroethene (PCE) and trichloroethene (TCE) are also present at the Site.

SECTION 2.0
PROJECT DESCRIPTION

This QAPP addresses chemical data to be generated as part of the pre-design investigations and the SVE pilot study being conducted as part of remedial design for OU-1 at the Site, as described in Sections 3 and 4 of the RD Work Plan, respectively. This QAPP also addresses the chemical data to be generated during the excavation of future areas of impacted soil as described in Appendix A of the RD Work Plan.

2.1 DATA USE

Data generated as part of the pre-design investigations and SVE pilot study will be used to evaluate the need for, and extent of various remedy components to be implemented at the Site. The pre-design investigation data will be used for:

- Evaluation of data in accordance with the procedures presented in the applicable Decision Diagram (RD Work Plan, Appendix D); and
- Evaluating the extent of the area for which the remedy will be implemented

The SVE pilot study is being completed to provide the data necessary for design of SVE systems to be constructed at the Site.

Data generated from the sampling of future excavation of impacted soil will be used to determine the extent of the area requiring excavation, appropriate disposal and document conditions in the soil remaining in place.

2.2 ANALYTICAL SCOPE

The project includes sampling and laboratory analysis of air, soil vapor and soil samples for potentially hazardous substances. A detailed plan for the investigation is provided in the FSP. Soil gas sampling will be conducted in accordance with the Advisory—Active Soil Gas Investigations dated April 2012, jointly issued by the DTSC and the California Regional Water Quality Control Board – Los Angeles Region (CalEPA 2015). Soil vapor and air samples will be collectively analyzed per DTSC/LARWQCB Advisory for VOCs by USEPA Method TO-15, TPH by USEPA Method TO-3, fixed gases (oxygen, nitrogen, carbon dioxide and carbon monoxide) by ASTM D-1946, polychlorinated dibenzo-p-dioxins and dibenzofurans by USEPA Method TO-9A, and methane by South Coast Air Quality Management District (SCAQMD) 25.1. Soil samples will be analyzed for VOCs by USEPA Method 8260B and selected background soil samples will be analyzed for polychlorinated dibenzo-p-dioxins and dibenzofurans by USEPA Method 8290.

SECTION 3.0
PROJECT ORGANIZATION

3.1 PROJECT ORGANIZATION

The parties and individuals involved in the project and their respective roles and relationships are presented on Figure 5 in the RD Work Plan and described below.

USEPA is the lead regulatory agency with primary oversight responsibility. Dante Rodriguez is the USEPA Remedial Project Manager although EPA is in the process of transitioning that role to Anhtu (Tu) Nguyen.

The Department of Toxic Substances Control (DTSC) will provide project oversight for the state. Safouh Sayed is the DTSC Project Manager.

Shell, AECOM, and NewFields are responsible for overall compliance with the CD and SOW. The project team consists of the following:

- Carol Campagna (Shell), Project Coordinator
- Peter Conwell (Shell), Technical Reviewer
- Julie Doane-Allmon (AECOM), Project Manager
- Lily Bayati (AECOM), Quality Assurance Manager
- Patrick Gobb (NewFields), Technical Consultant

3.2 LABORATORY

The primary laboratories will be Eurofins/Calscience Laboratories, Inc. (Calscience), in Garden Grove, California and Test America Laboratories Inc. (TestAmerica) in Sacramento, California. Calscience and TestAmerica are accredited by the California Department of Public Health (CDPH) Environmental Laboratory Accreditation Program (ELAP). The primary laboratories project managers will report to the AECOM data manager or QA manager on all aspects of the sample analysis. The laboratories will conform to the QA and QC procedures outlined in the laboratory quality manual (Appendix A and B) and laboratory standard operating procedures (SOP) (Appendix C and D).

3.3 TRAINING/CERTIFICATION

Project personnel will be knowledgeable and experienced in the various aspects of the work to which they are assigned. Field personnel will have 40-hour Hazardous Waste Operations and Emergency Response Training in accordance with 29 CFR 1910.120.

SECTION 4.0
DATA QUALITY OBJECTIVES

Data Quality Objectives (DQO) are specified so that the data collected are of sufficient quality for their intended use (USEPA 2006). DQOs specify the data type, quality, quantity, and uses needed to make decisions, and are the basis for designing data collection activities.

4.1 DATA QUALITY OBJECTIVE PROCESS

The project DQOs are based on USEPA's seven-step DQO process (USEPA 2006), and are as follows:

- **State the problem.** Additional soil, soil gas, and air samples and laboratory analyses are required to further characterize Site conditions and design the remedy, including excavation of future areas of impacted soil.
- **Identify the decision.** The additional soil, soil gas, and air data will be used to 1) further evaluate the need for various remedy components and the extent of the area where they will be implemented at the Site; 2) provide input to the RD, such as the SVE treatment technology to be used and evaluation of the need for dilution air in the treatment system influent; and 3) evaluate disposal options for impacted soil associated with excavation at future redevelopment projects, as described in Appendix A of the RD Work Plan.
- **Identify inputs to the decision.** Inputs to the decision will include validated results of field and laboratory analytical testing of soil, soil gas and air samples. Each sample will be tested for the analytes specified in the FSP and Section 2.0 of this QAPP, or the analytes specified in a property-specific excavation work plan, a template for which is provided in Appendix A of the RD Work Plan.
- **Define the study boundaries.** The study area encompasses each Site area where additional sampling will be completed during the RD investigation. The RD investigation areas are as follows:
    - Property 16 (indoor/outdoor air sampling);
    - Property 6, 11(shallow soil sampling);
    - Property 23 (shallow soil sampling, subslab vapor sampling, outdoor air sampling);
    - SA6 (deep soil sampling; soil vapor sampling); and,
    - SA11 (deep soil sampling, groundwater sampling).

  Note: Future excavation areas are currently unknown but will be defined in future work plans specific to excavations as they arise.

Shallow soil sampling will extend vertically to 15 feet bgs, while deep soil sampling will extend from 15 feet bgs to the water table (approximately 50 feet bgs). Subslab vapor samples will be collected from immediately under the building slab, while soil vapor samples will be from within the vadose zone. Groundwater sampling will be from the water table.

- **Develop a decision rule.** Pre-Design Investigations data will be evaluated in accordance with the procedures presented in the remedy-specific Decision Diagrams presented in Appendix D of the RD Work Plan to identify areas of remedy implementation. In general, remedy implementation will proceed within the areas for which the remedy-specific action levels/cleanup goals are exceeded. Exceptions to this include ICs implementation, which is an administrative control remedy not driven by analytical data, and the ISCO/SVE remedy component, which is limited to an area of concentrated NAPL mass that has been determined from past sampling events.

  RD decisions will be based primarily on professional judgment and experience rather than a set decision rules. One exception to this is analytical data collected from the treatment system effluent, which will be compared to SCAQMD criteria. Concentrations in excess of SCAQMD criteria will be deemed to be out of compliance, and result in modification of the treatment system.

  Data generated as part of the excavation of future areas of impacted soil will be used to evaluate the extent of the area requiring excavation and to characterize excavated soil as either hazardous or non-hazardous for disposal purposes. This data evaluation and characterization will be performed for future excavations as they arise, since excavation areas are currently unknown.

- **Specify limits on decision error.** This step is not applicable to the Pre-Design Investigations or the SVE Pilot Study given the investigation approach and objectives. The sampling approach is not statistical in nature, but rather based on professional judgment, familiarity with historical plant operations, and environmental data gathered during the various previous sampling efforts at this Site.

  The results of analytical testing will be subject to data validation as specified in Section 8.5. Data will be determined to be valid without qualification if the specified limits on precision, accuracy, representativeness, comparability, and completeness are achieved. Data will be considered to be usable for project purposes unless rejected during the validation process. The results of any detected target constituents will be considered in evaluating the need for additional sampling of vapor, soil gas, and soil samples, and assessing the necessity for reducing any risks posed by the potential contamination.

- **Optimize the design.** A description of the sampling and testing program design and rationale is presented in the FSP. The FSP has been designed to provide the type and

quantity of data needed to satisfy each of the project objectives. The quality of the data will be assessed through the procedures further described in this QAPP.

4.2 PRECISION, ACCURACY, REPRESENTATIVENESS, COMPARABILITY, AND COMPLETENESS

The basis for assessing the elements of data quality is discussed in the following subsections. In the absence of laboratory-specific precision and accuracy limits, the QC limits listed in this section must be met.

4.2.1 Precision

Precision measures the reproducibility of repetitive measurements. It is defined as the degree of mutual agreement among independent measurements as the result of repeated application of the sample analytical process under similar conditions.

Components of precision include analytical precision and total precision. Analytical precision is a measurement of the variability associated with duplicate or replicate analyses of the same sample in the laboratory, and is determined by analysis of laboratory quality control samples, such as duplicate control samples, matrix spike/matrix spike duplicate samples (MS/MSD), or field sample duplicates. If the recoveries of analytes in the specified control samples are comparable within established control limits, then precision is within limits.

Total precision is a measurement of the variability associated with the entire sampling and analytical process. It is determined by analysis of duplicate or replicate field samples, and measures variability introduced by both the laboratory and field operations. Field duplicate samples are analyzed to assess field and analytical precision.

Duplicate results are assessed using the relative percent difference (RPD) between duplicate measurements. If the RPD for laboratory quality control samples exceeds the laboratory's statistically determined acceptance ranges, data will be qualified as described in the applicable validation procedure. If the RPD between primary and duplicate field samples exceeds 100 percent, data will be qualified as described in the applicable validation procedure. The RPD will be calculated as follows:

$$\%RPD = 200 * \frac{(X_2 - X_1)}{(X_2 + X_1)}$$

where X_1 is the smaller of the two observed values, and X_2 is the larger of the two observed values.

4.2.2 Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systematic error. It reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike or standard.

Accuracy of laboratory analyses will be assessed by laboratory control samples, surrogate standards, MS samples, and initial and continuing calibrations of instruments. Laboratory accuracy is expressed as the percent recovery (%R). Statistically derived laboratory accuracy limits are included with the respective laboratory Quality Manual (Appendix A). If the percent recovery is determined to be outside of acceptance criteria, data will be qualified as described in the applicable validation procedure. The calculation of percent recovery is provided below:

$$\%R = 100 * \frac{X_S - X}{T}$$

where X_s is the measured value of the spiked sample, X is the measured value of the unspiked sample, and T is the true value of the spike solution added.

Field accuracy will be assessed through the analysis of trip blanks and equipment blanks. Analysis of blanks will monitor errors associated with the sampling process, field contamination, sample preservation, and sample handling. The DQO for trip blanks is that all values will be less than the reporting limit for each target constituent. If contamination is reported in the trip blanks and equipment blanks, data will be qualified as described in the applicable validation procedure.

4.2.3 Representativeness

Representativeness is the degree to which data accurately and precisely represent selected characteristics of the media sampled. Representativeness of data collection is addressed by careful preparation of sampling and analysis programs. This QAPP and the FSP address representativeness by:

- Specifying sufficient and proper numbers and locations of samples
- Incorporating appropriate sampling methodologies
- Specifying proper sample collection techniques and decontamination procedures
- Selecting appropriate laboratory methods to prepare and analyze air, soil gas and soil samples
- Establishing proper field and laboratory QA/QC procedures

4.2.4 Completeness

Completeness is the amount of valid data obtained compared to the amount that was expected under ideal conditions. The number of valid results divided by the number of possible results, expressed as a percentage, determines the completeness of the data set. The objective for completeness is to recover at least 90 percent of the planned data to support field efforts. The formula for calculation of completeness is presented, as follows:

$$\% \text{ Completeness} = 100 * \frac{\textit{number of valid results}}{\textit{number of expected results}}$$

4.2.5 Comparability

Comparability is an expression of confidence with which one data set can be compared to another. The objective of comparability is to ensure that data developed during the investigation are comparable to Site knowledge and adequately address applicable criteria or standards established by the USEPA and CalEPA. This QAPP addresses comparability by specifying laboratory methods that are consistent with the current standards of practice as approved by the USEPA and Cal-EPA. Field methods are discussed in the FSP.

SECTION 5.0
QUALITY CONTROL ELEMENTS

This section presents QC requirements relevant to analysis of environmental samples that will be followed during all project analytical activities, including the excavation of future areas of impacted soil. The purpose of the QC program is to produce data of known quality that satisfy the project objectives and that meet or exceed the requirements of the standard methods of analysis. This program provides a mechanism for ongoing control and evaluation of data quality measurements through the use of QC procedures and materials.

5.1 QUALITY CONTROL PROCEDURES

The chemical data to be collected will be used to determine the need for and extent of remedial components, to verify that excavations of future areas of impacted soil achieve the desired results, and for waste characterization. It is therefore critical that the chemical data be of the highest confidence and quality. Consequently, strict QA/QC procedures will be adhered to. These procedures include:

- Adherence to strict protocols for field sampling and decontamination procedures
- Collection and laboratory analysis of appropriate trip blanks and equipment blanks to monitor for contamination of samples in the field or the laboratory
- Collection and laboratory analysis of MS, MSD, and field duplicate samples to evaluate precision and accuracy
- Attainment of completeness goals

Additional information regarding specific aspects of the above procedures is provided below.

5.1.1 Equipment Decontamination

Non-dedicated equipment will be decontaminated before and after each sample is collected. In general, sampling equipment will be washed in a non-phosphate detergent and potable water, rinsed in potable water, and then rinsed in distilled water. A description of decontamination procedures is provided in the FSP.

5.1.2 Standards

Standards used for calibration or to prepare samples will be certified by National Institute of Standards and Technology (NIST), USEPA, or other equivalent source. The standards will be current. The expiration date will be established by the manufacturer, or will be based on chemical stability, the possibility of contamination, and environmental and storage

conditions. Standards will be labeled with expiration dates, and will reference primary standard sources if applicable. Expired standards will be discarded.

5.1.3 Supplies

Supplies will be inspected prior to their use in the field or laboratory. The descriptions for sample collection and analysis contained in the methods will be used as a guideline for establishing the acceptance criteria for supplies. A current inventory and appropriate storage system for these materials will ensure their integrity prior to use. Efficiency and purity of supplies will be monitored through the use of standards and blank samples.

5.1.4 Holding Time Compliance

Sample preparation and analysis will be completed within the required method holding time (Table 2). Holding time begins at the time of sample collection. If holding times are exceeded and the analyses are performed, the associated results will be qualified as described in the applicable validation procedure. The following definitions of extraction and analysis compliance will be used to assess holding times:

- Preparation or extraction completion – completion of the sample preparation process as described in the applicable method, prior to any necessary extract cleanup.
- Analysis completion – completion of all analytical runs, including dilutions, second-column confirmations, and any required re-analyses.

5.1.5 Preventive Maintenance

The AECOM Field Manager is responsible for documenting the maintenance of all field equipment prescribed in the manufacturer's specifications. Scheduled maintenance will be performed by trained personnel. Procedures specific to the calibration, use and maintenance of field equipment are presented in the FSP. The analytical laboratory is responsible for all analytical equipment calibration and maintenance as described in their laboratory QA Plan. Subcontractors will be responsible for maintenance of all equipment needed to carry out subcontracted duties. Backup instrumentation and equipment will be available locally and shipped to the Site as needed.

5.2 FIELD QA/QC SAMPLES

The types of field QC samples that will be collected during the project and their purpose in relation to the DQOs are discussed below.

5.2.1 Trip Blanks

The primary purpose of trip blanks is to detect potential additional sources of contamination that could potentially influence contaminant concentration values reported in field samples, both quantitatively and qualitatively. Trip blanks serve as a control mechanism for sample bottle preparation, blank water quality and sample handling. They are generally submitted to the laboratory for analysis of VOCs.

The trip blank consists of a VOC sample vial filled in the laboratory with ASTM Type II reagent grade water. The trip blank travels to the Site with the empty sample bottles and returns from the Site with the collected field samples in an effort to simulate sample handling conditions. One trip blank will be included in each shipping container transporting soil samples for VOCs analysis. The following are potential sources of contamination in trip blanks:

- Laboratory reagent water
- Sample containers
- Cross-contamination during shipment
- Ambient air, or contact with analytical instrumentation during preparation and analysis at the laboratory
- Laboratory reagents used in analytical procedures

When a trip blank is identified as contaminated, the appropriate validation flag, as described in the Contract Laboratory Program National Functional Guidelines guidance documents (USEPA 2017a, 2017b, 2016) will be applied to associated sample results. Other issues affecting the use and integrity of trip blanks include the following:

- Handling: Trip blanks may be held on the Site for a maximum of one week. The temperature of the trip blanks during storage will be maintained at 4 oC + 2 oC. Expired trip blanks will be returned to the laboratory for disposal.
- Holding Time: The holding time clock for analysis of trip blanks begins at the time of sample collection of the oldest sample in the set.

5.2.2 Field Duplicate Samples

Field duplicate samples will be collected and analyzed to evaluate sampling and analytical precision. Field duplicates will be collected and analyzed in the same manner as the primary samples. Agreement between duplicate sample results will indicate good sampling and analytical precision. Specific locations will be designated for collection of field duplicates prior to the start of field activities. Field duplicates will be collected at a frequency of at least

ten percent of the primary samples for vapor, soil gas and soil samples collected. Each duplicate sample will be analyzed for all laboratory analyses requested for the corresponding primary sample. The precision goal for field duplicate analyses will be plus or minus 100 percent relative percent difference for vapor and soil samples.

5.3 LABORATORY QC SAMPLES

Laboratory QC samples will be used to ensure conducted analyses are within QC limits and to document the quality of analytical results. The types of QC samples the laboratory will employ depend on the particular analytical methodology that will be used to analyze the samples. Each analytical method has required QCs that must meet laboratory-developed acceptance limits for the data to be considered valid. In addition, as part of the laboratory's accreditation program, performance evaluation samples and Method Detection Limit (MDL) studies are conducted to evaluate the laboratory's capability of performing the method accurately and precisely. The primary types of laboratory QC samples are discussed in the following sections.

5.3.1 Laboratory Method Blanks

A laboratory reagent blank is de-ionized, distilled water that is prepared and analyzed by the laboratory in the same manner as project samples in the analytical batch and analyzed as a sample. Analysis of the method blank indicates potential sources of contamination from laboratory procedures (e.g., contaminated reagents, improperly cleaned laboratory equipment, or persistent contamination due to presence of certain compounds in the ambient laboratory air). A method blank is included with the analysis of every analytical batch or as stated in the analytical method, whichever is more frequent.

5.3.2 Laboratory Control Samples

Laboratory control sample analyses will be performed by the analytical laboratory to evaluate the efficiency, accuracy and precision of the extraction and analysis procedures. The laboratory control sample is prepared by the addition of known quantities of target compounds to a blank matrix. The laboratory control sample is extracted and analyzed in the same manner as project samples in the analytical batch. The results of the analysis will be compared with the known additions and a laboratory control sample recovery will be calculated, giving an evaluation of the accuracy of the extraction and analysis procedures. Laboratory control sample recoveries will be reviewed to check that they are within acceptable range; however, the acceptable ranges vary widely with both sample matrix and analytical method. Laboratory control sample and laboratory control sample duplicates will be analyzed by the laboratory with each sample batch at a frequency of at least one per twenty, or 5 percent of the primary field samples. Laboratory control sample analyses may be performed in duplicate in order to evaluate the precision of the procedures as well as the

accuracy. Precision objectives (represented by agreement between laboratory control sample and laboratory control sample duplicate recoveries) and accuracy objectives (represented by laboratory control sample recovery results) will be based on statistically generated limits established annually by the analytical laboratory. If a bias is determined, the associated data will be qualified and the direction of the bias indicated in the data validation report.

5.3.3 Matrix Spike Samples

MS sample analyses will be performed by the analytical laboratory to evaluate the efficiency of the sample extraction and analysis procedures, and are necessary because matrix interference (that is, interference from the sample matrix) may have a widely varying impact on the accuracy and precision of the extraction analysis. The MS sample is prepared by the addition of known quantities of target compounds to a sample. The sample is extracted and analyzed. The results of the analysis will be compared with the known additions and a MS recovery is calculated, giving an evaluation of the accuracy of the extraction and analysis procedures. MS recoveries will be reviewed to check that they are within acceptable range. However, the acceptable ranges vary widely with both sample matrix and analytical method. MS and MS duplicates (MSD) will be analyzed by the laboratory at a frequency of at least one per twenty, or 5 percent of the primary field samples. Typically, analysis of MS samples are performed in duplicate to evaluate the precision of the procedures as well as the accuracy. Precision objectives (represented by agreement between MS and MSD recoveries) and accuracy objectives (represented by MS recovery results) will be based on statistically generated limits established annually by the analytical laboratory. Following collection of the primary sample, additional samples will be collected and indicated as an MS/MSD sample in the notes section column of the chain of custody. It is important to note that these objectives are goals rather than criteria. If matrix bias is suspected, the associated data will be qualified and the direction of the bias indicated in the data validation report. Site-specific samples will be used by the laboratory for the MS/MSD samples.

5.3.4 Performance Evaluation Samples

Double-blind performance evaluation (PE) samples may be submitted to the analytical laboratory during the investigation. These samples will be of soil matrix, and will be used to assess the accuracy of analytical procedures employed for a given sample set. If used, double-blind PE samples will be prepared by Environmental Resources Standards, or similar supplier, in similar sample containers as the project field samples and shipped from the field to the laboratory for analysis.

Double-blind PE samples will be prepared using NIST and/or A2LA-certified standards. The project-specific PE samples will contain known concentrations of the analytes of interest. Laboratory results will be evaluated against the original Certificates of Analyses for precision and accuracy. PE samples may be submitted for analysis as part of the laboratory pre-

qualification process, or as part of a given sampling event. Results will be reported to the laboratory and presented with associated field sample results.

SECTION 6.0
SAMPLING PROCEDURES

The defensibility of data is dependent on the use of well-defined, accepted sampling procedures. This section describes the sampling and handling procedures that will be followed for each sampling event.

6.1 FIELD PROCEDURES

Collection of environmental samples of high integrity is important to the quality of chemical data to be generated. To this end, strict field procedures have been developed as general descriptions of field methods that will be employed at various locations during phases of the field investigation. These procedures are described in the FSP. Additional information regarding sample collection associated with excavation of impacted soil identified at future property redevelopment projects will be presented in property-specific work plans, a template for which is presented in Appendix A of the RD Work Plan.

6.2 SAMPLE CONTAINERS, PRESERVATION AND HOLDING TIMES

Table 2 lists the required sample containers, preservatives, and recommended maximum holding times for samples. Sample containers will be provided by the laboratory or purchased commercially.

6.3 SAMPLE HANDLING AND STORAGE

Each sample container will be marked in the field with the sample number, location, date and time of sample collection. All sample containers will be wiped with paper towels and securely packed in a cooler with ice, in preparation for delivery to the laboratory.

The laboratory will immediately notify the Field Manager if problems are identified which require immediate resolution upon receipt of the samples. Such problems may include container breakage, missing or improper chain-of-custody, exceeded holding times, missing or illegible sample labeling, or temperature excursions.

6.4 SAMPLE CUSTODY

Each sample submitted to the laboratory for analysis will be documented on a chain-of-custody form supplied by the laboratory, including the sampling date and time, sample identification number, matrix type, requested analyses and methods, preservatives, and the sampler's name. The chain-of-custody form will also specify the laboratory turnaround time appropriate to meet the USEPA holding times for the requested methods.

Sampling team members will maintain custody of the samples until they are relinquished to laboratory personnel or a professional courier service. The chain-of-custody form will accompany the samples from the time of collection until received by the laboratory. Each party in possession of the samples (except the professional courier service) will sign the chain-of-custody form signifying receipt. The chain-of-custody form will be placed in a plastic bag and shipped with samples inside the cooler. After the samples, ice, and chain-of-custody forms are packed in the coolers, the cooler will be appropriately sealed before it is relinquished to the courier. A copy of the original completed form will be provided by the laboratory along with the report of results. Upon receipt, the laboratory will inspect the condition of the sample containers and report the information on chain-of-custody or similar form.

SECTION 7.0
ANALYTICAL PROCEDURES

The analytical methods used for this project are listed in Tables 1 and 2. Specific analytical method procedures are detailed in the laboratory Quality Manual and SOPs (Appendices A and B). QA/QC procedures will be implemented by the laboratory in accordance with project specific QC requirements (Table 1), and laboratory analytical SOPs (Appendix B). These documents will be reviewed by AECOM QA staff during laboratory audits to ensure that project specifications are met. Laboratory and data audits are discussed in Sections 9.2 and 9.3.

The analytical program for areas of impacted soil identified at future property redevelopment projects will be presented in property-specific excavation work plans, a template for which is presented in Appendix A of the RD Work Plan. With that exception, this QAPP is intended to be otherwise applicable to Appendix A and future property-specific work plans for soil excavation.

7.1 INTERNAL STANDARDS

Internal standards are measured amounts of method-specified compounds added after preparation, or extraction, of a sample. Internal standards will be added to samples, controls, and blanks in accordance with method requirements to identify column injection losses, purging losses, or viscosity effects.

Acceptance limits for internal standard recoveries are set forth in the applicable method. If the internal standard recovery falls outside of acceptance criteria, the testing instrument will be checked for malfunction and reanalysis of the sample will be performed after any problems are resolved.

7.2 RETENTION TIME WINDOWS

Retention time windows will be established as described in SW-846 Method 8000A for applicable analyses of organic compounds. Retention time windows will be used for qualitative identification of analytes and will be calculated based on multiple, replicated analyses of a respective standard.

Retention times will be checked on a daily basis. Acceptance criteria for retention time windows are established in the referenced method. If the retention time falls outside the respective window, actions will be taken to correct the problem. The testing instrument must be re-calibrated after any retention time window failure and the affected samples must be reanalyzed.

7.3 METHOD DETECTION LIMITS AND METHOD REPORTING LIMITS

The MDL is the minimum concentration of an analyte or compound that can be measured and reported with 99 percent confidence that the concentration is greater than zero. MDLs will be established for each method, matrix and analyte, and for each instrument used to analyze project samples. MDLs will be derived using the procedures described in 40CFR 136 Appendix B (USEPA 1990). USEPA requires that MDLs be established or verified on an annual basis. MDLs must be less than applicable reporting limits for each target analyte presented in Table 1.

The Method Reporting Limit (MRL) is the level at which an analyte must be present for its concentration to be reported with a reasonable degree of accuracy and precision, typically within 20 percent. The MRL will change accordingly with the sample dilution factor. The laboratory will strive to achieve reporting limits that are sufficiently low to allow for evaluation of the data with respect to USEPA Region 9 Regional Screening Levels (RSL) for a residential setting. For undiluted samples, the laboratory will achieve the minimum reporting limits specified in Table 1. Estimated concentrations detected below the reporting limit but above the method detection limit MDL will be reported by the laboratory and flagged with a “J”. In some cases, the desired reporting limits may not be achievable for some compounds due to interference caused by the presence of high concentrations of other compounds in the sample.

7.4 INSTRUMENT CALIBRATION

Analytical instruments will be calibrated in accordance with the procedures specified in the applicable method. All analytes that are reported shall be present in the initial and continuing calibrations, and these calibrations must meet the acceptance criteria specified in the reference method. Records of standard preparation and instrument calibration will be maintained. Records shall unambiguously trace the preparation of standards and their use in calibration and quantitation of sample results. Calibration records will be traceable to standard materials as described in Section 5.1.2.

At the onset of analysis, instrument calibrations will be checked using all of the analytes of interest. At a minimum, calibration criteria will satisfy method requirements. Analyte concentrations will be determined with either calibration curves or response factors, as defined in the method. Guidance provided in SW-846 should be considered to determine appropriate evaluation procedures.

SECTION 8.0
DATA REPORTING AND DOCUMENTATION

All project documents and records including all field and laboratory documents, the FSP and the QAPP will be retained at the AECOM Santa Barbara office.

8.1 FIELD DATA

Data measured by field instruments will be recorded in field notebooks, laptops, and/or on required field forms. The field data will be reviewed by the Project or Field Manager to evaluate completeness of the field records and appropriateness of the field methods employed. All field records will be retained in the project files.

8.2 LABORATORY DATA

Laboratory analytical data will contain the necessary sample results and quality control data to evaluate the DQOs defined for the project. Documentation requirements for laboratory data are defined in USEPA Region 9 Draft Laboratory Documentation Requirements for Data Validation (USEPA 2001b). The laboratory reports will be consistent with USEPA Level IV documentation and include the following data and summary forms:

- Narrative, cross-reference, chain of custody, and method references
- Analytical results
- Surrogate recoveries (as applicable)
- Blank results
- Calibration summary
- Instrument tuning summary
- Internal standard area count and retention time summary
- Laboratory control sample recoveries
- Duplicate sample results or duplicate spike recoveries
- Sample spike recoveries
- Associated raw data in electronic format upon request

The analytical result summary form will include reporting of estimated analyte concentrations detected below the laboratory reporting limit, but above the method detection limit.

8.3 DATA MANAGEMENT

Data management is the process of organizing, maintaining, and applying a variety of data to provide a useful and coherent view of the site conditions. Data collected for this investigation include sample collection data, field measurement data, and off-site laboratory analytical data. The data management resources include staff to review and maintain project data, a computerized data management system, and a documentation filing system. The project database management system will have the capability to:

- Maintain the relationship between sampling locations, samples collected, and field and laboratory analytical results
- Filter the data to create selected subsets of appropriate information
- Efficiently report large quantities of data in both tabular and graphical formats

Proprietary software software will be used for database management. Proprietary software developed by AECOM will additionally be used to manage, verify, report and store project data. Security of the data is maintained through limited access to original data and minimizing data transfers.

8.4 DATA FLOW

Data received by the Data Manager from the contracted laboratory will be either hardcopy or electronic format. Analytical results received in hardcopy form will be manually entered into a temporary file utilizing a proprietary data program. Analytical results received from the laboratory as an electronic file will be converted to the project's standard database structure. Printouts will be created from all sources of analytical data and verified for accuracy using the hardcopy report. Any errors will be noted by the reviewer and communicated to the Data Manager for correction. Upon completion of the data verification and data validation processes, the analytical data will be appended to a main, composite database for storage and eventual reporting. Data qualifiers assigned to particular analytical results upon completion of the data validation will be appended to the results in the database utilizing a proprietary validation program. Proprietary custom report programs will be used to generate tabular data presentations and statistical reports. Prior to distribution to project personnel, these database outputs will be re-verified for accuracy and consistency against the original data. Upon final approval, the final analytical tables and statistical reports will be distributed to project personnel for data evaluation and project decisions.

8.5 DATA VALIDATION

Data validation criteria are derived from the USEPA Contract Laboratory Program National Functional Guidelines for Laboratory Data Review, Organics, Inorganics, and high resolution

methods (USEPA 2017a, 2017b, 2016). The National Functional Guidelines provide specific data validation criteria that can be applied to data generated for this investigation.

Full data validation will be performed on 20 percent of the laboratory data, including checking the raw data, calibrations, and calculations in accordance with AECOM standard operating procedures and the principles presented in USEPA National Functional Guidelines for Laboratory Data Review, Organics, Inorganics, and high resolution methods (USEPA 2017a, 2017b, 2016). Limited validation will be conducted for the remaining data, which uses the same guidelines but relies on the data summary and QA/QC summary provided in the laboratory standard report rather than checking the raw data and calculations.

The laboratory data will be reviewed for quality and compliance with the applicable method and laboratory analytical SOPs. The following summarizes the areas of data validation:

- Data completeness
- Holding times
- Blanks
- Calibrations
- Laboratory control samples and laboratory control sample duplicate samples
- MS/MSD samples
- Surrogates
- Internal standards
- Instrument tuning summary
- Field quality control samples
- Compound identification and quantification

The application of data validation criteria is a function of project-specific DQOs. The QA/QC Manager will determine if the data quality objectives for the analytical data have been met. Results of the data validation review will be documented and summarized in a Data Validation Memorandum, which is summarized in the final investigation report.

Data validation will be documented in a manner consistent with these functional guidelines. The results of the data validation will be included in a Data Validation Memorandum. This document will be provided as an attachment to the sampling report.

8.6 DATA QUALIFIERS

The data validation procedures were designed to review each data set and identify biases inherent to the data and determine its usefulness. Data validation flags will be applied to those sample results that fall outside tolerance limits specified in Section 4.2 and in the applicable SOP, and, therefore, did not meet the program's quality goals. Data validation flags to be used for this project are defined in the National Functional Guidelines. Data validation flags will indicate if results are considered anomalous, estimated, or rejected. Only rejected data will be considered unusable for decision-making purposes; however, other qualified data may require further verification.

SECTION 9.0
PERFORMANCE AND SYSTEM AUDITS

Audit programs will be established and directed by the AECOM quality assurance staff to ensure that field and laboratory activities are performed in compliance with project-controlling documents. This section describes responsibilities, requirements and methods for scheduling, conducting and documenting audits of field and laboratory activities.

9.1 FIELD AUDITS

Field audits will be conducted by the QA Manager and/or the Field Manager, and will focus on appropriateness of personnel assignments and expertise, availability of field equipment, adherence to project controlling documents for sample collection and identification, sample handling and transport, use of QA samples, chain of custody procedures, equipment decontamination and documentation. Field audits are not required, but may be performed in the event significant discrepancies are identified that warrant evaluation of field practices.

9.2 LABORATORY AUDITS

Laboratory audits include reviews of sample handling procedures, internal sample tracking, SOPs, analytical data documentation, QA/QC protocols, and data reporting. The project laboratory is certified by the State of California for the applicable hazardous waste, vapor, and soil analyses, as appropriate, and will participate in a state approved Performance Evaluation Program. If no previous audit has been conducted by AECOM, a scheduled audit will be conducted by the QA staff during the course of this project to ensure the integrity of sample handling and processing by the laboratory.

9.3 DATA AUDITS

Data audits will be performed by the QA Manager on 20 percent of the analytical results received from the laboratory. These audits will be accomplished through the process of full data validation as described in Section 8.5, and involve a more detailed review of laboratory analytical records. Data audits require the laboratory to submit complete raw data files to AECOM for validation and verification. AECOM chemists will perform a review of the data consistent with the level-of-effort described in the National Functional Guidelines (USEPA 2017a, 2017b, 2016). This level of validation consists of a detailed review of sample data, including verification of data calculations for calibration and quality control samples, to assess if the data are consistent with method requirements. Upon request, the laboratory will make available all supporting documentation in a timely fashion.

9.4 AUDIT SCHEDULING

Laboratory audits will be conducted prior to the field investigation if an audit has not been previously conducted by AECOM for the laboratory. Field audits will be completed if significant deviations from the FSP and/or QAPP procedures occur. The overall frequency of audits conducted for these activities will be based on duration of work, as well as significant changes in project scope or personnel.

9.5 REPORTS TO MANAGEMENT AND RESPONSIBILITIES

Upon completion of any audit, the auditor will submit to the Project and Field Manager a report or memorandum describing any problems or deficiencies identified during the audit. It is the responsibility of the Project Manager to determine if the deviations will result in any adverse effect on the project conclusions. If it is determined that corrective action is necessary, procedures outlined in Section 9.6 will be followed.

9.6 CORRECTIVE ACTION

Corrective actions will be initiated whenever data quality indicators suggest that DQOs have not been met. Corrective actions will begin with identifying the source of the problem. Potential problem sources include failure to adhere to method procedures, improper data reduction, equipment malfunctions, or systemic contamination. The first level of responsibility for identifying the problems and initiating corrective action lies with the analyst/field personnel. The second level of responsibility lies with any person reviewing the data. Corrective actions may include more intensive staff training, equipment repair followed by a more intensive preventive maintenance program, or removal of the source of systemic contamination. Once resolved, the corrective action procedure will be fully documented, and if DQOs were not met, the samples in question must be recollected and/or reanalyzed utilizing a properly functioning system.

SECTION 10.0
REFERENCES

USEPA 2017a. Contract Laboratory Program National Functional Guidelines for Organic Superfund Methods Data Review SOM02.4) EPA 540-R-2017-002

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TABLES

TABLE 1
METHODS, ANALYTES, REPORTING LIMITS AND CONTROL LIMITS
Remedial Design Work Plan, Quality Assurance Project Plan
Del Amo Superfund Site OU-1

Soil Vapor							
Method	**Analyte**	**MDL**	**MRL**	**MS/MSD**		**LCS/ LCSD**	
		(ug/m3)	**(ug/m3)**	**%R**	**RPD**	**%R**	**RPD**
USEPA TO-15	1,1,1-Trichloroethane	0.6	2.7			70 - 130	30
	1,1,2,2-Tetrachloroethane	2.7	6.9			63 - 130	30
	1,1,2-Trichloroethane	0.6	2.7			70 - 130	30
	1,1-Dichloroethane	0.39	2			70 - 130	30
	1,1-Dichloroethene	0.36	2			70 - 135	30
	1,2,3-Trichloropropane	2.4	30			70 - 130	30
	1,2,4-Trichlorobenzene	10	15			31 - 151	30
	1,2,4-Trimethylbenzene	4.9	7.4			60 - 132	30
	1,2-Dibromoethane[1]	1.2	3.8			70 - 133	30
	1,2-Dichlorobenzene	1.7	3			48 - 138	30
	1,2-Dichloroethane	0.53	2			70 - 132	30
	1,2-Dichloropropane	0.37	2.3			70 - 130	30
	1,3,5-Trimethylbenzene	1.9	2.5			62 - 130	30
	1,3-Dichlorobenzene	1.9	3			56 - 134	30
	1,4-Dichlorobenzene	1.7	3			52 - 136	30
	2-Butanone (MEK)	2.1	4.4			66 - 132	30
	2-Hexanone	3.3	6.1			70 - 136	30
	4-Methyl-2-pentanone	4.1	6.1			70 - 130	30
	Acetone	2.6	4.8			67 - 133	30
	Benzene	0.27	1.6			70 - 130	30
	Bromodichloromethane	0.63	3.4			70 - 130	30
	Bromoform	3.1	5.2			63-147	30
	Bromomethane	1	1.9			70-139	30
	Carbon Disulfide	2.3	6.2			68 - 146	30
	Carbon Tetrachloride	0.62	3.1			70 - 136	30
	Chlorobenzene	0.46	2.3			70 - 130	30
	Chloroethane	0.87	1.3			65 - 149	30
	Chloroform	0.54	2.4			70 - 130	30
	Bromomethane	1	1.9			70 - 130	30
	Carbon Disulfide	2.3	6.2			68 - 146	30
	Carbon Tetrachloride	0.62	3.1			70 - 136	30
	Chlorobenzene	0.46	2.3			70 - 130	30
	Chloroethane	0.63	1.3			65 - 149	30
	Chloroform	0.34	2.4			70 - 130	30
	Chloromethane	0.29	1			69 - 141	30
	Dibromochloromethane	0.94	4.3			70 - 138	30
	Dichlorodifluoromethane	1	2.5			67 - 139	30
	Ethylbenzene	1.7	2.2			70 - 130	30
	Isopropylbenzene	1.6	2.5			70 - 130	30
	Methylene chloride	3.8	17			69 - 130	30
	Methyl-tert-butyl ether	2.4	7.2			68 - 130	30
	Naphthalene	3.4	26			24 - 144	30

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		(ug/m3)	**(ug/m3)**	**%R**	**RPD**	**%R**	**RPD**
USEPA TO-15	Styrene	1.5	6.4			65 - 131	30
	Tetrachloroethene	0.75	3.4			70 - 130	30
	Toluene	1.4	1.9			70 - 130	30
	Trichloroethene	0.59	2.7			70 - 130	30
	Trichlorofluoromethane	4.6	5.6			63 - 141	30
	Vinyl Acetate	3.5	7			58 - 130	30
	Vinyl chloride	0.36	1.3			70 - 134	30
	cis-1,2-Dichloroethene	1.1	2			70 - 130	30
	cis-1,3-Dichloropropene	1.2	2.3			70 - 130	30
	n-Butylbenzene	1.8	2.7			50 - 150	30
	n-Propylbenzene	1.9	2.5			68 - 130	30
	o-Xylene	1.3	2.2			69 - 130	30
	p/m-Xylene	3.4	8.7			70 - 132	30
	Sec-Butylbenzene	1.4	2.7			50 - 150	30
	trans-1,2-Dichloroethene	0.95	2			70 - 130	30
	trans-1,3-Dichloropropene	1.1	4.5			70 - 147	30
	Tert-Butylbenzene	1.4	2.7			50 - 150	30
		PPMV	**PPMV**				
SCAQMD 25.1	Methane (ppmv)	0.21	1	80 - 120	0 - 20	80 - 120	20
EPA TO-3	Total Petroleum Hydrocarbons (ppmv)	0.43	1.5	80 - 120	0 - 20	80 - 120	20
		%	**%**				
ASTM D-1946	Carbon Dioxide (%)	0.139	0.5			80 - 120	30
	Carbon Monoxide (%)	0.183	0.5			80 - 120	30
	Methane (%)	0.155	0.5			80 - 120	30
	Nitrogen (%)	0.477	0.5			80 - 120	30
	Oxygen (+ Argon) (%)	0.205	0.5			80 - 120	30
		pg/PUF					
EPA TO-9A	2,3,7,8-TCDD	20.0				70-130	30
	2,3,7,8-TCDF	20.0				70-130	30
	1,2,3,7,8-PeCDD	100				70-130	30
	1,2,3,7,8-PeCDF	100				70-130	30
	2,3,4,7,8-PeCDF	100				70-130	30
	1,2,3,4,7,8-HxCDD	100				70-130	30
	1,2,3,6,7,8-HxCDD	100				70-130	30
	1,2,3,7,8,9-HxCDD	100				70-130	30
	1,2,3,4,7,8-HxCDF	100				70-130	30
	1,2,3,6,7,8-HxCDF	100				70-130	30
	1,2,3,7,8,9-HxCDF	100				70-130	30
	2,3,4,6,7,8-HxCDF	100				70-130	30
	1,2,3,4,6,7,8-HpCDD	100				70-130	30
	1,2,3,4,6,7,8-HpCDF	100				70-130	30
	1,2,3,4,7,8,9-HpCDF	100				70-130	30
	OCDD	200				70-130	30
	OCDF	200				70-130	30
	Total TCDD	20.0					
	Total TCDF	20.0					
	Total PeCDD	100					
	Total PeCDF	100					
	Total HxCDD	100					
	Total HxCDF	100					
	Total HpCDD	100					
	Total HpCDF	100					

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Method	**Analyte**	**MDL**	**MRL**	**MS/MSD**		**LCS/ LCSD**	
		(ug/kg)	**(ug/kg)**	**%R**	**RPD**	**%R**	**RPD**
USEPA 8260B	1,1,1,2-Tetrachloroethane	0.24	1				
	1,1,1,2-Tetrachloroethane	0.24	1				
	1,1,1-Trichloroethane	0.23	1				
	1,1,2,2-Tetrachloroethane	0.35	2				
	1,1,2-Trichloroethane	0.35	1				
	1,1-Dichloroethane	0.21	1				
	1,1-Dichloroethene	0.35	1	55 - 133	0 - 41	68 - 128	20
	1,1-Dichloropropene	0.33	2				
	1,2,3-Trichlorobenzene	0.91	2				
	1,2,3-Trichloropropane	0.83	2				
	1,2,4-Trichlorobenzene	0.31	2				
	1,2,4-Trimethylbenzene	0.59	2				
	1,2-Dibromo-3-chloropropane	1.7	10				
	1,2-Dibromoethane[1]	0.26	1	57 - 153	0 - 39	80 - 120	20
	1,2-Dichlorobenzene	0.23	1	38 - 128	0 - 62	80 - 120	20
	1,2-Dichloroethane	0.31	1	80 - 120	0 - 20	80 - 120	20
	1,2-Dichloropropane	0.44	1				
	1,3,5-Trimethylbenzene	0.55	2				
	1,3-Dichlorobenzene	0.18	1				
	1,3-Dichloropropane	0.25	1				
	1,4-Dichlorobenzene	0.22	1				
	2,2-Dichloropropane	0.33	5				
	2-Butanone (MEK)	3.8	20				
	2-Chlorotoluene	0.23	1				
	2-Hexanone	1.8	20				
	4-Chlorotoluene	0.21	1				
	4-Methyl-2-pentanone	4.3	20				
	Acetone	6.2	50				
	Benzene	0.13	1	31 - 145	0 - 41	80 - 120	20
	Bromobenzene	0.21	1				
	Bromochloromethane	0.69	5				
	Bromodichloromethane	0.23	1				
	Bromoform	0.79	5				
	Bromomethane	9.4	20				
	Carbon Disulfide	0.31	10				
	Carbon Tetrachloride	0.28	1	49 - 133	0 - 48	58-142	20
	Chlorobenzene	0.22	1	54 - 126	0 - 50	80 - 120	20
	Chloroethane	1.5	2				
	Chloroform	0.24	1				
	Chloromethane	0.3	20				
	Dibromochloromethane	0.57	2				
	Dibromomethane	0.77	2				
	Dichlorodifluoromethane	0.44	2				
	Ethylbenzene	0.15	1	32 - 146	0 - 61	80 - 120	20
	Isopropylbenzene	0.55	1				
	Methylene chloride	1.3	10				
	Methyl-tert-butyl ether	0.3	2	61 - 145	0 - 33	64 - 124	20
	Naphthalene	0.81	10				
	Styrene	0.6	1				
	Tetrachloroethene	0.21	1				
	Toluene	0.52	1	39 - 141	0 - 52	80 - 120	20

TABLE 1
METHODS, ANALYTES, REPORTING LIMITS AND CONTROL LIMITS
Remedial Design Work Plan, Quality Assurance Project Plan
Del Amo Superfund Site OU-1

Soil Vapor							
Method	**Analyte**	**MDL**	**MRL**	**MS/MSD**		**LCS/ LCSD**	
		(ug/kg)	**(ug/kg)**	**%R**	**RPD**	**%R**	**RPD**
USEPA 8260B	Trichloroethene	0.3	2	57 - 129	0 - 47	80 - 120	20
	Trichlorofluoromethane	0.38	10				
	Vinyl Acetate	4.7	10				
	Vinyl chloride	0.5	1	47 - 137	0 - 58	68-120	20
	cis-1,2-Dichloroethene	0.28	1				
	cis-1,3-Dichloropropene	0.25	1				
	n-Butylbenzene	0.16	1				
	n-Propylbenzene	0.5	2				
	o-Xylene	0.56	1	80-120	0-20	80-122	20
	p/m-Xylene	0.27	2	80-120	0-20	80-122	20
	p-Isopropyltoluene	0.63	1				
	Sec-Butylbenzene	0.58	1				
	trans-1,2-Dichloroethene	0.51	1				
	trans-1,3-Dichloropropene	0.61	5				
	Tert-Butylbenzene	0.15	1				
Stack Emision Testing							
		pg/g	**pg/g**				
EPA 8290	2,3,7,8-TCDD	1.00	0.150			60-138	20
	2,3,7,8-TCDF	1.00	0.110			56-158	20
	1,2,3,7,8-PeCDD	5.00	0.300			70-122	20
	1,2,3,7,8-PeCDF	5.00	0.270			69-134	20
	2,3,4,7,8-PeCDF	5.00	0.290			70-131	20
	1,2,3,4,7,8-HxCDD	5.00	0.710			60-138	20
	1,2,3,6,7,8-HxCDD	5.00	0.580			68-136	20
	1,2,3,7,8,9-HxCDD	5.00	0.580			68-138	20
	1,2,3,4,7,8-HxCDF	5.00	0.300			74-128	20
	1,2,3,6,7,8-HxCDF	5.00	0.380			67-140	20
	1,2,3,7,8,9-HxCDF	5.00	0.300			71-137	20
	2,3,4,6,7,8-HxCDF	5.00	0.430			72-134	20
	1,2,3,4,6,7,8-HpCDD	5.00	0.460			71-128	20
	1,2,3,4,6,7,8-HpCDF	5.00	0.380			71-136	20
	1,2,3,4,7,8,9-HpCDF	5.00	0.650			68-129	20
	OCDD	10.0	1.50			70-128	20
	OCDF	10.0	1.20			63-141	20
	Total TCDD	1.00	0.150				
	Total TCDF	1.00	0.110				
	Total PeCDD	5.00	0.300				
	Total PeCDF	5.00	0.290				
	Total HxCDD	5.00	0.710				
	Total HxCDF	5.00	0.300				
	Total HpCDD	5.00	0.460				
	Total HpCDF	5.00	0.650				

Notes:
MDL – method detection limit MRL – method reporting limit
MS/MSD - Matrix Spike/ Matrix Spike Duplicate
LCS/LCSD – Laboratory Control Sample/ Laboratory Control Sample Duplicate
ug/m3 – micrograms per cubic meter
%R – Percent Recovery RPD – Relative Percent Difference
ppmv – parts per million by volume
pg/PUF - picogram per Poly-Urethane Foam sampler
pg/g - picogram per gram

TABLE 2
SUMMARY OF AIR, SOIL VAPOR, AND SOIL ANALYSES
Remedial Design Work Plan, Quality Assurance Project Plan
Del Amo Superfund Site OU-1

Media	Analyte	Method	Container	Preservative	Holding Time
Air and Soil Vapor	VOCs	EPA TO-15	1 Liter or 6 Liter Summa Canister	None	30 days
	Fixed Gases	ASTM D-1946	1 Liter or 6 Liter Summa Canister	None	30 days
	Methane	SCAQMD 25.1	1 Liter or 6 Liter Summa Canister	None	30 days
	TPH	USEPA TO-3	1 Liter or 6 Liter Summa Canister	None	30 days
	Dioxins / Furans	TO-9	Filter cartridge and and adsorbent cartridge in riginal shipping conainer	<4°C	7 days to extraction; 45 days from collection to analysis
	Dioxins / Furans	CARB 428	Particulate Filter and Front Half Solvent Rinses	<4°C	30 days to extraction; 45 days from extraction to analysis
			XAD-2 Resin and Back Half Solvent Rinses	<4°C	
Soil	VOCs	USEPA 8260B	3 Encore or 1 Terra Core	4°C	14 days
Trip Blanks	VOCs	USEPA 8260B	Three 40 mL VOA vials	4°C, HCl, pH <2	14 days

APPENDIX A
EUROFINS/CALSCIENCE LABORATORIES INC.
QUALITY MANUAL

QUALITY SYSTEMS MANUAL FOR ENVIRONMENTAL ANALYTICAL SERVICES

Calscience Environmental Laboratories, Inc.

Version 5.6
February 2014

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Based On

The NELAC Institute (TNI)
National Environmental Laboratory Accreditation Program (NELAP)
Management and Technical Requirements for Laboratories Performing Environmental Analysis
TNI Standard (EL-V1-2009) Effective September 09, 2009

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PREFACE TO THE QUALITY SYSTEMS MANUAL

Purpose

The purpose of this document is to provide implementation guidance on the establishment and management of quality systems for Calscience Environmental Laboratories, Inc and is based on the National Environmental Laboratory Accreditation Conference's (NELAC) Quality System requirements, the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) and International Organization for Standardization / International Electrotechnical Commission (ISO/IEC) 17025:2005.

These three programs are built upon one another and are mutually reinforcing in their Quality Assurance programs and protocols.

Background

To be accredited and in compliance under the following three programs:

1. The National Environmental Laboratory Accreditation Program (NELAP). Accredited laboratories shall have a comprehensive quality system in place, the requirements for which are outlined in The NELAC Institute (TNI) 2009 Volume 1: Management and Technical Requirements for Laboratories Performing Environmental Analysis (EL-V1-2009). This manual was written with guidance primarily from Volume 1: Modules 2, 3, 4, 5, and 7.

   Additional information may be found at:

   - http://www.nelac-institute.org/

2. The Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) will provide a means for laboratories to demonstrate conformance to the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM) as authorized by DoD Instruction 4715.15.

   The DoD QSM Revision 4.2 (October 25, 2010) is based on the National Environmental Laboratory Accreditation Conference (NELAC) Quality Systems standard which provides guidelines for implementing the international standard, ISO/IEC 17025. The DoD QSM Revision 5.0 (July 2013) standards will be implemented over the 2014-2015 time period.

   Additional information may be found at:

   - http://www.denix.osd.mil/edqw/Accreditation/
   - http://www.denix.osd.mil/edqw/upload/QSM-V4-2-Final-102510.pdf
   - http://www.denix.osd.mil/edqw/upload/QSM-Version-5-0-FINAL.pdf

3. ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories is for use by laboratories in developing their management system for quality, administrative and technical operations. Laboratory customers, regulatory authorities and accreditation bodies may also use it in confirming or recognizing the competence of laboratories.

   Additional information may be found at:

   - http://www.iso.org/iso/home.html

Project Specific Requirements

Project-specific requirements or regulations may supersede requirements contained in this manual. The laboratory bears the responsibility for meeting all **State requirements**. Nothing in this document relieves the laboratory from complying with contract requirements, or with **Federal, State, and/or local regulations**.

Results and Benefits

- **Standardization of Processes** – Because this manual provides the laboratory with a comprehensive set of requirements that meet the needs of many clients, as well as the NELAP, the laboratory may use it to create a standardized quality system. Ultimately, this standardization saves laboratory resources by establishing one set of consistent requirements for all environmental work. Primarily, the laboratory bears the responsibility for meeting all State requirements as outlined in their respective certification programs.

- **Deterrence of Improper, Unethical, or Illegal Actions** – Improper, unethical, or illegal activities committed by only a few laboratories have implications throughout the industry, with negative impacts on all laboratories. This manual establishes a minimum threshold program for all laboratories to use to deter and detect improper, unethical, or illegal actions.

- **Foundations for the Future** – A standardized approach to quality systems, shared by laboratories and the NELAP, paves the way for the standardization of other processes. For example, this manual might serve as a platform for a standardized strategy for Performance Based Measurement System (PBMS) implementation.

Document Format

This Calscience Environmental Laboratories, Inc. (Calscience) *Quality Systems Manual* (QSM) is designed to implement the TNI 2009 (EL-V1-2009) standards along with the DOD QSM 4.2 and the ISO/IEC 17025:2005 standards. The DoD QSM Revision 5.0 (July 2013) standards will be phased in over the 2014-2015 time period.

The section numbering has been changed from that of these standards as the manual is meant to be a stand-alone document. Thus the numbering in this document is not consistent with the numbering in the above-mentioned standards; however, all required elements are covered, herein.
.

ACROYNM LIST

°C: Degrees Celsius
ANSI/ASQC: American National Standards Institute / American Society for Quality Control
ASTM: American Society for Testing and Materials
CAS: Chemical Abstract Service
CCV: Continuing calibration verification
CFR: Code of Federal Regulations
CLP: Contract Laboratory Program
COC: Chain of Custody
CV: Coefficient of Variation
DO: Dissolved Oxygen
DOC: Demonstration of Capability
DoD: Department of Defense
DQOs: Data Quality Objectives
EPA: Environmental Protection Agency
g/L: Grams per Liter
GC/MS: Gas Chromatography / Mass Spectrometry
ICP-MS: Inductively Coupled Plasma / Mass Spectrometer
ICV: Initial Calibration Verification
ID: Identifier
ISO/IEC: International Standards Organization / International Electrotechnical Commission
LCS: Laboratory Control Sample
LCSD: Laboratory Control Sample Duplicate
LOD: Limit of Detection
LOQ: Limit of Quantitation
LQMP: Laboratory Quality Management Plan
MDL: Method Detection Limit
ME: Marginal Exceedance
mg/kg: Milligrams per Kilogram
MS: Matrix Spike
MSD: Matrix Spike Duplicate
NELAC: National Environmental Laboratory Accreditation Conference
NELAP: National Environmental Laboratory Accreditation Program
NIST: National Institute of Standards and Technology
OSHA: Occupational Safety and Health Administration
PBMS: Performance Based Measurement System
PC: Personal Computer
PCBs: Polychlorinated Biphenyls
PT: Proficiency Testing
QA: Quality Assurance
QAD: Quality Assurance Division (EPA)
QAMS: Quality Assurance Management Section
QAPP: Quality Assurance Project Plan
QSM: Quality Systems Manual
QC: Quality Control
RL: Reporting Limit
RPD: Relative Percent Difference
RSD: Relative Standard Deviation
SD: Serial Dilutions
SOP: Standard Operating Procedure
TNI: The NELAC Institute
TSS: Total Suspended Solids
UV: Ultraviolet
VOC: Volatile Organic Compound

QUALITY SYSTEMS

Quality Systems include all quality assurance (QA) policies and quality control (QC) procedures that are delineated in a Quality Systems Manual (QSM) and followed to ensure and document the quality of the analytical data. Calscience, accredited under the National Environmental Laboratory Accreditation Program (NELAP), assures implementation of all QA policies and the applicable QC procedures specified in this Manual. The QA policies, which establish essential QC procedures, are applicable to all areas of Calscience, regardless of size and complexity.

The intent of this document is to provide sufficient detail about quality management requirements so that all accrediting authorities evaluate laboratories consistently and uniformly.

The National Environmental Laboratory Accreditation Institute (TNI) is committed to the use of Performance Based Measurement Systems (PBMS) in environmental testing and provides the foundation for PBMS implementation in these standards. While this standard may not currently satisfy all the anticipated needs of PBMS, NELAC will address future needs within the context of State statutory and regulatory requirements and the finalized EPA implementation plans for PBMS.

Chapter 5 is organized according to the structure of ISO/IEC 17025, 2005. Where deemed necessary, specific areas within this Chapter may contain more information than specified by ISO/IEC 17025.

All items identified in this QSM shall be available for on-site inspection or data audit.

1.0 SCOPE

a) This QSM sets the general requirements that Calscience must successfully demonstrate to be recognized as competent to perform specific environmental tests.

b) This QSM includes additional requirements and information for assessing competence or for determining compliance by the organization or accrediting authority that grants approval.

   If more stringent standards or requirements are included in a mandated test method or by regulation, the laboratory demonstrates that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed.

c) Calscience uses this QSM in the development and implementation of its quality systems. Accreditation authorities use this NELAC based standard to assess the competence of environmental laboratories.

2.0 REFERENCES

See Appendix A.

3.0 DEFINITIONS

The relevant definitions from ISO/IEC Guide 2, ANSI/ASQC E-4, 1994, the EPA “Glossary of Quality Assurance Terms and Acronyms,” and the *International vocabulary of basic and general terms in metrology (VIM*) are applicable. The most relevant is quoted in Appendix A, Glossary, of Chapter 1 of NELAC, together with further definitions applicable for the purposes of this Standard.

4.0 ORGANIZATION AND MANAGEMENT

4.1 Legal Definition of Laboratory

Calscience is legally definable as evidenced by its business license, and current California Department of Health Services Environmental Laboratory Accreditation Program (CADHS ELAP) certificate. It is organized and operates in such a way that its facilities meet the requirements of the Standard. See the graphical presentations of the Organization and QA responsibility in Figures 1 and 2, respectively.

4.2 Organization

Calscience:

a) Has a managerial staff with the authority and resources necessary to discharge their duties;

b) Has processes to ensure that its personnel are free from any commercial, financial and other undue pressure that adversely affect the quality of their work;

c) Is organized in such a way that confidence in its independence of judgment and integrity is maintained at all times;

d) Specifies and documents the responsibility, authority, and interrelationship of all personnel who manage, perform or verify work affecting the quality of calibrations and tests;

   Such documentation includes:

   1) A clear description of the lines of responsibility in the laboratory, and is proportioned such that adequate supervision is ensured, and

   2) Job descriptions for all positions.

e) Provides supervision by persons familiar with the calibration or test methods and procedures, the objective of the calibration or test, and the assessment of the results.

   The ratio of supervisory to non-supervisory personnel ensures adequate supervision and adherence to laboratory procedures and accepted techniques.

f) Has a technical director who has overall responsibility for the technical operation of Calscience.

   The technical director certifies that personnel who perform the tests for which the laboratory is accredited have the appropriate educational and/or technical background. Such certification is documented.

   The technical director meets the requirements specified in the Accreditation Process. (See NELAC Section 4.1.1.1.)

g) Has a quality assurance manager who has responsibility for the quality system and its implementation.

   The quality assurance officer has direct access to the technical director and to the highest level of management at which decisions are made regarding laboratory policy or resources.

   The quality assurance manager (and/or his/her designees):

   1) Serves as the focal point for QA/QC activities, and is responsible for the oversight and/or review of quality control data;

2) Has functions independent from laboratory operations for which she/he has quality assurance oversight;

3) Is able to evaluate data objectively and perform assessments without outside (e.g., managerial) influence;

4) Has documented training and/or experience in QA/QC procedures and is knowledgeable in the quality system, as defined under NELAC;

5) Has a general knowledge of the analytical test methods for which data review is performed;

6) Arranges for and conducts internal audits as per Calscience QSM section 5.3 annually; and

7) Notifies Calscience management of deficiencies in the quality system and monitors corrective action.

h) Nominates, by way of the "Alternates List," deputies in case of absence of the technical director and/or the quality assurance officer;

i) Calscience makes every effort to ensure the protection of its clients' information as confidential and proprietary.

ii) Calscience is sensitive to the fact that much of the analytical work performed for clientele may be subject to litigatory processes. Calscience, therefore, holds all information in strict confidence with laboratory release only to the client.
iii) Information released to entities other than the client is performed only upon written request from the client.
iv) Due to the investigative nature of most site assessments, analytical information may become available to regulatory agencies or other evaluating entities during site assessment of the laboratory for the specific purpose of attaining laboratory certifications, accreditations, or evaluation of laboratory qualification for future work. During these occurrences, the laboratory will make every effort to maintain the confidence of client specific information.

j) For purposes of qualifying for and maintaining accreditation, participates in a proficiency test program as outlined in Chapter 2 of NELAC. Results of Calscience's performance in rounds of proficiency testing are available by request.

5.0 QUALITY SYSTEM – ESTABLISHMENT, AUDITS, ESSENTIAL QUALITY CONTROLS, AND DATA VERIFICATION

5.1 Establishment

Calscience establishes and maintains quality systems based on the required elements contained in this Manual and appropriate to the type, range and volume of environmental testing activities it undertakes.

a) The elements of this quality system are documented in this quality manual.

b) The quality documentation is available for use by all laboratory personnel.

c) The laboratory defines and documents its policies and objectives for, and its commitment to accepted laboratory practices and quality of testing services.

d) The laboratory management ensures that these policies and objectives are documented in the quality manual and are communicated to, understood and implemented by all laboratory personnel concerned.

i. All staff members are given access to a controlled copy of the Quality Systems Manual (QSM) for review at the commencement of employment. However, the individual Standard Operating Procedures are the training documents that have precedence. The QSM is provided as a general overview.

ii. A controlled copy of the quality manual is also available in each department.

e) The quality manual is maintained current under the responsibility of the quality assurance department. This manual is reviewed on an annual basis or more frequently, and revised as necessary.

5.2 Quality Systems Manual (QSM) Elements

This Quality Systems Manual (QSM) and related quality documentation state Calscience's policies and operational procedures established in order to meet the requirements of this Standard.

This manual lists on the title page: a document title; the laboratory's full name and address; the name, address, and telephone number of individuals responsible for the laboratory and the effective date of the version.

This quality manual and related quality documentation also contains:

a) A quality ***policy statement***, including objectives and commitments, by top management;

i. Calscience Environmental Laboratories, Inc. (Calscience) is committed to providing the highest quality environmental analytical services available. To ensure the production of scientifically sound, legally defensible data of known and proven quality, an extensive Quality Assurance program has been developed and implemented. This document, Calscience's Quality Systems Manual for Environmental Analytical Services, presents an overview of the essential elements of our Quality Assurance program. Calscience has modeled this systems manual after EPA guidelines as outlined in "Guidance for Quality Assurance Project Plans (EPA QA/G-5)", Office of Monitoring Systems and Quality Assurance, Office of Research and Development, U.S. EPA, EPA/240-R-02/009 December 2002. Calscience's QA Program is closely monitored at the Corporate, Divisional, and Group levels, and relies on clearly defined objectives, well-documented procedures, a comprehensive quality assurance/quality control system, and management support for its effectiveness.

ii. This QA Program Systems Manual is designed to control and monitor the quality of data generated at Calscience. The essential elements described herein are geared toward generating data that is in compliance with federal regulatory requirements specified under the Clean Water Act, the Safe Drinking Water Act, the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation, and Liability Act, and applicable amendments, and state and DoD/DoE equivalents. Although the quality control requirements of these various programs are not completely consistent, each of the programs base data quality judgments on the following three types of information, the operational elements of each being described elsewhere in this manual.

⇨ Data which indicates the overall qualifications of the laboratory to perform environmental analyses;
⇨ Data which measures the laboratory's daily performance using a specific method; and
⇨ Data which measures the effect of a specific matrix on the performance of a method.

iii. It is important to note that the QA guidelines presented herein will always apply unless adherence to specific Quality Assurance Project Plans (QAPPs) or client and/or regulatory agency specific requirements are directed. In these cases, the elements contained within specified direction or documentation shall supersede that contained herein.

iv. This manual is a living document subject to periodic modifications to comply with regulatory changes and technological advancements. All previous versions of this document are obsolete. Users are urged to contact Calscience to verify the current revision of this document.

b) The organization and management structure of the laboratory, its place in any parent organization and relevant organizational charts;

See Figure 1 Organizational Chart, and Figure 2 Responsibility Chart.

c) The relationship between management, technical operations, support services and the quality system;

d) Procedures to ensure that all records required under the NELAP are retained, as well as procedures for control and maintenance of documentation through a document control system which ensures that all standard operating procedures, manuals, or documents clearly indicate the time period during which the procedure or document was in force;

i. Ensuring a high quality work product in the environmental laboratory not only requires adherence to the quality issues discussed in the previous sections, but also requires the ability to effectively archive, restore, and protect the records that are generated.

ii. Procedures are in place to ensure that all records are retained. In addition, a documentation control system is employed to clearly indicate the time period during which a standard operating procedure, manual, or document was in force. These procedures are outlined in the laboratory standard operating procedure SOP-T002.

iii. All laboratory logbooks, instrument response printouts, completed analytical reports, chain-of-custodies, and laboratory support documentation are stored for a minimum of five years. Project specific data are stored in sequentially numbered project files and include copies of the applicable laboratory logbooks, instrument response printouts, completed analytical reports, chain-of-custodies, and any other pertinent supporting documentation.

iv. When complete, the project specific data are high speed optically scanned and transformed into digital CD media. Additional copies of these records are created at the time of scanning and are stored off-site for protection of the data. These records are stored for a minimum of five years.

v. Access to all systems is limited by use of log-in and password protection and is maintained by the system administrator.

vi. There are four forms of electronic data that are generated in the laboratory. Refer to Table 1 – Data Archiving Schedule below for a synopsis of general data archiving schedules.

vii. All electronic records are stored for a minimum of five years.

FIGURE 1:

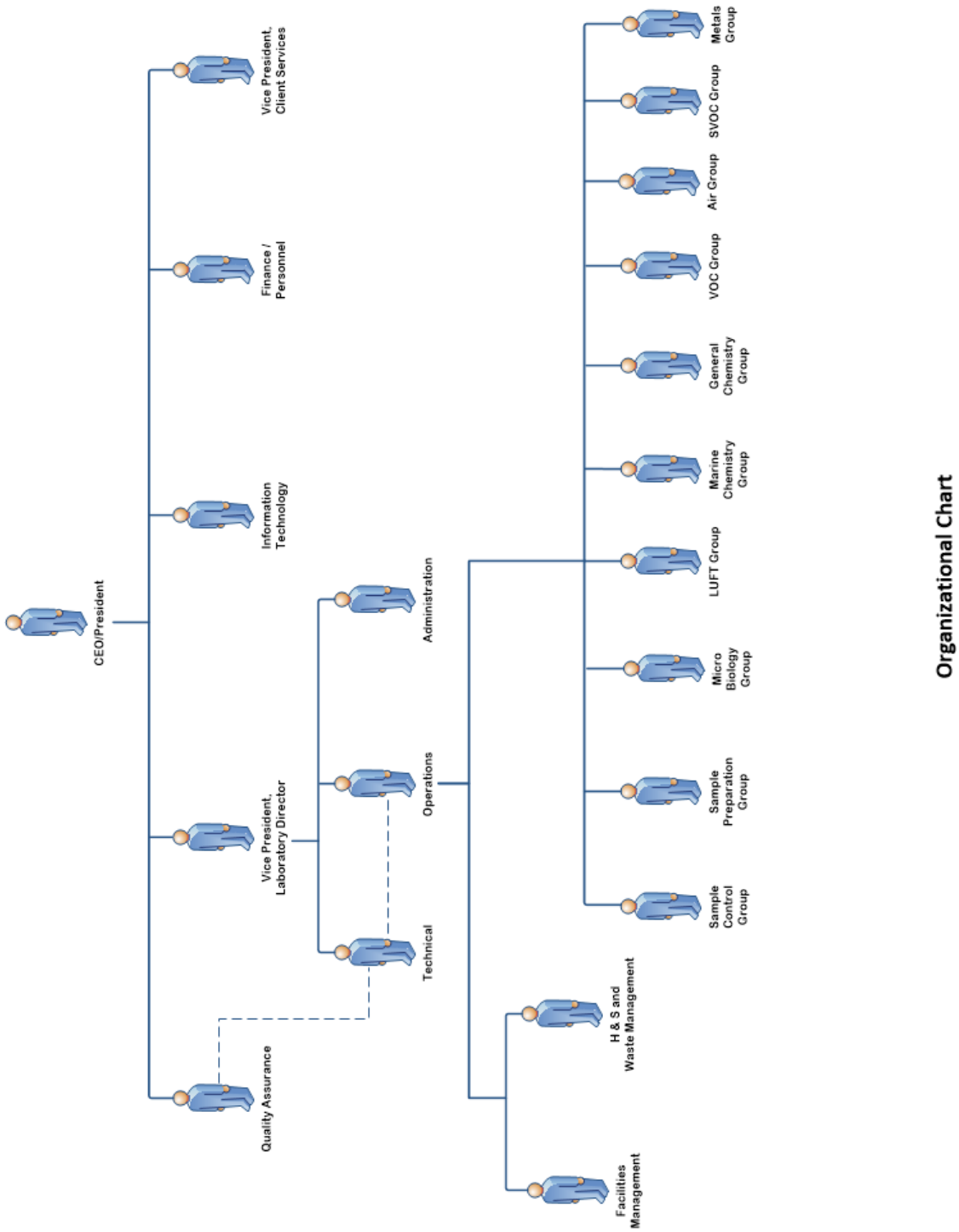
CEO/President
Vice President, Client Services
Finance / Personnel
Information Technology
Vice President, Laboratory Director
Quality Assurance
Administration
Operations
Technical
H & S and Waste Management
Facilities Management
Sample Control Group
Sample Preparation Group
Micro Biology Group
LUFT Group
Marine Chemistry Group
General Chemistry Group
VOC Group
Air Group
SVOC Group
Metals Group
Organizational Chart

FIGURE 2:

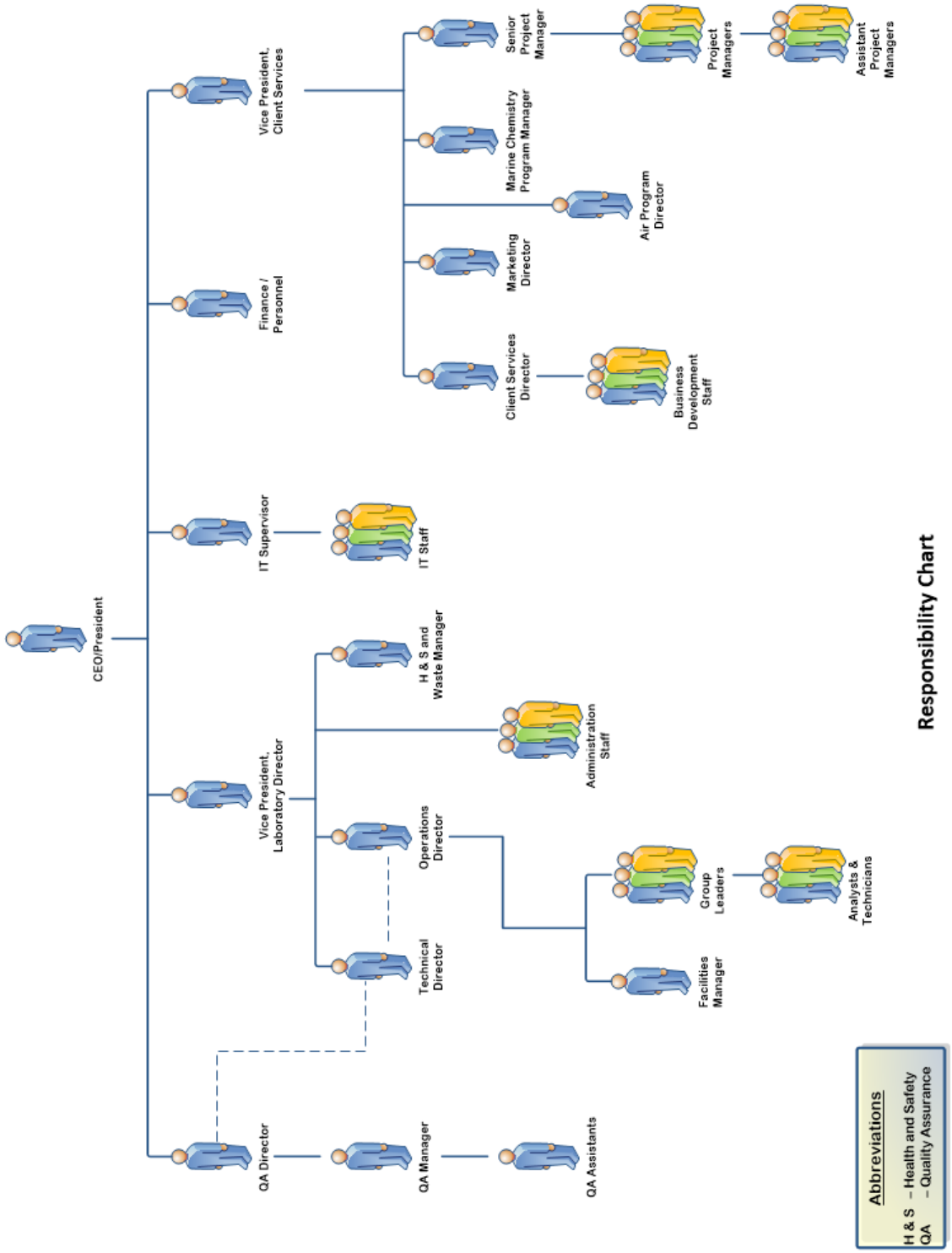
CEO/President
Vice President, Client Services
Finance / Personnel
IT Supervisor
Vice President, Laboratory Director
QA Director
Senior Project Manager
Marine Chemistry Program Manager
Marketing Director
Client Services Director
Project Managers
Assistant Project Managers
Air Program Director
Business Development Staff
IT Staff
H & S and Waste Manager
Administration Staff
Operations Director
Technical Director
Group Leaders
Analysts & Technicians
Facilities Manager
QA Manager
QA Assistants
Responsibility Chart
Abbreviations
H & S – Health and Safety
QA – Quality Assurance

TABLE 1 – DATA ARCHIVING SCHEDULE

LIMS Database	
Backup frequency:	Daily
Backup media:	Hard Disk
Backup software:	MS SQL Server Backup
Backup versions kept:	Ten previous versions
Onsite copy:	Redundancy by using mirrored hard drive
Offsite copy:	One (Replicate to Lampson Facility)
Instrument Data	
Backup frequency:	Daily
Backup media:	Hard Disk
Backup software:	NT Backup
Backup versions kept:	All versions
Offsite copy:	One (Replicate to Lampson Facility)

e) Job Descriptions, Roles and Responsibilities

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to their job function and the quality program as a whole.

The responsibility for quality lies with every employee at Calscience. As such, all employees have access to the Quality Assurance Manual and are responsible for knowing the content of this manual and upholding the standards therein. Each employee is expected to conduct themselves in accordance with the procedures in this manual and the laboratory's SOPs.

The following descriptions define the primary roles and their relationship to the Quality Assurance Program. Members of the key staff include the following:

- Management (e.g., President, Chief Executive Officer, Chief Operating Officer, Laboratory Director);
- Technical managers (e.g., Technical Director, Section Supervisors);
- Quality managers;
- Support systems and administrative managers (e.g., LIMS manager, purchasing manager, project managers); and
- Client services managers.

In these positions, members of the key staff are responsible for assuring compliance with the National Environmental Laboratory Accreditation Program (NELAP), California Environmental Laboratory Accreditation Program (ELAP), Department of Defense (DoD) ELAP, State and Federal Agencies, and ISO 17025:2005 Standard requirements. In these roles, key personnel may set or enforce quality policies, monitor compliance, initiate corrective actions, interface with laboratory, client, and regulatory personnel, and provide general program oversight.

Laboratory Director:

Calscience's Laboratory Director, through its President, is the final authority on all issues dealing with data quality and has the authority to require that procedures be amended or discontinued, or analytical results voided or repeated. He or she also has the authority to suspend or terminate employees on the grounds of non-compliance with QA/QC procedures. In addition, the Laboratory Director:

- ⇨ Ensures that Calscience remains current with all regulations which affect operations and disseminate all such changes in regulatory requirements to the QA Manager, Technical Director, and Group Leaders;

- ⇨ Provides one or more Technical Directors for the appropriate fields of testing. The name(s) of the Technical Director are included in the national database. (The Laboratory Director may also act in the Technical Director capacity.) If the Technical Director is absent for a period of time exceeding 15 consecutive calendar days, the Laboratory Director will designate another full time staff member meeting the qualifications of the Technical Director to temporarily perform this function. If the absence exceeds 35 consecutive calendar days, the primary accrediting authority will be notified in writing;
- ⇨ Ensures that all analysts and supervisors have the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented;
- ⇨ Ensures that personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work;
- ⇨ Oversees the development and implementation of the QA Program which assures that all data generated will be scientifically sound, legally defensible, and of known quality;
- ⇨ In conjunction with the QA Manager, conducts annual reviews of the QA Program;
- ⇨ Oversees the implementation of new and revised QA procedures to improve data quality;
- ⇨ Ensures that appropriate corrective actions are taken to address analyses Identified as requiring such actions by internal and external performance or procedural audits. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs may be temporarily suspended by the Laboratory Director;
- ⇨ Reviews and approves all SOPs prior to their implementation and ensures all approved SOPs are implemented and adhered to;
- ⇨ Oversees all laboratory accreditation efforts; and
- ⇨ Oversees in-house training on quality assurance and control.

Operations Director:

The Operations Director manages and directs the analytical production sections of the laboratory. He or she reports directly to the Laboratory Director and assists in determining the most efficient instrument utilization. More specifically, he/she:

- ⇨ Evaluate the level of internal/external non-conformances for all departments;
- ⇨ Continuously evaluate production capacity and improves capacity utilization;
- ⇨ Continuously evaluate turnaround time and addresses any problems that may hinder meeting the required and committed turnaround time from the various departments;
- ⇨ Develop and improve the training of all analysts in cooperation with the Laboratory Director, QA Director, QA Manager and Group Leaders, and in compliance with regulatory requirements;
- ⇨ Ensure that scheduled instrument maintenance is completed;
- ⇨ Are responsible for efficient utilization of supplies;
- ⇨ Constantly monitor and modify the processing of samples through the departments; and
- ⇨ Maintain sufficient personnel, equipment and supplies to achieve production goals.

Quality Assurance Director:

The Quality Assurance (QA) Director has full authority through the President in all matters relating to quality assurance and quality control systems. The QA Director can make recommendations to the President and/or Laboratory Director regarding the suspension analytical activities or the suspension or termination of employees on the grounds of non-compliance with QA/QC systems or procedures. An alternate QA Director is always assigned. In the absence of the primary designate, the alternate will act in the QA Director's

capacity with the full authority of the position as allowed by Calscience governing documents. In addition, the QA Director performs the following:

- ⇨ Oversight and monitoring of and compliance with Calscience's QA program;
- ⇨ Ensuring continuous improvement in all aspects of Calscience's QA program such as:
  - o accreditations/certifications;
  - o analytical method management;
  - o internal and external audits;
  - o documentation;
  - o training;
  - o proficiency evaluation studies;
- ⇨ Ensuring Calscience's QA program remains up-to-date consistent with current regulatory requirements and Calscience's QA policies;
- ⇨ Supervision and direction of all QA staff; and
- ⇨ Serving as a technical resource for analytical chemistry or QA matters;
- ⇨ Provide support and oversight to QA staff with regard to external audit responses. Provide input on, and define appropriate corrective actions for the laboratory. Document corrective action responses, and monitor the required audit response time frames, as needed.

Quality Assurance Manager:

The Quality Assurance (QA) Manager has full authority through the Quality Assurance Director in matters dealing within the laboratory. The QA Manager can make recommendations to the Quality Assurance Director and/or Laboratory Director regarding the suspension or termination of employees on the grounds of non-compliance with QA/QC procedures. An alternate QA Manager is always assigned. In the absence of the primary designate, the alternate will act in the QA Manager's capacity with the full authority of the position as allowed by Calscience governing documents. In addition, the QA Manager performs the following:

- ⇨ Maintains and updates the QAM on an annual basis;
- ⇨ Implements Calscience's QA Program;
- ⇨ Monitors the QA Program within the laboratory to ensure complete compliance with its objectives, QC procedures, holding times, and compliance with client or project specific data quality objectives;
- ⇨ Distributes performance evaluation (PE) samples on a routine basis to ensure the production of data that meets the objectives of its QA Program;
- ⇨ Maintains all SOPs used at Calscience;
- ⇨ Maintains records and archives of all PE results, audit comments, and customer inquiries concerning the QA program;
- ⇨ Performs statistical analyses of QC data and establish controls that accurately reflect the performance of the laboratory;
- ⇨ Conducts periodic performance and system audits to ensure compliance with the elements of Calscience's QA Program;
- ⇨ Prescribes and monitors corrective action;
- ⇨ Serves as in-house client representative on all project inquiries involving data quality issues;
- ⇨ Coordinates data review process to ensure that thorough reviews are conducted on all project files;
- ⇨ Develops revisions to existing SOPs;
- ⇨ Reports the status of in-house QA/QC to the Laboratory Director;
- ⇨ Maintains records and archives of all QA/QC data including but not limited to method detection limit (MDL) studies, accuracy and precision control charts, and completed log books; and
- ⇨ Conducts and/or otherwise ensures that an adequate level of QA/QC training is conducted within the laboratory.

Quality Assurance Assistant:

The QA Assistant reports to the QA Manager and performs the following functions:

- ⇨ Assists the QA Manager and lab staff with internal audits, corrective action review and overall implementation of the QA program;
- ⇨ Generates and reviews, in conjunction with the QA Manager, Control Charts and Method Detection Limit (MDL) studies;
- ⇨ Reviews and revises SOPs as needed;
- ⇨ Distributes new SOPs to all applicable lab areas.

Technical Director:

The Technical Director reports to the Laboratory Director and is responsible for all laboratory, client, and project technical issues. More specifically, he/she:

- ⇨ For major projects and/or clients, act as a technical resource for the client and the laboratory in matters of method selection or QC criteria.
- ⇨ Company-wide, maintains all training-related documentation in a single secure location. Develops training guides and other training documentation as needed;
- ⇨ Interface directly with Project Management staff in response to questions pre-release or from the client post-release. Determine causation and interface with QA staff to prevent recurrences;
- ⇨ Interface directly with clients, or other client representatives in matters related to technical data quality requests.
- ⇨ Attend client, Business Development, or industry meetings with or without management when a 'technical representative' is required or would be beneficial to Calscience.
- ⇨ Provide support to Business Development through the review of DOD-related SAPs, QAPPs, and work plans. Provide comment and alternative solutions if unable to meet specific requirements. Populate DOD UFP QAPP tables for client SAPs/QAPPs when needed;
- ⇨ Support QA and Operations with SOP revisions, where needed;
- ⇨ Perform full QA reviews and/or data validation where required;
- ⇨ Provide technical solutions to QA with regard to laboratory procedures, data quality issues, possible solutions, and appropriate corrective actions;
- ⇨ Provide technical opinions and support to Operations with regard to current procedures or new method development;
- ⇨ Interface with QA staff as necessary to ensure continuous improvement in all areas of Calscience's operations.
- ⇨ Provide LIMS input; and
- ⇨ As may be necessary, act as Program Director for DOD or other high profile projects.

Marine Chemistry Program Manager:

The Marine Chemistry Program Manager manages and directs the analytical production and methods development activity of the Marine Laboratory. He/she is responsible for all operations in the Marine laboratory. This position reports directly to the Business Development Director. More specifically, he/she:

- ⇨ Monitors the validity of the analytical data generated in the Marine Laboratory. Reviews all data packages. Works with Project Managers concerning Marine Chemistry work;
- ⇨ Along with the Business Development Director, determines the need for new methods in the Marine Laboratory. Researches new methods. Determines the equipment and personnel needed to perform methods as requested by the Business Development Director;

- ⇨ Works with the Business Development Director to insure that the Marine Laboratory is capable of performing potential work prior to bid submittal. Ensure the laboratory has adequate manpower to insure that samples are analyzed as per the client's specifications;
- ⇨ Write and review SOPs for the methods and other operations in the Marine Laboratory. Modifies SOPs as needed when new procedures are developed and proven;
- ⇨ Ensure that the Chemists and technicians in the Marine Laboratory are properly trained, and that they understand the operations they perform. This included insuring that the SOPs are followed;
- ⇨ Interfaces with the Operations Director to insure proper staffing. Requests staffing or supplies from the Operations Director if needed. Provides assistance to the Operations Director when needed; and
- ⇨ Insures that the Marine Laboratory follows the requirements of the QA/QC and Ethics programs.

Air Program Director

The Air Program Director reports to the Business Development Director and serves as a technical resource for air testing both internally and externally with the current and future client base. With the goal of total client satisfaction, the responsibilities include:

- ⇨ Ensuring Calscience remains current with air testing regulations;
- ⇨ Providing technical training regarding air testing internally and to clients;
- ⇨ Prepares air testing guides for internal and client use;
- ⇨ Identifies new air testing opportunities;
- ⇨ Works with the Business Development Team; and
- ⇨ Provides input in the preparation of air proposals and quotes.

Business Development Director:

The Business Development Director reports to the Laboratory Director and serves as the interface between the laboratory's technical departments and the laboratory's clients. The staff consists of the Project Management team, Business Development team and satellite office Operations Managers. With the overall goal of total client satisfaction, the functions of this position are outlined below:

- ⇨ Technical training and growth of the Project Management team;
- ⇨ Business liaison for the Project Management team;
- ⇨ Human resource management of the Project Management team;
- ⇨ Responsible for the review and negotiation of client contracts and terms and conditions;
- ⇨ Responsible for establishing standard fee schedules for the laboratory;
- ⇨ Responsible for preparation of proposals and quotes for clients and client prospects;
- ⇨ Accountable for response to client inquiries concerning sample status;
- ⇨ Responsible for assistance to clients regarding the resolution of problems concerning Chains-of-Custody;
- ⇨ Ensuring that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory;
- ⇨ Notifying the department managers of incoming projects and sample delivery schedules;
- ⇨ Accountable to clients for communicating sample progress in daily status meeting with agreed-upon due dates;
- ⇨ Responsible for discussing with client any project-related problems, resolving service issues, and coordinating technical details with the laboratory staff;
- ⇨ Responsible for staff familiarization with specific quotes, sample log-in review, and final report completeness; and
- ⇨ Ensure that all non-conformance conditions are reported to the QA Manager, Operations Manager, and/or Laboratory Director via the Corrective Action process.

Technical Managers (at Calscience known as Group Leaders):

The Group Leaders report directly to the Operations Director. They have the authority to accept or reject data based on pre-defined QC criteria. In addition, with the approval of the QA Manager, the Group Leaders may accept data that falls outside of normal QC limits if, in his or her professional judgment, there are technical justifications for the acceptance of such data. The circumstances must be well documented and any need for corrective action identified must be defined and initiated. The authority of the Group Leaders in QC related matters results directly from the QA Manager. The Group Leaders also

- ⇨ Coordinating, writing, and reviewing test methods and SOPs, with regard to quality, integrity, regulatory requirements and efficient production techniques;
- ⇨ Monitoring the validity of the analyses performed and data generated in the laboratory. This activity begins with reviewing and supporting all new business contracts, insuring data quality, analyzing internal and external non-conformances to identify root cause issues and implementing the resulting corrective and preventive actions, facilitating the data review process and providing technical and troubleshooting expertise on routine and unusual or complex problems;
- ⇨ Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis; and
- ⇨ Coordinates audit responses with supervisors and QA Manager.
- ⇨ Actively support the implementation of Calscience's QA Program;
- ⇨ Ensure that their employees are in full compliance with Calscience's QA Program;
- ⇨ Maintain accurate SOPs (by reviewing and implementing updates) and enforce routine compliance with SOPs;
- ⇨ Conduct technical training of new staff and when modifications are made to existing procedures;
- ⇨ Maintain a work environment which emphasizes the importance of data quality;
- ⇨ Ensure all logbooks are current, reviewed and properly labeled or archived;
- ⇨ Ensure that all non-conformance conditions are reported to the QA Manager, Operations Manager, and/or Laboratory Director via Corrective Action reports;
- ⇨ Provide guidance to analysts in resolving problems encountered daily during sample prep/analysis in conjunction with the Technical Director, Operations Manager, and/or QA Manager. Each is responsible for 100% of the data review and documentation, nonconformance issues, and the timely and accurate completion of performance evaluation samples and MDLs, for his/her department;.
- ⇨ Encourage the development of analysts to become cross-trained in various methods and/or operate multiple instruments efficiently while performing maintenance and using appropriate documentation techniques;.
- ⇨ Ensure that preventive maintenance is performed on instrumentation as detailed in the QA Manual or SOPs. He or she is responsible for developing and implementing a system for preventive maintenance, troubleshooting, and repairing or arranging for repair of instruments;
- ⇨ Provide written responses to external and internal audit issues; and
- ⇨ Provide support to all levels of Calscience Management.

Technical Managers (Sample Control Group Leader):

The Sample Control Group Leader reports to the Operations Manager. The responsibilities are outlined below:

- ⇨ Direct the receipt, handling, labeling and proper storage of samples in compliance with laboratory procedures and policies;
- ⇨ Oversee the training of Sample Control Technicians regarding the above items;

- ⇨ Direct the logging of incoming samples into the LIMS and ensure the verification of data entry from login;
- ⇨ Oversee all sample courier operations;
- ⇨ Acts as a liaison between Project Managers and Analytical departments in respect to handling rush orders and resolving inconsistencies and problems with chain-of-custody forms, and routing of subcontracted analyses; and
- ⇨ Oversees the handling of samples in accordance with the Waste Disposal SOP, the Hazardous Waste Contingency Plan in the Chemical Hygiene/Safety Manual, and the U. S. Department of Agriculture requirements.

Laboratory Analysts

Laboratory analysts are responsible for conducting analysis and performing all tasks assigned to them by the group leader or supervisor. The responsibilities of the analysts are listed below:

- ⇨ Perform analyses by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, the Data Integrity Policy, and project-specific QA plans honestly, accurately, timely, safely, and in the most cost-effective manner.
- ⇨ Document standard and sample preparation, instrument calibration and maintenance, data calculations, sample matrix effects, and any observed non-conformance on work sheets, bench sheets, preparation logbook, and/or a Non-Conformance report;
- ⇨ Report all non-conformance situations, instrument problems, matrix problems and QC failures, which might affect the reliability of the data, to the Group Leader and/or the QA Manager;
- ⇨ Perform 100% review of the data generated prior to entering and submitting for secondary level review; and
- ⇨ Work cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.

Laboratory Technicians:

- ⇨ Prepare samples for analysis by weighing, extracting or digesting, filtering, or concentrating samples; and
- ⇨ Prepare method specific QC Samples with each preparation batch. All personnel must adhere to all QC procedures specified in the analytical method and in accordance to procedures or policies and are responsible for the full documentation of these procedures.

Project Managers:

The Project Manager normally reports to the Senior Project Manager and/or Business Development Director. Typical responsibilities include:

- ⇨ Serving as the laboratories' primary point of contact for assigned clients;
- ⇨ Working with laboratory chemists to resolve questions on data;
- ⇨ Scheduling of courier deliveries and pick-ups;
- ⇨ Tracking the progress of all laboratory production efforts;
- ⇨ Advising clients of any scheduling conflicts, possible delays, or other problems which may arise;
- ⇨ Resolving any questions or issues that clients may have with regard to our services, especially our reports;
- ⇨ Preparation of bottle kits for use by clients in their sampling efforts (as necessary);
- ⇨ Reviewing of reports/EDDs (Electronic Data Deliverables) as necessary prior to release;
- ⇨ Invoice preparation and review prior to release to client;

- ⇨ Serving as back-up contact person for other Project Managers in the event of his/her absence;
- ⇨ Coordination of all subcontracting efforts for projects assigned;
- ⇨ Preparation and implementation of program QAPPs (Quality Assurance Project Plans), if needed;
- ⇨ Preparation of project Case Narratives, as needed; and
- ⇨ Assembly of full data packages in accordance with company or client protocol, as needed.

Project Management Assistant:

The Project Management Assistant normally receives direction from the Project Manager(s) for which he/she is assigned. Typical responsibilities include:

- ⇨ Working with laboratory chemists to resolve questions on data;
- ⇨ Scheduling of courier deliveries and pick-ups;
- ⇨ Tracking the progress of all laboratory production efforts;
- ⇨ Advising clients of any scheduling conflicts, possible delays, or other problems which may arise;
- ⇨ Resolving any questions or issues that clients may have with regard to our services, especially our reports;
- ⇨ Preparation of bottle kits for use by clients in their sampling efforts;
- ⇨ Reviewing of reports/EDDs (Electronic Data Deliverables) prior to release;
- ⇨ Invoice preparation and review prior to release to client;
- ⇨ Serving as back-up contact person for the project managers in the event of his/her absence;
- ⇨ Coordination of all subcontracting efforts for projects assigned; and
- ⇨ Preparation and implementation of program QAPPs (Quality Assurance Project Plans), if needed.
- ⇨ As part of the administrative staff, this person may also be required to answer phones, do occasional filing, mailing, etc.

Health, Safety, and Respiration Protection Manager:

The Health and Safety Manager reports to the Laboratory Director and ensures that systems are maintained for the safe operation of the laboratory. The EHS Manager is responsible for:

- ⇨ Conducting ongoing, necessary safety training and conducting new employee safety orientations;
- ⇨ Assisting in developing and maintaining the Chemical Hygiene/Safety Manual;
- ⇨ Oversees the inspection and maintenance of general safety equipment – fire extinguishers, safety showers, eyewash fountains, etc. and ensure prompt repairs as needed; and
- ⇨ Completes accident reports, follows up on root causes and defines corrective actions.

Hazardous Waste Coordinator:

The Hazardous Waste Coordinator reports directly to the Environmental Health & Safety Manager. The duties of the HWC consist of:

- ⇨ Staying current with the hazardous waste regulations and continuing training on hazardous waste issues;
- ⇨ Contacting the hazardous waste subcontractors for review of procedures and opportunities for minimization of waste;
- ⇨ Supervise the recording of the transfer of samples from refrigerated conditions to ambient conditions [in the sample disposal log sheets (SDLS)];
- ⇨ Check the records in SDLS against the logbook (LIMS) records;
- ⇨ Coordinate the collection of waste throughout the laboratory that will be disposed of through “Lab Packs”;
- ⇨ Coordinate and supervise Hazardous Waste Technician(s);

- ⇨ Dispose of solid waste to an assigned Tote;
- ⇨ Supervise the recording and disposal of acid and soil with methylene chloride extracts into appropriate drums;.
- ⇨ Prepare and discharge treated wastewater to the sewer system;
- ⇨ Maintain Uniform Hazardous Waste Manifest files;
- ⇨ Prepare weekly sample disposal schedules;
- ⇨ Coordinate and schedule waste pick-up;
- ⇨ Check all waste containers for appropriate labels; and
- ⇨ Maintain safe housekeeping and practices.

Education and Experience

Calscience makes every effort to hire analytical staff that posses a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions are made based upon experience and an individual's ability to learn as there are many in the industry that are more than competent, experts perhaps, who have not earned a college degree.

Selection of qualified individuals for employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Experience and specialized training may be accepted in lieu of a college degree (basic lab skills such as using a balance, aseptic or quantitation techniques, etc. are also considered).

Included in Section 5.2 (e) of this Quality Assurance Manual are the basic job titles and personnel responsibilities for anyone who manages, performs or verifies work affecting the quality of the laboratory's environmental sample testing. Minimum education and training requirements are summarized in the following table:

When an analyst does not meet these minimum requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Group Leader, and are considered an analyst in training. The person supervising an analyst in training is directly accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

f) Identification of the laboratory's approved signatories; at a minimum, the title page of the quality manual has the signed and dated concurrence (with appropriate titles) of all responsible parties including the QA Manager, Operation Director, QA Director, Technical Director, and the Laboratory Director;

g) The laboratory's procedures for achieving traceability of measurements;

Job Type	Education	Experience
Extractions, Digestions, some electrode methods (pH, DO, Redox, etc.), Titrimetric and Gravimetric Analyses,	H.S. Diploma or GED	On the job training
GFAA, CVAA, FLAA, Single component or short list Chromatography (e.g., Fuels, BTEX-GC, IC	A college degree in an applied science or 2 years of college with at least 1 year of college chemistry, or	2 years prior analytical experience is required
ICP, ICPMS, Long List or complex chromatography (e.g., Pest, PCB, Herb, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry, or	5 years of prior analytical experience is required
Spectra Interpretation	A college degree in an applied science or 2 years of college Chemistry, and	2 years relevant experience, or 5 years of prior analytical experience is required
Group Leaders – Advanced Instrumentation	Bachelors Degree in an applied science with 16 semester hours in chemistry. An advanced (MS, PhD.) degree may substitute for one year of experience, and	2 years experience in the analytical technique for environmental analysis of representative analytes for which they will oversee
Group Leaders – Wet Chemistry (Basic Skills)	Associates degree in an applied science or 2 years of college with 16 semester hours in Chemistry, and	2 years relevant experience

h) A list of all test methods under which the laboratory performs its accredited testing may be found in the Index of Standard Operating Procedures, a separate document.

i) Mechanisms for ensuring that the laboratory reviews all new work to ensure that it has the appropriate facilities and resources before commencing such work;

j) Reference to the calibration and/or verification test procedures used;
Calibration procedures and verification of acceptability for each set of required calibrations are defined in Section 13 (Calibration) and Section 12 (Quality Control) of each standard operating procedure.

k) Procedures for handling samples received;

The generation of quality analytical data begins with the collection of the sample and, therefore, the integrity of the sample collection process is of importance to Calscience. Samples must be collected in such a way that foreign material is not introduced into the samples and that analytes of interest do not

escape from the samples or degrade prior to their analysis. To ensure sample integrity and representativeness, the following items must be considered:

- ⇨ Samples must be collected in appropriate containers. In general, glass containers are used for organic analytes and polyethylene for inorganic/metal analytes;
- ⇨ Only new sample containers which are certified and documented clean in accordance with U.S. EPA OSWER Directive No. 9240.0-0.05 specifications shall be provided by Calscience for sample collection;
- ⇨ Certain extremely hazardous samples or samples that have the potential to become extremely hazardous will not be accepted. These include (but are not limited to)

    1. Radioactive samples that significantly exceed background levels
    2. Biohazardous samples (medical wastes, body fluids, etc.)
    3. Explosive samples in pure form (Semtex, Flash or gunpowder, ammunition, flares, etc.)
    4. Neurological or other toxic agents (Sarin, Anthrax, Ricin, etc.)

Calscience's chain-of-custody document is used to forward samples from the client to the laboratory. As the basic elements of most all chain-of-custody (COC) documents are similar, clientele may choose to use their own chain-of-custody document to forward samples to Calscience.

Any discrepancies in the COC must be documented on the Sample Receipt Form and resolved prior to analysis of samples. Further guidance may be found in SOP T100 “Sample Receipt and Log-In Procedures”.

Upon receipt by Calscience, samples proceed through an orderly processing sequence designed to ensure continuous integrity of both the sample and its documentation from sample receipt through its analysis and beyond.

All coolers that are received by the Sample Control Group undergo a preliminary examination in accordance of the Sample Receipt Form. Specifically, each sample is carefully examined for label identification, proper container (type and volume), chemical preservation when applicable, container condition, and chain-of-custody documentation consistency with sample labels. Discrepancies are noted on both the Sample Receipt Form and the Sample Anomaly Form and, if possible, discussed with the client prior to his or her departure. If this is not possible, the discrepancies are communicated to the client for resolution prior to the completion of the log-in process. The temperature of the cooler is measured and, with other observations, is recorded.

During the log-in process each sample is assigned a unique laboratory identification number through a computerized Laboratory Information Management System (LIMS), which stores all essential project information. Calscience maintains multiple security levels of access into LIMS to prevent unauthorized tampering/release of sample and project information.

Once all analyses for a sample have been completed and the sample container is returned to Sample Control, it shall remain in refrigerated storage for a period not less than 14 days following sample receipt unless the client requests return/forwarding of the sample. Following the 14-day refrigerated storage period, the samples are placed into ambient storage for another period not less than 14 days after which the samples are bulked into drums for later disposal.

Extended storage may be requested at prevailing per sample rates.

l) Reference to the major equipment and reference measurement standards used as well as the facilities and services used by the laboratory in conducting tests;

A list of major equipment is kept up-to-date on the List of Major Assets, reference APPENDIX G. This, as well as a list of reference measurement standards and their certificates of calibration, is maintained by the

QA Manager or the respective departments. In general, all calibrations and references should be traceable to NIST

m) Reference to procedures for calibration, verification and maintenance of equipment; Laboratory SOPs (T043 and T066) are available to staff for calibration, verification and maintenance of equipment. In general,

n) Reference to verification practices which may include interlaboratory comparisons, proficiency testing programs, use of reference materials and internal quality control schemes;

Instrument calibration is required to ensure that the analytical system is operating correctly and functioning at the proper sensitivity such that required reporting limits can be met. Each instrument is calibrated with standard solutions appropriate to the type of instrument and the linear range established for the analytical method. The manufacturer's guidelines, the analytical method, and/or the requirements of special contracts determine the frequency of calibration and the concentration of calibration standards, whichever is most applicable. The following are very general guidelines and are not meant to be all-inclusive. Detailed calibration procedures are specified in the SOP for each method performed.

Gas Chromatography/Mass Spectroscopy (GC/MS): Each day prior to analysis of samples, all GC/MS instruments are tuned with 4-bromofluorobenzene (BFB) for VOCs and decafluorotriphenylphosphine (DFTPP) for SVOCs in accordance with the tuning criteria specified in the applicable methods. Samples are not analyzed until the method-specific tuning requirements have been met.

After the tuning criteria are met, the instrument is then calibrated for all target analytes and an initial multipoint calibration curve established. The calibration curve is then validated by the analysis of a second source standard, referred to as the initial calibration verification (ICV). Alternatively, the previous calibration curve may be used if validated by a continuing calibration verification (CCV) standard. All target analytes are represented in the calibration and certain key target analytes referred to as system performance calibration compounds (SPCCs) and calibration check compounds (CCCs) are used for curve acceptance determination. For the initial calibration to be deemed acceptable, the SPCCs and CCCs must meet established acceptance criteria and must be re-evaluated and meet the acceptance criteria, at a minimum, every twelve (12) hours thereafter.

Non-GC/MS Chromatography: The field of chromatography involves a variety of instrumentation and detectors. While calibration standards and control criteria vary depending upon the type of system and analytical methodology required for a specific analysis, the general principles of calibration apply uniformly. Each chromatographic system is calibrated prior to sample analysis. An initial multipoint calibration curve is generated using all target analytes. All target analytes must meet the acceptance criteria for the calibration to be deemed acceptable. The calibration curve is then validated by the analysis of a second source standard, referred to as the initial calibration verification (ICV). The continued validity of the initial multipoint calibration is verified every 12 hours using continuing calibration verification (CCV) standard containing all target analytes. If the CCV fails to meet the acceptance criteria, the system is re-calibrated and all samples analyzed since the last acceptable CCV must be re-analyzed.

Inductively Coupled Plasma Emission Spectroscopy: Initial calibration consists of a calibration blank (CB) plus one calibration standard. The calibration is verified by the re-analysis of the standard and initial calibration verification (ICV) standard. If the standard and the ICV fail to meet the acceptance criteria, the initial calibration is considered invalid and is re-performed.

Continuing calibration verification (CCV) consists of a mid-concentration standard plus a calibration blank (CB) analyzed every 10 samples and at the end of the sequence. If the CCV and/or CB fail to meet the acceptance criteria, the instrument must be re-calibrated and all samples analyzed since the previous acceptable CCV and/or CB must be re-analyzed.

ICP/MS Spectroscopy: Each day prior to the analysis of samples, all ICP/MS instruments undergo mass calibration and resolution checks prior to initial calibration. Initial calibration consists of a calibration blank (CB) and at least one calibration standard. The calibration is verified by the re-analysis of the standard and initial calibration verification (ICV) standards. If the standard and the ICV fail to meet the acceptance criteria, the initial calibration is considered invalid and is re-performed.

Continuing calibration verification (CCV) consists of a mid-concentration standard plus a calibration blank (CB) analyzed every 10 samples and at the end of the sequence. If the CCV and/or CB fail to meet the acceptance criteria, the instrument must be re-calibrated and all samples analyzed since the previous acceptable CCV and/or CB must be re-analyzed.

Cold Vapor Atomic Absorption Spectroscopy: Initial calibration consists of a calibration blank plus a series of at least 5 standards. The calibration curve is then validated by the analysis of a second source standard, referred to as the initial calibration verification (ICV). Continuing calibration verification (CCV) consists of midpoint calibration standard plus a continuing calibration blank (CCB) analyzed every 10 samples and at the end of the sequence. If the CCV and/or CCB fail to meet the acceptance criteria, the instrument must be re-calibrated and all samples analyzed since the previous acceptable CCV and/or CCB must be re-analyzed. If the calibration blanks contain target analyte concentrations exceeding the acceptance limits, the cause must be determined and corrected.

Flame and Graphite Furnace Atomic Absorption Spectroscopy: Initial calibration consists of a calibration blank plus a low, medium, and high calibration standard. Continuing calibration verification (CCV) consists of midpoint calibration standard plus a continuing calibration blank (CCB) analyzed every 10 samples and at the end of the sequence. If the CCV and/or CCB fail to meet the acceptance criteria, the instrument must be re-calibrated and all samples analyzed since the previous acceptable CCV and/or CCB must be re-analyzed. If the calibration blanks contain target analyte concentrations exceeding the acceptance limits, the cause must be determined and corrected.

General Inorganic Analyses: General inorganic (non-metal) analyses involve a variety of instrumental and wet chemistry techniques. While calibration procedures vary depending on the type of instrumentation and methodology, the general principles of calibration apply universally. Each system or method is initially calibrated using standards prior to analyses being conducted with continual verification that the calibration remains acceptable throughout analytical processing. If continual calibration verification fails to meet the acceptance criteria, the instrument must be re-calibrated and all samples analyzed since the previous acceptable CCV must be re-analyzed.

o) Procedures to be followed for feedback and corrective action whenever testing discrepancies are detected, or departures from documented policies and procedures occur;

These procedures may be found in SOP-T015 (Correction/Prevention of Errors in Test Records) and SOP-T022 (Corrective/Preventive Actions).

p) The laboratory management arrangements for permitting exceptions and departures from documented policies and procedures or from standard specifications;

Calscience's SOPs are in substantial conformity with their corresponding published method references. Departure from approved SOPs shall be approved if necessary or appropriate due to the nature or composition of the sample or otherwise based on the reasonable judgment of Calscience's Laboratory Director, Technical Director, or QA Manager.
Departures shall be made on a case-by-case basis consistent with recognized standards of the industry. In no case shall departures be approved without written communication between Calscience and the affected client.

q) Procedures for dealing with complaints;

Procedures for dealing with complaints may be found in SOP-T018, Handling of Inquiries and Complaints.

r) Procedures for protecting confidentiality (including national security concerns) and proprietary rights;

Calscience is sensitive to the fact that much of the analytical work performed for clientele may be subject to litigatory processes. Calscience, therefore, holds all information in strict confidence with laboratory release only to the client or designee. Information released to entities other than the client is performed only upon written, facsimile or e-mail request from the client.

Due to the investigative nature of most site assessments, analytical information may become available to regulatory agencies or other evaluating entities during site assessment of the laboratory for the specific purpose of attaining laboratory certifications, accreditations, or evaluation of laboratory qualification for future work. During these occurrences, the laboratory will make its best effort to maintain the confidence of client specific information.

s) Procedures for audits;

Calscience participates in a wide variety of system and performance audits conducted by numerous federal and state agencies, as well as through its major clientele. These audits are conducted to verify that analytical data produced conforms to industry standards on a routine basis.

A System Audit is a qualitative evaluation of the measurement systems utilized at Calscience, specifically, that Calscience has, in place, the necessary facilities, staff, procedures, equipment, and instrumentation to generate acceptable data. This type of audit typically involves an on-site inspection of the laboratory facility, operations, and interview of personnel by the auditing agency.

A Performance Audit verifies the ability of Calscience to correctly identify and quantitate compounds in blind check samples. This type of audit normally is conducted by the auditing agency through laboratory participation in round robin Performance Evaluation (PE) programs. Examples of current PE program involvement include those offered by commercial suppliers like ERA (WS/WP/SOIL and DMR-QA), or other inter-laboratory studies not required for certification but done to ensure laboratory performance, as well as programs administered by major industry.

Outliers in required PE samples will be investigated and corrective actions documented using the Corrective/Preventive Action Record.

Should the result of any audit detect a significant error, which has been identified to adversely affect released data, the situation shall be thoroughly investigated. Corrective measures shall be enacted to include system re-evaluation, the determined affect on released data and client notification, as necessary. These measures shall be documented using the Corrective/Preventive Action Record.

t) Processes/procedures for establishing that personnel are adequately experienced in the duties they are expected to carry out and are receiving any needed training;

Quality control begins prior to sample(s) receipt at the laboratory. The selection of well qualified personnel, based upon education and/or experience is the first step in successful laboratory management. A thorough screening of job applicants and selection of the best candidate to fulfill a well-defined need is as important an aspect of a successful QA/QC program as a careful review of analytical data.
Employee training and approval procedures used at Calscience are specified in SOP-T010, “Employee Training”, and includes but is not limited to the following:

- ⇨ A thorough understanding of the applicable regulatory method and Calscience SOP;
- ⇨ A review of Calscience's QA Program Manual and thorough understanding of the specifics contained therein that are directly related to the analysis to be performed;

- ⇨ Instruction by the applicable Group Leader on all aspects of the analytical procedure;
- ⇨ Performance of analyses under supervision of experienced laboratory personnel, which shall include analysis of blind QC check samples, when deemed appropriate;
- ⇨ Participation in in-house seminars on analytical methodologies and procedures;
- ⇨ Participation in job related seminars outside of the laboratory; and
- ⇨ Participation in conventions and meetings, i.e., ACS, etc.

u) Ethics policy statement developed by the laboratory and processes/procedures for educating and training personnel in their ethical and legal responsibilities including the potential punishments and penalties for improper, unethical, or illegal actions;

A vital part of Calscience Environmental Laboratories' analytical laboratory services is their Laboratory Ethics Training Program. An effective program starts with an Ethics Policy Statement that is supported by all staff, and is reinforced with initial and ongoing ethics training.

"It shall be the policy of Calscience to conduct all business with integrity and in an ethical manner. It is a basic and expected responsibility of each staff member and manager to hold to the highest ethical standard of professional conduct in the performance of all duties."

A proactive ethics training program is the most effective means of deterring and detecting improper, unethical, or illegal actions in the laboratory. There are six facets to the program: (1) clearly define improper, unethical, and illegal actions; (2) outline elements of prevention and detection programs for improper, unethical, or illegal actions; and (3) identify examples of inappropriate (i.e., potentially fraudulent) laboratory practices; (4) Annual Ethics and Data Integrity Training to be documented and maintained in the personnel file of each employee., (5) Documented training on new revisions of the Quality Systems Manual (QSM) and for new employees as needed. (6) Signed Ethics and Data Integrity Agreement (to be completed for new employees and annually thereafter)

<u>Definition of Improper, Unethical, and Illegal Actions</u>

Improper actions are defined as deviations from contract-specified or method-specified analytical practices and may be intentional or unintentional.

Unethical or illegal actions are defined as the deliberate falsification of analytical or quality assurance results, where failed method or contractual requirements are made to appear acceptable.

Prevention of laboratory improper, unethical, or illegal actions begins with a zero-tolerance philosophy established by management. Improper, unethical, or illegal actions are detected through the implementation of oversight protocols.

<u>Prevention and Detection Program for Improper, Unethical, or Illegal Actions</u>

Calscience management has implemented a variety of proactive measures to promote prevention and detection of improper, unethical, or illegal activities. The following components constitute the basic program:

- ⇨ Data Integrity Standard Operating Procedure (SOP) T065
- ⇨ Data Integrity Documentation Procedures
- ⇨ An Ethics and Data Integrity Agreement that is read and signed by all personnel;
- ⇨ Initial and annual ethics training;
- ⇨ Internal audits;
- ⇨ Inclusion of anti-fraud language in subcontracts;
- ⇨ Analyst notation and sign-off on manual integration changes to data;
- ⇨ Active use of electronic audit functions when they are available in the instrument software; and

- ⇨ A "no-fault" policy that encourages laboratory personnel to come forward and report fraudulent activities.

A proactive, "beyond the basics" approach to the prevention of improper, unethical, or illegal actions are a necessary part of laboratory management. As such, in addition to the requirements above, Calscience has a designated ombudsman (data integrity officer) to whom laboratory personnel can report improper, unethical, or illegal practices, or provide routine communication of training, lectures, and changes in policy intended to reduce improper, unethical, or illegal actions.

Examples of Improper, Unethical, or Illegal Practices

Documentation that clearly shows how all analytical values were obtained are maintained by Calscience and supplied to the data user as needed. To avoid miscommunication, Calscience clearly documents all errors, mistakes, and basis for manual integrations within the project file and case narrative as applicable. Notification is also made to the appropriate supervisor so that appropriate corrective actions can be initiated. Gross deviations from specified procedures are investigated for potential improper, unethical, or illegal actions, and findings of fraud are fully investigated by senior management. Examples of improper, unethical, or illegal practices are identified below:

- ⇨ Improper use of manual integrations to meet calibration or method QC criteria (for example, peak shaving or peak enhancement are considered improper, unethical, or illegal actions if performed solely to meet QC requirements);
- ⇨ Intentional misrepresentation of the date or time of analysis (for example, intentionally resetting a computer system's or instrument's date and/or time to make it appear that a time/date requirement was met);
- ⇨ Falsification of results to meet method requirements;
- ⇨ Reporting of results without analyses to support (i.e., dry-labbing);
- ⇨ Selective exclusion of data to meet QC criteria (for example, initial calibration points dropped without technical or statistical justification);
- ⇨ Misrepresentation of laboratory performance by presenting calibration data or QC limits within data reports that are not linked to the data set reported, or QC control limits presented within QAPP that are not indicative of historical laboratory performance or used for batch control;
- ⇨ Notation of matrix inference as basis for exceeding acceptance limits (typically without implementing corrective actions) in interference-free matrices (for example, method blanks or laboratory control samples);
- ⇨ Unwarranted manipulation of computer software (for example, improper background subtraction to meet ion abundance criteria for GC/MS tuning, chromatographic baseline manipulations);
- ⇨ Improper alteration of analytical conditions (for example, modifying EM voltage, changing GC temperature program to shorter analytical run time) from standard analysis to sample analysis;
- ⇨ Misrepresentation of QC samples (for example, adding surrogates after sample extraction, omitting sample preparation steps for QC samples, over- or under-spiking); and
- ⇨ Reporting of results from the analysis of one sample for those of another.

v) Reference to procedures for reporting analytical results;

Standard operating procedures pertaining to the reporting of results are available to all laboratory personnel. They are: SOP-T009, Significant Figures, Rounding, and Reporting of Results; SOP-T025, Reporting of Tentatively Identified Compounds (TICs); and T-026, Reporting of Data Qualifiers.

All analytical data generated within Calscience is thoroughly checked for accuracy and completeness. The data validation process consists of data generation, reduction, and four levels of review as described below.

The analyst generating the analytical data has the primary responsibility for its correctness and completeness. All data is generated and reduced following protocols specified in the appropriate SOPs. Each analyst reviews the quality of his or her work based upon an established set of guidelines specified in the SOPs or as specified by project requirements. The analyst reviews the data package to ensure that:

- ⇨ Holding times have not been exceeded;
- ⇨ Sample preparation information is correct and complete;
- ⇨ Analysis information is correct and complete;
- ⇨ The appropriate procedures were employed;
- ⇨ Analytical results are correct and complete;
- ⇨ All associated QC is within established control limits and, if not, out-of-control forms are completed thoroughly explaining the cause and corrective action taken;
- ⇨ Any special sample preparation and analytical requirements have been met; and
- ⇨ Documentation is complete, i.e., all anomalies in the preparation and analysis have been documented; out-of-control forms, if required, are complete, etc.

The data reduction and validation steps are documented, signed, and dated by the analyst on the QC Review coversheet accompanying each data package. This initial review step, performed by the analyst, is designated as primary review. The analyst then forwards the data package to his or her Group Leader, or designated data reviewer, who performs a secondary review. Secondary reviews consist of an independent check equivalent to that of the primary review and are designed to ensure that:

- ⇨ Calibration data is scientifically sound, appropriate to the method, and completely documented;
- ⇨ QC data is within established guidelines or reported with appropriate clarification/qualification;
- ⇨ Qualitative identification of sample components is correct;
- ⇨ Quantitative results are correct;
- ⇨ Documentation is complete and any anomalies properly addressed and documented;
- ⇨ The data is ready for incorporation into the final report package; and
- ⇨ The data package is complete and ready for archiving.

A significant component of the secondary review is the documentation of any errors that have been identified and corrected during the review process. Calscience believes that the data package that is submitted for a secondary review should be free from errors. Errors that are discovered are documented and formally transmitted to the appropriate Group Leader. The cause of the errors are then addressed by additional training or clarification of procedures (SOP revisions) to ensure that similar errors do not recur and high quality data will be generated.

Signature of Data Reviewer and the date of review document the completion of secondary reviews on the QC Review coversheet. These constitute approval for data release and generation of analytical report.

During both of the QC review processes, 100% of the raw data associated with the entire project is available to the reviewer. Data packages are checked back to the raw data as deemed necessary by the reviewer.

Following draft report generation, the report is reviewed by the Project Manager to ensure that the data set and quality control data is complete and meets the specific requirements of the project. When available, the data is also evaluated against historical site information. Once all requested analytical work has been verified as complete, a final report is generated and signed by the Project Manager.

Following approval for release by the Project Manager, the Quality Assurance Manager or other qualified personnel may review 10% of the project files back to the raw data as an additional check, if a situation so warrants.

A variety of reporting formats, from Portable Document File (PDF), normal typed reports to computerized data tables to complex reports discussing regulatory issues are available. In general, Calscience reports contain the following information.

Analytical Data

Analytical data is reported by sample identification (both client and laboratory) and test. Pertinent information including date(s) sampled, received, prepared, and analyzed; any required data qualifiers are included on each results page. The reporting limit for each method analyte is also listed. Additional data may include Method Detection Limits (MDLs).

QC Data

A QC Summary is provided with each final report. Unless otherwise specified in a QAPP or requested by the client, QC Summaries include results for method blanks, matrix spikes, matrix spike duplicates, and surrogate spikes. Laboratory control sample and method blank surrogates are routinely included if matrix interference results in a QC outlier. The effective control limits for the reported QC values are also provided on the QC Summary as well as explanations for any QC outliers. Case Narratives may be included as appropriate.

As required for the project, data reports from “results only” through “full CLP-like” will be generated and provided. Included in this range are reports for the major DoD programs including NFESC, AFCEE, and USACE.

Methodology

References for the preparative and analytical methodology employed is included on all preliminary or final analytical reports.

Signatory

Final reports are ready for release to the client following review and approval by the Project Manager, as evidenced by his/her signature on the final report cover page. An approved signatories listing shall be maintained by the QA office.

Preliminary Data

Upon client request, preliminary data shall be released prior to completion of a full QC review. Preliminary data is subject to change pending QC review and, therefore, shall be clearly marked as “Preliminary”. This qualification is provided as notification to the client that the data review process has not been completed yet and that the data is subject to possible modification resulting therefrom.

Revised Data

Analytical reports that have been revised for any reason from the original sent report shall be noted as being revised with a report note, case narrative or indication as to the revision.

Formatting

At a minimum, an analytical report shall consist of the Report Cover Page, Analytical Results, QA/QC Data (Default), Footnotes/Comments Page, Sample Receipt Form and COC. Paginated reports shall be employed for all reports unless used for non-NELAP analysis.

w) A Table of Contents and applicable lists of references and glossaries, and appendices.

5.3 Audits

5.3.1 Internal Audits

The laboratory arranges streamlined quarterly and comprehensive annual internal audits to verify that its operations continue to comply with the requirements of the laboratory's said quality system. The Quality Assurance Manager or the Quality Assurance Assistant plans and organizes audits as required by a predetermined schedule and requested by management.

The Quality Assurance Assistant or other qualified personnel, independent of the activity to be audited, will carry out such audits following the procedures noted in SOP T028, Internal Audit Procedures.

Personnel do not audit their own activities except when it can be demonstrated that an effective audit will be carried out.

Where the audit findings cast doubt on the correctness or validity of the laboratory's calibrations or test results, the laboratory takes immediate corrective action and immediately notifies, in writing, any client whose work was involved.

i. List of available qualified personnel for internal audits include:

- QA Director
- QA Manager
- QA Assistant
- Department Manager
- Assistant Department Manager
- Group Leader (For departments other than their own)
- Program Manager
- Health and Safety Manager (For non-analytical departments)
- Any Senior Chemist (With documented training in proper internal auditing procedures from a qualified source).

ii. The minimum qualifications for an internal auditor shall be:

- Education: A Bachelors (BS) Degree in an applied science with 16 semester hours in chemistry.
- Experience: Two years' experience in an instrumental analytical technique for environmental analysis of representative environmental samples. Training to the most current revision of Calscience SOP T028 (Internal Audits). The training to be overseen by an individual that is ISO 17025 / 9001 trained in internal auditing procedures, or equivalent.
- An advanced (MS, PhD.) degree may be substituted for one year of experience.

Any outside audit findings will also be included in the Internal Audits.

5.3.2 Management Review

Calscience management conducts an annual review of its quality system and its testing and calibration activities to ensure its continuing suitability and effectiveness and to introduce any necessary changes or improvements in the quality system and laboratory operations.

This review takes account of reports from managerial and supervisory personnel, the outcome of recent internal audits, assessments by external bodies, the results of inter-laboratory comparisons or proficiency tests, any changes in the volume and type of work undertaken, feedback from clients, senior lab personnel, corrective actions, and other relevant factors.

The laboratory shall have a procedure for review by management, and maintain records of review findings and actions. Reference section 18.1 of this QSM and SOP T030 for more detailed descriptions.

5.3.3 Audit Review

All audit and review findings and any corrective actions that arise from them are documented. The laboratory management ensures that these actions are discharged within the agreed time frame as indicated in the quality manual and/or SOPs.

5.3.4 Performance Audits

In addition to periodic audits, the laboratory ensures the quality of results provided to clients by implementing checks to monitor the quality of the laboratory's analytical activities. Examples of such checks are:

a) Internal quality control procedures using statistical techniques (see Section 5.4 below);

b) Participation in proficiency testing or other interlaboratory comparisons;

c) Use of certified reference materials and/or in-house quality control using secondary reference materials as specified in Calscience QSM Section 5.4;

d) Replicate testing using the same or different test methods;

e) Re-testing of retained samples;

f) Correlation of results for different but related analysis of a sample (for example, total phosphorus should be greater than or equal to orthophosphate).

5.3.5 Corrective / Preventive Actions

a) In addition to providing acceptance criteria and specific protocols for corrective/preventive actions in SOP-T022, the laboratory implements general procedures to be followed to determine when departures from documented policies, procedures and quality control have occurred. These procedures include but are not limited to the following:

    1) Identify the individual(s) responsible for assessing each QC data type;

    2) Identify the individual(s) responsible for initiating and/or recommending corrective/preventive actions;

    3) Define how the analyst shall treat a data set if the associated QC measurements are unacceptable;

    4) Specify how out-of-control situations and subsequent corrective actions are to be documented; and

5) Specify procedures for management (including the QA officer) to review corrective/preventive action reports.

b) To the extent possible, sample results are reported only if all quality control measures are acceptable. If a quality control measure is found to be out of control, and the data are to be reported, all samples associated with the failed quality control measure are reported with the appropriate data qualifier(s).

5.4 Essential Quality Control Procedures

These general quality control principles apply, where applicable, to all testing at Calscience. The manner in which each is implemented is dependent on the types of tests performed by the laboratory and is further described in Appendix D and in SOP-T020, Internal Quality Control Checks. The standards for any given test type assures that the applicable principles are addressed:

a) All laboratories have detailed written protocols in place to monitor the following quality controls:

1) Positive and negative controls (blanks, spikes, reference toxicants, etc.) to monitor tests;

2) Tests to define the variability and/or repeatability of the laboratory results such as replicates;

3) Measures to assure the accuracy of the test method including calibration and/or continuing calibrations, use of certified reference materials, proficiency test samples, or other measures;

4) Measures to evaluate test method capability, such as detection limits and quantitation limits or range of applicability such as linearity;

5) Selection of appropriate formulae to reduce raw data to final results such as regression analysis, comparison to internal/external standard calculations, and statistical analyses;

6) Selection and use of reagents and standards of appropriate quality;

7) Measures to assure the selectivity of the test for its intended purpose; and

8) Measures to assure constant and consistent test conditions (both instrumental and environmental) where required by the test method, such as temperature, humidity, light or specific instrument conditions.

b) All quality control measures are assessed and evaluated on an on-going basis, and quality control acceptance criteria are used to determine the usability of the data. (See Appendix D.)

c) The laboratory has procedures for the development of acceptance/rejection criteria where no method or regulatory criteria exist. (See Calscience QSM Section 11.2, Sample Acceptance Policy.)

d) The quality control protocols specified in the method manual (Calscience QSM Section 10.1.2) is followed. Calscience ensures that the essential standards outlined in NELAC 5, Appendix D, or mandated methods or regulations (whichever are more stringent) are incorporated into the method manuals. When it is not apparent which is more stringent the QC in the mandated method or regulations is to be followed.

The essential quality control measures for testing are found in Appendix D.

6.0 PERSONNEL

6.1 General Requirements for Laboratory Staff

Calscience's testing departments have a sufficient level of personnel with the necessary education, training, technical knowledge and experience to perform the assigned functions.

All personnel are responsible for complying with all quality assurance/quality control requirements that pertain to their organizational/technical function. Each technical staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular function and a general knowledge of laboratory operations, test methods, quality assurance/quality control procedures and records management.

6.2 Laboratory Management Responsibilities

In addition to Calscience QSM Section 4.2.d, the laboratory management:

a) Defines the minimum level of qualification, experience and skills necessary for all positions in the laboratory. In addition to education and/or experience, basic laboratory skills such as using a balance and quantitative techniques, are considered.

b) Ensures that all technical laboratory staff members demonstrate capability in the activities for which they are responsible. Such demonstration is documented (See Appendix C). Note: In departments with specialized "work cells" (a well-defined group of analysts that together perform the method analysis), the group as a unit meets the above criteria and this demonstration is fully documented.

c) Ensures that the training of each member of the technical staff is kept up-to-date (on-going) by the following:

    1) Keeping evidence on file that demonstrates that each employee has read, understood, and is using the latest version of the laboratory's in-house quality documentation that relates to his/her job responsibilities.

    2) Documenting training courses or workshops on specific equipment, analytical techniques, or laboratory procedures.

    3) Documenting employee attendance at training courses on ethical and legal responsibilities including the potential punishments and penalties for improper, unethical or illegal actions. Keeping on file evidence that demonstrates that each employee has read, acknowledges, and understands their personal ethical and legal responsibilities including the potential punishments and penalties for improper, unethical or illegal actions.

    4) Maintains up-to-date analyst training records that contain a certification that technical personnel have read, understood and agreed to perform the most recent version of the test method (the approved method or SOP as defined by the laboratory document control system, Calscience QSM Section 5.2.d) and documentation of continued proficiency by at least one of the following once per year:

        i. Acceptable performance of a blind sample (single blind to the analyst);

        ii. Another demonstration of capability;

iii. Successful analysis of a blind performance sample on a similar test method using the same technology (e.g., GC/MS volatiles by purge and trap for Methods 524.2, 624, or 5035/8260) would only require documentation for one of the test methods;

iv. At least four consecutive laboratory control samples with acceptable levels of precision and accuracy;

v. If i-iv cannot be performed, analysis of authentic samples with results statistically indistinguishable from those obtained by another trained analyst.

d) Documents all analytical and operational activities of the laboratory;

e) Supervises all personnel employed by the laboratory;

f) Ensures that all sample acceptance criteria (Calscience QSM Section 11.0) are verified and that samples are logged into the sample tracking system and properly labeled and stored.

g) Documents the quality of all data reported by the laboratory.

h) Develops a proactive program for the prevention and detection of improper, unethical, or illegal actions. Components of this program could include: internal proficiency testing (single and double blind); post-analysis electronic and magnetic tape audits; effective reward program to improve employee vigilance and co-monitoring; and separate SOPs identifying appropriate and inappropriate laboratory and instrument manipulation practices.

6.2.1 Ownership Transfer / Out of Business

a) In the event that the laboratory transfers ownership or goes out of business, Calscience will ensure that the records are maintained or transferred according to client instruction.

b) Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives will be clearly established. In cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records will be followed.

c) In the event that the laboratory goes out of business, all records will revert to the control of the client or regulatory agency, as applicable. As much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

6.3 Records

Records on the relevant qualifications, training, skills and experience of the technical personnel are maintained by the laboratory (see Calscience QSM Section 6.2.c), including records on demonstrated proficiency for each laboratory test method, such as the criteria outlined in Calscience QSM Section 10.5 for chemical testing.

7.0 PHYSICAL FACILITIES – ACCOMMODATION AND ENVIRONMENT

7.1 Environment

a) Laboratory accommodations, test areas, energy sources, lighting, heating and ventilation are such that they facilitate proper performance of tests.

b) The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of the measurements. Particular care shall be taken when such activities are undertaken at sites other than the permanent laboratory premises.

c) The laboratory shall provide for the effective monitoring, control and recording of environmental conditions as appropriate. Such environmental conditions may include biological sterility, dust, electromagnetic interference, humidity, main voltage, temperature, and sound and vibration levels.

d) In instances where monitoring or control of any of the above-mentioned items is specified in a test method or by regulation, the laboratory meets and documents adherence to the laboratory facility requirements.

7.2 Work Areas

a) There is effective separation between neighboring areas when the activities therein are incompatible including volatile organic chemicals handling areas.

b) Access to and use of all areas affecting the quality of these activities are defined and controlled.

c) Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality.

d) Workspaces are available to ensure an unencumbered work area. Work areas include:

   1) Access and entryways to the laboratory;

   2) Sample receipt areas;

   3) Sample storage areas;

   4) Chemical and waste storage areas; and

   5) Data handling and storage areas.

8.0 EQUIPMENT AND REFERENCE MATERIALS

a) Calscience is furnished with all items of equipment (including reference materials) required for the correct performance of tests for which accreditation is maintained. Note that Calscience does not use equipment outside its permanent control.

b) All equipment is properly maintained, inspected, and cleaned. Maintenance procedures are documented.

c) Any equipment item that has been subjected to overloading or mishandling, or that gives suspect results, or has been shown by verification or otherwise to be defective, is taken out of service, clearly identified and wherever possible stored at a specified place until it has been repaired and shown by calibration, verification or test to perform satisfactorily. The laboratory shall examine the effect of this defect on previous calibrations or tests.

d) When appropriate, each item of equipment, including reference materials, is labeled, marked, or otherwise identified to indicate its calibration status.

e) Records are maintained of each major item of equipment and all reference materials significant to the tests performed. These records include documentation on all routine and non-routine maintenance activities in assigned log books and reference material verifications.

The records include:

1) The name of the item of equipment;

2) The manufacturer's name, type identification, and serial number or other unique identification;

3) Date received and date placed in service (if available);

4) Current location, where appropriate;

5) If available, condition when received (e.g., new, used, reconditioned);

6) Copy of the manufacturer's instructions, where available;

7) Dates and results of calibrations and/or verifications and date of the next calibration and/or verification;

8) Details of maintenance carried out to date and planned for the future; and

9) History of any damage, malfunction, modification or repair.

9.0 MEASUREMENT TRACEABILITY AND CALIBRATION

9.1 General Requirements

All measuring operations and testing equipment having an effect on the accuracy or validity of tests are calibrated and/or verified before being put into service and on a continuing basis. The laboratory has an established program for the calibration and verification of its measuring and test equipment. This includes balances, thermometers and control standards.

9.2 Traceability of Calibration

a) The overall program of calibration and/or verification and validation of equipment is designed and operated so as to ensure that measurements made by the laboratory are traceable to national standards of measurement.

b) Calibration certificates indicate the traceability to national standards of measurement and provide the measurement results and associated uncertainty of measurement and/or a statement of compliance with an identified metrological specification. The laboratory maintains records of all such certification in the QA office.

c) Where traceability to national standards of measurement is not applicable, the laboratory provides satisfactory evidence of correlation of results, for example, by participation in a suitable program of interlaboratory comparisons, proficiency testing, or independent analysis.

9.3 Reference Standards

a) Reference standards of measurement held by the laboratory (such as Class S or equivalent weights, or traceable thermometers) are used for calibration only and for no other purpose, unless it can be demonstrated that their performance as reference standards has not been invalidated. A body that can provide traceability calibrates reference standards of measurement. Where possible, this traceability is to a national standard of measurement.

b) There is a program of calibration and verification for reference standards.

   i. Two weeks prior to their date of calibration expiration, individual thermometers are removed from service and replaced by newly calibrated units from the supplier.

   ii. Calscience keeps two sets of Class S weights on hand for use in the laboratory. One set is used for daily calibration checks, and the second set is kept for back up use should the first set be damaged, lost or otherwise compromised. The second set of weights is also place in service when the daily use set is shipped off site for recalibration.

   iii. Analytical balances are serviced and calibrated on a routine, annual schedule.

c) Where relevant, reference standards and measuring and testing equipment are subjected to in-service checks between calibrations and verifications. Reference materials are traceable. Where possible, traceability is to national or international standards of measurement, or to national or international standard reference materials.

d) NIST-Traceable Weights and Thermometers

   i. Reference standards of measurement shall be used for the purposes of calibration only. NIST traceable thermometers and NIST-traceable weights shall not be used for routine testing. If NIST traceable reference sources are used for routine testing they shall not be used for calibration purposes unless it can be shown that their performance as reference standards would not be invalidated.

   ii. For NIST-traceable weights and thermometers, Calscience requires that all calibrations be conducted by a calibration laboratory accredited by ACLASS, A2LA or other recognized accrediting body.

      a. The calibration laboratory must hold ISO 17025 or ISO 9001 accreditation for the services rendered. Prior to use, QA verifies that the selected vendor holds the appropriate scope of accreditation for the services required.

      b. The calibration certificate or report supplied by the calibration laboratory must contain a traceability statement, the conditions under which the calibrations were made, a compliance statement with an identified metrological specification and the pertinent clauses when applicable, and a clearly identified record of the quantities and functional test results before and after re-calibration.

      c. The certificate and scope of accreditation is kept on file at the laboratory and is reviewed yearly.

   iii. If significant amendments are made to a calibration certificate, it must have its own unique report identifier and must reference the one it is replacing. The piece of equipment must be identified in the amended report using its unique serial number or other laboratory defined identifier. The amended report is maintained with the original calibration report.

   iv. Laboratory balances are recalibrated annually by an external, certified vendor that is certified to ISO 17025 / ISO 9001 standards for calibration. Prior to use, QA verifies that the selected vendor holds the appropriate scope of accreditation for the services required. This service is documented on each balance with a signed and dated certification sticker.

   v. NIST mercury thermometers are sent out for recalibration every five years, or are replaced. All working mercury thermometers are calibrated annually against a NIST-traceable reference

thermometer. All digital temperature measuring devices (min/max thermometers, IR guns) are calibrated quarterly. Equipment that does not meet acceptance criteria is removed from service and repaired or replaced. Calibration reports are maintained by the QA Manager

vi. Balance calibrations and temperature readings of ovens, refrigerators, and incubators are checked on each day of use. Min/Max thermometers are used for refrigerators and freezers to continually monitor temperature performance.

e) Traceable Reference Standards and Materials

i. Reference standards and materials are traceable to certified reference materials, where available. Commercially prepared standard materials are purchased from vendors accredited by A2LA, NVLAP (National Voluntary Lab Accreditation Program) or other recognized vendor, and come with a Certificate of Analysis that documents the purity of the standard and expiration date, if assigned. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis against a known reference.

ii. Analytical reagents must be at a minimum the purity required by or stated in the test method. Commercial materials that are purchased for the preparation of calibration, verification or spiking solutions, are usually accompanied by an assay certificate or the purity is noted on the label. If the purity is $\geq$96%, the weight provided by the vendor may be used without correction. If the purity is <96%, a correction will be made to solution concentrations prepared from that material.

iii. The receipt of all reference standards and materials, including received date and expiration date, is documented by the laboratory at the time of receipt, in chemical receiving logbooks. All documentation received with the reference standard or material (Certificate of Analysis or Purity Certificates) is retained by the laboratory. To prevent contamination and/or deterioration in quality, all standards and materials are handled and stored according to the method or manufacturer's requirements.

iv. Preparation of standard or reference materials are documented in Standard Preparation Logbooks maintained in each department. These records show the traceability to the purchased standards or materials, and include the method of preparation, date of preparation, expiration date, and preparer's initials, at a minimum. Reference standards are assigned a unique identifier and are then labeled with the identifier and expiration date. Refer to Calscience SOP, T003, Standards and Reagents Login, Preparation, Storage and Disposal, for additional information.

v. All standards, reference, primary and working, whether purchased from a commercial vendor or prepared by the laboratory, must be checked regularly to ensure that the variability of the standard from the 'true' value does not exceed method requirements. Calibration standards are checked by comparison with a standard from a second source, usually another manufacturer and vendor. In cases where a second manufacturer is not available, a different lot, with vendor certification, may be used as a second source.

vi. Quality control (QC) criteria for primary and second source standards are defined in laboratory SOPs. The Reagent and Chemicals SOP, T107, gives a general overview of the requirements with the determinative SOPs for each process further defining the QC acceptance criteria. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS/LCSD (where there is no sample preparation) is used as the second source verification of a primary calibration source.

9.4 Calibration

Calibration requirements are divided into two parts: (1) requirements for analytical support equipment, and (2) requirements for instrument calibration. In addition, the requirements for instrument calibration are divided into initial calibration and second source or initial calibration verification, and continuing calibration verification.

9.4.1 Support Equipment

These standards apply to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, thermometers, and volumetric dispensing devices (such as Eppendorf®, or automatic dilutor/dispensing devices) if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume.

a) All support equipment is maintained in proper working order. The records of all repair and maintenance activities, including service calls is kept.

b) All support equipment is calibrated or verified at least annually, using NIST traceable references when available, over the entire range of use. The results of such calibration are within the specifications required of the application for which this equipment is used or:

   1) The item is removed from service until repaired; or

   2) The laboratory maintains records of established correction factors to correct all measurements.

c) Raw data records are retained to document equipment performance.

d) Prior to use on each working day, balances, ovens, refrigerators, freezers, and water baths are checked in the expected use range, with NIST traceable calibrated references. The acceptability for use or continued use is according to the needs of the analysis or application for which the equipment is being used.

e) Mechanical volumetric dispensing devices including burettes (except Class A glassware) are checked for accuracy on at least a quarterly use basis. Glass microliter syringes are to be considered Class A glassware, and come with a certificate from the manufacturer attesting to established accuracy or the accuracy is initially demonstrated and documented by the laboratory.

9.4.2 Instrument Calibration

This manual specifies the essential elements that define the procedures and documentation for initial instrument calibration and continuing instrument calibration verification to ensure that the data are of known quality and be appropriate for a given regulation or decision. This manual does not specify detailed procedural steps ("how to") for calibration, but establishes the essential elements for selection of the appropriate technique(s). This approach allows flexibility and permits the employment of a wide variety of analytical procedures and statistical approaches currently applicable for calibration. If more stringent standards or requirements are included in a mandated test method or by regulation, the laboratory demonstrates that such requirements are met. If it is not apparent which standard is more stringent, then the requirements of the regulation or mandated test method are to be followed.

Note: In the following sections, initial instrument calibration is directly used for quantitation and continuing instrument calibration verification is used to confirm the continued validity of the initial calibration, unless otherwise stipulated by the analytical method.

9.4.2.1 Initial Instrument Calibrations

The following items are essential elements of initial instrument calibration:

a) The details of the initial instrument calibration procedures including calculations, integrations, acceptance criteria and associated statistics are included or referenced in the test method SOP. When initial instrument calibration procedures are referenced in the test method, the referenced material is retained by the laboratory and is available for review.

b) Sufficient raw data records are retained to permit reconstruction of the initial instrument calibration, e.g., calibration date, test method, instrument, analysis date, each analyte name, analyst's initials or signature; concentration and response, calibration curve or response factor; or unique equation or coefficient used to reduce instrument responses to concentration.

c) Sample results are quantitated from the initial instrument calibration and may not be quantitated from any continuing instrument calibration verification unless specifically stated in a mandated test method.

d) All initial instrument calibrations is verified with a standard obtained from a second manufacturer or lot. Traceability shall be to a national standard, when available.

e) Criteria for the acceptance of an initial instrument calibration is established, e.g., correlation coefficient or relative percent difference. The criteria used is appropriate to the calibration technique employed.

f) Results of samples not bracketed by initial calibration standards (within calibration range) are reported as having less certainty, e.g., defined qualifiers or flags or explained in the case narrative. As determined by the method, the lowest calibration standard is at or above the method detection limit and at or below the reporting limit.

g) If the initial instrument calibration results are outside established acceptance criteria, corrective actions are performed. Data associated with an unacceptable initial instrument calibration is not reported.

h) Calibration standards include concentrations at or below the regulatory limit/decision level, if the laboratory knows these limits/levels, unless these concentrations are below the laboratory's demonstrated detection limits (See Calscience QSM Section Appendix D.1.5 Detection Limits).

i) If a reference or mandated method does not specify the number of calibration standards, the minimum number is two, not including blanks or a zero standard. The laboratory's standard operating procedure defines the number of points for establishing the initial instrument calibration.

9.4.2.2 Continuing Instrument Calibration Verification

When an initial instrument calibration is not performed on the day of analysis, the validity of the initial calibration is verified prior to sample analyses by analyzing a continuing calibration verification standard with each analytical batch. The following items are essential elements of continuing calibration verification:

a) The details of the continuing calibration procedure, calculations and associated statistics must be included or referenced in the test method SOP.

b) A continuing calibration verification standard must be analyzed at the beginning and end of each analytical batch, and where required by method or project, at a specific frequency, every 10 or 20 samples or 12 hours, within the batch. The concentrations of the calibration verification shall be varied within the established calibration range. If an internal standard is used, only one continuing calibration verification standard must be analyzed, prior to sample or QC analysis, per analytical batch.

c) Sufficient raw data records must be retained to permit reconstruction of the continuing calibration verification, e.g., test method, instrument, analysis date, each analyte name, concentration and response, calibration curve or response factor, or unique equations or coefficients used to convert instrument

responses into concentrations. Continuing calibration verification records must explicitly connect the continuing calibration verification data to the initial calibration.

d) Criteria for the acceptance of a continuing calibration verification must be established, e.g., relative percent difference.

e) If the continuing calibration verification results obtained are outside established acceptance criteria, corrective actions must be performed. If routine corrective action procedures fail to produce a second (consecutive and immediate) calibration verification within acceptance criteria, then the laboratory shall demonstrate performance after corrective action with two consecutive successful calibration verifications, or a new instrument calibration must be performed. If the laboratory has not demonstrated acceptable performance, sample analyses shall not occur until a new initial calibration curve is established and verified.

   As an exception, sample data associated with an unacceptable continuing calibration verification may be reported as qualified data under the following special conditions:

   i. When the acceptance criteria for the continuing calibration verification are exceeded high, i.e., high bias and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise the samples affected by the unacceptable calibration verification are reanalyzed after a new calibration curve has been established, evaluated and accepted.

   ii. When the acceptance criteria for the continuing calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise the samples affected by the unacceptable verification are reanalyzed after a new calibration curve has been established, evaluated and accepted.

10.0 TEST METHODS AND STANDARD OPERATING PROCEDURES

10.1 Methods Documentation

a) The laboratory has documented instructions on the use and operation of all relevant equipment, on the handling and preparation of samples and for calibration and/or testing, where the absence of such instructions could jeopardize the calibrations or tests.

b) All instructions, standards, manuals, and reference data relevant to the work of the laboratory are maintained up-to-date and be readily available to the staff.

10.1.1 Standard Operating Procedures (SOPs) Administrative

Calscience maintains standard operating procedures that accurately reflect all phases of current laboratory activities such as instrument operation, assessing data integrity, corrective actions, handling customer complaints, reporting of test results, etc.

a) These documents, for example, may be equipment manuals provided by the manufacturer or internally written documents.

b) The test methods may be copies of published methods as long as any changes or selected options in the methods are documented and included in the SOP (See 10.1.2.)

c) Copies of all SOPs are accessible to all personnel.

d) The SOPs are organized.

e) Each SOP clearly indicates the effective date of the document, the revision number and the signatures of the approving authorities.

10.1.2 Standard Operating Procedures (SOPs) Analytical

a) The laboratory has and maintains SOPs for each accredited analyte or test method.

b) This SOP may consist of copies of published or referenced test methods or standard operating procedures that have been written by the laboratory. In cases where modifications to the published method have been made by the laboratory or where the referenced test method is ambiguous or provides insufficient detail, these changes or clarifications are clearly described. Each test method includes or references where applicable:

1) Identification of the test method;
2) Applicable matrix or matrices;
3) Detection limit;
4) Scope and application, including components to be analyzed;
5) Summary of the test method;
6) Definitions;
7) Interferences;
8) Safety;
9) Equipment and supplies;
10) Reagents and standards;
11) Sample collection, preservation, shipment, and storage;
12) Quality control;
13) Calibration and standardization;
14) Procedure;
15) Calculations;
16) Method performance;
17) Pollution prevention;
18) Data assessment and acceptance criteria for quality control measures;
19) Corrective actions for out-of-control data;
20) Contingencies for handling out-of-control or unacceptable data;
21) Waste management;
22) References; and
23) Any tables, diagrams, flowcharts, and validation data.
24) Modifications
25) Revision History

Laboratory procedures other than preparative or analytical procedure may use a shortened format as outlined in SOP T001.

10.2 Exceptionally Permitting Departures from Documented Policies / Procedures

a) If it is necessary to depart from a documented procedure or policy due to circumstances outside of Calscience's control or due to conditions encountered while preparing or analyzing a sample, the following will be documented.

1) The nature of the exception
2) How the data or procedure may be impacted
3) Any Corrective Action that may be needed.
4) Any approval from a client that may be required.
5) Approval by management to report or proceed with the exception.
6) A Case Narrative with the Final Report explaining the exception.

10.3 Test Methods

The laboratory uses appropriate test methods and procedures for all tests and related activities within its responsibility (including, as applicable, sample collection, sample handling, transport and storage, sample preparation and sample analysis). The method and procedures shall be consistent with the accuracy required, and with any standard specifications relevant to the calibrations or tests concerned.

a) When the use of specific test methods for a sample analysis is mandated or requested, only those methods are used.

b) Where test methods are employed that are not required, as in the Performance Based Measurement System approach, the methods are fully documented and validated (see Calscience QSM Section 10.1.2 and Appendix C), and are available to the client and other recipients of the relevant reports.

10.4 Test Method Assessment

The laboratory will periodically conduct a Test Method Assessment (TMA) on the analytical methods in use. These TMAs will be conducted under the guidance of SOP T029. The purpose is to evaluate the compliance between bench performances of the method versus the current Calscience Standard Operating Procedure versus the promulgated or published method. Discrepancies will need to be addressed and resolved. Note that some methods are totally prescriptive while others may contain prescriptive aspects, and still others are performance based. In many cases, modifications to the published method may be required due to circumstances outside the laboratories' control.

10.5 Demonstration of Capability

a) Prior to acceptance and institution of any test method, satisfactory demonstration of method capability is required. (See Calscience QSM Section Appendix C and 6.2.b.) This demonstration does not test the performance of the method in real world samples, but in the applicable and available clean matrix (sample of a matrix is which no target analytes or interferences are present at concentrations that impact the results of a specific test method), e.g., water, solids and air. In addition, for analytes that do not lend themselves to spiking, the demonstration of capability may be performed using quality control samples.

b) Continuing demonstration of method performance, as per the quality control requirements in Appendix D (such as laboratory control samples) is required.

c) In cases where Calscience analyzes samples using a test method that has been in use by the laboratory before July 1999, and there have been no significant changes in instrument type, personnel or test method, the continuing demonstration of method performance and the analyst's documentation of continued proficiency shall be acceptable. The laboratory shall have records on file to demonstrate that an initial demonstration of capability is not required.

d) In all cases, the appropriate forms, such as the Certification Statement (Appendix C), is completed and retained by the laboratory to be made available upon request. The laboratory retains all associated supporting data necessary to reproduce the analytical results summarized in the Certification Statement. (See Appendix C for an example of a Certification Statement.)

e) Demonstration of capability is completed each time there is a significant change in instrument type, personnel, or test method.

f) In departments with specialized "work cell(s)" (a group consisting of analysts with specifically defined tasks that together perform the test method), the group as a unit must meet the above criteria and this demonstration of capability is fully documented.

g) When a work cell is employed, and the members of the cell change, the new employee(s) must work with an experienced analyst in that area of the work cell where they are employed. This new work cell must demonstrate acceptable performance through acceptable continuing performance checks (appropriate sections of Appendix D, such as laboratory control samples). Such performance is documented and the four preparation batches following the change in personnel must not result in the failure of any batch acceptance criteria, e.g., method blank and laboratory control sample, or the demonstration of capability must be repeated. In addition, if the entire work cell is changed or replaced, the new work cell must perform the demonstration of capability (Appendix C).

h) Performance of the work cell is linked to the training records of the individual members of the work cell (See Calscience QSM Section 6.2).

10.6 Sample Aliquots

Where sampling (as in obtaining sample aliquots from a submitted sample) is carried out as part of the test method, the laboratory shall use documented procedures and appropriate techniques to obtain representative subsamples. Reference SOP M230, Homogenization and Compositing of Solid, Soil and Sediment Samples for further guidance.

10.7 Data Verification

Calculations and data transfers are subject to appropriate checks.

a) The laboratory has Standard Operating Procedures that ensure that the reported data are free from transcription and calculation errors.

b) The laboratory has Standard Operating Procedures that ensure that all quality control measures are reviewed, and evaluated before data are reported. Refer to SOPs T020, internal Quality Control Checks and T062, Project Management and Analytical Report Review

c) The laboratory has Standard Operating Procedures that address manual calculations including manual integrations. Refer to SOPs T065, Data Integrity and T023, Peak Integration Procedures.

10.8 Documentation and Labeling of Standards and Reagents

Documented procedures exist for the purchase, receipt and storage of consumable materials used for the technical operations of the laboratory.

a) The laboratory retains records for all standards, reagents and media including the manufacturer/vendor, the manufacturer's Certificate of Analysis or purity (if supplied), the date of receipt, recommended storage conditions, and an expiration date after which the material is not used, unless the laboratory verifies its suitability for testing use.

b) Original containers (such as those provided by the manufacturer or vendor) are labeled with an expiration date.

c) Records are maintained on reagent and standard preparation. These records indicate traceability to purchased stocks or neat compounds, reference to the method of preparation, date of preparation, expiration date and preparer's initials.

d) All containers of prepared reagents and standards bear a unique identifier and expiration date and are linked to the documentation requirements in Calscience QSM Section 10.8.c above.

10.9 Computers and Electronic Data Related Requirements

Where computers, automated equipment, or microprocessors are used for the capture, processing, manipulation, recording, reporting, storage or retrieval of test data, Calscience ensures that:

a) All requirements of the NELAC Standard (i.e., Chapter 5 of NELAC) are met;

b) Computer software is tested and documented to be adequate for use, e.g., internal audits, personnel training, focus point of QA and QC;

c) Procedures are established and implemented for protecting the integrity of data. Such procedures include, but are not limited to, integrity of data entry or capture, data storage, data transmission and data processing;

d) Computer and automated equipment are maintained to ensure proper functioning and provided with the environmental and operating conditions necessary to maintain the integrity of calibration and test data; and,

e) It establishes and implements appropriate procedures for the maintenance of security of data including the prevention of unauthorized access to, and the unauthorized amendment of, computer records.

11.0 SAMPLE HANDLING, SAMPLE ACCEPTANCE POLICY AND SAMPLE RECEIPT

While Calscience does not have control of field sampling activities, the following are essential to ensure the validity of the laboratory's data.

11.1 Sample Tracking

a) The laboratory has a documented system for uniquely identifying the items to be tested, to ensure that there can be no confusion regarding the identity of such items at any time. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates. The laboratory assigns a unique identification (ID) code to each sample container received in the laboratory. (The use of container shape, size, or other physical characteristic, such as amber glass, or purple top, is not an acceptable means of identifying the sample.)

b) This laboratory code is maintained as an unequivocal link with the unique field ID code assigned each container.

c) The laboratory ID code is placed on the sample container as a durable label.

d) The laboratory ID code is entered into the laboratory records (see Calscience QSM Section 11.3.d) and is the link that associates the sample with related laboratory activities such as sample preparation or calibration.

e) In cases where the sample collector and analyst are the same individual or the laboratory pre-assigns numbers to sample containers, the laboratory ID code may be the same as the field ID code.

11.2 Sample Acceptance Policy

The laboratory has a written sample acceptance policy that clearly outlines the circumstances under which samples are accepted or rejected. Data from any samples that do not meet the following criteria are flagged in an unambiguous manner, and the nature of the variation is clearly defined. The sample acceptance policy is available to sample collection personnel and includes, but is not limited to, the following areas of concern:

a) Proper, full, and complete documentation, that includes sample identification, the location, date and time of collection, collector's name, preservation type, sample type and any special remarks concerning the sample;

b) Proper sample labeling that includes a unique identification and a labeling system for the samples with requirements concerning the durability of the labels (water resistant) and the use of indelible ink;

c) Use of appropriate sample containers;

d) Adherence to specified holding times;

e) Adequate sample volume. Sufficient sample volume must be available to perform the necessary tests; and,

f) Procedures to be used when samples show signs of damage, contamination or inadequate preservation.

g) Samples are NOT accepted if classified as extremely hazardous, reference section 5.2 k for examples.

11.3 Sample Acceptance Policy (Posted)

This sample acceptance policy outlines the circumstances in which received samples are accepted or rejected by Calscience. If any of the below criteria are not met, it may delay Calscience's processing of samples, possibly compromising "short" holding time analyses. Where received samples do not meet these criteria, Calscience will contact the client. If immediate client contact cannot be made, and hold times are not an issue, samples will be appropriately stored until the situation is clarified with the client. If a delay in sample processing will result in missed holding times, and Calscience deems there is sufficient information provided on the Chain-of-Custody (COC), the lab will proceed with sample log-in and processing; however, Calscience will not assume any liability for samples processed under these circumstances.

Data from samples that do not meet the sample acceptance criteria are flagged and/or addressed in a case narrative, with the nature of the deviation clearly defined. Samples must have written authorization to proceed if not in compliance with this guidance.

1. Complete COC with the following information:

   Unique sample identification, date and time of collection, sample matrix, analysis requested, sampler's name, preservation type (if applicable), client name and address, any additional comments, signature of relinquishing party and date and time that samples were relinquished.

2. Sample temperature upon receipt of >0°C to 6°C, as applicable to the method.

   In the event that samples are collected on the same day that they are received by the laboratory, they are deemed acceptable if they are received on ice and the cooling process has begun.

3. Sample containers and preservatives must be appropriate for the test and method being requested on the COC.

4. Sample labels must include a unique identification written with indelible ink on water resistant labels that correspond with the COC.

5. Adequate sample volume must be provided for the analyses requested on the COC, and containers for volatile analyses must be free of headspace. This includes Tedlar bags and Summa canisters.

6. Sufficient holding time available to perform the analyses requested:

   Samples shall be received at the laboratory within 72 hours of sampling, or with at least 1/2 of the holding time left for the analysis, whichever is less. Calscience always makes a best effort to

ensure that holding times are not exceeded under these circumstances. In the event that a preparation or analysis is performed outside of the associated holding time, the data will be qualified in the report.

7. Coolers and samples must be received in good condition, with no obvious signs of damage or tampering.
8. Received with a copy of Calscience's Foreign Soil Permit, if applicable.
9. Please note, mixed waste, or samples classified as extremely hazardous are **NOT** accepted.

If you require additional information or clarification, please do not hesitate to contact Calscience, or your Project Manager at (714) 895-5494.

11.4 Sample Receipt Protocols

a) Upon receipt, the condition of the sample, including any abnormalities or departures from standard condition as prescribed in the relevant test method, is recorded. All items specified in Calscience QSM Section 11.2 above are checked.

   1) All samples that require cold temperature preservation are considered acceptable if the arrival temperature is within 2°C of the required temperature or the method-specified range. For samples with a specified temperature of 4°C, samples with a temperature ranging from just above the freezing temperature of water to 6°C shall be acceptable. Samples that are hand delivered to the laboratory immediately after collection may not meet these criteria. In these cases, the samples shall be considered acceptable if there is evidence that the chilling process has begun, such as arrival on ice.

   2) The laboratory shall implement procedures for checking chemical preservation using readily available techniques, such as pH or free chlorine, prior to or during sample preparation or analysis.

      With the exception of residual chlorine measurements in aquatic toxicity samples, certain measurements, such a pH, are performed and recorded just prior to analysis.

      Field filtration for dissolved metals, Perchlorate and others may also be required. If there is no documentation of field filtration on the Chain of Custody when required, the Project Manager is notified and the client asked. If samples are not field filtered, they are sent to the lab for filtration within 24 or 48 hours depending on the analysis.

b) The results of all checks are recorded on Sample Receipt and, as needed, Sample Anomaly forms.

c) When there is any doubt as to the item's suitability for testing, when the sample does not conform to the description provided, and when the test required is not fully specified, the laboratory makes every attempt to consult the client for further instruction before proceeding. The laboratory establishes whether the sample has received all necessary preparation, or whether sample preparation has yet to be performed. If the sample does not meet the sample receipt acceptance criteria listed in this standard, the laboratory:

   1) Retains correspondence and/or records of conversations concerning the final disposition of rejected samples; or

   2) Fully documents any decision to commence with the analysis of samples not meeting acceptance criteria.

      i. The condition of these samples is, at a minimum, noted on the chain of custody record or transmittal form, and laboratory receipt documents.

ii. The analysis data is/are appropriately "qualified" on the final report.

d) The laboratory utilizes a permanent chronological record such as a logbook or electronic database to document receipt of all sample containers.

1) This sample receipt log records the following:

i. Client/Project Name;

ii. Date and time of laboratory receipt;

iii. Unique laboratory ID code (see Calscience QSM Section 11.1); and

iv. Signature or initials of the person making the entries.

2) During the login process, the following information is linked to the log record or included as a part of the log. If such information is recorded/documented elsewhere, that document becomes part of the laboratory's permanent records, easily retrievable upon request, and readily available to individuals who will process the sample. Note: The placement of the laboratory ID number on the sample container is not considered a permanent record.

i. The field ID code that identifies each container is linked to the laboratory ID code in the sample receipt log.

ii. The date and time of sample collection is linked to the sample container and to the date and time of receipt in the laboratory.

iii. The requested analyses (including applicable approved test method numbers) are linked to the laboratory ID code.

iv. Any comments resulting from inspection for sample rejection are linked to the laboratory ID code.

e) All documentation (i.e., memos or transmittal forms) that are conveyed to the laboratory by the sample submitter is retained.

f) A complete chain of custody record form is maintained.

11.5 Storage Conditions

The laboratory has documented procedures and appropriate facilities to avoid deterioration, contamination, and damage to the sample during storage, handling, preparation, and testing; any relevant instructions provided with the item are followed. Where items must be stored or conditioned under specific environmental conditions, these conditions are maintained, monitored, and recorded.

a) Samples are stored according to the conditions specified by preservation protocols:

1) Samples that require thermal preservation are stored under refrigeration at +/-2° of the specified preservation temperature unless method-specified criteria exist. For samples with a specified storage temperature of 4°C, storage at a temperature above the freezing point of water to 6°C is acceptable.

2) Samples are stored away from all standards, reagents, food, and other potentially contaminating sources. Samples are stored in such a manner to prevent cross contamination.

b) Sample fractions, extracts, leachates, and other sample preparation products are stored according to Calscience QSM Section 11.4.a above or according to specifications in the test method.

c) When a sample or portion of a sample needs to be held secure (for example, for reasons of record, safety or value, or to enable check calibrations or tests to be performed later), the laboratory has storage and security arrangements that protect the condition and integrity of the secured items or portions concerned.

11.6 Sample Disposal

The laboratory has standard operating procedures for the disposal of samples, digestates, leachates and extracts or other sample preparation products. Refer to SOP T005, Disposal of Laboratory Samples and Wastes.

12.0 RECORDS

The laboratory maintains a record system to suit its particular circumstances and comply with any applicable regulations. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the test report for a minimum of five years.

There are two levels of sample handling: 1) sample tracking and 2) legal chain of custody protocols that are used for evidentiary or legal purposes. All essential requirements for sample tracking (e.g., chain of custody form) are outlined in Calscience QSM Sections 12.1, 12.2 and 12.3. Calscience details the Legal/Evidentiary and Internal Chain of Custody procedures in SOP T100, Sample Receipt and Log-In Procedures.

12.1 Record Keeping System and Design

The Calscience record keeping system allows historical reconstruction of all laboratory activities that produced the analytical data. The history of the sample is readily understood through the documentation. This includes inter-laboratory transfers of samples and/or extracts.

a) The records include the identity of personnel involved in sampling, sample receipt, preparation, calibration or testing.

b) All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification, are documented.

c) The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes, e.g., set format for naming electronic files.

d) All changes to records are signed or initialed by responsible staff. The reason for the signature or initials is clearly indicated in the records such as “sampled by,” “prepared by,” or “reviewed by.”

e) All generated data, except those that are generated by automated data collection systems, are recorded directly, promptly, and legibly in permanent ink.

f) Entries in records are not be obliterated by methods such as erasures, overwritten files or markings. All corrections to record-keeping errors are made by one line marked through the error. The individual making the correction signs (or initials) and dates the correction. These criteria also apply to electronically maintained records.

g) Refer to 10.9 for Computer and Electronic Data.

12.2 Records Management and Storage

a) All records (including those pertaining to calibration and test equipment), certificates and reports are safely stored, and held secure and in confidence to the client. NELAP-related records are available to the accrediting authority.

b) All records, including those specified in Calscience QSM Section 12.3, are retained for a minimum of five years from generation of the last entry in the records. The laboratory maintains all information necessary for the historical reconstruction of data. Records stored only on electronic media are supported by the hardware and software necessary for their retrieval.

c) Records that are stored or generated by computers or personal computers have hard copy or write-protected backup copies.

d) The laboratory has an established record management system for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation storage and reporting.

e) Access to archived information is documented with an access log. These records are protected against fire, theft, loss, environmental deterioration, vermin, and in the case of electronic records, electronic or magnetic sources.

f) The laboratory has a plan to ensure that the records are maintained or transferred according to the clients' instructions (see 4.1.8.e of NELAC) in the event of Laboratory Transfer of Ownership, Going out of Business or Bankruptcy. In all cases, appropriate regulatory and state legal requirements concerning laboratory records will be followed. Reference QSM Section 6.2.1 and SOP T-002, Document Control, for detailed policies and procedures for handling of client records and data in these situations.

12.3 Laboratory Sample Tracking

12.3.1 Sample Handling

A record of all procedures to which a sample is subjected while in Calscience's possession is maintained. These include but are not limited to all records pertaining to:

a) Sample preservation, including appropriateness of sample container and compliance with holding time requirement;

b) Sample identification, receipt, acceptance or rejection, and log-in;

c) Sample storage and tracking, including shipping receipts, sample transmittal forms (chain of custody form); and

d) Documentation procedures for the receipt and retention of test items, including all provisions necessary to protect the integrity of samples.

12.3.2 Laboratory Support Activities

In addition to documenting all the above-mentioned activities, the following is retained:

a) All original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts work sheets and data output records (chromatograms, strip charts, and other instrument response readout records);

b) A written description or reference to the specific test method used, which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value;

c) Copies of final reports;

d) Archived standard operating procedures;

e) Correspondence relating to laboratory activities for a specific project;

f) All corrective/preventive action reports, audits and audit responses;

g) Proficiency test results and raw data; and,

h) Results of data review, verification, and cross-checking procedures.

12.3.3 Analytical Records

The essential information associated with analyses, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

a) Laboratory sample ID code;

b) Date of analysis and time of analysis if the method-specified holding time is 72 hours or less, or when time critical steps are included in the analysis, e.g., extractions, and incubations;

c) Instrument identification and instrument operating conditions/parameters (or reference to such data);

d) Analysis type;

e) All manual calculations e.g., manual integrations;

f) Analyst's or operator's initials/signature or chemist ID number;

g) Sample preparation including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;

h) Sample analysis;

i) Standard and reagent origin, receipt, preparation, and use;

j) Calibration criteria, frequency and acceptance criteria;

k) Data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions;

l) Quality control protocols and assessment;

m) Electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and,

n) Method performance criteria including expected quality control requirements.

12.3.4 Administrative Records

The following are maintained:

a) Personnel qualifications, experience and training records;

b) Ethics Statements;

c) Records of demonstration of capability for each analyst; and

d) A log of names, initials and signatures for all individuals who are responsible for signing or initialing any laboratory record.

13.0 LABORATORY REPORT FORMAT AND CONTENTS

The results of each test, or series of tests carried out by the laboratory must be reported accurately, clearly, unambiguously and objectively. The results normally reported in a test report and include all the information necessary for the interpretation of the test results and all information required by the method used. Some regulatory reporting requirements or formats, such as monthly operating reports may not require all items listed below, however, Calscience will provide all the required information to their client for use in preparing such regulatory reports.

a) Except as discussed in 13.b, each report to an outside client includes at least the following information (those prefaced with “where relevant” are not mandatory):

   1) A title, e.g., "Analytical Report," or "Test Certificate," "Certificate of Results" or "Laboratory Results”;

   2) Name and address of laboratory, and location where the test was carried out if different from the address of the laboratory and phone number with name of contact person for questions;

   3) Unique identification of the certificate or report (such as serial number) and of each page, and the total number of pages;

      This requirement may be presented in several ways:

      i. The total number of pages may be listed on the first page of the report as long as the subsequent pages are identified by the unique report identification and consecutive numbers, or

      ii. Each page is identified with the unique report identification, the pages are identified as a number of the total report pages (example: 3 of 10, or 1 of 20).

      Other methods of identifying the pages in the report may be acceptable as long as it is clear to the reader that discrete pages are associated with a specific report, and that the report contains a specified number of pages.

   4) Name and address of client, where appropriate and project name if applicable;

   5) Description and unambiguous identification of the tested sample including the client identification code;

   6) Identification of test results derived from any sample that did not meet NELAC sample acceptance requirements such as improper container, holding time, or temperature;

   7) Date of receipt of sample, date and time of sample collection, date(s) of performance test, and time of sample preparation and/or analysis if the required holding time for either activity is less than or equal to 72 hours;

   8) Identification of the test method used, or unambiguous description of any nonstandard method used;

9) If the laboratory collected the sample, reference to sampling procedure;

10) Any deviations from (such as failed quality control), additions to or exclusions from the test method (such as environmental conditions), and any nonstandard conditions that may have affected the quality of results, and including the use and definitions of data qualifiers.

11) Measurements, examinations and derived results, supported by tables, graphs, sketches, and photographs as appropriate, and any failures identified; identify whether data are calculated on a dry weight or wet weight basis; identify the reporting units such as µg/l or mg/kg;

12) When required, a statement of the estimated uncertainty of the test results;

13) A signature and title, or an equivalent electronic identification of the person(s) accepting responsibility for the content of the certificate or report (however produced), and date of issue;

14) At the Calscience's discretion, a statement to the effect that the results relate only to the items tested or to the sample as received by the laboratory;

15) At the Calscience's discretion, a statement that the certificate or report shall not be reproduced except in full, without the written approval of the laboratory;

16) Clear identification of all test data provided by outside sources, such as subcontracted laboratories, clients, etc.; and

17) Clear identification of numerical results with values outside of quantitation limits.

b) Where the certificate or report contains results of tests performed by subcontractors, these results are clearly identified by subcontractor name or applicable accreditation number and the entirety of the subcontract report is included with the final Calscience report.

c) After issuance of the report, the laboratory report remains unchanged. Material amendments to a calibration certificate, test report or test certificate after issue may be made only in the form of a further document, or data transfer, including the statement "Supplement to Test Report or Test Certificate, serial number . . . [or as otherwise identified]", or equivalent form of wording. Such amendments meet all the relevant requirements of the NELAC Standard.

d) Calscience notifies clients promptly, in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any calibration certificate, test report or test certificate or amendment to a report or certificate.

e) The laboratory will, where clients require transmission of test results by telephone, telex, facsimile or other electronic or electromagnetic means, follow documented procedures that ensure that the requirements of this Standard are met and that confidentiality is preserved.

f) Calscience will certify that all its NELAC-certified test results reported meet all requirements of NELAC or provide reasons and/or justification if they do not.

14.0 SUBCONTRACTING ANALYTICAL SAMPLES

When Calscience subcontracts work whether because of unforeseen circumstances (e.g. workload, need for further expertise or temporary incapacity) or on a continuing basis (e.g. through client direction, contractual arrangement or permanent subcontracting), this work shall be placed with a laboratory accredited under NELAP, or other appropriate certification, for the tests to be performed or with a laboratory that meets

applicable statutory and requirements for performing the tests and submitting the results of tests performed. All subcontracted work shall be referenced and so noted in the final Calscience analytical report.

Subcontract laboratories will provide or make available, current copies of the following documents prior to Calscience submitting samples. This information will be updated annually or on an as needed basis.

a) Laboratory accreditations / certifications

b) Upon request, any Proficiency Testing (PT) or Performance Evaluation (PE) results relevant to the subcontracted samples.

c) Insurance Certificates

d) Quality Assurance Manual

e) Subcontract laboratories will also submit statements affirming that Calscience will be notified if any of the following occur.

- There is a change or loss in accreditation for the applicable analysis.
- Most recent PT or PE study results for the applicable analysis are unacceptable *AND* are not able to be addressed via Corrective Action.
- There is a need to subcontract Calscience project samples. Prior Calscience approval is required in writing for subcontracting samples.

f) The client project requirements will be used to evaluate the subcontract laboratories and to determine their acceptability. Approval by either: the QA Manager, Laboratory Director or Client Services Director (or designee) is required.

g) A master list of approved laboratories will be created and distributed to Sample Control and all Project Managers. All subcontracting must utilize a laboratory from this list.

The procedure for subcontracting samples will follow these guidelines:

a) Calscience will advise its client via written, facsimile or e-mail notification of its intention to subcontract any portion of the testing to another party in cases when unforeseen circumstances occur. Calscience shall gain approval by the client in writing, facsimile or via e-mail response.

b) Calscience may subcontract samples on a continuing basis without written, facsimile or e-mail notification under the following (but not limited to) cases:

- Standing Client direction or instruction
- Contractual specification or requirement
- Project historical precedent

c) A separate Chain of Custody will be created specifically for the subcontracted sample(s). This (or a copy) will be included with the full and complete subcontract report in the final Calscience analytical report.

d) Calscience shall retain records demonstrating that the above requirements have been met.

e) If the samples to be subcontracted are submitted to Calscience under special regulatory, agency or governmental accreditation, Example: Department of Defense, that have more comprehensive or differing quality criteria, Example: DoD QSM for Environmental Laboratories Version 4.2 October 2010, then the subcontract laboratory MUST have certification for the subcontracted analysis from the same entity and MUST have undergone similar assessment as the primary laboratory for the subcontracted component. Written authorization from the client or authorizing body must be obtained prior to usage of each subcontract laboratory.

15.0 OUTSIDE SUPPORT SERVICES AND SUPPLIES

Calscience does not procure outside services and supplies, other than those referred to in this Manual.

Service providers and vendors are evaluated in accordance with ISO/IEC 17025:2005 or ISO 9001 guidelines prior to use by Calscience, reference SOP T019 and T107 for additional information.

16.0 INQUIRIES AND COMPLAINTS

Calscience SOP-T018 addresses the policies and procedures for the resolution of inquiries and complaints received from clients or other parties about the laboratory's activities. Where an inquiry or complaint, or any other circumstance, raises doubt concerning the laboratory's compliance with the laboratory's policies or procedures, or with the requirements of this manual or otherwise concerning the quality of the laboratory's calibrations or tests, the laboratory shall ensure that those areas of activity and responsibility involved are promptly audited in accordance with NELAC Section 5.3.1. Records of the complaint and subsequent actions are maintained and are available for audits.

17.0 REVIEW OF WORK REQUESTS, CONTRACTS AND TENDERS

Calscience has established procedures for the review of work requests contracts and tenders. Projects, proposals and contracts are reviewed for adequately defined requirements and the ability of Calscience to meet those requirements. A thorough review of all technical and quality control requirements contained in these requests is performed to ensure a project's success. The appropriateness of requested methods, and the lab's capability to perform them must be established. A review of the laboratory's capability to analyze non-routine analytes is also part of this review process. Additionally, alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, detection and reporting levels, and quality control limits. During the review process, the laboratory determines whether it has the necessary physical, personnel and information resources to meet the project requirements, and if the personnel have the expertise needed to perform the required testing. Each proposal is also checked for its impact on the overall capacity of the laboratory. The proposed turnaround time will be checked for feasibility. Electronic or hard copy deliverable requirements are evaluated against the laboratory's ability to produce such documentation.

This review process ensures that the laboratory's test methods are suitable to achieve regulatory and/or client requirements and that the laboratory holds the appropriate certifications to perform the work. In the event that the use of a subcontract laboratory is needed, also confirming that they meet all project requirements and maintain the appropriate certifications for the proposed subcontract analyses. If the laboratory cannot provide all services and therefore intends to use the services of a subcontract laboratory, this will be documented and discussed with the client prior to project or contract approval.

Following the review process, the laboratory informs the client of the results of the review and notes any potential conflict, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any

discrepancy between the client's requirements and the capability of the laboratory to meet those requirements is resolved in writing before acceptance of the project or contract. It is necessary that the project requirements or contract be acceptable to both the client and the laboratory prior to the start of the work. The review process is repeated when there are amendments to the original contract by the client.

All contracts, Quality Assurance Project Plans (QAPPs), Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record.

Review Personnel

Depending upon the scope of a project or contract, one or more key persons may review and accept work on behalf of the laboratory. For routine projects, a review by the Project Manager (PM) is considered adequate. The PM confirms that the laboratory has the necessary certifications, that it can meet the clients' data quality, reporting and turn-around time requirements.

For new, complex or large projects, the proposed project proposal or contract is given to the Business Development Director for an initial review that encompasses all facets of the operation. The scope of work is then distributed to the following personnel, as needed based on scope of contract, to evaluate all of the project related requirements:

- Laboratory Director
- Operations Director
- Technical Director
- Quality Assurance Director
- Quality Assurance Manager
- Group Leaders
- Project Manager(s)

Appropriate records are maintained for every contract or work request. Copies of the agreed-upon contract will be distributed to key personnel as needed and the signed copies maintained by the Business Development Director and/or Laboratory Director.

Project Kick-off and Status Meetings

For routine project work, project managers ensure that specific technical and QC requirements are effectively evaluated and communicated to laboratory personnel through the use of the LIMS system: special requirements section of the chemist's worksheet.

Prior to work on a new or complex project, project managers or key personnel will hold meetings with operations personnel to discuss schedules and any unique aspects of the project. Items discussed include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, and any other special requirements.

Project requirements are given to the laboratory staff during project kick-off meetings or the daily status meetings. Information disseminated during these meetings provides direction to the laboratory staff in order to maximize production, maintain high quality and ensure client satisfaction.

During the project, changes to the scope of work may occur due to client, sampling or regulatory reasons. If these changes impact the laboratory's role in the project (use of a non-standard method or modification of a method to comply with revised requirements) then the changes need to be discussed with and agreed upon

with the client prior to continuing with the work. These changes must be documented prior to implementation and communicated to the laboratory staff during a status or project specific meeting. Documentation of the modification is made in the analytical report narrative.

And at all times, records of all pertinent discussions with a client relating to the project or contract are documented and maintained as a part of the project record.

18.0 MANAGEMENT REVIEW, MANAGEMENT OF CHANGE AND CONTINUOUS IMPROVEMENT

18.1 Management Review

A comprehensive Management Review of the entire Calscience Quality System will be conducted by the Laboratory Director on an annual basis, no later than the end of the first quarter for the previous year's review. The SOP T-030 may be consulted for detailed guidance. All major stakeholders will be given an opportunity to provide comment or input for the review. These will include:

- Laboratory Director
- Client Services Director
- Operations Director
- Technical Director
- Senior Project Manager
- Other Operational / Project Management personnel as appropriate.
- Clients

The purpose and goal of the Management Review will identify weaknesses, areas requiring more resources or oversight, opportunities for continuous improvement and follow up on previous recommendations.

The final completed review is part of the NELAP laboratory documentation requirements and may be submitted to Calscience authorized auditing agencies or clients upon request.

18.2 Management of Change

Whenever a change is made in a controlled environment (not just production) the laboratory is put at risk. However, one needs to constantly make changes to keep pace with business / regulatory requirements. The challenge to the laboratory is to minimize the risk and impact of that change.

An organization must have an operating process in place for which an evaluation has been conducted, and that allows proper lead times and approvals to ensure that the laboratory is unaffected when changes are made. But to successfully implement a change, one also needs to have a comprehensive understanding of the infrastructure that supports the services to determine the overall impact. The Management of Change process will facilitate, as referenced in SOP T030, this evaluation.

The Management of Change process will track and implement the following types of changes:

a) Permanent Change: – A change that is considered long term and durable. Any change which is not categorized as a Temporary Change.

b) Temporary Change: – A change which has a defined lifetime and which will be removed before a defined date (usually no more than six months). All temporary changes must have a specified removal date that is documented on the approved MOC form.

c) Emergency Change: – An emergency change path that allows the change to be implemented and commissioned immediately in order to address an immediate safety, operational, health, environmental, or product quality situations.

The functional categories that will be managed include:

a) Laboratory Facility Acquisition
b) Laboratory Instrument Acquisition
c) Analytical Method Development and Validation
d) Laboratory Operations Process Change
e) Department Relocation
f) Activation of Analytical Method
g) Waste Stabilization and Disposition
h) Human Resources
i) Information Technology
j) Safety and Security

18.3 Continuous Improvement

In order for Calscience to be proactive and a leader in the industry, the entire Calscience Quality system is designed to ensure the production of scientifically sound, legally defensible data of known and proven quality. The addition of the Management Review and Management of Change processes enhances Calscience's ability to foster continuous improvement.

Continuous improvement is an ongoing effort to improve data integrity, services or processes. These efforts can seek "incremental" improvement over time or "breakthrough" improvement all at once. All staff at Calscience participates in continuous improvement, from the Laboratory Director down to the beginning technician, as well as external stakeholders when applicable.

The following procedures / inputs have direct involvement in the continuous improvement process:

a) External Audits (Regulatory and Client Based)
b) Internal Audits
c) Corrective / Preventive Actions
d) Statistical Quality Control (SQC) Monitoring
e) Proficiency Testing Performance
f) Client Feedback – Complaints and Commendations
g) Management Review
h) Management of Change

The Management of Change process will guide and document the major improvements. The Corrective / Preventive Action procedure will enable and record the more incremental changes.

The principal elements are commitment to quality, focused effort, involvement of all employees, willingness to change, and communication.

NELAC APPENDICES

APPENDIX A - REFERENCES

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APPENDIX B - GLOSSARY

The following definitions are used in the text of Quality Systems. In writing this document, the following hierarchy of definition references was used: ISO 8402, ANSI/ASQC E-4, EPA's Quality Assurance Division Glossary of Terms, and finally definitions developed by NELAC. The source of each definition, unless otherwise identified, is the Quality Systems Committee.

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one. (NELAC)

Accrediting Authority: The Territorial, State, or Federal agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation. (NELAC) [1.5.2.3]

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Analysis Duplicate: The second measurement of the target analyte(s) performed on a single sample or sample preparation.

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality. (NELAC)

Analytical Reagent (AR) Grade: Designation for the high purity of certain chemical reagents and solvents given by the American Chemical Society. (Quality Systems)

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of NELAC). (NELAC)

Audit: A systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity. (EPA-QAD)

Batch: Environmental samples, which are prepared and/or analyzed together with the same process and personnel using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same NELAC-defined matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples. (NELAC Quality Systems Committee)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Blind Sample: A sub-sample for analysis with a composition known to the submitter. The analyst/ laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process. (NELAC)

Calibration: To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements. (NELAC)

Calibration Curve: The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (NELAC)

Calibration Method: A defined technical procedure for performing a calibration. (NELAC)

Calibration Standard: A substance or reference material used to calibrate an instrument. (QAMS)

Certified Reference Material (CRM): A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body. (ISO Guide 30 - 2.2)

Chain of Custody Form: A record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; collector; time of collection; preservation; and requested analyses. (NELAC)

Compromised Samples: Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions compromised samples are not analyzed. If emergency situations require analysis, the results must be appropriately qualified. (NELAC)

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to:

- Second column confirmation;
- Alternate wavelength;
- Derivatization;
- Mass spectral interpretation;
- Alternative detectors; or
- Additional cleanup procedures. (NELAC)

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ ASQC E4-1994)

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality (i.e., that they meet specified acceptance criteria). (NELAC)

Data Reduction: The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form. (EPA-QAD)

Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Demonstration of Capability: A procedure to establish the ability of the analyst to generate acceptable accuracy. (NELAC)

Desorption Efficiency: The mass of target analyte recovered from sampling media, usually a sorbent tube, divided by the mass of target analyte spiked on to the sampling media expressed as a percentage. Sample target analyte masses are usually adjusted for the desorption efficiency. (NELAC)

Detection Limit: The lowest concentration or amount of the target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value. See Method Detection Limit. (NELAC)

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed. (ASQC)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA- QAD)

Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised. (40 CFR Part 136)

Inspection: An activity such as measuring, examining, testing, or gauging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformance is achieved for each characteristic. (ANSI/ ASQC E4-1994)

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method. (NELAC)

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Laboratory: A body that calibrates and/or tests. (ISO 25)

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to assess the performance of all or a portion of the measurement system. (NELAC)

Laboratory Duplicate: Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently. (NELAC)

Limit of Detection (LOD): Limit of Detection (LOD): The smallest concentration of a substance that must be present in a sample in order to be detected at the DL with 99% confidence. At the LOD, the false negative rate (Type II error) is 1%. (NELAC)

Limit of Quantitation (LOQ): The smallest concentration that produces a quantitative result with known and recorded precision and bias. (NELAC)

Manager (however named): The individual designated as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory. A supervisor may report to the manager. In some cases, the supervisor and the manager may be the same individual. (NELAC)

Matrix: The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

- Aqueous: Any aqueous sample excluded from the definition of Drinking Water matrix or Saline/Estuarine source. Includes surface water, groundwater, effluents, and TCLP or other extracts.
- Drinking Water: Any aqueous sample that has been designated a potable or potential potable water source.
- Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.
- Non-aqueous Liquid: Any organic liquid with <15% settleable solids.
- Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.
- Solids: Includes soils, sediments, sludges and other matrices with >15% settleable solids.
- Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined.
- Air: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter or other device. (NELAC)

Matrix Spike (spiked sample or fortified sample): A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency. (QAMS)

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte. (QAMS)

May: Denotes permitted action, but not required action. (NELAC)

Media: Material that supports the growth of a microbiological culture.

Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. (NELAC)

Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136 Appendix B)

Must: Denotes a requirement that must be met. (Random House College Dictionary)

National Accreditation Database: The publicly accessible database listing the accreditation status of all laboratories participating in NELAP. (NELAC)

National Environmental Laboratory Accreditation Conference (NELAC): A voluntary organization of State and Federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories. A subset of NELAP. (NELAC)

National Environmental Laboratory Accreditation Program (NELAP): The overall National Environmental Laboratory Accreditation Program of which NELAC is a part. (NELAC)

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results. (NELAC)

Objective Evidence: Any documented statement of fact, other information, or record, either quantitative or qualitative, pertaining to the quality of an item or activity, based on observations, measures, or tests that can be verified. (ASQC)

Performance Audit: The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory. (NELAC)

Performance Based Measurement System (PBMS): A set of processes wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner. (NELAC)

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects. (NELAC)

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (NELAC)

Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample. (NELAC)

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (NELAC) [2.1]

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (NELAC)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria. (QAMS)

Protocol: A detailed written procedure for field and/or laboratory operation (e.g., sampling, and analysis) which must be strictly followed. (EPA- QAD)

Pure Reagent Water: Shall be water (defined by national or international standard) in which no target analytes or interferences are detected as required by the analytical method. (NELAC)

Quality Assurance: An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. (QAMS)

Quality Assurance (Project) Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EPA-QAD)

Quality Control: The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users. (QAMS)

Quality Control Sample: An uncontaminated sample matrix with known amounts of analytes from a source independent from the calibration standards. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system. (EPA-QAD)

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (NELAC)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC. (ANSI/ ASQC E-41994)

Quantitation Limits: Levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported at a specific degree of confidence. (NELAC)

Range: The difference between the minimum and the maximum of a set of values. (EPA-QAD)

Raw Data: Any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments. If exact copies of raw data have been prepared (e.g., tapes which have been transcribed verbatim, data and verified accurate by signature), the exact copy or exact transcript may be submitted. (EPA-QAD)

Reagent Blank (method reagent blank): A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps. (QAMS)

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions. (EPA-QAD)

Reference Material: A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30- 2.1)

Reference Method: A method of known and documented accuracy and precision issued by an organization recognized as competent to do so. (NELAC)

Reference Standard: A standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived. (VIM-6.08)

Reference Toxicant: The toxicant used in performing toxicity tests to indicate the sensitivity of a test organism and to demonstrate the laboratory's ability to perform the test correctly and obtain consistent results (see Chapter 5, Appendix D, Section 2.1.f). (NELAC)

Replicate Analyses: The measurements of the variable of interest performed identically on two or more sub-samples of the same sample within a short time interval. (NELAC)

Requirement: Denotes a mandatory specification; often designated by the term "shall". (NELAC)

Sampling Media: Material used to collect and concentrate the target analytes(s) during air sampling such as solid sorbents, filters, or impinger solutions.

Selectivity: (Analytical chemistry) The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. (EPA-QAD)

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (NELAC)

Shall: Denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled. (ANSI)

Should: Denotes a guideline or recommendation whenever noncompliance with the specification is permissible. (ANSI)

Spike: A known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes. (NELAC)

Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of NELAC and meets the approval requirements of NELAC procedures and policies. (ASQC)

Standard Operating Procedure (SOP): A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks. (QAMS)

Standardized Reference Material (SRM): A certified reference material produced by the U.S. National Institute of Standards and Technology or other equivalent organization and characterized for absolute content, independent of analytical method. (EPA-QAD)

Supervisor (however named): The individual(s) designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training and experience to perform the required analyses. (NELAC)

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes. (QAMS)

Systems Audit (also Technical Systems Audit): A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Director: Individual(s) who has overall responsibility for the technical operation of the environmental testing laboratory. (NELAC)

Test: A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate. (ISO/IEC Guide 2-12.1, amended)

Test Method: An adoption of a scientific technique for a specific measurement problem, as documented in a laboratory SOP. (NELAC)

Testing Laboratory: Laboratory that performs tests. (ISO/ IEC Guide 2 - 12.4)

Test Sensitivity/Power: The minimum significant difference (MSD) between the control and test concentration that is statistically significant. It is dependent on the number of replicates per concentration, the selected significance level, and the type of statistical analysis (see Chapter 5, Appendix D, Section 2.4.a). (NELAC)

Tolerance Chart: A chart in which the plotted quality control data is assessed via a tolerance level (e.g. +/- 10% of a mean) based on the precision level judged acceptable to meet overall quality/data use requirements instead of a statistical acceptance criteria (e.g. +/- 3 sigma) (applies to radiobioassay laboratories). (ANSI)

Traceability: The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons. (VIM - 6.12)

Validation: The process of substantiating specified performance criteria. (EPA- QAD)

Verification: Confirmation by examination and provision of evidence that specified requirements have been met. (NELAC)

NOTE: In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment.

The result of verification leads to a decision either to restore in service, to perform adjustment, to repair, to downgrade, or to declare obsolete. In all cases, it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.

Work Cell: A well-defined group of analysts that together perform the method analysis. The members of the group and their specific functions within the work cell must be fully documented. (NELAC)

Sources:

American Society for Quality Control (ASQC), Definitions of Environmental Quality Assurance Terms, 1996

American National Standards Institute (ANSI), Style Manual for Preparation of Proposed American National Standards, Eighth Edition, March 1991

ANSI/ASQC E4, 1994

ANSI N42.23- 1995, Measurement and Associated Instrument Quality Assurance for Radiobioassay Laboratories

International Standards Organization (ISO) Guides 2, 30, 8402

International Vocabulary of Basic and General Terms in Metrology (VIM): 1984. Issued by BIPM, IEC, ISO and OIML

National Institute of Standards and Technology (NIST)

National Environmental Laboratory Accreditation Conference (NELAC), July 1998 Standards

Random House College Dictionary

U.S. EPA Quality Assurance Management Section (QAMS), Glossary of Terms of Quality Assurance Terms, 8/31/92 and 12/6/95

U.S. EPA Quality Assurance Division (QAD)

40 CFR, Part 136

Webster's New World Dictionary of the American Language

APPENDIX C - DEMONSTRATION OF CAPABILITY

C.1 PROCEDURE FOR DEMONSTRATION OF CAPABILITY

A demonstration of capability (DOC) must be made prior to using any test method, and at any time there is a change in instrument type, personnel or test method. (See NELAC 10.2.1.)

Note: Where tests are performed by specialized "work cells" (a well-defined group of analysts that together perform the method analysis), the work cell as a unit meets the above criteria and this demonstration is fully documented.

In general, this demonstration does not test the performance of the method in real world samples, but in the applicable and available clean matrix (a sample of a matrix in which no target analytes or interferences are present at concentrations that impact the results of a specific test method), e.g., water, solids and air. However, before any results are reported using this method, actual sample spike results may be used to meet this standard, i.e., at least four consecutive matrix spikes within the last twelve months. In addition, for analytes that do not lend themselves to spiking, e.g., TSS, the demonstration of capability may be performed using quality control samples.

All demonstrations shall be documented through the use of the form in this appendix.

The following steps, which are adapted from the EPA test methods published in 40 CFR Part 136, Appendix A, are performed if required by mandatory test method or regulation. Note: For analytes for which spiking is not an option and for which quality control samples are not readily available, the 40 CFR approach is one way to perform this demonstration. The laboratory documents that other approaches to DOC are adequate, and this is documented in the laboratory's Quality Manual.

a) A quality control sample is obtained from an outside source. If not available, the QC sample may be prepared by the laboratory using stock standards that are prepared independently from those used in instrument calibration.

b) The analyte(s) is diluted in a volume of clean matrix sufficient to prepare four aliquots at the concentration specified, or if unspecified, to a concentration approximately 10 times the method-stated or laboratory-calculated method detection limit.

c) At least four aliquots are prepared and analyzed according to the test method either concurrently or over a period of days.

d) Using all of the results, the mean recovery ($\overline{X}$) is calculated in the appropriate reporting units (such as µg/L) and the standard deviations of the population sample (n-1) (in the same units) for each parameter of interest. When it is not possible to determine mean and standard deviations, such as for presence/absence and logarithmic values, the laboratory will assess performance against established and documented criteria.

e) Compare the information from (d) above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory-generated acceptance criteria (if there are no established mandatory criteria). If all parameters meet the acceptance criteria, the analysis of actual samples may begin. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter.

f) When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst must proceed according to 1) or 2) below.

1) Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with c) above.

2) Beginning with c) above, repeat the test for all parameters that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all compounds of interest beginning with c).

C.2 CERTIFICATION STATEMENT

The following certification statement shall be used to document the completion of each demonstration of capability. A copy of the certification statement shall be retained in the personnel records of each affected employee (see Calscience QSM Section 6.3 and 12.3.4.b.).

Demonstration of Capability
Certification Statement

Date: Page __of __
Laboratory Name:
Laboratory Address:
Analyst(s) Name(s):

Matrix: _____
(examples: laboratory pure water, soil, air, solid, biological tissue)

Method number, SOP#, Rev #, and Analyte, or Class of Analytes or Measured Parameters:
_____ (examples: barium by 200.7, trace metals by 6010, benzene by 8021, etc.)

We, the undersigned, CERTIFY that:

1. The analysts identified above, using the cited test method(s), which is in use at this facility for the analyses of samples under the National Environmental Laboratory Accreditation Program, have met the Demonstration of Capability.

2. The test method(s) was performed by the analyst(s) identified on this certification.

3. A copy of the test method(s) and the laboratory-specific SOPs are available for all personnel on-site.

4. The data associated with the demonstration capability are true, accurate, complete and self-explanatory (1).

5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well organized and available for review by authorized assessors.

_____	_____	_____
Technical Director's Name and Title	Signature	Date
_____	_____	_____
Quality Assurance Officer's Name	Signature	Date

This certification form must be completed each time a demonstration of capability study is completed.

(1) True: Consistent with supporting data.
Accurate: Based on good laboratory practices consistent with sound scientific principles/practices.
Complete: Includes the results of all supporting performance testing.
Self-explanatory: Data properly labeled and stored so that the results are clear and require no additional explanation.

(*Note: Form may be modified so long as the essential items are included in the updated form)*

APPENDIX D - ESSENTIAL QUALITY CONTROL REQUIREMENTS

The quality control protocols specified by the laboratory's method manual (10.1.2) shall be followed. The laboratory shall ensure that the essential standards outlined in Appendix D are incorporated into their method manuals.

All quality control measures shall be assessed and evaluated on an ongoing basis and quality control acceptance criteria shall be used to determine the validity of the data. The laboratory shall have procedures for the development of acceptance/rejection criteria where no method or regulatory criteria exists.

The requirements from the body of Chapter 5, e.g., Section 5.4, apply to all types of testing. The specific manner in which they are implemented is detailed in each of the sections of this Appendix, i.e., chemical testing.

The Standard Operating Procedure (SOP) T020 "Internal Quality Control Checks" and the specific analytical method SOPs have a more detailed outline of the quality control procedures.

D.1 CHEMICAL TESTING

D.1.1 Positive and Negative Controls

a) Negative Controls

1) Method Blanks - Shall be performed at a frequency of one per preparation batch of samples per matrix type. The results of this analysis shall be one of the QC measures to be used to assess the batch. The source of contamination must be investigated and measures taken to correct, minimize or eliminate the problem if

   i) the blank contamination exceeds a concentration greater than 1/10 of the measured concentration of any sample in the associated sample batch or

   ii) the blank contamination exceeds the concentration present in the samples and is greater than 1/10 of the specified regulatory limit.

Any sample associated with the contaminated blank shall be reprocessed for analysis or the results reported with appropriate data qualifying codes.

b) Positive Controls

1) Laboratory Control Sample (LCS) - (QC Check Samples) Shall be analyzed at a minimum of 1 per preparation batch of 20 or less samples per matrix type, except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to assess the batch. NOTE: The matrix spike (see 2 below) may be used in place of this control as long as the acceptance criteria are as stringent as for the LCS.

   a. The NELAC requirements (2009 Standard, Section 1.7.4.2 b) allow the usage of LCS Marginal Exceedance control limits for those analyses with multiple reporting analytes.

   b. The NELAC standards state that if a large number of analytes are in the LCS, it becomes statistically likely that a few will be outside control limits. This may not indicate that the system is out of control; therefore, corrective action may not be necessary. Upper and lower marginal exceedance (ME) limits can be established to determine when corrective action is necessary. ME is defined as being beyond the LCS control limit but within the ME limits. ME limits are between 3 and 4 standard deviations around the mean.

c. The number of allowable marginal exceedance is based on the number of analytes in the LCS. If there is any analyte that exceed the LCS control limits, it does not necessary mean the LCS fails. The NELAC standard states if the number of analytes fails LCS control limits but is within the ME limits, it is acceptable.

2) Matrix Spikes (MS) - Shall be performed at a frequency of one out of every 20 samples per matrix type prepared over time, except for analytes for which spiking solutions are not available such as, total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The selected sample(s) shall be rotated among client samples so that various matrix problems may be noted and/or addressed. Poor performance in a matrix spike may indicate a problem with the sample composition and shall be reported to the client whose sample was used for the spike.

3) Surrogates - Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with the sample composition and shall be reported to the client whose sample produced the poor recovery.
4) If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene, and PCBs in Method 608), the test method has an extremely long list of components or components that are incompatible, a representative number (minimum of 10%) of the listed components may be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit-specified analytes, and other client-requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

D.1.2 Analytical Variability/Reproducibility

Matrix Spike Duplicates (MSDs) or Laboratory Duplicates - Shall be analyzed at a minimum of 1 in 20 samples per matrix type per sample extraction or preparation method. The laboratory shall document its procedure to select the use of appropriate type of duplicate. The selected sample(s) shall be rotated among client samples so that various matrix problems may be noted and/or addressed. Poor performance in the duplicates may indicate a problem with the sample composition and shall be reported to the client whose sample was used for the duplicate.

D.1.3 Method Evaluation

In order to ensure the accuracy of the reported result, the following procedures shall be in place:

a) Demonstration of Analytical Capability - (Section 10.5) shall be performed initially (prior to the analysis of any samples) and with a significant change in instrument type, personnel, matrix or test method.

b) Calibration - Calibration protocols specified in Section 9.4 shall be followed.

c) Proficiency Test Samples - The results of such analyses (4.2.j or 5.3.4) shall be used by the laboratory to evaluate the ability of the laboratory to produce accurate data.

D.1.4 Analytical Measurement Uncertainty Estimation

Uncertainty is “a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand” (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1).

Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. For environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error.

Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to have a Gaussian distribution, and be reducible by increasing the total number of measurements.

Knowledge of the uncertainty of a measurement provides additional confidence in the validity of a result as its value accounts for all the factors which could possibly affect the result. Certain test methods will specify limits to the values of sources of uncertainty of measurement (EPA 500 series methods, etc.) and will specify the form of presentation of calculated results.

When the method makes these stipulations, there is no need to provide a mechanism for calculating the uncertainty. Where this information is not provided within a method or other regulatory device, the uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte because LCS recoveries incorporate all of the laboratory-related variables associated with a given test over time. It is recognized that other approaches exist; however, Calscience's standard for estimating analytical data uncertainty uses this approach.

D.1.4.1 Using the Laboratory Control Sample (LCS) to Estimating Analytical Uncertainty

a) The estimated measurement uncertainty can be expressed as a range (±) around the reported analytical results at a specified confidence level. For methods that use statistically-derived LCS control limits based on historical LCS recovery data to assess the performance of the measurement system, these limits are considered an estimate of the minimum laboratory contribution to measurement uncertainty at a 99% confidence interval, The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

- Uncertainty values may be reported for specific projects upon request. In absence of alternate client-specified approaches or confidence levels,

  Calscience will use the following procedure:

  > To calculate the uncertainty value of a reported analytical result, the lower uncertainty range value is calculated by subtracting the product of the result and the lower LCS percent recovery from the result; and the upper uncertainty value result is calculated by adding the product of the result and the upper LCS percent recovery.
  >
  > These calculated values represent approximately a 99% confidence level. In other words, approximated 99% of the measured values for the analyte will fall within this calculated range.

- Example: If the reported result is 1.0 mg/l, and the LCS percent recovery range is 75 to 125%. The uncertainty range would be 0.75 to 1.25 mg/l, which could also be written as 1.0 +/- 0.25 mg/l.

- The Laboratory Quality and Accreditation Office has made available to the public both a spreadsheet that calculates analytical measurement uncertainty and an SOP describing how to use it. This SOP applies to test methods that are within the scope of ISO/IEC 17025-1999 Standard: General Requirements for the Competence of Testing and Calibration Laboratories and it is based on the general rules outlined in Guide to the Expression of Uncertainty in Measurement (GUM).

The spreadsheet provides a QC-based nested approach for estimating measurement uncertainty using laboratory generated calibration and QC spike results. This spreadsheet has been authorized to be used on DOD projects, if requested.

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D.1.4.2 Additional Components to Estimating Analytical Uncertainty

When estimating analytical measurement uncertainty, all significant components of uncertainty must be identified and quantified. Components that affect analytical measurement uncertainty include sampling, handling, transport, storage, preparation and testing. A typical environmental laboratory will have the greatest contribution to uncertainty in the storage, preparation and testing portion of the analytical train, hence the estimation can be limited to those three areas, assuming all other factors are within recommended guidelines for sample size, container type, preservation (chemical, temperature, temporal) and handling/transport. If the latter are *NOT* within guidelines then these additional estimations of variability must be accounted for, and may supersede the laboratory contribution to uncertainty.

Definitive references and procedural manuals for calculating Analytical Measurement Uncertainty are listed below. Note that there are different theories on the "best" way to estimate uncertainty, it is up to the end user to determine that which best meets their project needs.

a) "Environmental Analytical Measurement Uncertainty Estimation – Nested Hierarchical Approach", William Ingersoll, Defense Technical Information Center # ADA396946, 2001

b) "Quantifying Uncertainty in Analytical Measurement", EuraChem / CITAC Guide CG 4, Second Edition, QUAM 2000.1

c) "Quantifying Measurement Uncertainty in Analytical Chemistry – A Simplified Practical Approach", Thomas W. Vetter, National Institute of Standards and Technology

d) ISO Guide to the Expression of Uncertainty in Measurement (GUM), 1993

e) "Estimation of Analytical Measurement Uncertainty - Laboratory Quality and Accreditation Office Uncertainty Calculator Standard Operating Procedure. Downloaded from http://www.denix.osd.mil/edqw/upload/UNCERTAINTY-SOP.PDF , 2013

f) QC-based Nested Approach for Estimating Measurement Uncertainty Spreadsheet, Microsoft Excel Spreadsheet, Ingersoll, William Stephen, 2002

The process in general involves the following steps:

1. Specify the Measurand – Write down a clear statement of what is being measured, including the relationship between the measurand and the input quantities, i.e., measured quantities, constants, calibration standard values, etc.

2. Identify uncertainty sources – This will include sources that contribute to the uncertainty on the parameters in the relationships identified in step 1, but may include other sources and must include sources arising from chemical assumptions.

3. Quantify uncertainty components – Measure or estimate the size of the uncertainty component associated with each potential source of uncertainty identified. It is often possible to estimate or determine a single contribution to uncertainty from the aggregate of multiple sources.

4. Calculate combined uncertainty – The information obtained in step 3 will consist of a number of quantified contributions to overall uncertainty, whether associated with individual sources or with the combined effects of several sources.

The process outlined above relates to the measurement of uncertainty for the preparative / analytical laboratory procedure. However, there are uncertainty contributions from other factors outside the preparative / analytical procedure. These can be controlled to a great extent by specifying uniform and standardized training or conditions.

Examples:

Human Factors

a) All personnel at Calscience undergo documented training in the method and / or instrument used. Minimum levels of education or experience are required.

b) Initial and continuing Demonstrations of Capability (DOC) must be performed and documented prior to and in continuance of analytical work related to their areas of responsibilities.

c) Blind Proficiency Testing samples are analyzed twice a year to gauge each department, matrix and method.

d) Data Integrity and Ethics Training are provided to new employees and on an annual basis to all employees.

Accommodation and Environmental Conditions

a) Calscience has standardized operating procedures for transport, storage and tracking of samples, extracts and digests through out the laboratory. All incoming orders are logged into a Laboratory Information System that assigns a specific identifier code to each work order, sample container and analytical result.

b) The sample control areas are secured with restricted access using card key portals. Internal chain of custody is available if the project requires.
c) The laboratory has over 35,000 sq ft of laboratory space with temperature controlled and air positive or negative environmental controls.

d) Regular safety inspections are performed to identify potentially hazardous conditions and to ensure general cleanliness.

Environmental Test Methods and Method Validation

a) All methods in use have Standard Operating Procedures (SOPs) based upon published methods from the EPA, ASTM, Standard Methods or other established body. These are controlled documents assigned to each department. An annual review is performed.

b) Each method has internal and external quality control criteria for preparative efficiency, instrument performance, calibration, continuing method performance and possible matrix effects as appropriate.

c) Ongoing Proficiency Testing program.

Equipment and Instrumentation

a) Each instrument in use has performance parameters that must be evaluated to specific standards based on the established method prior to any analytical use.

b) Routine and preventative maintenance is performed to maintain optimum operational performance.

c) Complex instrument systems are covered under manufacturer service contracts as appropriate.

Measurement Traceability

a) Every reagent used must meet the indicated purity and fitness for usage as referenced in the method SOPs.

b) All calibration standards are certified by the manufacturer to meet or exceed purity levels as recorded in the accompanying Certificate of Traceability to NIST or other standards verification.

c) Each reagent, standard or working standard is recorded, assigned a tracking identifier. This is referenced in the analytical log book as needed to assure traceability to the original source.

d) All Balances, Dispensers, Pipettors, Refrigerators, Freezers and Thermometers are checked on a daily or other routine basis to specified tolerances.

D.1.5 Detection Limits

The laboratory shall utilize a test method that provides a detection limit that is appropriate and relevant for the intended use of the data. Detection limits shall be determined by the protocol in the mandated test method or applicable regulation, e.g., Method Detection Limit (MDL). If the protocol for determining detection limits is not specified, the selection of the procedure must reflect instrument limitations and the intended application of the test method. Refer to SOP T006, Determination of Detection Limits.

a) A detection limit study is not required for any component for which spiking solutions or quality control samples are not available such as temperature.

b) The detection limit shall be initially determined for the compounds of interest in each test method in a matrix in which there are not target analytes nor interferences at a concentration that would impact the results or the detection limit must be determined in the matrix of interest (see definition of matrix).

c) Detection limits must be determined each time there is a change in the test method that affects how the test is performed, or when a change in instrumentation occurs that affects the sensitivity of the analysis.

d) All samples processing steps of the analytical method shall be included in the determination of the detection limit.

e) All procedures used must be documented. Documentation must include the matrix type. All supporting data must be retained.

f) The laboratory must have established procedures to relate detection limits with quantitation limits.

g) The test method's quantitation limits must be established and must be above the detection limits.

D.1.6 Data Reduction

The procedures for data reduction, such as use of linear regression, shall be documented.

D.1.7 Quality of Standards and Reagents

a) The source of standards shall comply with 9.3.

b) Reagent Quality, Water Quality and Checks:

1) Reagents - In methods where the purity of reagents is not specified, analytical reagent grade shall be used. Reagents of lesser purity than those specified by the test method shall not be used. The labels on the container should be checked to verify that the purity of the reagents meets the requirements of the particular test method. Such information shall be documented.

2) Water - The quality of water sources shall be monitored and documented and shall meet method specified requirements.

3) The laboratory will verify the concentration of titrants in accordance with written laboratory procedures.

D.1.8 Selectivity

a) Absolute retention time and relative retention time aid in the identification of components in chromatographic analyses and to evaluate the effectiveness of a column to separate constituents. The laboratory shall develop and document acceptance criteria for retention time windows.

b) A confirmation shall be performed to verify the compound identification when positive results are detected on a sample from a location that has not been previously tested by the laboratory. Such confirmations shall be performed on organic tests such as pesticides, herbicides, or acid extractable or when recommended by the analytical test method except when the analysis involves the use of a mass spectrometer. Confirmation is required unless stipulated in writing by the client. All confirmation shall be documented.

c) The laboratory shall document acceptance criteria for mass spectral tuning.

D.1.9 Constant and Consistent Test Conditions

a) The laboratory shall assure that the test instruments consistently operate within the specifications required of the application for which the equipment is used.

b) Glassware Cleaning - Glassware shall be cleaned to meet the sensitivity of the test method.

   Any cleaning and storage procedures that are not specified by the test method shall be documented in laboratory records and SOPs.

D.1.10 Method Validation – Modified Procedures, Non-Standard Methods, Additional Analytes

Often times, modifications to published methods are promulgated to allow the laboratory flexibility, increased productivity and, in some cases, it allows for better hazardous waste management, all while maintaining the quality of the data generated. But, this cannot be done without following standard method validation procedures to guarantee that the results achieved from the modified version are equal to or greater than the actual published or routinely accepted method.

Validation procedures are done to make sure that the sensitivity and selectivity of the process is appropriate for the method or analytes chosen. Interference checks are performed to show that the changes or additions will not contribute interferences to previous analytes or on-going processes. Accuracy and precision requirements are established, or previously defined, and used to demonstrate the capability of an analyst to perform the method, initially and on-going.

In the event that a non-standard method (significantly modified or newly-developed) is needed to meet client requirements, the method specifications and how they impact the project requirements must be relayed to the client for approval prior to beginning work on project samples. The client must understand the limits of the

method, why it was developed and when it will be used on their project samples, and they must agree to its use.

Any significantly modified or newly-developed method (including the addition of analytes to established procedures) must be fully defined in a Standard Operating Procedure. The validation must be performed by qualified personnel, using appropriate reagents, standards and equipment/instrumentation and that process must be documented. The following items must be performed (as applicable to the method) and the completed documentation with all raw data provided to the Operations Manager and QA Manager for review prior to granting approval for use. A new method cannot be put into production without Operations and QA approval. For situations where NELAP approval is being sought, the method cannot be used for client samples until the certification has been received from the State, unless approval is given by the client.

D.1.10.1 Significant Modification / New Method / Additional Analyte Documentation:

Prior to the acceptance of client samples for analysis, the following documentation, as applicable to the type of modification or method status, must be provided to both Operations and QA for review and approval.

1. Approved Standard Operating Procedure for Analytical or Preparation Processes. Include all related raw data for the SOP revision with the draft version.

    a) Modification of existing method: - Revised SOP with modifications clearly spelled out:

    b) New Method: - New SOP in NELAC format – QA will assign SOP number

    c) Additional Analytes: - Revised SOP with modifications clearly spelled out:

2. Method Detection Limit (MDL) Study: Compliant with 40CFR, Part 136.

    a) Include summary form and all raw data for the review

3. MDL Verification Standard spiked at 1-4x the MDL, or the level specified by the specific program or contract. Example: 1-2x the MDL, reference specific program requirements.

    b) Recovery within 30 -150%, or a minimum response distinguishable from the established instrument noise level.

4. Reporting Limit Verification (when an MDL verification is not performed)

    a) For analytical methods, reprocess the low calibration standard as percent recovery – recovery between 50% and 150% is acceptable.

    b) For extraction methods, or where required by project or program, spike a blank matrix at the reporting limit and process through all steps of the procedure. Note the spike level and percent recoveries. Method defined control limits are used for recovery evaluation, or default recoveries between 40% and 160% if method defined limits are not available.

5. Tuning Check (as applicable to the method)

6. Degradation Check (as applicable to the method)

7. A Valid Initial Calibration and Verification

    a) Minimum of 5 sequential points, unless otherwise stated in the method or in-house SOP.

    b) Low calibration standard at or below the Reporting/Quantitation Limit.

c) Initial Calibration Verification Standard

8. Retention Time Window Study

9. Second Column Confirmation for all analytes (as applicable to the method)

10. Inter-element Correction (as applicable to the method)

11. Linear Range Study (as applicable to the method)

12. GCMS Spectral Profile(s) (as applicable to the method)

13. Interference Check – Method Blank

    a) Analysis of a blank matrix that has gone through all related steps, preparation and /or analysis, as applicable.

14. Acceptable PT Sample required for all new analytes where NELAP accreditation is being sought.

    a) At least one PT sample (preferably two) required for all new methods

    b) Where a PT sample is not available, or accreditation is not needed, accuracy can be measured through the use of a second source standard.

15. For California ELAP or State NELAP, process a real world sample for MS and MSD. The sample does not have to contain any target analytes but recoveries for surrogates, internal standards and spikes must be within lab or method defined criteria.

    a) Use Tap Water for drinking water only methods, tap or other clean water source for ground, surface, etc. methods

    b) Local Soil sample for SW-846 methods (if applying for soil or soil/water)

16. Initial Demonstration of Capability (IDOC) per analyst

    a) 4 LCS for each matrix, spiked with all associated new analytes – most acceptance criteria are in the methods, if none, use an initial recovery range of 40-160% and an RPD of 30%.

    b) Non-Standard methods – Follow the procedure in the 2003 NELAC Standards, Chapter 5 appendix C.3.3 (b).

17. Certification / Approval from Regulatory Agency where available.

APPENDIX E – LIST OF ACCREDITED METHODS

E.1 Alaska Department of Environmental Conservation – Laboratory ID UST-102

a) View at: http://www.calscience.com/PDF/Alaska2.pdf

E.2 Arizona Department of Health Services – Laboratory ID AZ0781

a) View at: http://www.calscience.com/PDF/Arizona2.pdf

E.3 California State Department of Health ELAP – Laboratory ID 2803

a) View at: http://www.calscience.com/PDF/ELAP1.pdf

California State Department of Health ELAP Fields of Accreditation

a) View at: http://www.calscience.com/PDF/ELAP2.pdf

E.4 California State Department of Health NELAP – Laboratory ID 03220CA

a) View at: http://www.calscience.com/PDF/NELAP1.pdf

California State Department of Health NELAP Fields of Accreditation

b) View at: http://www.calscience.com/PDF/NELAP2.pdf

E.5 Florida Department of Health – Laboratory ID E971101

a) View at: http://www.calscience.com/PDF/Florida2.pdf

E.6 Guam Environmental Protection Agency – Laboratory ID E971101

a) View at: http://www.calscience.com/PDF/Guam2.pdf

E.7 Hawaii Department of Health – Laboratory ID (None)

a) View at: http://www.calscience.com/PDF/Hawaii.pdf

E.8 Kansas Department of Health & Environment – Laboratory ID E-10409

a) View at: http://www.calscience.com/PDF/Kansas2.pdf

E.9 Louisiana Department of Environmental Quality – Laboratory ID 05038 / AI 181640

a) View at: http://www.calscience.com/PDF/Louisiana2.pdf

E.10 Nevada Department of Conservation and Natural Resources – Laboratory ID CA001112013-1

a) View at: http://www.calscience.com/PDF/Nevada2.pdf
b) View at: http://www.calscience.com/PDF/Nevada0.pdf

E.11 New York Department of Health – Laboratory ID 11896

a) View at: http://www.calscience.com/PDF/New_York.pdf

E.12 Oregon Environmental Laboratory Accreditation Program – Laboratory ID CA300001

a) View at: http://www.calscience.com/PDF/Oregon2.pdf

E.13 Oregon Environmental Laboratory Accreditation Program – Laboratory ID CA200010

a) View at: http://www.calscience.com/PDF/Oregon4.pdf

E.14 Southern California Air Quality Management District Laboratory Accreditation Program – Laboratory ID 93LA0830

a) View at: http://www.calscience.com/PDF/SCAQMD.pdf

E.15 Texas Commission of Environmental Quality – Laboratory ID T104704499-13-3

a) View at: http://www.calscience.com/PDF/Texas2.pdf

E.16 United States Department of Agriculture Certificate No. P330-10-00403, Permit to Receive Soil

a) View at: http://www.calscience.com/PDF/USDA_Soil_Permit.pdf

E.17 United States Department of Defense ELAP Certificate L12-86-R1 and Fields of Accreditation

a) View at: http://www.calscience.com/PDF/DoD_ELAP.pdf

E.18 Utah Department of Health – Laboratory ID CA001112013

a) View at: http://www.calscience.com/PDF/Utah2.pdf

E.19 Washington Department of Ecology – Laboratory ID C916

a) View at: http://www.calscience.com/PDF/Washington2.pdf

E.20 All State Certifications / Scopes / Permits

a) View at: http://www.calscience.com/QAQC/Certifications.aspx

APPENDIX F – LIST OF PHYSICAL LOCATIONS

F.1 Main Laboratory

- 7440 Lincoln Way, Garden Grove, CA 92841-1427
- 714-895-5494 Fax 714-894-7501

F.2 Satellite Laboratory 1

- 7445 Lampson Avenue, Garden Grove, CA 92841-2903
- Fax 714-898-2036

F.3 Satellite Laboratory 2

- 11380 Knott Street, Garden Grove, CA 92841-1400

F.4 Concord, CA Service Center

- 5063 Commercial Circle, Suite H, Concord, CA 94520-8577
- 925-689-9022 Fax 925-689-9023

F.5 Houston, TX Service Center

- 1300 Bay Area Boulevard, Suite B-122, Houston, TX 77058-2558
- 832-284-4566 Fax 832-284-4568

APPENDIX G – SPECIAL PROGRAM REQUIREMENTS

F.1 United States Department of Defense Environmental Laboratory Accreditation Program

1. Calscience participates and is accredited in the United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP).

2. The DoD ELAP will provide a means for laboratories to demonstrate conformance to the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM) as authorized by DoD Instruction 4715.15, Environmental Quality Systems, December 2006 and as required by the DoD Policy and Guidelines for Acquisitions Involving Environmental Sampling or Testing, December, 2007. The DoD QSM is based on the National Environmental Laboratory Accreditation Conference (NELAC) Quality Systems standard (Chapter 5), which provides guidelines for implementing the international standard, ISO/IEC 17025, General Requirements for the Competence of Testing and Calibration Laboratories.

3. The DoD ELAP will apply to environmental programs / projects at DoD operations, activities, and installations, including Government-owned, contractor-operated facilities and formerly used defense sites, where testing is being performed in support of environmental restoration programs. The program will apply to all laboratories, including permanent, temporary, or mobile facilities, that generate definitive data, regardless of their size, volume of business, or field of accreditation; the collection of screening data will be governed by project specific requirements.

4. The current DoD Quality Systems Manual for Environmental Laboratories is Version 4.2, dated October 25, 2010.

5. Implementation of the DoD Quality Systems Manual for Environmental Laboratories Version 5.0, dated July 2013, will be phased in over the 2014-2015 time period.

6. The Calscience Management will provide sufficient training, resources and other measures to ensure compliance with the DoD QSM as appropriate. (including but not limited to):

   a. Specific Standard Operating Procedures (SOPs) and / or Appendicles
   b. DoD compliant Laboratory Information Management System (LIMS) analytical test codes
   c. Specialized technician and chemist training
   d. Enhanced Quality Assurance (QA) oversight
   e. Project specific instruments
   f. Assigned Project Management personnel
   g. Quality Assurance Project Plans (QAPP)
   h. DoD analytical data reporting qualifiers
   i. Calibration and reference materials that meet DoD requirements.

APPENDIX H – LISTING OF MAJOR ANALYTICAL INSTRUMENTATION

GC/MS SYSTEMS

Designation	Manufacturer/Model	Serial Number	Acquired	Department	OS
GC/MS-K	HP 6890	US00024158	1998	Air	XP
	HP5973	US82311263	1998		
	Entech 7100A	0063	1998		
	Entech 7016CA	00142	1998		
GC/MS-L	HP 6890	US00023714	1998	Volatiles	XP
	Agilent 5973	US82311287	1998		
	Tekmar Atomx	US09163001	2009		
GC/MS-M	HP 6890	US00028876	1999	Volatiles	XP
	HP 5973	US9192601	1999		
	Tekmar Stratum	US08283015	2010		
	Varian Archon	MS0903W013	2010		
GC/MS-O	Agilent 6890N	US00034260	2000	LUFT-TPPH	XP
	Agilent 5973	US94240048	2000		
	Tekmar 3100	US02261003			
	Varian Archon	13863	2002		
GC/MS-P	Agilent 6890	US00034661	2000	Semivolatiles	XP
	Agilent 5973N	US94240038	2000		
GC/MS-Q	Agilent 6890	US00037519	2000	Volatiles	XP
	Agilent 5973	US03340458	2000		
	Tekmar 3100	00242002	2000		
	Varian Archon	13386	2000		
GC/MS-R	Agilent 6890	US00037782	2000	Volatiles	XP
	Agilent 5973	US03340489	2000		
	Tekmar Stratum	US12111001	2013		
	Varian Archon	14040	2003		
GC/MS-S	Agilent 6890	US00030897	2000	Volatiles	XP
	Agilent 5973	US03340414	2000		
	Tekmar Atomx	US11034002	2011		
GC/MS-T	Agilent 6890	US00039185	2000	Volatiles	XP
	Agilent 5973	US03940628	2000		
	Tekmar Atomx	US11048001	2011		
GC/MS-U	Agilent 6890	US00036171	2001	Summa QC	XP
	Agilent 5973	US02450134	2001		
GC/MS-V	Agilent 6890	US00036172	2001	Air	XP
	Agilent 5973	US02450131	2001		
	Entech 7100A	1092	2005		

	Entech 7016CA	1041	2005		
GC/MS-W	Agilent 6890	US00036170	2001	Volatiles	XP
	Agilent 5973	US02450128	2001		
	Tekmar 3100	US01362003	2001		
	Varian Archon	13573	2001		
GC/MS-X	Agilent 6890N	US10203064	2002	LUFT-TPPH	XP
	Agilent 5973	US10462129	2002		
	Tekmar 3100	00305010	2001		
	Varian Archon	13616	2001		
GC/MS-Y	Agilent 6890	US10203153	2002	Semivolatiles	XP
	Agilent 5973	US10442209	2002		
GC/MS-Z	Agilent 6890N	US10225110	2002	Volatiles	XP
	Agilent 5973	US21842958	2002		
	Tekmar 3100	US02213007	2002		
	Varian Archon	15278	2008		
GC/MS-AA	Agilent 6890N	US10225149	2002	Air	XP
	Agilent 5973N	US21843250	2002		
	Entech 7100A	1045	2003		
	Entech 7016CA	1183	2004		
	Entech 7016CA	1212	2004		
GC/MS-BB	Agilent 6890N	US1023004	2002	Volatiles	XP
	Agilent 5973N	US21843288	2002		
	Tekmar 3100	US02249001	2007		
	Varian Archon	15208	2007		
GC/MS-CC	Agilent 6890N	US10233039	2002	Volatiles	XP
	Agilent 5973N	US21843272	2002		
	Tekmar Stratum	US10272001	2011		
	Varian Archon	13431	2002		
GC/MS-DD	Agilent 6890N	US10239018	2002	Air	XP
	Agilent 5973N	US21843913	2002		
	Entech 7100A	1432			
	Entech 7016CA	1018	2002		
	Entech 7016CA	1187			
GC/MS-EE	Agilent 6890N	US10248096	2003	LUFT-TPPH	2000
	Agilent 5973N	US21844395	2003		
	Tekmar 3100	US01317009	2001		
	Varian Archon	MS092W026			
GC/MS-FF	Agilent 6890N	DE00020253	2003	Summa QC	XP
	Agilent 5973N	US21844222	2003		
GC/MS-GG	Agilent 6890N	CN10337014	2003	Marine Lab	XP

	Agilent 5973N	US33246020	2003		
	Agilent GC 80 SPME	CH00213565	2011		
GC/MS-HH	Agilent 6890N	CN10337015	2003	Air	XP
	Agilent 5973	US30945837	2003		
	Entech 7100A	1081	2003		
	Entech 7016CA	1012	2003		
	Entech 7016CA	1038	2003		
GC/MS-II	Agilent 6890	CN10517039	2005	Air	XP
	Agilent 5973	US44647341	2005		
	Entech 7100A	1458	2008		
	Entech 7016CA	1098	2005		
	Entech 7016CA	1225	2008		
GC/MS-JJ	Agilent 6890N	CN10547073	2005	Volatiles	XP
	Agilent 5973	US53941344	2005		
	Tekmar Stratum	US10230002	2010		
	Varian Archon	14529	2005		
GC/MS-KK	Agilent 6890	CN10545117	2005	Air	XP
	Agilent 5973	US53941343	2005		
	Entech 7100A	1221	2005		
	Entech 7016CA	1207			
	Entech 7016CA	1210			
GC/MS-LL	Agilent 6890N	CN10651084	2007	Volatiles	XP
	Agilent 5975B	US63214670	2007		
	Tekmar Stratum	US13099008	2013		
	Tekmar SOLATek	US09040001	2009		
GC/MS-MM	Agilent 6890N	CN10651076	2007	Semivolatiles	XP
	Agilent 5975B	US62715103	2007		
GC/MS-NN	Agilent 7890A	CN10717056	2007	Air	XP
	Agilent 5975C	US71215995	2007		
	Entech 7100A	1291	2012		
	Entech 7016CA	1211			
	Entech 7150	45	2010		
	Entech 7410	138	2010		
GC/MS-OO	Agilent 7890A	CN10745139	2007	Volatiles	XP
	Agilent 5975C	US73317841	2007		
	Tekmar Stratum	US07277008	2009		
	Tekmar SOLATek	US09049003	2009		
GC/MS-PP	Agilent 7890A	CN10744086	2007	Volatiles	XP
	Agilent 5975C	US73317584	2007		
	Tekmar Stratum	US07277012	2009		

	Tekmar SOLATek	US09051008	2009		
GC/MS-QQ	Agilent 7890A	CN10742034	2007	Volatiles	XP
	Agilent 5975C	US71216778	2007		
	Tekmar Stratum	US07277018	2008		
	Tekmar SOLATek	US08032004	2008		
GC/MS-RR	Agilent 7890A	CN10730015	2007	Volatiles	XP
	Agilent 5975C	US73317844	2007		
	Tekmar Stratum	US08032004	2008		
	Tekmar SOLATek	US08032006	2008		
GC/MS-SS	Agilent 7890A	CN10803049	2007	Semivolatiles	XP
	Agilent 5975C	US80618497	2007		
GC/MS-TT	Agilent 7890A	CN10806032	2007	Semivolatiles	XP
	Agilent 5975C	US80618456	2007		
GC/MS-UU	Agilent 7890A	CN10805004	2007	Volatiles	XP
	Agilent 5975C	US71215984	2007		
	Tekmar Stratum	US08087006	2008		
	Tekmar SOLATek	US08092001	2008		
GC/MS-VV	Agilent 7890A	CN10805094	2007	Volatiles	XP
	Agilent C5975	US80118376	2007		
	Tekmar Stratum	US08283015	2008		
	Tekmar SOLATek	US09050003	2008		
GC/MS-WW	Agilent 7890A	CN10803015	2007	Volatiles	XP
	Agilent 5975C	US80118375	2007		
	Tekmar Stratum	US08283014	2009		
	Tekmar SOLATek	US09040001	2009		
GC/MS-XX	Agilent 7890A	CN10815050	2008	Volatiles	XP
	Agilent 5975C	US80828968	2008		
	Tekmar 3100	US02233006	2008		
	Varian Archon	15273	2008		
GC/MS-YY	Agilent 7890A	CN10814115	2008	Air	XP
	Agilent C5975	US80828967	2008		
	Entech 7100A	1431	2008		
	Entech 7016CA	1208	2008		
	Entech 7016CA	1214	2008		
GC/MS-ZZ	Agilent 7890A	CN10814050	2008	Air	XP
	Agilent 5975C	US80828953	2008		
	Markes TD-100	GB00K10173	2011		
GC/MS-AAA	Agilent 7890A	CN10812068	2008	Semivolatiles	XP
	Agilent 5975C	US80828988	2008		
GC/MS-BBB	Agilent 7890A	CN10947130	2009	Semivolatiles	XP

	Agilent 5975C	US93414124	2009		
	Agilent 7693 (Tray)	CN94701470	2009		
	Agilent 7693 (Injector)	CN11200098	2009		
GC/MS-CCC	Agilent 7890A	CN10947129	2009	Semivolatiles	XP
	Agilent 5975C	US93414097	2009		
	Agilent 7693 (Tray)	CN94901515	2009		
	Agilent 7693 (Injector)	CN95002678	2009		
GC/MS-DDD	Agilent 7890A	CN10031142	2009	Semivolatiles	XP
	Agilent 5975C	US10197302	2009		
	Agilent 7693 (Tray)	CN10210002	2009		
	Agilent 7693 (Injector)	CN10140077	2009		
GC/MS-EEE	Agilent 7890A	CN10241112	2009	Semivolatiles	XP
	Agilent 5975C	US10257401	2009		
	Agilent 7693 (Tray)	CN10210100	2009		
	Agilent 7693 (Injector)	CN10230009	2009		
GC/MS-FFF	Agilent 7890A	CN10391179	2010	Volatiles	XP
	Agilent 5975C	US10407502	2010		
	Tekmar Atomx	US10200002	2010		
GC/MS-GGG	Agilent 7890A	CN10401096	2010	Volatiles	XP
	Agilent 5975C	US10287508	2010		
	Tekmar Atomx	US10246002	2010		
GC/MS-HHH	Agilent 7890A	CN10521074	2010	Semivolatiles	Win 7
	Agilent 5975C	CN11030007	2010		
	Agilent 7693 (Tray)	US11077507	2010		
	Agilent 7693 (Injector)	CN11050288	2010		
GC/MS-III	Agilent 7890A	CN10521075	2010	Semivolatiles	Win 7
	Agilent 5975C	US11077506	2010		
	Agilent 7693 (Tray)	CN11030009	2010		
	Agilent 7693 (Injector)	CN11050291	2010		
GC/MS-JJJ	Agilent 7890A	CN11441070	2011	Semivolatiles	Win 7
	Agilent 5975C	US11447702	2011		
	Agilent 7693 (Tray)	CN11440045	2011		
	Agilent 7693 (Injector)	CN11390136	2011		
GC/MS-KKK	Agilent 7890A	CN11441059	2011	Air	Win 7
	Agilent 5975C	US11447704	2011		
	Entech 7100A	1384	2008		
	Entech 7016CA	1212	2008		
	Entech 7016CA	1183	2007		
GC/MS-LLL	Agilent 7890A	CN12031151	2012	Marine Lab	Win 7

	Agilent 5975C	US12097802	2012		
GC/MS-MMM	Agilent 7890A	CN12261027	2012	Air	Win 7
	Agilent 5975C	US12262A09	2012		
	Markes TD-100	GB00k10257	2012		

GC TRIPLEQUAD SYSTEMS

Designation	Manufacturer/Model	Serial Number	Acquired	Department	OS
GC/TQ-1	Agilent 7890A	US11041024	2011	Marine Lab	Win 7
	Agilent 7000 TQ/MS	US11046401	2011		
	Agilent 7693 (Tray)	CN11030015	2011		
	Agilent 7693 (Injector)	CN11050297	2011		
GC/TQ-2	Agilent 7890A	US11291011	2011	Marine Lab	Win 7
	Agilent 7000 TQ/MS	US11196604	2011		
	Agilent 7693 (Tray)	CN11180027	2011		
	Agilent 7693 (Injector)	CN95002669	2011		

GC SYSTEMS

Designation	Manufacturer/Model	Serial Number	Acquired	Department	OS
GC-1	HP 5890 Series II Detector(s): PID/FID	3310A48771	1987	LUFT-GRO	2000
	OI 4560	M049460695	2000		
	Varian Archon	15301	2008		
GC-4	HP 5890 Detector(s): PID/FID	2750A17251	1989	LUFT-GRO	XP
	OI 4560	B239040			
	Varian Archon	13142	1999		
GC-8	HP 5890 Series II PID/FID	3033A31219	1990	LUFT-GRO	XP
	Tekmar 3100	US02249004	2002		
	Varian Archon	MS1010W015			
GC-9	HP 5890 Series II Detector(s): FID/FID	3033A32951	1991	Semivolatiles	NT
GC-12	HP 5890 Series II Detector(s): FID/TCD	3118A35448	1991	Semivolatiles	NT
GC-13	HP 5890 Series II FID/TCD	3033A32929	1990	Air	XP
GC-14	HP 5890 Series II Detector(s): FPD	3126A36770	1991	Air	XP
GC-18	HP 5890 Series II Detector(s): PID/FID	3235A44156	1992	LUFT-GRO	2000
	EST Encon	512080906			
	Varian Archon	15307	2008		

GC-21	HP 5890 Series II Detector(s): PID/FID	3336A51475	1994	LUFT-GRO	XP
	OI 4560	H416460182			
	Varian Archon	MS0902W025			
GC-22	HP 5890 Series II+ Detector(s): PID/FID	3336A61360	1994	LUFT-GRO	XP
	OI Eclipse 4660	D815466810P			
	Varian Archon	14699	2006		
GC-24	HP 5890 Series II+ Detector(s): PID/FID	3336A53949	1994	LUFT-GRO	2000
	Tekmar 3000	98194007	1998		
	Varian Archon	13864	2004		
GC-25	HP 5890 Series II+ Detector(s): PID/FID	2921A23805	1994	LUFT-GRO	XP
	Tekmar 3100	314009			
	Varian Archon	13470	2001		
GC-26	HP 6890 Detector(s): NPD/NPD	US00001017	1995	Semivolatiles	XP
GC-29	HP 5890 Series II Detector(s): PID/FID	3310A47430	2000	LUFT-GRO	XP
	Tekmar 3100	US02249008	2002		
	Varian Archon	13874	2002		
GC-31	HP 6890 Detector(s): ECD/ECD	US00037979	2000	Semivolatiles	XP
GC-34	HP 5890 Series II Detector(s): FID	3033A32699	2000	Air	XP
GC-35	Agilent 6890N Detector(s): NPD/NPD	US10206061	2002	Semivolatiles	XP
GC-36	Agilent 6890N Detector(s): FID/TCD	US10346058	2004	Air	XP
GC-37	Agilent 6890N Detector(s): ECD/ECD	CN10350094	2004	Marine Lab	XP
GC-38	HP 5890 Series II Detector(s): FID	3029A30188	1995	Air	XP
GC-40	Agilent 7890N Detector(s): ECD/ECD	CN10647089	2007	Semivolatiles	XP
GC-41	Agilent 7890N Detector(s): ECD/ECD	CN10650013	2007	Semivolatiles	XP
GC-42	Agilent 6890N Detector(s): PID/FID	CN10647056	2007	LUFT-GRO	XP
	Tekmar 3100	US01274007			
	Varian Archon	14370	2004		
GC-43	Agilent 6890N Detector(s): FID	CN10720004	2007	LUFT-DRO	XP
GC-44	Agilent 6890N Detector(s): FID/FID	CN10721103	2007	Semivolatiles	XP
GC-45	Agilent 7890A Detector(s): FID/FID	CN10808107	2007	LUFT-DRO	XP

GC-46	Agilent 7890A Detector(s): FID/FID	CN1080815	2007	LUFT-DRO	XP
GC-47	Agilent 7890A Detector(s): FID/FID	CN10819056	2008	LUFT-DRO	XP
GC-48	Agilent 7890A Detector(s): FID/FID	CN10819057	2008	LUFT-DRO	XP
GC-49	Agilent 7890A Detector(s): FID/FID	CN10820151	2008	LUFT-DRO	XP
GC-50	Agilent 7890A Detector(s): FID/FID	CN10820150	2008	LUFT-DRO	XP
GC-51	Agilent 7890A Detector(s): ECD/ECD	CN10822026	2008	Semivolatiles	XP
GC-52	Agilent 7890N Detector(s): FID	CN10824005	2008	Air	XP
GC-53	Agilent 6890N Detector(s): FID	US00002691	2000	Air	XP
GC-54	Agilent 7890A Detector(s): FPD	US10840051	2008	Air	XP
GC-55	Agilent 7890N Detector(s): TCD	CN10844112	2008	Air	XP
GC-56	Agilent 7890N Detector(s): FID	CN10847124	2009	LUFT-GRO	XP
	OI Eclipse	D647466449P			
	Varian Archon	15139	2007		
GC-57	Agilent 7890N Detector(s): ECD/ECD	CN10847113	2009	LUFT-GRO	XP
	OI Eclipse	D81466987P			
	Varian Archon	15140	2007		
GC-58	Agilent 7890N	CN10942196	2009	Semivolatiles	XP
GC-59	Agilent 7890N Detector(s): FID	CN10041127	2009	Air	XP
GC-60	Agilent 6890N Detector(s): FID	US10247091	2003	Air	XP
GC-61	Agilent 6890N Detector(s): FID	US00007963	1998	Air	XP
GC-62					
GC-63	Agilent 7890A Detector(s): ECD/ECD	CN12151152	2012	Marine	XP
GC-64	Agilent 6890A Detector(s): FID	US00030941		Air	XP
GC-65	Agilent 7890A Detector(s): FID	CN12111151	2012	Air	XP
GC-66	Agilent 7890A Detector(s): FID Agilent 7693 (Tray) Agilent 7693 (Injector)	CN12421146 CN12320016 CN12300140	2012	Semivolatiles	XP

Inductively Coupled Plasma Spectrophotometers (ICP)

Designation	Manufacturer/Model	Serial Number	Acquired	Department	OS
ICP-6	PE Optima 5300 DV	077C6121502	2006	Metals	XP
ICP-7	PE Optima 7300 DV	077C8120401	2008	Metals	XP
	ESI SC FAST	FST04-TSP-091203			

Inductively Coupled Plasma/Mass Spectrometers (ICP/MS)

Designation	Manufacturer/Model	Serial Number	Acquired	Department	OS
ICP/MS-3	PE ELAN DRC-e		2009	Metals	XP
ICP/MS-4	PE ELAN DRC-e	AH 13440801	2009	Metals	XP
	ESI SC4 DX	X4DX5HSTSP16110603			
ICP/MS-5	PE NexION 300D	81DN1120502	2011	Metals	XP
	ESI SC4 DX		2001		

Flame Atomic Absorption Spectrometers (FAA)

Designation	Manufacturer/Model	Serial Number	Acquired	Department	OS
FAA-3	PE PinAAcle 900F	PFAS11090701	2011	Metals	Win 7

Mercury Analyzers

Designation	Manufacturer/Model	Serial Number	Acquired	Department	OS
HG-4	PE FIMS-400		2005	Metals	XP
HG-5	PE FIMS-400		2005	Metals	XP
HG/AF-1	Teledyne Hydra II	1095	2011	Metals	Win 7

High Performance Liquid Chromatographs (HPLC)

Designation	Manufacturer/Model	Serial Number	Acquired	Department	OS
HPLC-5 Agilent 1100 HPLC	Variable Wave. Det.	JP116144U1	2001	Semivolatiles	XP
	Column Compartment	DE11120911	2001		
	Quat. Pump	DE11114727	2001		
	Degasser	JP05029389	2001		
	Autosampler	DE11115637	2001		
HPLC-6 Agilent 1100 HPLC	Variable Wave. Det.	JP11414177	2001	Semivolatiles	XP
	Quat. Pump	DE11114712	2001		
	Degasser	JP05029404	2001		
	Autosampler	DE11115492	2001		
HPLC-7 Agilent 1100 HPLC	Variable Wave. Det.	DE43602867	2004	Semivolatiles	XP
	Iso Pump	DE409006799	2004		

	Column Compartment	DE111210117	2004		
	Autosampler	DE33225927	2004		
Pickering	Pinnacle PCX	513305	2013		
HPLC-8	Multi. Wave. Det.	DE60555324		Marine Lab	XP
Agilent 1200 HPLC	Iso Pump	DE62956826			
	Fraction Collector	DE60555134			
	Autosampler	DE63055195			

Liquid Chromatography/Mass Spectrometry (LC/MS/MS)

Designation	Manufacturer/Model	Serial Number	Acquired	Department	OS
LC/TQ-1	Varian 1200L Triple Quad	3060	2005	Inorganics	XP
	Varian Prostar 210	4151	2005		
	Varian Prostar 210	4152	2005		
	Varian 410 Autosampler	50062	2005		
LC/TQ-2	Agilent 6430 LC/MS Triple Quad	SG11077104	2013	Inorganics	7
	Agilent 1260 Quat Pump	DEAB707001	2013		
	Agilent 1260 ALS	DEAAC17936	2013		
TOC-5	OI Soil Module Detector(s): IR	C726776952	2007	Inorganics	XP
TOC-6	OI Aurora 1030	J025730749P	2011	Inorganics	XP
	OI 1088 A/S	J025730749P	2011		
TOC-8	OI Aurora 1030	N248731638P	2012	Inorganics	XP
	OI 1088 A/S	E248788640	2012		
IC-7	Dionex ICS-1000 Detector(s): Conductivity	3100486	2003	Inorganics (Anions)	XP
IC-8	Dionex ICS-2000 Detector(s): Conductivity	4100279	2004	Inorganics (Perchlorate)	XP
IC-9	Dionex ICS-1000 Detector(s): Conductivity	8120823	2008	Inorganics (Anions)	XP
IC-10	Dionex ICS-1000 Detector(s): Conductivity	8120822	2008	Inorganics (Anions)	XP
IC-11	Variable Wave. Detector	8120958	2009	Inorganics	XP
Dionex ICS-3000	Single Pump	9010071	2009	(Cr(VI))	
	Column Comp.	8120362	2009		
IC-12	Variable Wave. Detector	9060673	2009	Inorganics	XP
Dionex ICS-3000	Single Pump	9060616	2009	(Cr(VI))	
	Column Comp.	9010928	2009		

IC-13	Dionex ICS-1100 Detector(s): Conductivity	9120764		Inorganics	XP
IC-14 Dionex ICS-5000	Variable Wave. Detector	9100584		Inorganics	XP
	Single Pump	10100152			
	Column Comp.	10100022			
	AS-DV Autosampler	10100586			
ACA1	OI 3360 Flow Analyzer Detector(s): UV	751893730	2007	Inorganics	XP
UV-4	Thermo Detector(s): UV	3DUK232006	2007	Inorganics	XP
UV-5	Thermo Detector(s): UV	3DUK228001	2007	Inorganics	XP
UV-7	Agilent 8453 Detector(s): Diode Array	CN22807187	2008	Inorganics	XP
UV-8	Agilent 8453 Detector(s): Diode Array	CN22808466	2010	Inorganics	XP
UV-9	Agilent 8453 Detector(s): Diode Array	CN22809400	2013	Inorganics	XP

FT-IR Spectrometer

Designation	Manufacturer/Model	Serial Number	Acquired	Department	OS
IR-2	P.E. Spectrum Two	89327	2011	LUFT-DRO	Win 7

Automated Extractors

Designation	Manufacturer/Model	Serial Number	Acquired	Department
ASE-1	Dionex ASE-200	98120515	1999	Marine Lab
ASE-2	Dionex ASE-200	99090112	1999	Extractions
ASE-3	Dionex ASE-300	1100597	2002	Extractions
ASE-4	Dionex ASE-300	1100598	2002	Extractions
ASE-5	Dionex ASE-200	07040191	2007	Marine Lab
ASE-6	Dionex ASE-200	07010483	2007	Extractions
ASE-7	Dionex ASE-350	08080167	2010	Extractions
ASE-8	Dionex ASE-350	09020620	2010	Extractions
ASE-9	Dionex ASE-350	10090204	2012	Extractions
ASE-10	Dionex ASE-350	10090546	2012	Extractions

Solid Phase Extraction Unit

Designation	Manufacturer/Model	Serial Number	Acquired	Department
SPE-1	Horizon Tech/ 4790		2010	Extractions

SPE-2	Horizon Tech/ 4790		2010	Extractions
SPE-3	Horizon Tech/ 4790		2010	Extractions
SPE-4	Horizon Tech/ 4790		2010	Extractions
SPE-5	Horizon Tech/ 4790		2010	Extractions
SPE-6	Horizon Tech/ 4790		2010	Extractions
SPE-7	Horizon Tech/ 4790		2010	Extractions
SPE-8	Horizon Tech/ 4790		2010	Extractions

Particle Size Analyzer

Designation	Manufacturer/Model	Serial Number	Acquired	Department	OS
PSA-1	B.C. LS13320	AT39390	2011	Marine Lab	XP

Gas Mixer

Designation	Manufacturer/Model	Serial Number	Acquired	Department
Mixer 1	Environics Series 2000	1490	2005	Air
Mixer 2	Environics Series 2000	4618	2009	Air

END OF DOCUMENT

APPENDIX B
TEST AMERICA LABORATORIES, INC.
QUALITY MANUAL

Exemption 4, Claimed CBI, pages 296-738

APPENDIX C
HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN AVAILABLE UPON REQUEST

UPDATED ANNUALLY

APPENDIX D
DECISION DIAGRAMS

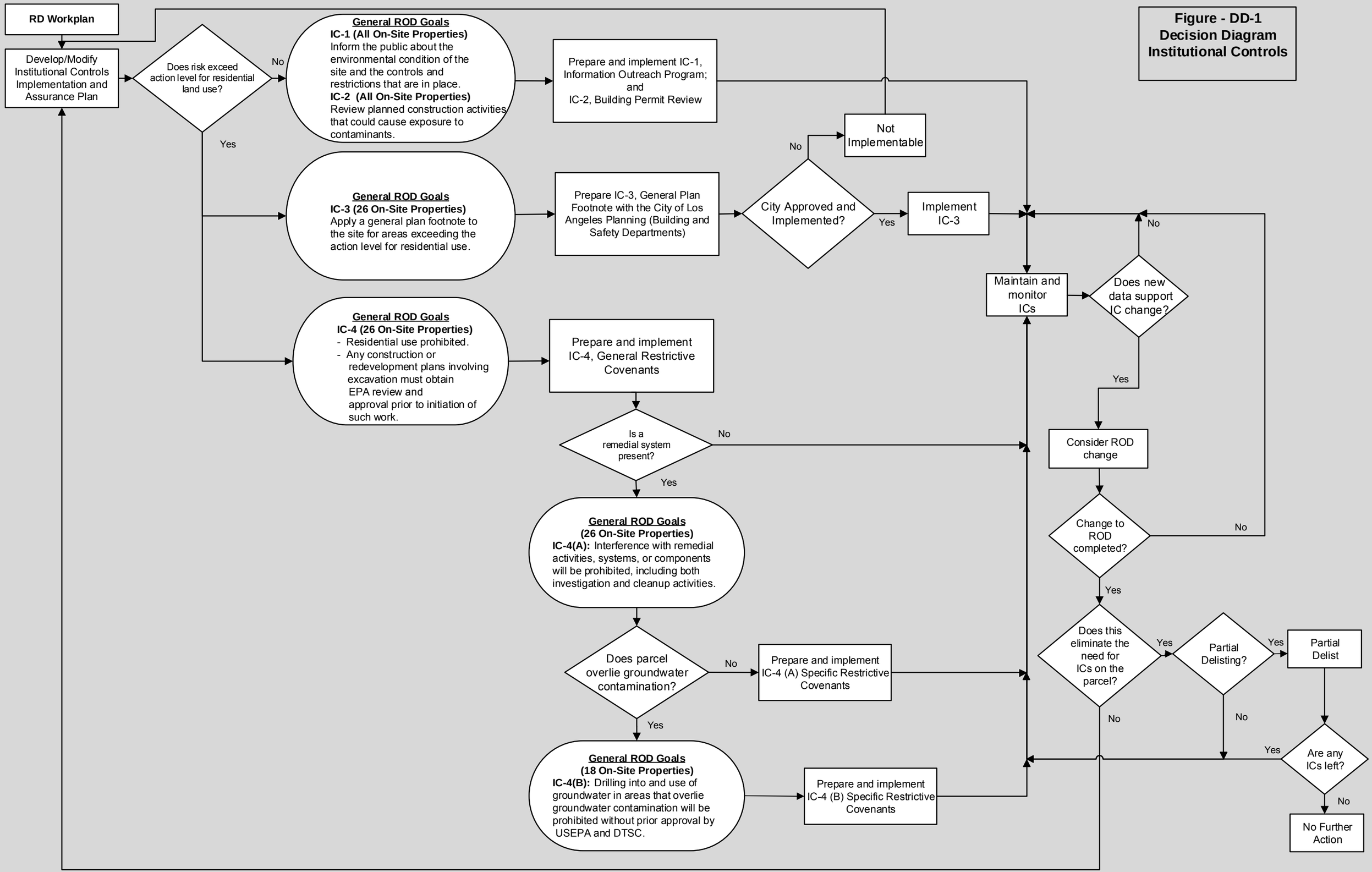
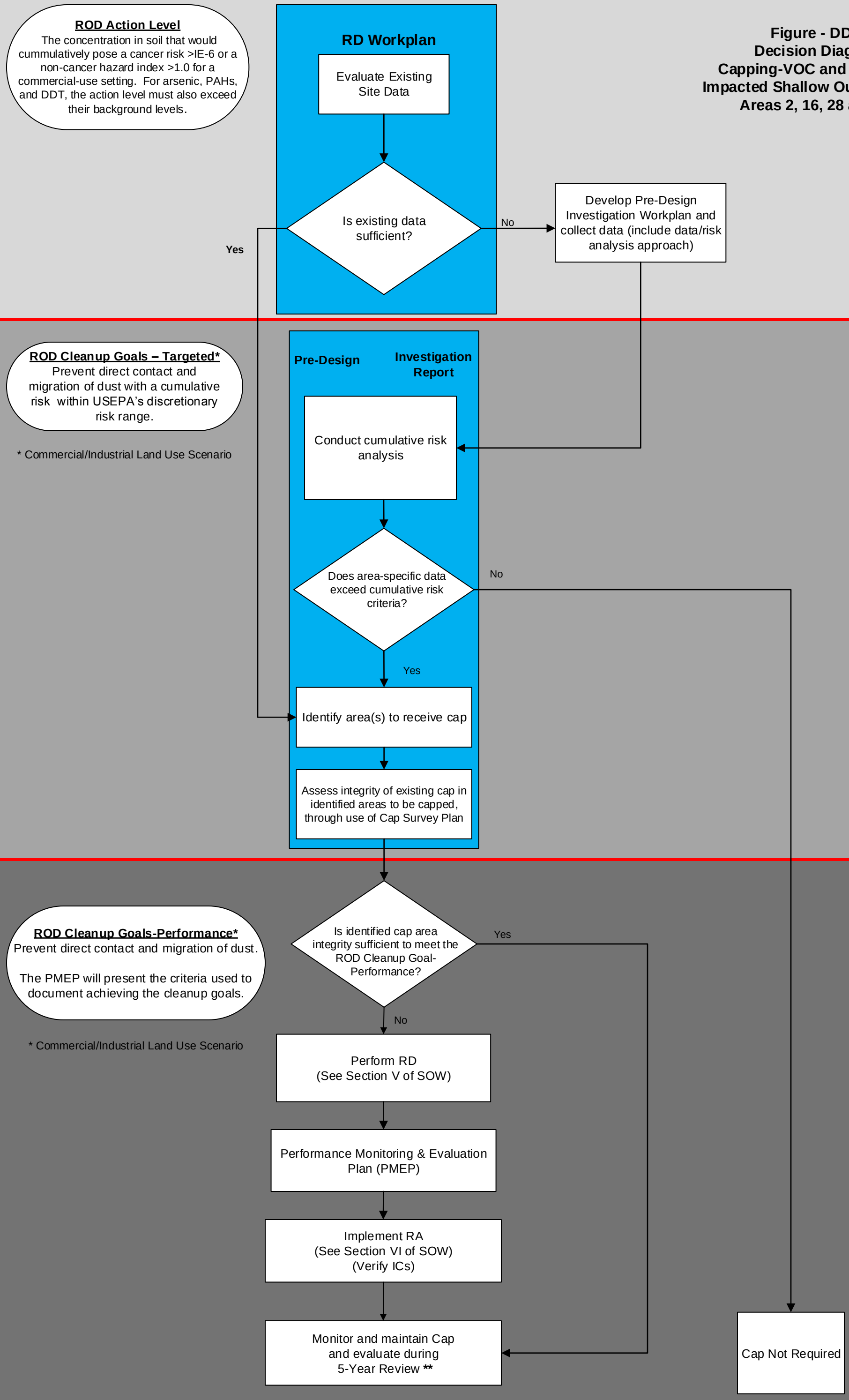


Figure - DD-1
Decision Diagram
Institutional Controls
RD Workplan
Develop/Modify Institutional Controls Implementation and Assurance Plan
Does risk exceed action level for residential land use?
No
Yes
General ROD Goals
IC-1 (All On-Site Properties)
Inform the public about the environmental condition of the site and the controls and restrictions that are in place.
IC-2 (All On-Site Properties)
Review planned construction activities that could cause exposure to contaminants.
Prepare and implement IC-1, Information Outreach Program; and IC-2, Building Permit Review
General ROD Goals
IC-3 (26 On-Site Properties)
Apply a general plan footnote to the site for areas exceeding the action level for residential use.
Prepare IC-3, General Plan Footnote with the City of Los Angeles Planning (Building and Safety Departments)
City Approved and Implemented?
No
Not Implementable
Yes
Implement IC-3
General ROD Goals
IC-4 (26 On-Site Properties)
- Residential use prohibited.
- Any construction or redevelopment plans involving excavation must obtain EPA review and approval prior to initiation of such work.
Prepare and implement IC-4, General Restrictive Covenants
Is a remedial system present?
No
Yes
General ROD Goals
(26 On-Site Properties)
IC-4(A): Interference with remedial activities, systems, or components will be prohibited, including both investigation and cleanup activities.
Does parcel overlie groundwater contamination?
No
Prepare and implement IC-4 (A) Specific Restrictive Covenants
Yes
General ROD Goals
(18 On-Site Properties)
IC-4(B): Drilling into and use of groundwater in areas that overlie groundwater contamination will be prohibited without prior approval by USEPA and DTSC.
Prepare and implement IC-4 (B) Specific Restrictive Covenants
Maintain and monitor ICs
Does new data support IC change?
No
Yes
Consider ROD change
Change to ROD completed?
No
Yes
Does this eliminate the need for ICs on the parcel?
Yes
No
Partial Delisting?
Yes
No
Partial Delist
Are any ICs left?
Yes
No
No Further Action

Figure - DD-2
Decision Diagram
Capping-VOC and Non-VOC Impacted Shallow Outdoor Soils
Areas 2, 16, 28 and 35



** An Area-Specific Remedial Action Report will be prepared when performance standards have been achieved.

Figure - DD-3
Decision Diagram
Building Engineering Controls (BECs) for VOC-Impacted Shallow Soils Under A Building
Area 16

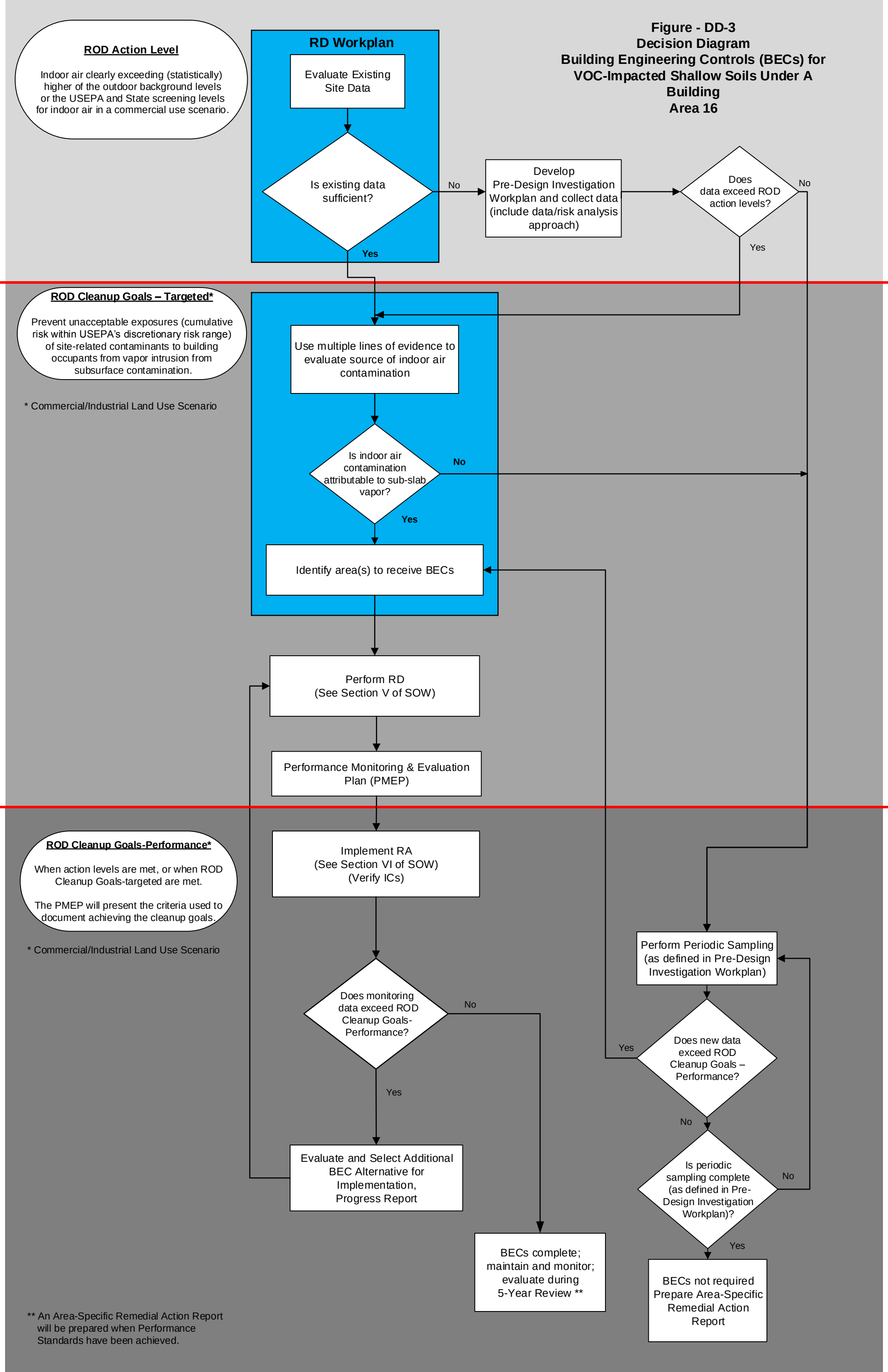


Figure - DD-4
Decision Diagram
Soil Vapor Extraction (SVE)
VOC-Impacted Outdoor Shallow Soils
Areas 6,11,& 23

(Only Area 23 has been identified to receive a Pilot Study, as agreed with USEPA)

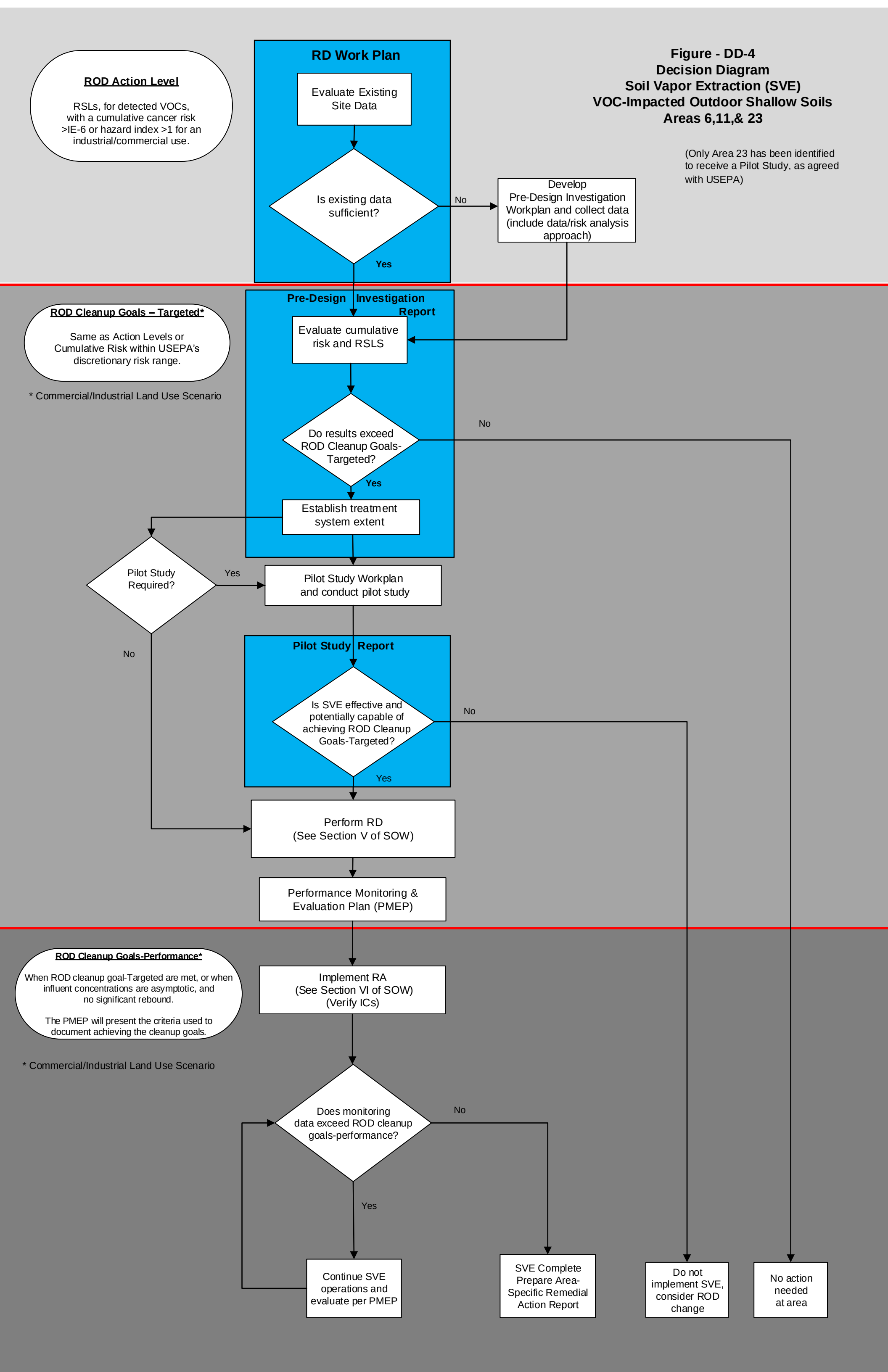


Figure - DD-5
Decision Diagram
Soil Vapor Extraction (SVE)
VOC Impacted Soils
Under a Building
Area 23 (Southern Portion of the Building)

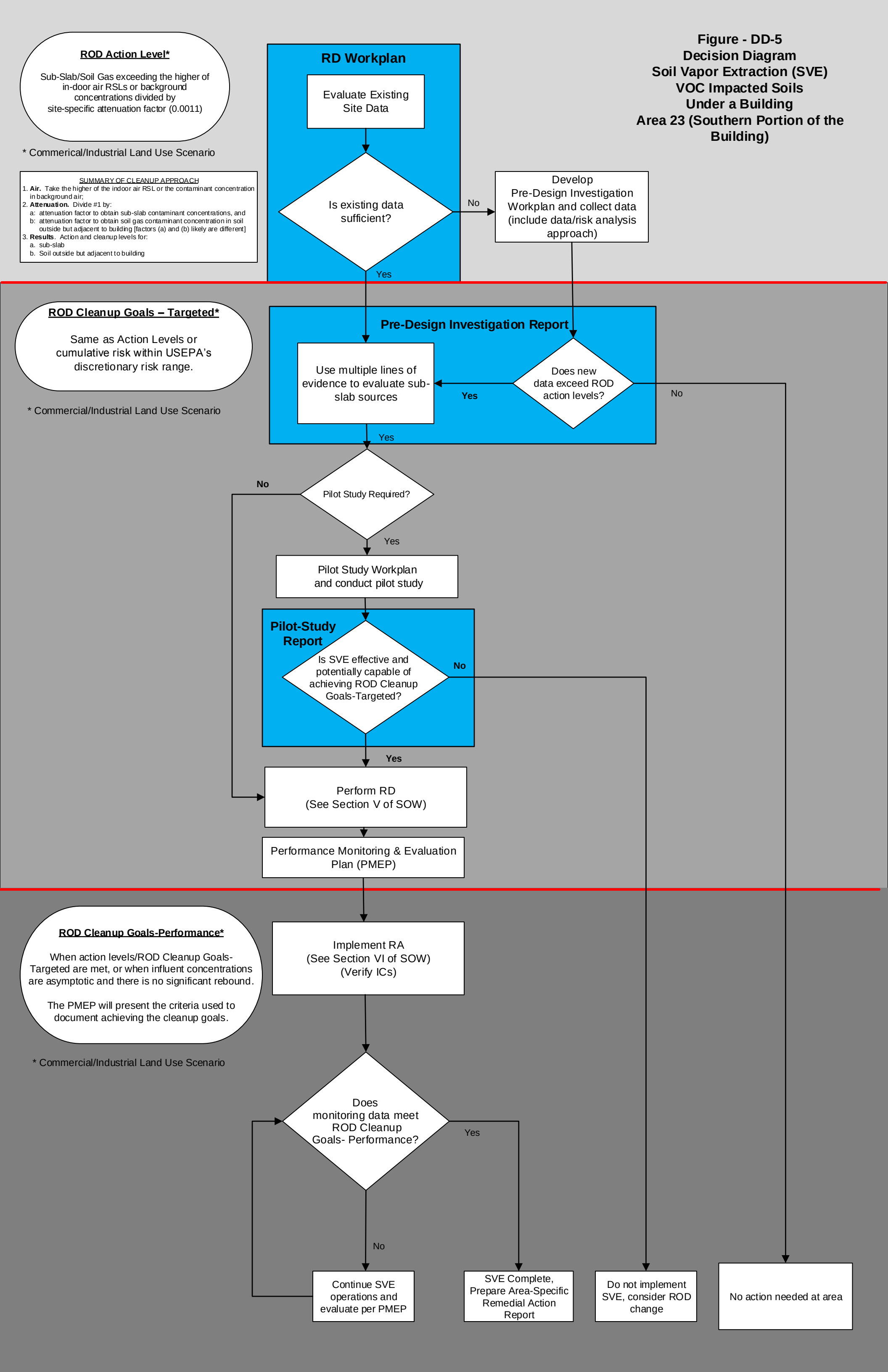


Figure - DD-6
Decision Diagram
Soil Vapor Extraction (SVE)
Vadose Soil in a VOC NAPL-Impacted Groundwater Contamination
Source Area 6 (SA-6)

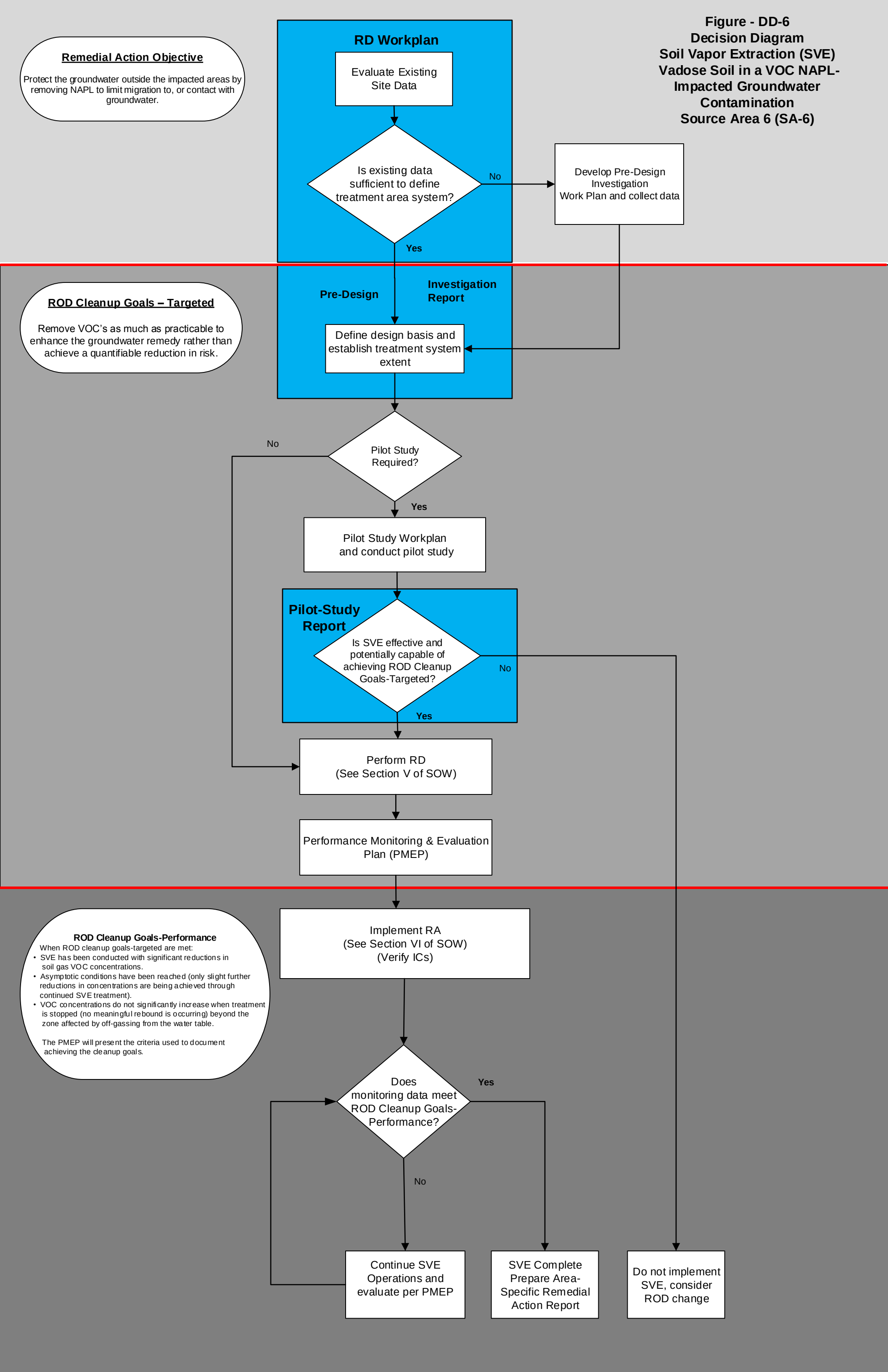
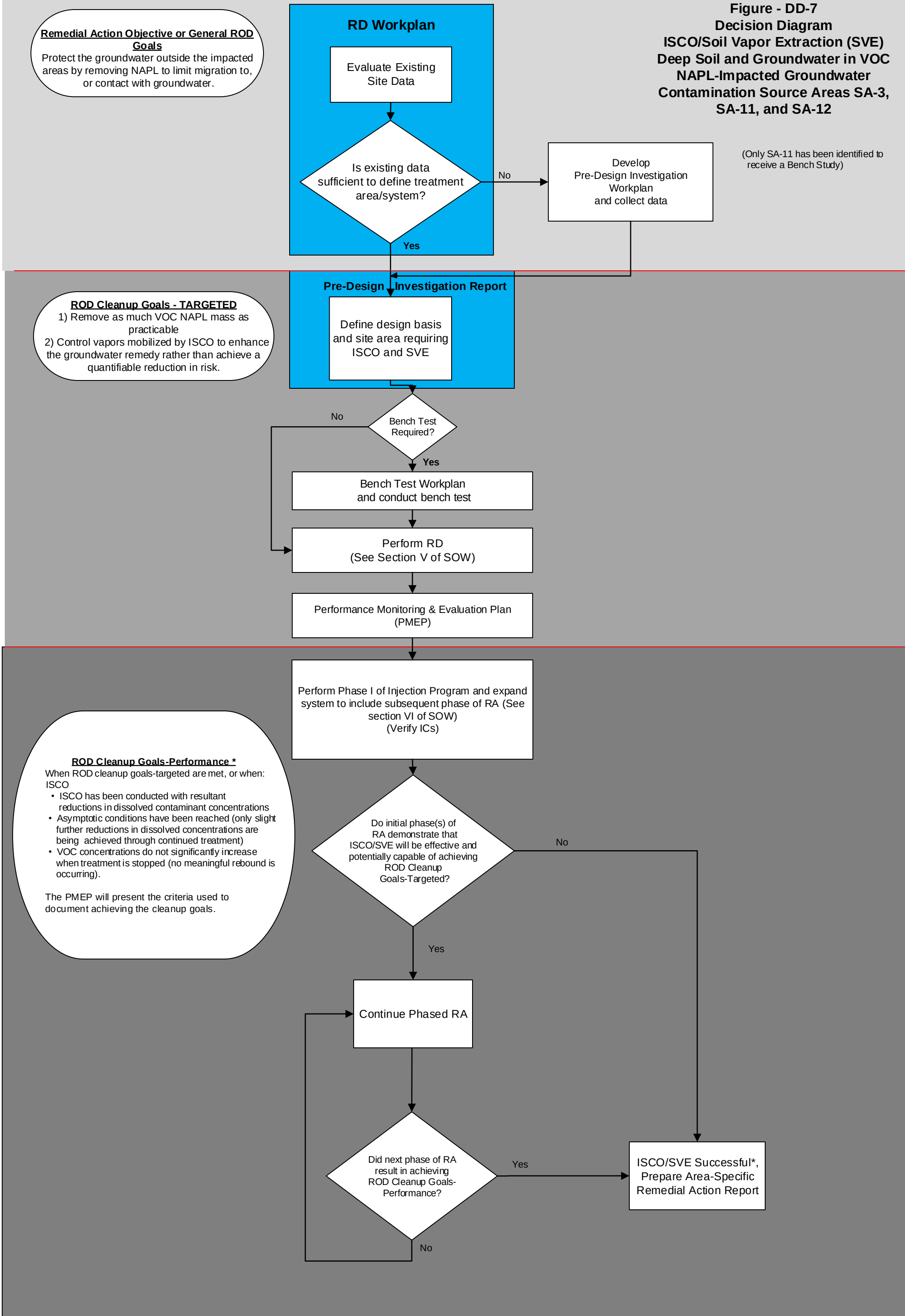
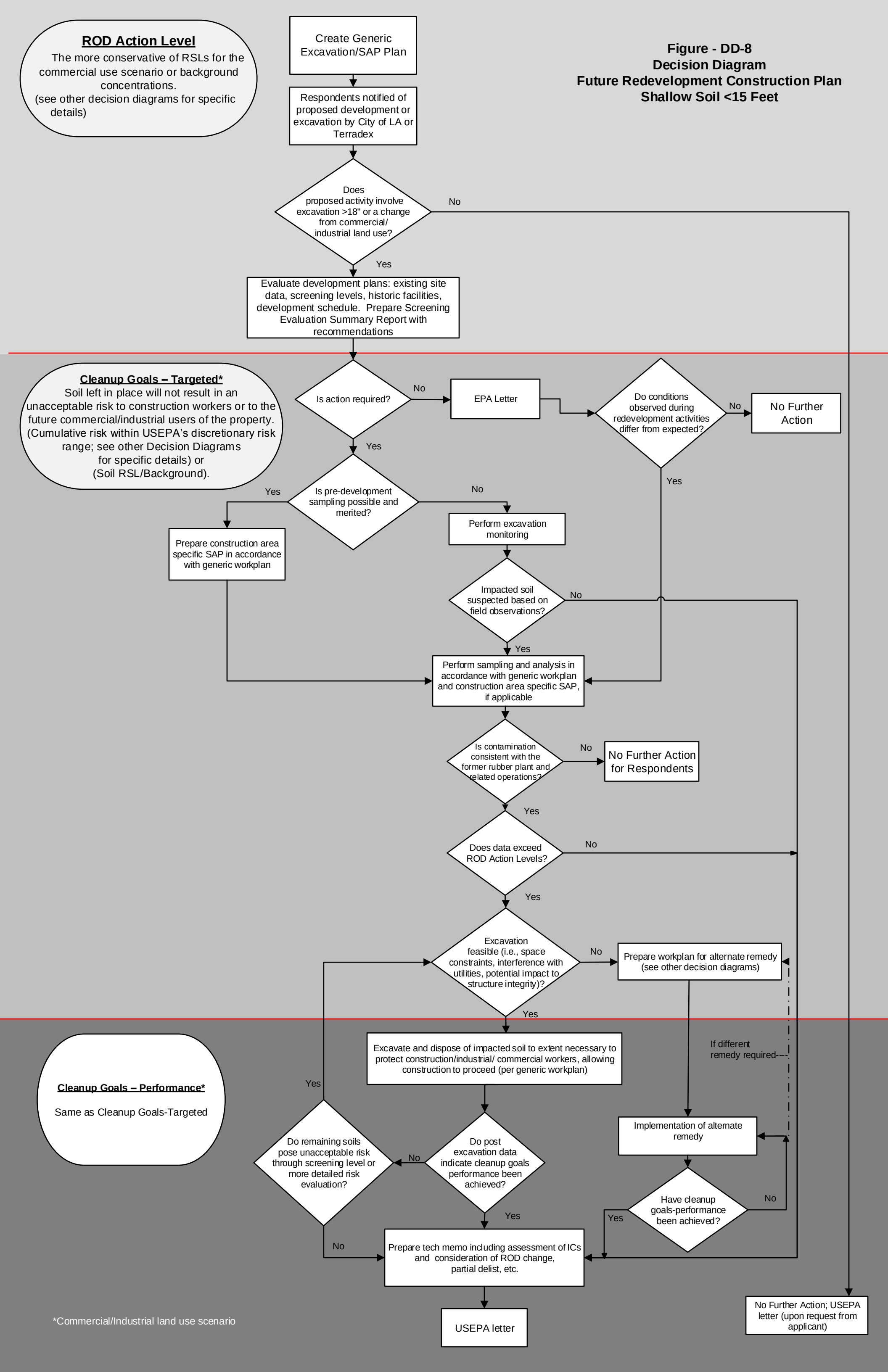


Figure - DD-7
Decision Diagram
ISCO/Soil Vapor Extraction (SVE)
Deep Soil and Groundwater in VOC
NAPL-Impacted Groundwater
Contamination Source Areas SA-3, SA-11, and SA-12



* The ISCO remedy will have reached the cleanup goal, be deemed complete, and will be terminated when USEPA, in consultation with DTSC, determines that the remediation has reached the point of diminishing returns (i.e., additional applications of oxidant result in little to no further decreases in dissolved VOC concentrations and production of oxidation by-products).

Figure - DD-8
Decision Diagram
Future Redevelopment Construction Plan
Shallow Soil <15 Feet



*Commercial/Industrial land use scenario

APPENDIX E
CAP SURVEY FIELD INSPECTION FORM

CAP SURVEY FIELD INSPECTION FORM
DEL AMO SUPERFUND SITE

Inspection Date:_____ Property: _____ Inspected by:_____ Page: 1

This Inspection Form is used to document the results of Cap Surveys conducted to evaluate the quality and integrity of existing ground covers in areas that require capping as an engineering control as part of Alternative 4 required in the ROD for Properties 2, 16, 28 and 35, Surface Soil and NAPL, Operable Unit (OU) 1 at the Del Amo Superfund Site. The design, construction and operation and maintenance (O&M) of the existing covers should prevent direct contact exposure, account for the current and future land use, and prevent contaminated soil from surface migration due to overland flow and erosion.

_____

A. SITE PLAN AND SURFACE FEATURES – Include a sketch drawing and photographs of the inspected area and vicinity, delineating the approximate areal extent of required capping area defined by soil sampling. Show surface features (e.g., buildings, parking areas, sidewalks, roads, hardscape, landscape, fences, storm drains) and indicate the type and materials of the existing ground covers (e.g., asphalt, concrete paving, bricks, soil, vegetation). Include photographs of the inspected areas. Attach additional pages if necessary.

Attach Sketch Drawing	Attach Photographs

Indicate current use of each cover:

Cover	Use

B. ASPHALT AND CONCRETE PAVING – Inspect all asphalt, concrete or brick paved areas and walkways for cracks, gaps, settlement, worn or missing areas, vegetation growth, deep rooted vegetation, ongoing construction or repairs, or other significant damage or deterioration. Attach additional pages if necessary.

Are all paved areas acceptable?
____ Yes _____ No If No, Describe Unacceptable Conditions (Attach Photographs):

Location	Condition

Is caulking in joint seals between the foot of building walls and exterior paved areas acceptable?
____ Yes _____ No If No, Describe Unacceptable Conditions (Attach Photograph):

Location	Condition

CAP SURVEY INSPECTION FORM (Cont.)
DEL AMO SUPERFUND SITE

Inspection Date:_____ Property: _____ Inspected by:_____ Page: 2

C. UNPAVED / LANDSCAPED AREAS - Inspect all unpaved and landscaped areas for soil erosion, burrowed holes by small animals, overland flow soil migration, unhealthy vegetation, ongoing construction/excavation or repairs, or other significant damage or deterioration. Attach additional pages if necessary.

Are all unpaved and landscaped areas acceptable?
____ Yes _____ No If No, Describe Unacceptable Conditions (Attach Photographs):

Location	Condition

D. AREAS NOT INSPECTED – Identify any areas within the footprint of the capping area that were not inspected and indicate the reason(s) why they were not inspected (e.g., not accessible, under construction). Attach additional pages if necessary.

Were all areas inspected?
____ Yes _____ No If No, Describe Uninspected Areas and Reason (Attach Photographs):

Uninspected Area	Reason

APPENDIX F
FIELD SAMPLING PLAN

FIELD SAMPLING PLAN

FOR THE
SOIL AND NAPL OPERABLE UNIT
DEL AMO SUPERFUND SITE

LOS ANGELES, CALIFORNIA

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LIST OF ACRONYMS

ASTM	American Society of Testing and Materials
BEC	Building Engineering Control
bgs	below ground surface
BRA	Baseline Risk Assessment
COC	constituent of concern
DOT	Department of Transportation
DTSC	Department of Toxic Substances Control
EAPC	Exposure Areas of Potential Concern
FSP	Field Sampling Plan
HASP	Health and Safety Plan
HDPE	high-density polyethylene
IDW	Investigation-Derived Waste
ISCO	In-Situ Chemical Oxidation
kg	kilogram
ml/min	milliliters per minute
NAPL	Non-Aqueous Phase Liquid
NDPA	n-Nitrosodiphenylamine
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbons
PCE	Tetrachloroethene
PID	photoionization detector
PM	Project Manager
psi	pounds per square inch
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RD	Remedial Design
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
Site	Del Amo Superfund Site
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
TCE	Trichloroethene
USA	Underground Service Alert
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compound

SECTION 1.0
INTRODUCTION

This Field Sampling Plan (FSP) was prepared by AECOM for the Soil and Non-Aqueous Phase Liquid (NAPL) Operable Unit (OU-1) at the Del Amo Superfund Site in Los Angeles, California (Site). The FSP is submitted as part of the Remedial Design (RD) Work Plan, pursuant to Consent Decree, Civil Action No. 2:15-cv-07619-R (AGRx). The purpose of the FSP is to present the scope of the RD Work Plan field investigation and the associated procedures by which the various field tasks will be completed, including sampling during the excavation of future areas of impacted soil as described in Appendix A of the RD Work Plan. This FSP will be updated every five years at a minimum.

1.1 SITE DESCRIPTION AND BACKGROUND

The Site is located at the southwest corner of the intersection of the 405 and 110 Freeways in the Harbor Gateway area of Los Angeles, California, adjacent to the cities of Torrance to the west and Carson to the east. The Site comprises approximately 280 acres that were formerly occupied by a synthetic rubber plant.

The plant was constructed in 1942 by the U.S. Government in support of World War II activities and included styrene, butadiene and copolymer plancors. Styrene and butadiene were combined in the copolymer plancor to produce the synthetic rubber. Other chemicals stored and used in the process as either feedstock or intermediary products included ethylbenzene, propane, butylene, butane and lesser amounts of other chemicals. The plant was sold to Shell Chemical in 1955 and continued to operate until 1972 when it was decommissioned and sold to a land development company. Since decommissioning, the Site has been subdivided and gradually redeveloped into the current business park. Environmental investigation of the Site began in the 1980s, revealing past releases from pipelines, storage tanks, processing units and waste pits that impacted underlying soil and groundwater.

The Site comprises 83 parcels and additional surface streets, including Vermont Avenue, Francisco Street, Magellan Drive, Pacific Gateway Drive and Knox Street. The majority of parcels have been developed with occupied business buildings and associated parking lots. The Waste Pits Operable Unit (OU-2) occupies two parcels along the southern boundary of the Site and is not addressed in this FSP.

Site constituents of concern (COC) that are driving remedy components include the volatile organic compounds (VOC) including benzene, ethylbenzene, tetrachloroethene (PCE), and trichloroethene (TCE); polycyclic aromatic hydrocarbons (PAH) including benzo(a)pyrene (BaP), benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(cd)pyrene; and semi-volatile organic compounds (SVOC) including n-nitrosodiphenylamine (NDPA).

Remedial action (RA) is being implemented to: (a) address potential health risks associate

with exposure to shallow soil (<15 feet) at selected Site properties; and (b) reduce NAPL mass at selected groundwater contamination source areas and enhance the groundwater remedy. Active remedy components associated with shallow soil apply to Site properties that generally consist of individual parcels or street segments corresponding to the "Exposure Areas of Potential Concern" (EAPC) identified in the Baseline Risk Assessment (BRA) (URS/Geosyntec 2006). While a few properties have been subdivided into multiple parcels since completion of the BRA, the system used in the BRA and Record of Decision (ROD; USEPA 2013), in which 37 properties of concern (Properties 1-37) were identified, is retained in this document to avoid confusion and discrepancies between documents. Remedy components associated with NAPL apply to selected groundwater contamination source areas at the Site where NAPL or NAPL-impacted soil is present. Source areas are not limited by and do not correspond with property boundaries; a single source area can be present on multiple properties.

The Site remedy, as described in the ROD, includes the following components at one or more areas on the Site:

- Institutional controls
- Capping
- Building engineering controls (BEC)
- Soil vapor extraction (SVE) for outdoor shallow soil
- SVE for soil under a building
- SVE for deep soil
- In-situ chemical oxidation (ISCO)/SVE for soil and groundwater in a NAPL-impacted source area
- Excavation for areas of impacted shallow soil that may be discovered in the future as a result of redevelopment activities. In the event that excavation is impractical, one or more of the other remedy components would be considered for implementation

Additional details regarding the above remedy components are presented in the RD Work Plan.

1.2 OBJECTIVES

The overall objective of the proposed field work is to generate soil, soil vapor, air and groundwater data necessary to support RD for the various remedy components. The generated data will be used to:

- Confirm the need for various remedy components

- Delineate areas where concentrations of risk-driving COCs necessitate implementation of one or more remedy components
- Evaluate the appropriate spacing and injection/extraction rates for future vapor extraction wells, vapor monitoring wells, and ISCO injection points

Field work will also include collection and analysis of soil samples at properties where areas of impacted soil have been identified in association with future redevelopment activities. The generated data will be used to document soil conditions and to characterize excavated soils for disposal. Details regarding this work will be presented in property-specific excavation work plans, a template for which is provided in Appendix A of the RD Work Plan.

1.3 PROJECT ORGANIZATION

RD field tasks will be conducted by an AECOM team under the direction of the project manager (PM) and task managers. The project team will communicate regarding project status, schedule, data management, QA/QC, and health and safety to complete RD effectively and efficiently.

A state-certified laboratory will be used for analytical services. Information regarding the selected laboratory is provided within the Quality Assurance Project Plan (QAPP) in Appendix B of the RD Work Plan.

SECTION 2.0
SCOPE

This FSP primarily addresses the Pre-Design Investigations portion of the RD Work Plan, and to a limited extent, SVE pilot testing, the ISCO bench study, and excavation of future areas of impacted soil. Pre-design Investigation field work includes sampling of various media to generate the data by which the need for and extent of various active remedy component will be evaluated. Field work described in this FSP that is associated with the SVE Pilot Study is limited to installation of required SVE wells and vapor monitoring wells. Pilot testing procedures are presented separately in Section 4 of the RD Work Plan. For the ISCO Bench Study, only collection of the required bulk samples of soil and groundwater is described in this FSP. The ISCO Bench Study will be conducted by an outside laboratory and applicable procedures are summarized in Section 5 of the RD Work Plan. Applicability of this FSP to excavation of future areas of impacted soil is limited to quality control and sample documentation, as described in Sections 4.0 and 5.0, respectively. The sampling and analytical program for these future areas will be presented separately in property-specific excavation work plans, a template for which is provided in Appendix A of the RD Work Plan.

Detailed procedures for the various tasks and subtasks to be completed as part of the investigations are presented in Section 3. Sampling and analytical work under this FSP is summarized in the Sampling and Analytical Plan, Table 1.

SECTION 3.0
FIELD METHODS AND PROCEDURES

3.1 PRE-FIELD ACTIVITIES

Field investigation activities will require advance planning and coordination with the various stakeholders to ensure that it is performed in a safe and efficient manner. Details regarding these pre-field activities are discussed below. RD field work will be conducted in accordance with the site-specific health and safety plan (HASP), which is updated annually, included as Appendix C of the RD Work Plan.

3.1.1 Property Access and Subcontractor Coordination

AECOM currently maintains property ownership and access agreement records for Site properties that were initially developed as part of previous Remedial Investigation/Feasibility Study (RI/FS) activities and ongoing Groundwater Operable Unit (OU-3) activities. AECOM will review existing access agreements to ensure that they are current, contain appropriate contact information, and can accommodate the specific activities planned for each property. As needed, individual access agreements will be updated and modified through negotiation with the individual land owners or their representatives. Field activities will not occur without an approved access agreement being in place.

Tasks anticipated to be subcontracted in support of RD activities include utility clearance, traffic control, concrete/pavement coring, soil boring drilling/sampling, well installation, surveying, investigation-derived waste (IDW) removal, and laboratory testing services.

3.1.2 Agency Notification

United States Environmental Protection Agency (USEPA) will be notified a minimum of 28 days prior to the start of field investigations. USEPA will also be notified at least seven days prior to the scheduled initiation of field work in the event that the field work will be delayed.

3.2 UTILITY CLEARANCE

Utility clearance will be completed for all tasks requiring ground surface penetrations, including sub-slab vapor probe installations, soil borings, and installation of SVE and vapor monitoring wells.

3.2.1 Indoor Operations

All sampling locations will be marked and cleared with a representative of the building owner with respect to subsurface obstructions and utilities. Clearance of the sampling locations will be based on as-built building plans and subsurface utility locating equipment and/or services.

3.2.2 Outdoor Operations

Underground Services Alert (USA) will be notified at least 48 hours prior to initiation of intrusive field tasks. All proposed locations will be clearly marked with white paint or surveyors flagging. Three alternate locations will be clearly marked at each proposed boring location. All soil borings will be located a minimum of five feet from identified underground utilities.

USA will contact utility owners of record within the area of proposed work and inform them of the planned subsurface work. Prior to commencing field activities, it will be verified that utility owners of record have responded to the USA notification by either marking the position of all buried utilities or confirming that they do not maintain or operate subsurface utilities in the areas to be investigated. The current landowner will also be contacted regarding knowledge or records they may have regarding the presence and location of buried utilities or services. Following USA mark-out, a private utility location service will additionally conduct utility clearance using geophysical instruments, which may include the use of ground penetrating radar and/or one or more electromagnetic methods.

Further protection of subsurface utilities will be achieved through use of an air knife for the upper portion of all excavations, to a minimum depth of 8 feet below ground surface (bgs). If a subsurface object is encountered with the air knife, the hole will be abandoned and relocated to avoid the obstruction. For areas where soil sampling is required within the upper 8 feet, the borehole will be cleared using an air-knife to the top of the depth interval required for sampling, and the sample will then be collected using a hand-auger. Following sampling, the borehole clearance will be completed to 8 feet bgs using an air-knife prior to advancing the remainder of the boring. If air-knife methods are technically infeasible, borehole clearance may be conducted using a hand auger after obtaining approval from the Project Coordinator.

3.3 AIR SAMPLING

Air sampling is required to complete Pre-Design Investigations related to BECs (Property 16) and SVE under the building (Property 23). Indoor and outdoor air sampling will be conducted in general accordance with the *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air* (DTSC 2011). These procedures are summarized in the following sections, and the complete guidance can be found at the following website: https://www.dtsc.ca.gov/AssessingRisk/upload/Final_VIG_Oct_2011.pdf.

3.3.1 Building Survey

A walk-through building survey will be completed prior to each indoor air sampling event to identify potential sources of VOCs that could influence sampling results. Information collected during this survey will be documented on a building survey form (Appendix B). This survey will include on-site observations, field screening, interviews with employees, and review of hazardous materials management plans and other information pertaining to the use and storage of chemicals within the building. A photo-ionization detector (PID) will be used during the walk-through to aid in identifying VOC sources. Indoor VOC sources will be contained or eliminated to the extent possible at least 48 hours prior to sampling. If VOC sources are identified that cannot be adequately contained or removed due to the nature of the ongoing business operations, source-specific sampling and testing may be necessary to account for the contribution of the indoor source. Any identified indoor sources of COCs that cannot be contained or removed will be problematic in that it may not be possible to discriminate between their contribution to indoor air and the potential vapor intrusion contribution.

3.3.2 Equipment Setup and Testing

Modifications to the proposed air sampling locations should be considered based on observed Site conditions. For indoor air samples, final sampling locations should minimize business disruption and influence from air intake locations. For outdoor air samples, final sampling locations should represent conditions upwind of building air intake locations.

Indoor and outdoor air samples will be collected using evacuated, 6-liter, certified clean Summa™ canisters provided by the analytical laboratory. The vacuum in the canisters will be measured and recorded on a field sheet prior to sample collection (Appendix C). The canisters will be equipped with flow controllers and vacuum gauges to allow for an 8-hour or 12-hour sample collection period or an approximate sample rate of 12.5 milliliters per minute (ml/min) or 8.33 ml/min, respectively.

3.3.3 Sample Collection

Summa™ canisters will be placed at a height of approximately 5 feet above the ground (typical human breathing zone). Outdoor air sampling will be initiated approximately one hour before commencement of associated indoor air sampling (Property 16) or sub-slab vapor sampling (Property 23), and will be conducted during typical working hours at the respective buildings. Sampling will be initiated by opening the flow controller valve for each canister and recording the start time on a field data sheet (Appendix C). The canister will be checked periodically during the 8-hour or 12-hour sampling period to ensure the sample is being collected at the appropriate rate and that the vacuum in the canister has not decreased to ambient conditions. Canister valves will be closed and sample collection terminated shortly before the vacuum condition decreases to ambient pressure, indicating the

canisters are nearly full. A residual vacuum of at least 5 pounds per square inch (psi) should be present in the canister at the completion of sampling. Following completion, the flow controller valve will be closed, and the time and residual vacuum will be recorded on the field data sheet. Summa™ canisters will be labeled to identify the project name, sampling location, sample height, date and time of collection. The canisters will be transported to the analytical laboratory within 24 hours of collection along with appropriate chain-of-custody documentation.

All samples will be analyzed for VOCs by Calscience using USEPA Method TO-15. Laboratory analytical procedures will be in accordance with the existing QAPP presented in Appendix B of the RD Work Plan.

3.4 SUB-SLAB VAPOR SAMPLING

Sub-slab vapor sampling is required to complete Pre-Design Investigations related to SVE under a building (Property 23). Sub-slab vapor sampling will be conducted in general accordance with the *DTSC Advisory – Active Soil Gas Investigations* (DTSC 2015). These procedures are summarized in the following sections, and the complete guidance can be found at the following website: https://www.dtsc.ca.gov/SiteCleanup/upload/VI_ActiveSoil GasAdvisory_FINAL.pdf.

3.4.1 Vapor Pin™ Installation

Vapor Pins™ will be installed in 1½-inch-diameter holes cut through the floor slab using a concrete coring drill. The 1½-inch borehole will extend at least 1 ¾-inches below the top of the slab. A 5/8-inch-diameter hole will then be drilled through the center of the 1 ½-inch borehole approximately 1-inch below the bottom of the slab and into the underlying soil. Cuttings and debris will be removed from the boring using a vacuum. The Vapor Pin™ assembly will be placed into the drilled hole with a silicone sleeve sealing the Vapor Pin™ from ambient air. The Vapor Pin™ will be set into the boring using the installation/extraction tool and a dead blow hammer or equivalent. Following Vapor Pin™ installation, sub-slab conditions will be allowed a minimum of two hours to equilibrate prior to sampling. Sample collection equipment consisting of metal and Teflon™ tubing, Summa™ canisters, a vacuum pump, and valves will then be connected to the top of each Vapor Pin™ to enable sampling.

3.4.2 Equipment Setup and Testing

Prior to sample collection, shut-in testing will be conducted to confirm the integrity of the silicon seal around the Vapor Pin™ and the above-grade sample collection equipment. Leak testing of the sample collection equipment will be accomplished by assembling all above-ground valves, lines, and sampling canisters, closing the appropriate valves to isolate the system from the probe, and then establishing a vacuum of at least 100 inches of water in the system using the vacuum pump. A vacuum gauge will be monitored for several minutes to observe whether the vacuum is maintained while the pump is off. If a loss or decrease in vacuum is observed, the system will be repaired until the vacuum can be maintained.

Following completion of a successful shut-in test, the sampling train will not be altered.

Leak testing of the Vapor Pin™ seal will be accomplished by placing a small enclosure over the top of the Vapor Pin™ and introducing helium into the enclosed airspace. The pump will then be operated to apply a vacuum to the Vapor Pin™, and the produced vapor will be monitored by capturing samples of the produced vapor in Tedlar bags and measuring the helium concentrations in the samples with a factory calibrated, portable helium detector comparable to a Mark Products Model 9822. Helium concentrations detected in the samples must be less than 10 percent of the concentrations measured within the enclosed airspace to be acceptable. If the concentration exceeds 10 percent, the Vapor Pin™ seal will be considered inadequate and will either be repaired, replaced or a new sampling location will be selected and prepared.

The Vapor Pin™ will be purged prior to sampling to remove stagnant air from the system and ensure that samples are representative of vapor from the subsurface. Three purge volumes will be removed during this process. One purge volume is defined as the sum of the following:

- The internal volume of the tubing and probe tip
- The void space of the sand pack around the probe tip
- The void space of the dry bentonite in the annular space

The flow rate during purging will be limited to 100 to 200 ml/min. All information collected during leak testing and purge testing will be recorded on the Air/Soil Vapor Field Data Sheet (Appendix C).

3.4.3 Sample Collection

Sub-slab vapor samples will be collected by opening the appropriate valves, allowing the vacuum within the Summa™ canisters to induce the flow of vapor from beneath the slab into the Vapor Pin™, through the tubing, and into the Summa™ canisters. Vapor flow rate during sampling will be automatically limited to no more than 200 ml/min by flow controllers that are attached to the Summa™ canisters. Summa™ canister valves will be closed and sample collection terminated when the vacuum has diminished to approximately five inches of water, indicating the Summa™ canisters are nearly full.

Sample information, including sampling start and end times, container pressures at the start and end of sampling, and identification numbers for sampling containers and flow controllers will be recorded on an Air/Soil Vapor Sampling Field Data Sheet (Appendix C). Summa™ canisters will be labeled immediately following completion of sampling with the sampling location, date and time of collection, and the identity of the sample collector. The samples will be transported to a state-certified analytical laboratory within 24 hours of collection, accompanied by chain-of-custody documentation. All vapor samples will be analyzed for VOCs using USEPA Method TO-15. Laboratory analytical procedures will be in accordance

with the QAPP presented in Appendix B of the RD Work Plan.

3.5 SOIL SAMPLING

3.5.1 Shallow Soil Sampling

Shallow soil sampling is required to complete Pre-Design Investigations related to SVE in shallow outdoor soil (Properties 6, 11, and 23). Shallow soil sampling will be conducted in general accordance with American Society for Testing and Materials (ASTM) D6282: *Direct Push Soil Sampling for Environmental Site Characterizations* (ASTM 2014). These procedures are summarized in the following sections. Soil sampling associated with excavation of future areas of impacted soil is described separately in Appendix A of the RD Work Plan.

Upon completion of borehole clearance activities, shallow soil borings will be advanced to a depth of 15 feet using a direct-push rig comparable to a Geoprobe® 6610DT. All drilling and sampling equipment will be decontaminated before drilling commences, between each sample, and between boreholes. Decontamination will be completed by washing equipment with a non-phosphate detergent and triple-rinsing with deionized or distilled water.

The direct-push drilling rig will be used to advance the core sampler from 8 feet bgs to the targeted sample depths. The core sampler will be lined with acetate sleeves up to five feet in length. After advancing the sampler to the targeted depth, the sampler will be removed from the borehole, opened, and the soil-filled acetate sleeve removed. The acetate sleeve will be opened using a purpose-built cutting tool. Soil from the sleeves will be continuously logged using the Unified Soil Classification System (USCS; ASTM Standard D 2487). Soil texture and composition (ASTM Standard D 2488), along with color, as compared to the Munsell Soil Chart, and PID readings will be recorded on a Soil Boring Log (Appendix D).

Samples will be collected for VOC and/or physical parameter analysis in accordance with Table 1. Samples for VOC analysis will be collected using the Encore system, with the sample comprising three separate Encore containers. Samples for physical testing will consist of two, 6-inch stainless steel rings. Immediately following sample collection, sample containers will be sealed, labeled, recorded in the field log, and temporarily stored in a cooled ice chest. Sample labels will include the project name, sample name, sample matrix, sample collector initials, and date and time of collection.

For each sample that is submitted to the laboratory for analysis, an entry will be made on a chain-of-custody form supplied by the laboratory. The information to be recorded will include the sampling date and time, sample identification number, matrix type, requested analyses and methods, preservatives, and the sampler's name. The chain-of-custody will be placed in a sealable plastic bag and will accompany all sample shipments.

Sampling team members will maintain custody of the samples until they are relinquished to laboratory personnel or a professional courier service. The chain-of-custody will accompany

the samples from the time of collection until received by the laboratory. Each party in possession of the samples (except the professional courier service) will sign the chain-of-custody form signifying receipt.

3.5.2 Deep Soil Sampling for SVE in Deep Soil at SA-6

Deep soil sampling is required to complete Pre-Design Investigations for SVE in deep soil at SA-6. Deep soil sampling will be conducted in general accordance with ASTM D6151: *Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling* (ASTM 2015). These procedures are summarized in the following sections.

Upon completion of borehole clearance activities, 8.25-inch-diameter soil borings will be advanced using a hollow-stem auger rig to approximately 48 feet bgs. All drilling and sampling equipment will be decontaminated before drilling commences and between boreholes. Sampling equipment will also be decontaminated between each sample. Decontamination will be completed by washing equipment with a non-phosphate detergent and triple-rinsing with deionized or distilled water.

Soil borings to characterize VOC impacts at SA-6 will be continuously cored and logged using the USCS (ASTM Standard D 2487), including soil texture and composition (ASTM Standard D 2488), color and PID readings. Soil samples for laboratory analysis will be collected using a California modified split-spoon sampler equipped with stainless-steel sleeves and will be from between 15 to 48 feet bgs (approximately five feet above the local water table). Sample depths for the samples for VOC analysis will be selected in the field based on visual observations and PID readings of total organic vapor concentrations and should be representative of intervals of both impacted and clean soil. These samples will be collected using the Encore system, with each sample comprising three separate Encore containers. Samples for physical testing will be collected to be representative of the principal soil types encountered and will consist of two 6-inch stainless steel rings. Table 1 indicates the approximate number and type of samples to be collected at each boring location.

Immediately following sample collection, sample containers will be sealed, labeled, recorded in the field log, and temporarily stored in a cooled ice chest. Sample labels will include the project name, sample name, sample matrix, sample collector initials, and date and time of collection.

The sampling date and time, sample identification number, matrix type, requested analyses and methods, and the sampler's name will be entered on a chain-of-custody form for each sample submitted for laboratory analysis. The chain-of-custody will be placed in a sealable plastic bag to accompany all shipments of samples to the analytical laboratory. Sampling team members will maintain custody of the samples until they are relinquished to laboratory personnel or a professional courier service. The chain-of-custody form will accompany the samples from the time of collection until received by the laboratory. Each party in possession of the samples (except the professional courier service) will sign the chain-of-custody form

signifying receipt.

3.5.3 Deep Soil Sampling for ISCO Bench Study and Physical Testing

Deep soil sampling for physical parameter analysis will be conducted in conjunction with bulk soil sampling to support the ISCO Bench Study at SA-11. Drilling and bulk soil collection for the Bench Study will be conducted in general accordance with ASTM D6914: *Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices* (ASTM 2010). Deep soil sampling for physical parameter analysis will be conducted in general accordance with ASTM D1587: *Standard Practice for Thin Walled Tube Sampling of Soils for Geotechnical Purposes* (ASTM 2012).

Upon completion of utility clearance activities, a 6-inch-diameter outer casing with a 4-inch diameter sampling barrel will be advanced using a sonic drill rig to a total depth of approximately 70 feet bgs. All drilling and sampling equipment will be decontaminated before drilling commences and between boreholes. Decontamination will be completed by washing equipment with a non-phosphate detergent and triple-rinsing with deionized or distilled water.

Soil samples for physical testing will be collected by pushing a 2-inch diameter Shelby tube 18 inches into the soil. The soil sample will be left in the Shelby tube for delivery to the laboratory. For collection of the bulk ISCO Bench Study samples, a 4-inch-diameter sampling barrel will be advanced in approximately 10-foot increments using a combination of vibration, rotation, and downward pressure. Upon reaching the bottom of each sampling interval, a 6-inch-diameter outer casing will be advanced over the sampling barrel to protect against borehole cave-in. The sampling barrel will then be removed from the borehole, and the bulk samples collected by placing a 2-foot long sample receiving bag over the bottom of the sample barrel, and vibrating the sample barrel to extract the soil. Each bag will be field-screened for VOCs using a PID and the results will be recorded on a boring log. For the impacted soil sample, a minimum of 30 kilograms (kg) of impacted soil will be collected. The most impacted interval is anticipated to occur between approximately 46 and 56 feet bgs. Each foot of a 4-inch-diameter sampling barrel contains approximately 3.5 kg of soil. As necessary, an additional soil boring will be completed adjacent to PBSL-34 to obtain a sufficient volume of impacted soil. For the boring advanced outside of the SA-11 source area, at least 3 kg of un-impacted soil will be collected from the same depth interval. The bulk sample bags will be placed in 2.5-gallon buckets with sealed lids immediately following sample collection for shipment to the laboratory.

All samples will be sealed, labeled, recorded in the field log, and temporarily stored in a cooled ice chest. Sample labels will include the project name, sample name, sample matrix, sample collector initials, and date and time of collection.

Bulk soil samples will be submitted to PRIMA Environmental, Inc. of El Dorado Hill, California for completion of the ISCO bench study. Physical parameter samples will be

submitted to a suitable State-certified laboratory to be selected prior to Pre-Design Investigations. The sampling date and time, sample identification number, matrix type, and the sampler's name will be entered on a chain-of-custody form for each sample submitted to the laboratory. The chain-of-custody will be placed in a sealable plastic bag to accompany all shipments of samples to the laboratory.

3.6 BULK GROUNDWATER SAMPLING

Bulk sampling of impacted and relatively un-impacted groundwater at SA-11 is required to support the ISCO bench study. Samples will be collected from existing wells XMW-01HD (impacted) and XMW-03HD (un-impacted) using an inertial pump such as a Waterra Hydrolift. Clean high-density polyethylene (HDPE) tubing will be lowered into the wells such that the foot (check) valve is set halfway between the static water level and the bottom of the screened interval, and connected to the inertial pump. The pump will be turned on and groundwater samples will be collected in 1-liter amber glass bottles from the effluent.

At least 50 liters of impacted groundwater will be collected from well XMW-01HD. NAPL should not be present in the sample and is not expected based on recent monitoring event observations at XMW-01HD. As a conservative measure to ensure that NAPL does not enter the pump tubing, water level drawdown during sampling should be controlled by operating the pump at the lowest possible flow rate and periodically checking drawdown with an interface probe. The flow rate may be increased as sampling progresses, but the water level should be maintained at least one foot above the foot valve during sampling.

At least 3 liters of un-impacted groundwater will be collected from well XMW-03HD. Drawdown will also be minimized as described in the previous paragraph to ensure the representativeness of the collected sample.

The bulk groundwater samples will be sealed, labeled, recorded in the field log, and temporarily stored in a cooled ice chest. Sample labels will include the project name, sample name, sample matrix, sample collector initials, and date and time of collection. The samples will be submitted to Prima Environmental for completion of the ISCO bench study. The sampling date and time, sample identification number, matrix type, and the sampler's name will be entered on a chain-of-custody form for each sample that is submitted. The chain-of-custody will be placed in a sealable plastic bag to accompany all sample shipments.

3.7 WELL INSTALLATION

Well installation is required to facilitate SVE pilot testing at Property 23 (shallow SVE and SVE under a building) and SA-6 (deep SVE). Eight-inch diameter soil borings will be advanced to total depth using a hollow-stem auger rig in general accordance with ASTM D6151: *Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling* (ASTM 2015). All drilling and sampling equipment will be decontaminated before drilling commences and between boreholes. Decontamination will be completed by washing equipment with a non-phosphate detergent and triple-rinsing with deionized or distilled

water.

SVE wells will be constructed using 2-inch-diameter Schedule 40 polyvinyl chloride (PVC) casing with 0.020-inch slotted screened intervals. The annulus between the borehole and the well casing and screen will be backfilled with Monterey sand #2/12 from total depth to approximately at least one foot above the top of the well screen, followed by at least three feet of hydrated bentonite chips. For shallow SVE wells, the bentonite seal will extend to 1 foot bgs. For deep SVE wells, cement bentonite grout will be emplaced from the top of the bentonite seal to one foot bgs. Concrete will be used to fill the remainder of the boreholes and set a flush-mounted, traffic-rated well vault. A locking cap will be placed on each wellhead. SVE well construction details may be modified based on the results of the field and laboratory data collected during the Pre-Design Investigation.

3.8 BOREHOLE ABANDONMENT

Borehole abandonment is required after completion of sub-slab vapor and soil boring sampling.

3.8.1 Indoor Operations

Following completion of sampling, Vapor Pins™ will be removed and the sampling locations abandoned by filling the concrete core hole with bentonite pellets to approximately six inches below the top of the slab and adding water to hydrate. Concrete will be used to fill the remainder of the core hole and troweled flush with the top of the slab. In the event that floor tiles are damaged during sampling activities, arrangements will be made for their repair or replacement.

3.8.2 Outdoor Operations

Upon completion of soil boring advancement and sample collection, borings will be abandoned with bentonite chips. A tremie pipe will be inserted into each boring and the chips gradually poured into the surrounding annulus up to the bottom of the surface cover. Water will then be poured into the tremie pipe while the pipe is incrementally removed to hydrate the chips. After the hydrated bentonite stabilizes, the remainder of the boring will be filled with cement or asphalt and finished to match the surrounding surface.

3.9 WASTE DISPOSAL

Soil cuttings, decontamination water, and miscellaneous waste generated during the field activities will be temporarily stored onsite at the Waste Pits in Department of Transportation (DOT)-approved 55-gallon drums or an appropriate soil bin. Results of laboratory analyses will be used to profile the waste material for transport to appropriate facilities for disposal/recycling.

3.10 SVE PILOT TESTING

For SVE pilot testing activities and corresponding field procedures, refer to Section 4.1 of the RD Work Plan.

SECTION 4.0
QUALITY CONTROL

This section discusses the quality control (QC) samples that will be collected as part of the pre-design investigations, SVE pilot testing for the OU-1 remedial design and excavation of future areas of impacted soil, including field and laboratory QC samples. Further details are specified in the QAPP included as Appendix B of the RD Work Plan.

4.1 QA/QC SAMPLES

Quality Assurance (QA)/QC samples will include trip blanks, equipment blanks, and field duplicate samples. The number of field QA/QC samples to be collected is as follows:

- One trip blank will be collected and submitted for VOC analysis with each shipment of samples.
- One equipment blank sample will be collected and submitted for analysis each day where groundwater wells are purged using non-dedicated equipment.
- Ten percent of the total number of field samples for each sample matrix and type of laboratory analysis per day will be collected as field duplicates excluding samples collected for physical testing analyses. If less than ten samples are collected for a matrix, at least one field duplicate is collected.

4.2 SAMPLE PACKAGING

Sealed sample containers will be placed in clear, plastic, leak resistant bags immediately after collection and labeling. The bagged samples will be placed in a cooler with packaging material to minimize the potential for disturbance and/or breakage of the sample containers, and ice or “Blue Ice” packs to minimize the potential for loss of volatiles during transport to the analytical laboratory. Samples known to contain relatively low contaminant concentrations will not be placed in the same coolers as samples with higher concentrations to minimize the potential for cross-contamination between samples during shipment.

Completed shipping labels will be attached to the sealed sample coolers requiring commercial shipping and copies of all records pertaining to the shipment of a sample are retained, including chain-of-custody forms, freight bills, post office receipts, and bills of lading.

SECTION 5.0
SAMPLE DOCUMENTATION

This section discuses field recordkeeping, including logbooks, preprinted forms, photographs, and other documentation.

5.1 FIELD LOG BOOK

A bound field log book will be maintained by sampling personnel to provide a daily record of events. At the beginning of each entry, the following information will be recorded:

- Date
- Time
- Field personnel present
- Level of personnel protective equipment
- List of on-site visitors and the level of personal protective equipment
- General nature and purpose of field work to be completed
- Signature of the person making the entry

Field log book entries will have as much detail as necessary to ensure that essential information is properly documented. All documentation in field books will be made in ink. If an error is made, corrections will be made by crossing a line through the error and entering the correct information. Corrections will be dated and initialed. No entries will be obliterated or rendered unreadable. The cover of each log book will contain the following information:

- Person and organization to whom the book is assigned
- Book number
- Start date and time
- End date and time

Entries in the log book will include, at a minimum, the following for each sample date:

- Site identification
- Location of sampling points
- Description of sampling points
- References to photographs (if applicable)
- Collectors' names

- Field observations
- Type of sample (soil, sediment or water)
- Type of sampling equipment used
- Field instrument readings and calibration
- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, etc.)
- Preliminary sample descriptions (e.g., for soils: clay loam, very wet; for water: clear water with strong ammonia-like odor)
- Sample preservation

Other daily activities and relevant observations will also be included in the field log book.

5.2 PHOTOGRAPHS

Photographs will be taken at the sampling locations and at other areas of interest to verify information entered in the field logbook. For each photograph taken, the following information will be written in the logbook or recorded in a separate field photography log:

- Time, date, location, and weather conditions
- Description of the subject photographed
- Name of person taking the photograph

5.3 SAMPLE LABELS

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. The samples will have pre-assigned, identifiable, and unique numbers. Every sample, including samples collected from a single location but going to separate laboratories, will be assigned a unique sample number. At a minimum, sample labels will contain the following information: location, date of collection, analytical parameter(s), and method of preservation.

5.4 CHAIN-OF-CUSTODY RECORD

Chain-of-custody forms will accompany all shipments of samples to analytical laboratories. The chain-of-custody will be signed by each individual who takes the samples into their possession except the professional courier service. For samples shipped by commercial carrier, the waybill serves as an extension of the chain-of-custody between shipment by the field custodian and receipt by the laboratory technician. Upon receipt by the laboratory, the receiving personnel will compare the samples received with the chain-of-custody record, ensure that document information is accurate and complete, record the temperature inside the

cooler, and sign and date the chain-of-custody. Any discrepancies will be noted on the chain-of-custody form and reported to field personnel. The completed chain-of-custody will be returned to the project manager and maintained in the project file. An example chain-of-custody is provided in Appendix E.

SECTION 6.0
REFERENCES

ASTM International (ASTM). 2015. Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling (D6151).

2014. Standard Practice for Direct Push Soil Sampling for Environmental Site Characterizations (D6282).

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2011. Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance). October 2011.

GeoSyntec and URS Corporation (URS). 2006. Baseline Risk Assessment Report, Del Amo Site, Los Angeles, California. GeoSyntec Consultants with URS Corporation. September 7, 2006.

U.S. Environmental Protection Agency (USEPA). 2013. Record of Decision for the Del Amo Facility Superfund Site, Soil and NAPL Operable Unit, Los Angeles, California. July 26, 2013.

2011. Record of Decision for the Del Amo Facility Superfund Site, Soil and NAPL Operable Unit, Los Angeles, California. September 11, 2011.

TABLES

TABLE 1
PRE-DESIGN INVESTIGATIONS SAMPLING AND ANALYTICAL PLAN

Work Phase	Remedy Component	Property Number	APN	Area	Media	Locations or Borings	Samples Per Location	Total Number of Samples	Total Number of Field Duplicates[2]	Total Number of MS/MSD Samples[3]	Frequency	Laboratory Analyses			
												Analysis	Method	Sample Container Type and Number	Laboratory
Pre-Design Investigations	Cap	2	7351-031-020	West	--	--	--	--	--	--	--	--	--	--	--
		16	7351-034-015, -050, -056	Northwest	--	--	--	--	--	--	--	--	--	--	--
		28	7351-034-069	Northwest	--	--	--	--	--	--	--	--	--	--	--
				East	--	--	--	--	--	--	--	--	--	--	--
		35	Magellan Drive	North	--	--	--	--	--	--	--	--	--	--	--
				Central	--	--	--	--	--	--	--	--	--	--	--
				South	--	--	--	--	--	--	--	--	--	--	--
	BECs	16	7351-034-015, -050, -056	Building interior	Indoor Air	13	1-2	17	3	--	Two events, 6 months apart	VOCs	TO-15 SIM	1 Summa	Calscience
				West side of building	Outdoor Air	2	1	2			Two events, 6 months apart	VOCs	TO-15 SIM	1 Summa	Calscience
				Interior	Subslab Soil Vapor	7	1	7			Two events, 6 months apart	VOCs + MTBE	TO-15	1 Summa	Calscience
	SVE – Outdoor Shallow Soil	6	7351-033-022	West	Shallow Soil	7	2-4	14-28	2-3	2-3	one time	VOCs	8260B	Three Encore	Calscience
						2	2	4	--	--	one time	Physical Testing[1]	API RP 40	Two 6" SS Rings	To be determined
		11	7351-033-034	South	Shallow Soil	4	2-4	8-16	1-2	1-2	one time	VOCs	8260B	Three Encore	Calscience
						2	2	4	--	--	one time	Physical Testing[1]	API RP 40	Two 6" SS Rings	To be determined
		23	7351-034-057	Northwest	Shallow Soil	13	2-4	26-52	3-5	3-5	one time	VOCs	8260B	Three Encore	Calscience
						3	2	6	--	--	one time	Physical Testing[1]	API RP 40	Two 6" SS Rings	To be determined
				Southwest	Shallow Soil	2	2-4	4-8	1	1	one time	VOCs	8260B	Three Encore	Calscience
						1	2	2	--	--	one time	Physical Testing[1]	API RP40	Two 6" SS Rings	To be determined
				East	Shallow Soil	6	2-4	12-24	2-3	2-3	one time	VOCs	8260B	Three Encore	Calscience
						2	2	4	--	--	one time	Physical Testing[1]	API RP40	Two 6" SS Rings	To be determined
				Northeast	Shallow Soil	1	2-4	2-4	1	1	one time	VOCs	8260B	Three Encore	Calscience
						1	2	2	--	--	one time	Physical Testing[1]	API RP40	Two 6" SS Rings	To be determined
	SVE – Under Building	23	7351-034-057	SE Corner of Main Building	Subslab Soil Vapor	5	1	5	1	--	one time	VOCs + MTBE	TO-15	1 Summa	Calscience
					Outdoor Air	2	1	2			one time	VOCs	TO-15 SIM	1 Summa	Calscience
	SVE – Deep Soil	23	7351-034-057	SA-6	Deep Soil	10	4-6	40-60	4-6	4-6	one time	VOCs	8260B	Three Encore	Calscience
						2	3	6	--	--	one time	Physical Testing[1]	API RP40	Two 6" SS Rings	To be determined
	ISCO/SVE	6 9 15	7351-033-022 7351-033-027 7351-033-900	SA-11	Deep Vadose Zone Soil[5]	2	3	6	--	--	one time	Physical Testing[1]	API RP40	Two 6" SS Rings	To be determined
					Saturated Zone Soil[5]	2	3	6	--	--	one time	Physical Testing[1]	API RP40	Two 6" SS Rings	To be determined
												Hydraulic Conductivity Package[4]	API RP40, EPA 9100, mod. ASTM D425	Two 6" SS Rings	To be determined
	ISCO Bench Study Baseline Sampling	6 9	7351-033-022 7351-033-027	SA-11	Unimpacted Soil	1	1	1	--	--	one time	ISCO Bench Study testing program (see Tables 7 and 8)	ISCO Bench Study testing program (see Tables 7 and 8)	One 2.5 gallon bucket	Prima Environmental
					Impacted Soil	1	1	1	--	--	one time	ISCO Bench Study testing program (see Tables 7 and 8)	ISCO Bench Study testing program (see Tables 7 and 8)	Two 2.5 gallon buckets	
					Unimpacted Groundwater	1 (XMW-03HD)	1	1	--	--	one time	ISCO Bench Study testing program (see Tables 7 and 8)	ISCO Bench Study testing program (see Tables 7 and 8)	Six 1-Liter Amber Glass	
					Impacted Groundwater	1 (XMW-01HD)	1	1	--	--	one time	ISCO Bench Study testing program (see Tables 7 and 8)	ISCO Bench Study testing program (see Tables 7 and 8)	Fifty 1-liter amber glass	

Notes:

1) Physical Testing includes porosity, moisture content, grain size distribution, and air permeability
2) Field Duplicate is counted as a discrete sample at a 10% frequency
3) Matrix Spike/Matrix Spike Duplicate is not a discrete sample but triples the amount of sample and containers collected. This is collected at a 10% frequency.
4) Hydraulic conductivity package includes tests for hydraulic conductivity, grain density, dry bulk density, total porosity, air filled porosity, moisture content, and total pore fluid saturation
5) Deep vadose zone and saturated zone samples may originate from the same boring location

APPENDIX A
CAP SURVEY FIELD INSPECTION FORM

APPENDIX A
CAP SURVEY FIELD INSPECTION FORM
DEL AMO SUPERFUND SITE

Inspection Date:_____Property:_____Inspected by:_____ Page: 1

This Inspection Form is used to document the results of Cap Surveys conducted to evaluate the quality and integrity of existing ground covers in areas that require capping as an engineering control as part of Alternative 4 required in the ROD for Properties 2, 16, 28 and 35, Surface Soil and NAPL, Operable Unit (OU) 1 at the Del Amo Superfund Site. The design, construction and operation and maintenance (O&M) of the existing covers should prevent direct contact exposure, account for the current and future land use, and prevent contaminated soil from surface migration due to overland flow and erosion.

A. SITE PLAN AND SURFACE FEATURES – Include a sketch drawing and photographs of the inspected area and vicinity, delineating the approximate areal extent of required capping area defined by soil sampling. Show surface features (e.g., buildings, parking areas, sidewalks, roads, hardscape, landscape, fences, storm drains) and indicate the type and materials of the existing ground covers (e.g., asphalt, concrete paving, bricks, soil, vegetation). Include photographs of the inspected areas. Attach additional pages if necessary.

Attach Sketch Drawing	Attach Photographs

Indicate current use of each cover:

Cover	Use

B. ASPHALT AND CONCRETE PAVING – Inspect all asphalt, concrete or brick paved areas and walkways for cracks, gaps, settlement, worn or missing areas, vegetation growth, deep rooted vegetation, ongoing construction or repairs, or other significant damage or deterioration. Attach additional pages if necessary.

Are all paved areas acceptable?
____Yes _____No If No, Describe Unacceptable Conditions (Attach Photographs):

Location	Condition

Is caulking in joint seals between the foot of building walls and exterior paved areas acceptable?
____ Yes_____No If No, Describe Unacceptable Conditions (Attach Photograph):

Location	Condition

APPENDIX A (Cont.)
CAP SURVEY INSPECTION FORM
DEL AMO SUPERFUND SITE

Inspection Date:_____Property:_____Inspected by:_____ Page: 2

C. UNPAVED / LANDSCAPED AREAS - Inspect all unpaved and landscaped areas for soil erosion, burrowed holes by small animals, overland flow soil migration, unhealthy vegetation, ongoing construction/excavation or repairs, or other significant damage or deterioration. Attach additional pages if necessary.

Are all unpaved and landscaped areas acceptable?
____Yes _____No If No, Describe Unacceptable Conditions (Attach Photographs):

Location	Condition

D. AREAS NOT INSPECTED – Identify any areas within the footprint of the capping area that were not inspected and indicate the reason(s) why they were not inspected (e.g., not accessible, under construction). Attach additional pages if necessary.

Were all areas inspected?
____ Yes_No If No, Describe Uninspected Areas and Reason (Attach Photographs):

Uninspected Area	Reason

APPENDIX B
BUILDING SURVEY FORM

APPENDIX B
BUILDING SURVEY FORM

This form must be completed for each building involved in an indoor air investigation.

Preparer's name_____Date prepared _____

Preparer's affiliation _____

Telephone number _____

1. OCCUPANT

Name _____

Address _____

_____

City _____

Telephone number _____

2. OWNER

Name _____
(If different than occupant)

Address _____

_____

Telephone number _____

A. Building Construction

Building Age _____

Number of stories _____

Area of the Building (square feet) _____

Is the building insulated? yes / no How sealed is the building?_____

Number of elevators in the building _____

Condition of the elevator pits (sealed, open earth, etc.) _____

General description of building construction materials _____

_____

B. Foundation Characteristics (circle all that apply)

1. Full basement, crawlspace, slab on grade, other _____

2. Basement floor description: concrete, dirt, wood, other _____

   a. The basement is: wet, damp, dry _____

   b. Sump present? yes / no_____Water in sump? yes / no _____

   c. The basement is: finished, unfinished _____

   d. Is the basement sealed? Provide a description _____

   _____

3. Concrete floor description: unsealed, painted, covered; with _____

4. Foundation walls: poured concrete, block, stone, wood, other _____

5. Identify all potential soil gas entry points and their size (e.g., cracks, voids, pipes, utility ports, sumps, drain holes, etc.). Include these points on the building diagram.

C. Heating, Ventilation, and Air Conditioning (circle all that apply)

1. The type of heating system(s):

Hot Air Circulation	Heat Pump
Hot Water Radiation	Unvented Kerosene Heater
Steam Radiation	Wood Stove
Electric Baseboard	Other (specify) _____

2. The type of fuel used: Natural Gas, Fuel Oil, Electric, Wood, Coal, Solar

   Other (specify) _____

3. Location of heating system: _____

4. Is there air-conditioning? yes / no Central Air or Window Units?

   Specify the location _____

5. Are there air distribution ducts present? yes / no

6. Describe the supply and cold air return duct work including whether there is a cold air return and comment on the tightness of duct joints.

   _____

7. Temperature settings inside during sampling. Note day and night temperatures.
   a. Daytime temperature(s) _____
   b. Nighttime temperature(s) _____
   (Note times if system cycles during non-occupied hours during the day)

8. Estimate the average time doors and windows are open to allow fresh outside air into the building. Note rooms that frequently have open windows or doors.

_____

D. Potential Indoor Sources of Pollution

1. Has the building ever had a fire? yes / no

2. Is there a kerosene heater present? yes / no

3. Is there a workshop area in the building? yes / no

4. An inventory of all products used or stored in the building should be performed. Any products that contain volatile organic compounds or chemicals similar to the target compounds should be listed. The attached product inventory form should be used for this purpose.

5. Is smoking allowed in the building? yes / no

11. Has the building ever been fumigated or sprayed for pests? If yes, give date, type and location of treatment.

_____

E. Water and Sewage (Circle the appropriate response)

Source of Water

Public Water Drilled Well Driven Well Dug Well Other (Specify) _____

Water Well Specifications

Well Diameter_____ Grouted or Ungrouted _____

Well Depth_____ Type of Storage Tank _____

Depth to Bedrock_____ Size of Storage Tank _____

Feet of Casing_____ Describe type(s) of Treatment _____

Water Quality

Taste and/or odor problems with water? yes / no If so, describe _____

Is the water chlorinated, brominated, or ozonated? yes / no _____

How long has the taste and/or odor problem been present? _____

Sewage Disposal: Public Sewer Septic Tank Leach Field Other (Specify) _____

Distance from well to septic system_____Type of septic tank additives _____

F. Plan View

Sketch each floor and if applicable, indicate air sampling locations, possible indoor air pollution sources, preferential pathways and field instrument (PID) readings.

G. Potential Outdoor Sources of Pollution

Draw a diagram of the area surrounding the building being sampled. If applicable, provide information on the spill locations (if known), potential air contamination sources (industries, service stations, repair shops, retail shops, landfills, etc.), outdoor air sampling locations, and field instrument readings.

Also, on the diagram, indicate barometric pressure, weather conditions, ambient and indoor temperatures, compass direction, wind direction and speed during sampling, the locations of the water wells, septic systems, and utility corridors if applicable, and a statement to help locate the site on a topographical map.

APPENDIX C
AIR/SOIL VAPOR SAMPLING FIELD DATA SHEET

APPENDIX C
Air/Soil Vapor Sampling Field Data Sheet

Project Name: _____

Date:_____ **Time:**_____

Sample Location:_____ **Height:**_____

Sample ID: _____

Duplicate ID: _____

PURGE AND LEAK CHECK DATA

Starting Purge Time	Ending Purge Time	Volume Removed (liters)	VOC Concentration (ppm)	Helium Concentration (ppm)

Helium concentration inside chamber: _____%

Flow rate set by flow controller: _____ml/min

SAMPLING DATA

Summa Canister ID	Flow Controller ID	Starting Pressure (in Hg)	Ending Pressure (in Hg)	Start Sampling Time	Ending Sampling Time

NOTES:

APPENDIX D
SOIL BORING LOG

By_____ Drilling Contractor _____

Date_____Checked by _____ _____

BORING LOG

LOCATION OF BORING	JOB NUMBER	LOCATION **APN:**
DATUM..... ELEVATION	**DRILLING METHOD:** _____	**BORING NUMBER**
		SHEET of
	SAMPLING METHOD: _____	
		DRILLING
	SURFACE CONDITIONS: _____	START TIME / FINISH TIME
		DATE / DATE

SAMPLER TYPE	FEET DRIVEN / FEET RECOVERED	TIME	SAMPLE DEPTH	BLOWS/FT. SAMPLER	PID SAMPLE	SAMPLE NUMBER	DEPTH (feet)	SOIL GRAPH
							0	
							1	
							2	
							3	
							4	
							5	
							6	
							7	
							8	
							9	
							0	

T/Ladd/StandardStuff/BoringLogForm-General

APPENDIX E
CHAIN OF CUSTODY

Shell Oil Products US Chain Of Custody Record

AECOM

LAB (LOCATION)

- ☐ ACCUTEST (________________________)
- ☐ CALSCIENCE (________________________)
- ☐ TESTAMERICA (________________________)
- ☐ Other (________________________)

Lab Vendor # Dropdown

Please Check Appropriate Box:

☐ SGW FDG	☐ MOTIVA RETAIL	☐ SHELL RETAIL
☐ MOTIVA SD&CM	☐ CONSULTANT	☐ LUBES
☐ SHELL PIPELINE	☐ OTHER ________________	

Print Bill To Contact Name:	PlaNet Project ID
PO #	**GSAP ProjectID**

☐ CHECK IF NO INCIDENT # APPLIES

DATE: ______________

PAGE:________ of ________

SAMPLING COMPANY:	LOG CODE:	SITE ADDRESS: Street and City	State
ADDRESS:		EDF DELIVERABLE TO (Name, Company, Office Location):	PHONE NO.:
PROJECT CONTACT (Hardcopy or PDF Report to):		SAMPLER NAME(S)(Print):	*LAB USE ONLY*
TELEPHONE:	FAX:	Bill To Contact E-MAIL:	

AECOM Project / Task Number:

E-MAIL: | CONSULTANT PROJECT NO.:

TURNAROUND TIME (CALENDAR DAYS):
☐ STANDARD (14 DAY) ☐ 5 DAYS ☐ 3 DAYS ☐ 2 DAYS ☐ 24 HOURS ☐ RESULTS NEEDED ON WEEKEND

☐ LA - RWQCB REPORT FORMAT ☐ UST AGENCY:

DELIVERABLES: ☐ LEVEL 1 ☐ LEVEL 2 ☐ LEVEL 3 ☐ LEVEL 4 ☐ OTHER (SPECIFY) ________________

TEMPERATURE ON RECEIPT C° Cooler #1 | Cooler #2 | Cooler #3

SPECIAL INSTRUCTIONS OR NOTES :

- ☐ SHELL CONTRACT RATE APPLIES
- ☐ STATE REIMBURSEMENT RATE APPLIES
- ☐ EDD NOT NEEDED
- ☐ RECEIPT VERIFICATION REQUESTED
- ☐ PROVIDE LEDD DISK

REQUESTED ANALYSIS

UNIT COST | **NON-UNIT COST**

FIELD NOTES:

TEMPERATURE ON RECEIPT C°

Container PID Readings or Laboratory Notes

LAB USE ONLY	Field Sample Identification	SAMPLING DATE	SAMPLING TIME	MATRIX	PRESERVATIVE HCL	HNO3	H2SO4	NONE	OTHER	NO. OF CONT.

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

Version: 11Dec15

APPENDIX G
SVE FIELD FORMS AND EQUIPMENT

FIELD SHEET-1
SHALLOW STEP TEST PRESSURE READINGS
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Date	Time	Elapsed Time (hours)	Applied Vacuum at SVE-1A (Inches of Water)	Flow Rate at SVE-1A (scfm)	Monitoring Well Pressure Readings (Inches of Water)					COMMENTS
					VM-1A	VM-2A	VM-3A	VM-4A	VM-5A	
					Dist. from SVE-1A: 7 ft	Dist. from SVE-1A: 10 ft	Dist. from SVE-1A: 15 ft	Dist. from SVE-1A: 20 ft	Dist. from SVE-1A: 30 ft	
		0 (Baseline Pre-SVE-1A Step Test)	0	0						Baseline Readings Prior to the Start of Testing
		1 (End of Step 1)								
		2 (End of Step 2)								
		3 (End of Step 3)								
		4 (End of Step 4)								

NOTES:
Baseline pressure readings will be recorded on a field sheet with a plus symbol ("+") indicating positive pressure and a negative symbol ("-") indicating negative pressure or vacuum.
1) Off-site well to evaluate response due to change in atmosphere

FIELD SHEET-2
SHALLOW STEP TEST SYSTEM READINGS SAMPLE COLLECTION
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Date	Time	Elapsed (min)	System Readings																														
			Extraction Well Field Data (SVE-1A)											System Dilution Data						System Influent Data											System Effluent Data		
			Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2, 3]	Percent Open (%)	Temp (^oF)	RH (%)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Vacuum (in. WC)	Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2]	Temp (^oF)	PID (ppmv)	FID (ppmv)
STEP 1																																	
		1											x																	x			
		30																															
		60																															
STEP 2																																	
		1											x																	x			
		30																															
		60																															
STEP 3																																	
		1											x																	x			
		30																															
		60																															
STEP 4																																	
		1											x																	x			
		30																															
		60											x																	x			

NOTES:
x: Sample will be collected
RH: Relative Humidity
1) Flow rate will be calculated using differential pressure
2) Samples will be analyzed for TPH-G (TO-3), VOCs (TO-15M), Fixed Gas (D-1946), & Methane (SCAQMD 25.1)
3) If Dilution is not being used then well field samples will not be collected

FIELD SHEET-3
DEEP STEP TEST PRESSURE READINGS
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Date	Time	Elapsed Time (hours)	Applied Vacuum at SVE-1B (Inches of Water)	Flow Rate at SVE-1B (scfm)	Monitoring Well Pressure Readings (Inches of Water)					COMMENTS
					VM-1B	VM-2B	VM-3B	VM-4B	VM-5B	
					Dist. from SVE-1B: 15 ft	Dist. from SVE-1B: 22 ft	Dist. from SVE-1B: 27 ft	Dist. from SVE-1B: 37 ft	Dist. from SVE-1B: 49 ft	
		0 (Baseline Pre SVE-1A Step Test)	0	0						Baseline Readings Prior to the Start of Testing
		0 (Baseline Pre SVE-1B Step Test)	0	0						
		1 (End of Step 1)								
		2 (End of Step 2)								
		3 (End of Step 3)								
		4 (End of Step 4)								

NOTES:
Baseline pressure readings will be recorded on a field sheet with a plus symbol ("+") indicating positive pressure and a negative symbol ("-") indicating negative pressure or vacuum.
1) Off-site well to evaluate response due to change in atmosphere

FIELD SHEET-4
DEEP STEP TEST SYSTEM READINGS SAMPLE COLLECTION
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Date	Time	Elapsed (min)	System Readings																														
			Extraction Well Field Data (SVE-1B)											System Dilution Data						System Influent Data											System Effluent Data		
			Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2, 3]	Percent Open (%)	Temp (^oF)	RH (%)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Vacuum (in. WC)	Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2]	Temp (^oF)	PID (ppmv)	FID (ppmv)
STEP 1																																	
		1											x																	x			
		30																															
		60																															
STEP 2																																	
		1											x																	x			
		30																															
		60																															
STEP 3																																	
		1											x																	x			
		30																															
		60																															
STEP 4																																	
		1											x																	x			
		30																															
		60											x																	x			

NOTES:
x: Sample will be collected
RH: Relative Humidity
1) Flow rate will be calculated using differential pressure
2) Samples will be analyzed for TPH-G (TO-3), VOCs (TO-15M), Fixed Gas (D-1946), & Methane (SCAQMD 25.1)
3) If Dilution is not being used then well field samples will not be collected

FIELD SHEET-5
SHALLOW CONSTANT RATE TEST PRESSURE READINGS
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Date	Time	Elapsed Time (hours)	Applied Vacuum at SVE-1A (Inches of Water)	Flow Rate at SVE-1A (scfm)	Monitoring Well Pressure Readings (Inches of Water)					COMMENTS
					VM-1A	VM-2A	VM-3A	VM-4A	VM-5A	
					Dist. from SVE-1A: 7 ft	Dist. from SVE-1A: 10 ft	Dist. from SVE-1A: 15 ft	Dist. from SVE-1A: 20 ft	Dist. from SVE-1A: 30 ft	
		0 hours								
		4 hours								
		8 hours								
		24 hours								
		48 hours								
		72 hours								
		96 hours								
		96.5 hours								Post-Constant Rate Test
		97 hours								Post-Constant Rate Test
		97.5 hours								Post-Constant Rate Test
		98 hours								Post-Constant Rate Test

NOTES:
Baseline pressure readings will be recorded on a field sheet with a plus symbol ("+") indicating positive pressure and a negative symbol ("-") indicating negative pressure or vacuum.
1) Off-site well to evaluate response due to change in atmosphere

FIELD SHEET-6
SHALLOW CONSTANT RATE TEST SYSTEM READINGS AND SAMPLE COLLECTION
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Day	Date	Time	Elapsed Time (hour)	System Readings																															
				Extraction Well Field Data (SVE-1A)											System Dilution Data						System Influent Data											System Effluent Data			
				Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2, 3]	Percent Open (%)	Temp (^oF)	RH (%)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Vacuum (in. WC)	Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2]	Temp (^oF)	PID (ppmv)	FID (ppmv)	Lab Sample Collected[4]
1			0																																
			1.5											x																	x				x
			3																																
			4.5																																
			6																																
			7.5																																
			9																																
			10.5																																
			12																																
			13.5																																
			15																																
			16.5																																
			18																																
			19.5																																
			21																																
			22.5																																
			24																																

FIELD SHEET-6
SHALLOW CONSTANT RATE TEST SYSTEM READINGS AND SAMPLE COLLECTION
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Day	Date	Time	Elapsed Time (hour)	System Readings																															
				Extraction Well Field Data (SVE-1A)											System Dilution Data						System Influent Data											System Effluent Data			
				Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2, 3]	Percent Open (%)	Temp (^oF)	RH (%)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Vacuum (in. WC)	Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2]	Temp (^oF)	PID (ppmv)	FID (ppmv)	Lab Sample Collected[4]
2			25.5																																
			27																																
			28.5																																
			30																																
			31.5																																
			33																																
			34.5																																
			36																																
			37.5																																
			39																																
			40.5																																
			42																																
			43.5																																
			45																																
			46.5																																
			48											x																	x				x

FIELD SHEET-6
SHALLOW CONSTANT RATE TEST SYSTEM READINGS AND SAMPLE COLLECTION
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Day	Date	Time	Elapsed Time (hour)	System Readings																															
				Extraction Well Field Data (SVE-1A)											System Dilution Data						System Influent Data											System Effluent Data			
				Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2, 3]	Percent Open (%)	Temp (^oF)	RH (%)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Vacuum (in. WC)	Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2]	Temp (^oF)	PID (ppmv)	FID (ppmv)	Lab Sample Collected[4]
3			49.5																																
			51																																
			52.5																																
			54																																
			55.5																																
			57																																
			58.5																																
			60																																
			61.5																																
			63																																
			64.5																																
			66																																
			67.5																																
			69																																
			70.5																																
			72																																

FIELD SHEET-6
SHALLOW CONSTANT RATE TEST SYSTEM READINGS AND SAMPLE COLLECTION
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Day	Date	Time	Elapsed Time (hour)	System Readings																																
				Extraction Well Field Data (SVE-1A)											System Dilution Data						System Influent Data											System Effluent Data			
				Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2, 3]	Percent Open (%)	Temp (^oF)	RH (%)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Vacuum (in. WC)	Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2]	Temp (^oF)	PID (ppmv)	FID (ppmv)	Lab Sample Collected[4]
4			73.5																																	
			75																																	
			76.5																																	
			78																																	
			79.5																																	
			81																																	
			82.5																																	
			84																																	
			85.5																																	
			87																																	
			88.5																																	
			90																																	
			91.5																																	
			93																																	
			94.5																																	
			96											x																	x				x

NOTES:
x: Sample will be collected
1) Flow rate will be calculated using differential pressure
2) Samples will be analyzed for TPH-G (TO-3), VOCs (TO-15M), Fixed Gas (D-1946), & Methane (SCAQMD 25.1)
3) If Dilution is not being used then well field samples will not be collected
4) Samples will be analyzed for TPH-G (TO-3) and VOCs (TO-15M)

FIELD SHEET-7
DEEP CONSTANT RATE TEST PRESSURE READINGS
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Date	Time	Elapsed Time (hours)	Applied Vacuum at SVE-1B (Inches of Water)	Flow Rate at SVE-1B (scfm)	Monitoring Well Pressure Readings (Inches of Water)					COMMENTS
					VM-1B	VM-2B	VM-3B	VM-4B	VM-5B	
					Dist. from SVE-1B: 15 ft	Dist. from SVE-1B: 22 ft	Dist. from SVE-1B: 27 ft	Dist. from SVE-1B: 37 ft	Dist. from SVE-1B: 49 ft	
		0 hours								
		4 hours								
		8 hours								
		24 hours								
		48 hours								
		72 hours								
		96 hours								
		96.5 hours								Post-Constant Rate Test
		97 hours								Post-Constant Rate Test
		97.5 hours								Post-Constant Rate Test
		98 hours								Post-Constant Rate Test

NOTES:
Baseline pressure readings will be recorded on a field sheet with a plus symbol ("+") indicating positive pressure and a negative symbol ("-") indicating negative pressure or vacuum.
1) Off-site well to evaluate response due to change in atmosphere

FIELD SHEET-8
DEEP CONSTANT RATE TEST SYSTEM READINGS AND SAMPLE COLLECTION
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Day	Date	Time	Elapsed Time (hour)	System Readings																															
				Extraction Well Field Data (SVE-1B)											System Dilution Data						System Influent Data											System Effluent Data			
				Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2, 3]	Percent Open (%)	Temp (^oF)	RH (%)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Vacuum (in. WC)	Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2]	Temp (^oF)	PID (ppmv)	FID (ppmv)	Lab Sample Collected[4]
1			0																																
			1.5											x																	x				x
			3																																
			4.5																																
			6																																
			7.5																																
			9																																
			10.5																																
			12																																
			13.5																																
			15																																
			16.5																																
			18																																
			19.5																																
			21																																
			22.5																																
			24																																

FIELD SHEET-8
DEEP CONSTANT RATE TEST SYSTEM READINGS AND SAMPLE COLLECTION
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Day	Date	Time	Elapsed Time (hour)	System Readings																															
				Extraction Well Field Data (SVE-1B)											System Dilution Data						System Influent Data											System Effluent Data			
				Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2, 3]	Percent Open (%)	Temp (^oF)	RH (%)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Vacuum (in. WC)	Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2]	Temp (^oF)	PID (ppmv)	FID (ppmv)	Lab Sample Collected[4]
2			25.5																																
			27																																
			28.5																																
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			39																																
			40.5																																
			42																																
			43.5																																
			45																																
			46.5																																
			48											x																	x				x

FIELD SHEET-8
DEEP CONSTANT RATE TEST SYSTEM READINGS AND SAMPLE COLLECTION
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Day	Date	Time	Elapsed Time (hour)	System Readings																															
				Extraction Well Field Data (SVE-1B)											System Dilution Data						System Influent Data											System Effluent Data			
				Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2, 3]	Percent Open (%)	Temp (^oF)	RH (%)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Vacuum (in. WC)	Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2]	Temp (^oF)	PID (ppmv)	FID (ppmv)	Lab Sample Collected[4]
3			49.5																																
			51																																
			52.5																																
			54																																
			55.5																																
			57																																
			58.5																																
			60																																
			61.5																																
			63																																
			64.5																																
			66																																
			67.5																																
			69																																
			70.5																																
			72																																

FIELD SHEET-8
DEEP CONSTANT RATE TEST SYSTEM READINGS AND SAMPLE COLLECTION
SVE PILOT TEST - PROPERTY 23/SOURCE AREA 6
REMEDIAL DESIGN WORK PLAN
DEL AMO SUPERFUND SITE

Day	Date	Time	Elapsed Time (hour)	System Readings																															
				Extraction Well Field Data (SVE-1B)											System Dilution Data						System Influent Data											System Effluent Data			
				Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2, 3]	Percent Open (%)	Temp (^oF)	RH (%)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Vacuum (in. WC)	Temp (^oF)	Differential Pressure (In. WC)[1]	Flow Rate (scfm)	Applied Vacuum (in. WC)	PID (ppmv)	FID (ppmv)	O_2 (%)	CH_4 (%)	CO_2 (%)	RH (%)	Lab Sample Collected[2]	Temp (^oF)	PID (ppmv)	FID (ppmv)	Lab Sample Collected[4]
4			73.5																																
			75																																
			76.5																																
			78																																
			79.5																																
			81																																
			82.5																																
			84																																
			85.5																																
			87																																
			88.5																																
			90																																
			91.5																																
			93																																
			94.5																																
			96											x																	x				x

NOTES:
x: Sample will be collected
1) Flow rate will be calculated using differential pressure
2) Samples will be analyzed for TPH-G (TO-3), VOCs (TO-15M), Fixed Gas (D-1946), & Methane (SCAQMD 25.1)
3) If Dilution is not being used then well field samples will not be collected
4) Samples will be analyzed for TPH-G (TO-3) and VOCs (TO-15M)

Drewelow Remediation Equipment, Inc.
A CERTIFIED SMALL BUSINESS ENTERPRISE
WWW.DRE-EQUIP.COM

DE-31 Data Sheet

Equipment description – Stealth Firecat 250 scfm thermal / catalytic oxidizer. 30 gallon gas/liquid separator with auto drain, Sutorbilt 4L positive displacement blower, 7.5 hp electric motor, v-belt drive, exhaust silencer, SCH 40 carbon steel piping, 250 scfm oxidizing thermal / catalytic oxidizing chamber, exhaust stack, skid mounted with NEMA 4 control panel and a Yokogawa 4 pen strip chart recorder.

Model number	FC-250	**SCAQMD permit number**	
Maximum design flow rate	250 scfm	**Maximum blower vacuum**	10 in hg.
Influent connection	3 inch (f)NPT	**Supplemental fuel connection**	1 inch NPT
Electrical requirements	230/3/60 460/3/60	**Sub panel amp rating**	100 amps

Equipment dimensions

Length	12 feet	**Width**	7 feet 6 inches
Height without exhaust stack	7.5 feet	**Stack height**	15 feet above grade
Color	Gray	**Weight**	Approx 3,500 lbs

APPENDIX H
ISCO OXIDANT AND VENDOR INFORMATION

PRODUCT INFORMATION FOR IRON-ACTIVATED PERSULFATE

Procedure for Activating Klozur® Persulfate with Dissolvine® Iron-EDTA

Background

Klozur® Persulfate can be activated with Dissolvine® iron – EDTA (chelated iron) for the oxidative destruction of organic contaminants of concern, including PCE, TCE, DCE, vinyl chloride, BTEX, low molecular weight aromatic hydrocarbons, methyl-*tert*-butyl ether (MTBE), 1,4-dioxane and others.

For the iron – EDTA (FeEDTA) activation of Klozur Persulfate, the iron concentration in the groundwater needs to be maintained between 150 mg / L (ppm) and 600 mg / L (ppm). Iron concentrations below 150 ppm will result in kinetics that may not be favorable for the oxidation of various contaminants, and concentrations in excess of 600 ppm may lead to increased persulfate auto-decomposition. Dissovline Iron – EDTA is 13% iron by weight, thus requiring between 1,154 ppm and 4,615 ppm FeEDTA to maintain the desired groundwater iron concentrations.

FMC recommends the addition of FeEDTA as an activator when iron activation is selected, even if there is iron already present in the sub-surface. Measured iron concentrations present in soils may not be available for persulfate activation or the iron may not be distributed evenly enough through the treatment zone to insure adequate activation of the persulfate.

Safety and Handling

Dissolvine FeEDTA is a yellowish-green powder with slight health hazards. Appropriate Personal Protective Equipment (PPE), including chemical goggles is required when handling this product. **Review the MSDS with all workers prior to handling this chemical.**

FMC does not recommend combining FeEDTA with persulfate in the same batching tank, as persulfate decomposition may occur with subsequent generation of heat and oxidant loss.

Procedure for determining the amount of FeEDTA needed:

1. Determine the volume of groundwater to be treated with Fe-EDTA activated persulfate.

2. The minimum amount of FeEDTA needed to achieve 150 ppm of Fe in the groundwater can be determined by:

$$\text{Lbs FeEDTA} = \text{\# gallons of groundwater} * 150 * 6.38 \times 10^{-5}$$

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Applying Klozur persulfate solution and FeEDTA activator to a contaminated site

Various combinations of Klozur persulfate and FeEDTA in solution may undergo an exothermic reaction, potentially leading to significant heat generation (with temperature increases to 100 C possible) and oxidant loss. As a result:

FMC does not recommend combining FeEDTA with persulfate in the same batching tank.

Instead, it is recommended that separate batch tanks be utilized to make up the persulfate solution and the FeEDTA solution. The solutions may then be mixed prior to the well-head and co-injected or injected separately in a serial fashion.

At room temperature, FeEDTA is soluble at a concentration of 0.75 lb / gallon.

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PRODUCT INFORMATION FOR pH-ACTIVATED PERSULFATE

Procedure for Activating Klozur® Persulfate with a 25% Sodium Hydroxide Solution

Background

For alkaline activation of Klozur Persulfate, the pH of the soil and groundwater will need to be maintained between 10.5 and 12. Sodium Hydroxide (NaOH, caustic soda) can be used to achieve the pH target range. The NaOH demand arises from two sources; 1) soil and groundwater acidity, and 2) the generation of acid formed during the decomposition of Klozur Persulfate. The amount of the NaOH needed to raise soil and groundwater pH must be determined experimentally (see procedure below). In addition, to address the persulfate generated acid, 2 moles of NaOH per mole of Klozur Persulfate must be added to neutralize the persulfate-generated acid.

Total NaOH Demand = NaOH needed to raise soil and groundwater to target pH 10.5-12 + 2 moles NaOH / mole Klozur persulfate

Safety and Handling

Sodium Hydroxide is a corrosive chemical and can cause severe chemical burns to body tissue if mishandled. Therefore, appropriate Personal Protective Equipment (PPE), including chemical goggles and face shield, is required when handling and transferring NaOH. **Review the MSDS with all workers prior to handling this chemical.**

Sodium Hydroxide is sold commercially in a variety of concentrations. Common concentrations include; 50%, 73%, and solid flakes or pellets (100%). These highly concentrated forms of NaOH may generate extreme exothermic reactions upon dilution. In certain circumstances, so much heat may be liberated that it can boil the solution causing steam eruptions, loss of product containment and damage to equipment. Use of concentrated NaOH require very long dilution times and/or heat exchange equipment with agitation or good mixing.

FMC recommends NaOH solutions of no more than 25% by weight be used to activate Klozur persulfate.

This will help to minimize the generation of heat upon mixing the NaOH with water. FMC does not permit use of NaOH concentrations greater than 25% in its Klozur mixing rental equipment.

Use of NaOH solutions in excess of 25 wt% or in solid form may increase the risk of injury, loss of product containment and equipment damage.

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Activation Procedures

Part A: Soil Titration Method for 25% NaOH determination

1. Take a 500 gram (1.1 lb) sample of the soil from an area that is representative of the contaminated site.
2. Take a 1500 gram (3.31 lb) sample of the ground water.
3. Place these samples in a clean glass or plastic container and mix thoroughly for 5 minutes.
4. Determine and record the pH of the water.
5. Take 100 ml aliquot of the mixed soil/ water slurry in a clean glass beaker. Insert a pH probe to measure the pH as NaOH is added.
6. Set up a burette with 25% NaOH solution.
7. Slowly dose 25% NaOH into the beaker until the pH reaches 10.5 and maintains 10.5 for 30 minutes. Add more 25% NaOH if the pH drops during the test.
8. Record the ml's of 25% NaOH required to neutralize 100 ml's of soil slurry.
9. Calculate and scale up the amount of NaOH to Field scale conditions based on total treatment soil volume.

Note: 3785 ml's (3.785 L) = 1 gallon.

Part B: Determine the amount of 25% NaOH to neutralize the Persulfate- Generated Acid

1. Determine total Klozur® requirement in lbs
2. Multiply lbs of Klozur® by 0.1267 to determine gallons of 25% NaOH required

Note: 2 lb-moles NaOH required / lb-mole persulfate persulfate → 1.344 lb of 25 wt% NaOH / lb of Klozur persulfate Density of 25 wt% NaOH = 10.61 lb / gal → 126.67 gal 25 wt% NaOH / 1000 lb Klozur persulfate

The total 25 wt% NaOH demand = amount from Part A + amount from Part B

Applying Klozur solution and 25% NaOH activator to a contaminated site

1. 25% NaOH solution can be:

- applied to a site prior to addition of the Klozur persulfate solution
- applied to a site post addition of the Klozur persulfate solution
- applied to a site simultaneous to the addition of the Klozur persulfate solution

2. It is recommended that if the Klozur persulfate and 25 wt% NaOH solution are added simultaneously

- No more than **0.2 gallons** of 25% NaOH should be added per gallon of 30% Klozur solution
- No more than **0.4 gallons** of 25% NaOH should be added per gallon of 20% Klozur solution
- No more than **0.6 gallons** of 25% NaOH should be added per gallon o 10% Klozur solution

Mixing of NaOH and persulfate solutions in ratios greater than mentioned above may lead to increases in solution temperature.

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MSDS FOR SODIUM PERSULFATE

Material Safety Data Sheet

Klozur® SP

MSDS #: 7775-27-1-12
Revision Date: 2014-04-15
Version 3

This MSDS has been prepared to meet U.S. OSHA Hazard Communication Standard 29 CFR 1910.1200 And Canadian Workplace Hazardous Materials Information System (WHMIS) requirements.

1. PRODUCT AND COMPANY IDENTIFICATION

Product name	**Klozur® SP**
Synonyms	Sodium Peroxydisulfate; Disodium Peroxydisulfate; Peroxydisulfuric acid, disodium salt; Peroxydisulfuric acid, sodium salt
Formula	Na2O8S2 and $Na_2S_2O_8$
Recommended use:	In situ and ex situ chemical oxidation of contaminants and compounds of concern for environmental remediation applications
Restrictions on use:	No uses to be advised against were identified

Manufacturer

PeroxyChem LLC
1735 Market Street
Philadelphia, PA 19103
Phone: +1 215/ 299-5858 (General Information)
E-Mail: sdsinfo@peroxychem.com

Emergency telephone number

For leak, fire, spill or accident emergencies, call:
1 800 / 424 9300 (CHEMTREC - U.S.A.)
1 703 / 527 3887 (CHEMTREC - Collect - All Other Countries)
1 303/ 389-1409 (Medical - U.S. - Call Collect)

2. HAZARDS IDENTIFICATION

Emergency Overview

White, odorless crystals
Oxidizer; Contact with combustible material may cause fire.
Decomposes in storage under conditions of moisture and/or excessive heat causing release of sulfur oxides and oxygen that supports combustion (See Section 10).

Potential health effects

Acute Toxicity

Eyes	Causes moderate eye irritation.
Skin	Moderately irritating to the eyes. May cause sensitization by skin contact.
Inhalation	May cause irritation of respiratory tract. Respiratory sensitizer.
Ingestion	Harmful if swallowed.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients

Chemical Name	CAS-No	Weight %
Sodium Persulfate	7775-27-1	> 99

4. FIRST AID MEASURES

General advice Remove from exposure, lie down. Show this material safety data sheet to the doctor in attendance.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids intermittently. Consult a physician. In case of contact, immediately flush eyes with plenty of water. If symptoms persist, call a physician.

Skin contact Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Get medical attention if irritation develops and persists.

Inhalation Remove from exposure, lie down. If breathing is irregular or stopped, administer artificial respiration. Call a physician immediately.

Ingestion Do NOT induce vomiting. Call a physician or poison control center immediately. Rinse mouth. Drink 1 or 2 glasses of water.

5. FIRE-FIGHTING MEASURES

Flash Point Not flammable

Suitable extinguishing media Water. Cool containers with flooding quantities of water until well after fire is out.

Unsuitable Extinguishing Media Do not use carbon dioxide or other gas filled fire extinguishers; they will have little effect on decomposing persulfate.

Explosion Data
Sensitivity to Mechanical Impact Not applicable
Sensitivity to Static Discharge Not applicable

Specific hazards arising from the chemical Decomposes under fire conditions to release oxygen that intensifies the fire.

Protective equipment and precautions for firefighters As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA	Health Hazard 2	Flammability 0	Stability 1	Special Hazards OX

6. ACCIDENTAL RELEASE MEASURES

Personal precautions Keep off any unprotected persons. Avoid contact with the skin and the eyes. Avoid breathing dust. Wear personal protective equipment.

Methods for containment Vacuum, shovel or pump waste into a drum and label contents for disposal. Avoid dust formation Store in closed container

Methods for cleaning up Clean up spill area and treat as special waste. Clean up the area with plenty of water.

Other Never add other substances or combustible waste to product residues.

7. HANDLING AND STORAGE

Handling

Wear personal protective equipment. Refer to Section 8. Use only in area provided with appropriate exhaust ventilation. Avoid dust formation. Handle product only in closed system or provide appropriate exhaust ventilation at machinery. Avoid contact with skin and eyes. Avoid breathing dust. Remove and wash contaminated clothing before re-use.

Storage

Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from heat. Do not store near combustible materials. Avoid contamination of opened product. Keep away from food, drink and animal feedingstuffs. Avoid formation and deposition of dust.

8. EXPOSURE CONTROL / PERSONAL PROTECTION

Exposure guidelines .

Chemical Name	ACGIH TLV	OSHA PEL	NIOSH	Mexico
Sodium Persulfate 7775-27-1	TWA: 0.1 mg/m^3			

Chemical Name	British Columbia	Quebec	Ontario TWAEV	Alberta
Sodium Persulfate 7775-27-1	TWA: 0.1 mg/m^3		TWA: 0.1 mg/m^3	TWA: 0.1 mg/m^3

Occupational exposure controls

Engineering measures

Local exhaust ventilation w >90% efficiency.

Respiratory protection

If exposure limits are exceeded or irritation is experienced, NIOSH/MSHA approved respiratory protection should be worn. Positive-pressure supplied air respirators may be required for high airborne contaminant concentrations. Respiratory protection must be provided in accordance with current local regulations.

Eye/face protection

Eye protection recommended. Chemical goggles consistent with EN 166 or equivalent.

Skin and body protection

Wear suitable protective clothing. Protective shoes or boots.

Hand protection

Protective gloves: Neoprene gloves, Polyvinylchloride, Natural Rubber.

Hygiene measures

Keep away from food, drink and animal feeding stuffs. Do not eat, drink or smoke when using this product. Wash hands before breaks and after shifts. Keep work clothes separate, remove contaminated clothing - launder after open handling of product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	Crystalline solid
Color	white
Physical state	solid
Odor	Odorless
Odor Threshold	Not applicable
pH	6.0 (1% solution)
Melting Point/Range	Decomposes on heating. 180 °C
Freezing point	Not applicable
Boiling Point/Range	Decomposes
Flash Point	Not flammable
Evaporation rate	Not applicable
Oxidizing properties	Oxidizer
Explosive properties	Not explosive
Vapor pressure	6.07E-30 mm Hg at 25ºC
Vapor density	No information available

Specific Gravity	1.68
Molecular Weight	238.1
Water solubility	730 g/L @ 25 °C
Percent volatile	No information available
Partition coefficient	Not applicable
Viscosity	(Solid)
Decomposition Temperature	> 100 °C
Autoignition Temperature	No evidence of combustion up to 600°C

10. STABILITY AND REACTIVITY

Stability Stable.

Conditions to avoid Heat; Moisture; Combustibles such as paper and wood.

Materials to avoid Acids, Bases, Halides, Oxidizing agents, Strong reducing agents, Combustible materials,

Hazardous decomposition products None known .

Hazardous polymerization Hazardous polymerization does not occur.

Hazardous reactions Use of persulfates in chemical reactions requires appropriate precautions and design considerations for pressure and thermal relief.

Decomposing persulfates will evolve large volumes of gas and/or vapor, can accelerate exponentially with heat generation, and create significant and hazardous pressures if contained and not properly controlled or mitigated.

Use with alcohols in the presence of water has been demonstrated to generate conditions that require rigorous adherence to process safety methods and standards to prevent escalation to an uncontrolled reaction.

11. TOXICOLOGICAL INFORMATION

Acute effects

Eye irritation Irritating to eyes. Has been shown to exhibit eye irritation properties in human case reports following occupational exposure and consumer use. Slight irritation (rabbit).

Skin irritation Irritating to skin. Persulfates in general, specifically diammonium persulfate and dipotassium persulfate, exhibited skin irritation properties in human case reports, following occupational exposure and consumer use. Slight irritation (rabbit).

LD50 Oral	1200 mg/kg (Rat) Sodium Persulfate
LD50 Dermal	> 10,000 mg/kg (rabbit) Sodium Persulfate
LC50 Inhalation	=> 5.1 mg/L (4-hr) (Rat) Sodium Persulfate

Sensitization Sensitizing to skin and respiratory system Positive in a local lymph node assay.

Chronic Toxicity

Carcinogenicity Did not show carcinogenic effects in animal experiments

Mutagenicity In vivo tests did not show mutagenic effects. In vitro tests did not show mutagenic effects.

Target Organ Effects Eyes, Skin, Respiratory system.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Sodium Persulfate (7775-27-1)

Active Ingredient(s)	Duration	Species	Value	Units
Sodium Persulfate	96 h LC50	Rainbow trout	163	mg/L
Sodium Persulfate	48 h LC50	Daphnia magna	133	mg/L
Sodium Persulfate	96 h LC50	Grass shrimp	519	mg/L
Sodium Persulfate	72 h EC50	Algae S. capricornutum	116	mg/L

Persistence and degradability Biodegradability does not pertain to inorganic substances.

Bioaccumulation Does not bioaccumulate.

Mobility Dissociates into ions.

Other adverse effects None known

13. DISPOSAL CONSIDERATIONS

Waste disposal methods This material, as supplied, is a hazardous waste according to federal regulations (40 CFR 261). It must undergo special treatment, e.g. at suitable disposal site, to comply with local regulations.

RCRA D Waste Code D001 (ignitable).

Contaminated packaging Dispose of in accordance with local regulations.

14. TRANSPORT INFORMATION

DOT

UN/ID No UN 1505
Proper shipping name SODIUM PERSULFATE
Hazard Class 5.1
Packing group III
Reportable Quantity (RQ) not applicable

TDG

UN/ID No UN 1505
Proper shipping name SODIUM PERSULFATE
Hazard Class 5.1
Packing group III

ICAO/IATA

UN/ID No UN 1505
Proper shipping name SODIUM PERSULFATE
Hazard Class 5.1
Packing group III

IMDG/IMO

UN/ID No UN 1505
Proper shipping name SODIUM PERSULFATE
Hazard Class 5.1
Packing group III

ADR/RID

UN/ID No 1505
Proper shipping name SODIUM PERSULFATE

Hazard Class	5.1
Packing group	III
Description	Oxidizer

15. REGULATORY INFORMATION

International Inventories

TSCA Inventory (United States of America)	Complies
DSL (Canada)	Complies
NDSL (Canada)	Complies
EINECS/ELINCS (Europe)	Complies
ENCS (Japan)	Complies
IECSC (China)	Complies
KECL (Korea)	Complies
PICCS (Philippines)	Complies
AICS (Australia)	Complies
NZIoC (New Zealand)	Complies

U.S. Federal Regulations

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazard Categories

Acute Health Hazard	yes
Chronic Health Hazard	no
Fire Hazard	yes
Sudden Release of Pressure Hazard	no
Reactive Hazard	no

CERCLA

This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

International Regulations

Mexico - Grade Moderate risk, Grade 2

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS Hazard Class

C Oxidizing materials
D2A Very toxic materials
D2B Toxic materials

16. OTHER INFORMATION

HMIS	Health Hazard 2	Flammability 0	Stability 1	Special precautions J

Protection=J (Safety goggles, gloves, apron, combination dust and vapor respirator)

Product Certifications

Revision Date: 2014-04-15
Reason for revision: Initial Release.

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Prepared By

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End of Material Safety Data Sheet

PRODUCT INFORMATION FOR CATALYZED HYDROGEN PEROXIDE

Fact Sheet and Briefing Book

In-Situ Oxidative Technologies (ISOTEC)

A fast and cost effective approach to remediation of your groundwater and soil using in-situ chemical oxidation services and specializing in the use of modified Fenton's reagent.

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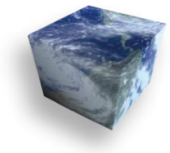
2. FAQs



In-Situ Oxidative Technologies (ISOTEC)

We are a leader in oxidative remediation and provide a full complement of in-situ chemical oxidation technologies including the ISOTEC Process - a patented chelated Fenton's reagent.

In-Situ Chemical Oxidation

Remediation of groundwater contamination using ISCO (in-situ chemical oxidation) involves injecting oxidants directly into the source zone and downgradient plume. The oxidant chemicals react with the contaminant, producing innocuous substances such as carbon dioxide (CO_2), water (H_2O), and inorganic chloride. ISOTEC's patented Fenton's process uses hydrogen peroxide and a chelated organo-metallic catalyst.

Examples of potential contaminants that are amenable to treatment by ISCO include BTEX (benzene, toluene, ethylbenzene, and xylenes), chlorinated ethenes (PCE, TCE, DCE, VC), chlorinated ethanes (TCA, DCA), MTBE (methyl-tert-butyl-ether), polyaromatic hydrocarbons (PAHs), pentachlorophenol (PCP), and chlorinated pesticides.

To learn more about in-situ chemical oxidation, download the document prepared by the Interstate Technology Regulatory Council, Technical and Regulatory Guidance for In-situ Chemical Oxidation of Contaminated Soil and Groundwater, June 2001 - http://www.itrcweb.org/ISCO-1.pdf.

Additional technical information can be found at EPA's Technology Innovation Office Web Site. – http://www.clu-in.org/conf/itrc/isco_092701/resource.htm.

PROFILE

In-Situ Oxidative Technologies, Inc. (ISOTEC) has revolutionized environmental remediation through its proprietary in-situ treatment of soil and groundwater contamination. Our unique processes destroy contaminants in soil and groundwater in a time and cost-effective manner and with minimal site disruption.

Our patented Fenton's reagent based oxidation technology known as the ISOTEC Process combines our proprietary catalysts, oxidizers, and stabilizers in an optimal, chemical formulation, and employs a site-specific injection design for uniform delivery of reagents.

The ISOTEC Process is effective on a wide range of contaminants including recalcitrant compounds such as petroleum hydrocarbons, gasoline additives including MTBE, chlorinated solvents and pesticides. Hydroxyl radicals generated by the ISOTEC Process will oxidize nearly all contaminants with carbon/carbon double bonds (i.e. TCE and PAH) and single bonded contaminants with extractable hydrogen (i.e. TCA).

THE ISOTEC APPROACH

Our typical project approach, starting in the laboratory and scaling-up in the field, ensures that the ISOTEC Process is optimized for each site.

First, we perform a laboratory treatability study. This step allows us to test several types and concentrations of our patented catalysts and oxidizers on soil and groundwater samples obtained from the site.

Following the treatability study, a field pilot program is designed to evaluate not only the efficiency of our reagents, but also the distribution of the reagents within the impacted media. The data generated during the pilot program allows ISOTEC to design a full-scale remediation program that will be the most effective in remediating your site.

At some sites, appropriate geology and contaminant types allow ISOTEC to mobilize directly to the field and begin full-scale remediation.

ISOTEC PROCESS

Fenton's reagent is quickly emerging as the state-of-the-art remedial technique of the 21st century. But if you are familiar with how conventional Fenton's is most often applied, using strong acids and high reagent concentrations under pressure...then you are familiar with its shortcomings... often including incomplete treatment, explosive reactions, organic vapor generation and contaminant migration. ISOTEC's patented modified Fenton's reagent process was specifically designed to overcome these problems.

Conventional Fenton's reagent requires acid injection into the subsurface to maintain catalyst mobility. ISOTEC's modified Fenton's reagent utilizes a patented chelated catalyst which allows injection into the subsurface at neutral (background) pH conditions. ISOTEC's catalyst differentiates ISOTEC from traditional Fenton's processes.

ISOTEC's patented catalysts allow its reagents to be effectively distributed within the aquifer destroying contaminants in soil and groundwater without generating organic vapors or high temperatures. That's because the ISOTEC Process does not use acids or high pressures.

The ISOTEC Process is an in-situ remedial treatment technology that destroys organic contamination through a chemical oxidation process. The ISOTEC Process consists of injecting patented organo-metallic catalysts, mobility control agents, oxidizers (H_2O_2), and stabilizers into contaminated aquifers or vadose zones.

As compared to conventional Fenton's reagent which requires acidic conditions (pH~3), the ISOTEC Process is effective at neutral (pH~7) conditions. This is an important consideration in full-scale application since acidifying an aquifer is typically impractical.

As an effective modified Fenton process, ISOTEC uses patented reagents designed for neutral subsurface conditions and efficient hydroxyl radical generation. ISOTEC's oxidation method utilizes a site-specific injection program designed to treat organic

ISOTEC's expertise over the last seven years in successfully applying in-situ chemical oxidation services to various contaminants and hydrogeology is unsurpassed. This expertise is a combination of our professional backgrounds in groundwater and soil remediation, hydrogeology, and a working knowledge of what actually works in the field through previous remediation project experience.

Fenton's reagent technology is not only capable of treating groundwater, but also treats sorbed contaminants including NAPL. This results in contaminant mass reduction necessary to ensure continued low contaminant levels in the groundwater after the completion of chemical oxidation injection.

contaminants within an area of concern. ISOTEC oxidants and catalysts generate hydroxyl radicals, which react with the organic contaminants within the subsurface producing innocuous by-products such as carbon dioxide and water (and chloride ions if chlorinated compounds are being treated).

Oxidant Comparison

A comparison of commonly used oxidation technologies is shown below:

	Fenton's Reagent	Permanganate	Ozone
Physical State	Liquid	Liquid	Gas
Molecular Composition	$OH^{\bullet}$	MnO_4^-	O_3
Hydroxyl Radical Formation	Yes	Under Very Limited Conditions	Under Certain Conditions
Oxidation Potential	2.8V (highest)	1.7 V	2.07 V
Reaction Times	Very Fast	Slow	Fast
By-Products	Ferric iron, O_2, H_2O	Dissolved Manganese, potential heavy metals	Oxygen
Contaminant Mass / NAPL Reduction	Yes	Limited	Limited
Potential to Enhance Bioremediation	Yes, under neutral conditions	Unlikely	Yes
Capital Costs	Low	Low	High
Reagent Costs	Moderate	Moderate	Moderate
Metals Mobilization / Oxidation Potential	Possible under acidic conditions	Possible oxidation of Cr^{3+} to Cr^{6+}	Potential

ISOTEC chemical oxidation services are superior to other in-situ oxidation technologies for the following reasons:

- Neutral pH conditions (e.g. 5-8) are used; therefore, no acidification of the aquifer is required as with conventional Fenton-based processes.
- Reagents are highly mobile in the subsurface due to the use of patented chelated organo-metallic catalysts that resist precipitation and soil adsorption. This results in efficient hydroxyl radical generation throughout the plume unlike conventional Fenton's catalysts that are consumed near the point of injection.

- Health and safety concerns are minimized due to the use of low concentration of oxidizers (typically < 15% H_2O_2) and low pressure injection which results in minimal (< 25 ^oF) temperature increase.
- Injected reagents decompose into water, oxygen, and ferric iron leaving no toxic residues.
- Impact to the native microbial population is temporary and can lead to longer-term enhancement.
- Capital, reagent, operation and maintenance costs are relativity low.
- Fast, efficient and verifiable results in treatment timeframes that are typically measured in months as opposed to years.

FAQS

- **ISOTEC^{SM} Process Chemistry**
- **Laboratory Bench-Scale Study**
- **Treatment Application**
- **Contaminant Treatment**
- **Reporting**
- **Health and Safety**

ISOTEC PROCESS CHEMISTRY

What is the difference between ISOTEC and conventional Fenton reagent vendors?

Circum-neutral pH Conditions: Conventional Fenton-based processes function only under acidic conditions due to the inability of iron catalyst to remain dissolved in the natural subsurface pH range of 6-7. ISOTEC Process utilizes specially developed and patented catalysts composed of active components that chelate the iron and keep it in dissolved form as an organo-metallic complex that functions effectively in the circum-neutral pH range (i.e. pH ≅ 7.0) for contaminant destruction.

Mobility Characteristics: One of the biggest challenges of in-situ oxidation is to ensure that the injected reagents travel to the location of contamination without being subjected to losses caused by precipitation or surface fixation. Iron, which is the key component required to promote Fenton's reaction, will precipitate within inches from the point of injection when introduced as a solution of any of

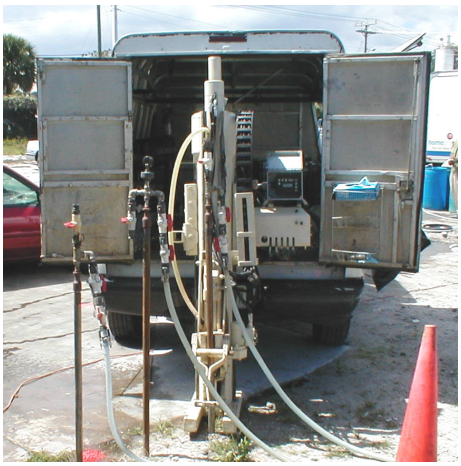
its typical salts. For example, a ferrous sulfate catalyst tends to precipitate to its oxidized form (ferric), thereby, making hydroxyl radical generation magnitudes slower. Typically, 95% to 97% of a ferrous sulfate catalyst gets sorbed to the soil allowing only the remaining 3% to 5% of the catalyst to be utilized for hydroxyl radical generation. Acidified iron solution will remain in solution longer than non-acidified iron solution; however, the low pH is quickly buffered by the native soil to its natural circum-neutral pH resulting in iron precipitation. Furthermore, acidification of the entire contaminated aquifer is not only impractical but may also result in permanently increasing the corrosivity of groundwater. ISOTEC's catalysts have superior mobility compared to conventional Fenton's catalysts and they function under natural subsurface conditions. The chelating components prevent precipitation or fixation of iron to native soil, thereby promoting its availability for hydroxyl radical generation from peroxide.

Research: ISOTEC developed its reagents through years of research – both in-house as well as through affiliated academic institutions. The injection technology has been fine-tuned through years of laboratory and field experimentation. ISOTEC's reagents are especially designed for in-situ application. ISOTEC performs a field pilot program based on the results of laboratory testing conducted on site-specific samples. Laboratory bench tests are conducted in an effort to determine the stoichiometric molar ratio of ISOTEC reagents best suited to achieve maximum contaminant destruction at the subject site.

LABORATORY BENCH-SCALE STUDY

What site constraints or contaminants limit the effectiveness of the ISOTEC Process?

The ISOTEC Process may not be effective on samples containing high concentrations of heavier end (i.e. Carbon-10 or greater) aliphatics, polychlorinated alkanes and certain polyaromatic compounds. These contaminants are strongly adsorbed to the soil and are not easily available for treatment by the aqueous generated hydroxyl radicals. In addition, samples from wells that contain free product will require free product removal prior to initiating the ISOTEC Process. Contaminants such as TCE, PCE and BTEX can be treated due to the presence of carbon-carbon double bonds within the target contaminants that are vulnerable for attack by hydroxyl radicals during the reaction. Factors such as native pH and total organic carbon (TOC) content of the site soils are also critical. Samples containing unusually high or low pH may reduce the effectiveness of the reaction propagation. Sites with high total organic carbon (TOC) content of soil result in peroxide wastage due to competition provided by TOC for hydrogen peroxide.



TREATMENT APPLICATION

Describe how the bench-scale test results will be used to develop full scale-up recommendations.

A specific stoichiometry will be determined through a bench-scale lab study, with preliminary treatment quantities calculated. Application is typically tested in the field during a pilot program to determine the efficiency and radial extent of treatment, which varies depending on the site's subsurface characteristics. Based upon a successful lab study and pilot program, design and implementation of full-scale remediation is proposed (if required).

Discuss temperatures and pressures encountered with the proposed process during the treatment and how they will be controlled. Will standard PVC injection wells be utilized or will special well casing be required?

As stated above, an ISOTEC reagent combination utilized at a site is first tested during a bench-scale lab study. The ISOTEC Process utilizes low reagent concentrations under low pressure injection. Reagents utilized are stabilized and at a low concentration, with injection in a controlled manner to reduce the possibility of any hazard occurring. Temperature increases of up to 10 degrees Celsius have been noted for a short period (< 24 hours). The slight increase in groundwater temperature and low-pressure injection mechanism does not result in any type of excessive heat or pressure release.

Standard PVC injection points are sufficient with the ISOTEC Process. Treatment program activities are limited to the specific areas within the known contaminant plume, with injection of treatment chemicals controlled at the surface during the application.

How are such parameters as pH and alkalinity manipulated as part of the full-scale treatment process in order to optimize performance of the Fenton's reagent?

Laboratory treatability studies and corresponding field treatment programs can be performed at sites with varying subsurface conditions such as low acidic pH levels to higher alkaline levels. ISOTEC's patented catalysts allow for the generation of hydroxyl radicals and chemical oxidation to occur through most of the pH scale. ISOTEC's 4000 series catalysts are designed to function under natural subsurface conditions (i.e. pH of 7) and are suitable for majority of the sites. Therefore, no manipulation is required.

Are ISOTEC reagents prepared on site? What happens to these chemicals when injected into the subsurface?

ISOTEC catalysts consist of a site-specific chelated iron complex, while stabilized hydrogen peroxide (H_2O_2) is used as the oxidizer. ISOTEC typically uses H_2O_2 at a concentration less than 15% during

injection activities. Typically, the H_2O_2 is shipped directly to the site and stored in DOT approved 55-gallon drums with an initial concentration of 35%. Field dilution and addition of ISOTEC's proprietary non-hazardous stabilizers and mobility control agents are performed as determined during our bench scale studies. All reagent components are premixed in a dry form and packaged prior to shipment to any site. The reagent additives will be mixed/ diluted on-site and added during dilution activities. The ISOTEC series catalysts consist of a chelated iron complex, which is similar and at levels comparable to that of naturally occurring metals within the soil matrix. The chelating components keep the catalyst in dissolved form until adequate dispersion is completed. The oxidizer slowly consumes the catalytic components before a gradual liberation of catalyst throughout the treatment area occurs. This process allows the catalyst to distribute evenly within subsurface before finally adsorbing to the soil particles. After a short period of time, the catalyst is oxidized to simple ferric iron. The oxidizer is itself reduced to carbon dioxide, water and oxygen.

CONTAMINANT TREATMENT

Discuss your experience with the mobilization and control of DNAPLs resulting from your process.

The ISOTEC chemical oxidation process is a contact remedial treatment and works through contaminant desorption from the soil phase followed by oxidation in the aqueous phase. When injecting ISOTEC reagents into a DNAPL area, a conversion from DNAPL into dissolved phase will occur. Therefore, a thorough investigation must be completed at a site prior to remedial activities to determine the plume contaminant mass in the area to be treated. Once the plume mass has been calculated, a sufficient amount of reagents can be calculated to treat the contaminants in the area.

ISOTEC has noted on some projects an increase in VOC concentrations after a chemical oxidation application. This scenario indicates the presence of large amounts of residual contamination bound to the soil matrix in the vicinity of the treatment area or monitoring points. Such increases are caused by the desorption process of organics from the site soils and initial reagent quantities calculated not being sufficient to oxidize all organic contamination which may have been present in the treatment area. This is overcome by additional injection points and/or treatment applications, plus an increase in reagent volume injected.

If an unknown quantity of DNAPL is present in the portion of the site area tested, it is difficult to calculate the exact number of injections and/or quantity of reagent required to complete a remedial cleanup using chemical oxidation. However, ISOTEC will be better able to determine these amounts once the treatment program has commenced and initial data and trends can be evaluated.

REPORTING

When will final laboratory and pilot reports be available?

Laboratory treatability study report is typically available within five weeks from the date of sample submission to ISOTEC. Pilot program reports are typically available within one month after receipt of the final post-treatment sampling results by ISOTEC from the analytical laboratory.

HEALTH AND SAFETY

What is your experience in dealing with Fenton's reagent in states where innovative technologies are not widely accepted, including any precedents for injecting Fenton's reagents into potential drinking waters?

The ISOTEC Process has been accepted by several EPA Regions along with numerous state agencies as a remedial treatment alternative. The ISOTEC Process was also reviewed and approved by the Florida Department of Environmental Protection (FDEP) within their Innovative Technology Evaluation program. The state of Florida is a sole source of drinking water aquifer system, and ISOTEC is currently working on several treatment programs within the state. ISOTEC has performed remedial work in numerous states including New Jersey, Pennsylvania, Florida, Indiana, Michigan, Oklahoma, Colorado, California, Washington, Oregon, Utah, Kansas, and Illinois.

Please describe briefly your approach to health and safety in the field (designated personnel, monitoring, safety controls, etc.).

Safety is a priority with the ISOTEC Process. ISOTEC has not had a health and safety incident in over seven years of field application. Most negative effects noted with in-situ oxidation occur with aggressive oxidation reactions utilizing high concentration reagents under pressurized conditions. These conditions can create a significant temperature rise and an enormous amount of carbon dioxide and/or oxygen off-gas, which can mobilize vapors and contaminants within the subsurface.

ISOTEC does not utilize this approach. Reagents utilized by ISOTEC are stabilized and at low concentrations, with injection in a controlled manner to reduce the possibility of surface breakout or subsequent migration. Furthermore, based on sites with shallow groundwater, extreme caution must be exercised while injecting reagents as the mounding effect created raises the ground water elevation to close proximity of the surface. Again, the stabilized ISOTEC reagents utilized, along with control of the injection process, limit these concerns.

MSDS FOR HYDROGEN PEROXIDE

SAFETY DATA SHEET

Version 3.12
Revision Date 03/06/2015
Print Date 04/10/2015

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name	:	Hydrogen peroxide solution
Product Number	:	H1009
Brand	:	Sigma
CAS-No.	:	7722-84-1

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses	:	Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company	:	Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA
Telephone	:	+1 800-325-5832
Fax	:	+1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #	:	(314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Oxidizing liquids (Category 1), H271
Acute toxicity, Oral (Category 4), H302
Skin corrosion (Category 1A), H314
Serious eye damage (Category 1), H318
Acute aquatic toxicity (Category 3), H402

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word: Danger

Hazard statement(s)

H271	May cause fire or explosion; strong oxidiser.
H302	Harmful if swallowed.
H314	Causes severe skin burns and eye damage.
H318	Causes serious eye damage.
H402	Harmful to aquatic life.

Precautionary statement(s)

P210	Keep away from heat.
P220	Keep/Store away from clothing/ combustible materials.
P221	Take any precaution to avoid mixing with combustibles.
P264	Wash skin thoroughly after handling.

P270	Do not eat, drink or smoke when using this product.
P273	Avoid release to the environment.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P283	Wear fire/ flame resistant/ retardant clothing.
P301 + P312 + P330	IF SWALLOWED: Call a POISON CENTER or doctor/ physician if you feel unwell. Rinse mouth.
P301 + P330 + P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304 + P340 + P310	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER or doctor/ physician.
P305 + P351 + P338 + P310	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or doctor/ physician.
P306 + P360	IF ON CLOTHING: rinse immediately contaminated clothing and skin with plenty of water before removing clothes.
P363	Wash contaminated clothing before reuse.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.
P371 + P380 + P375	In case of major fire and large quantities: Evacuate area. Fight fire remotely due to the risk of explosion.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.2 Mixtures

Formula : H_2O_2

Molecular weight : 34.01 g/mol

Hazardous components

Component		Classification	Concentration
Hydrogen peroxide			
CAS-No. EC-No. Index-No.	7722-84-1 231-765-0 008-003-00-9	Ox. Liq. 1; Acute Tox. 4; Skin Corr. 1A; Eye Dam. 1; Aquatic Acute 3; H271, H302 + H332, H314, H318, H402	>= 30 - < 50 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice

Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact

Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Consult a physician.

In case of eye contact

Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.Continue rinsing eyes during transport to hospital.

If swallowed

Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
No data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Nature of decomposition products not known.

5.3 Advice for firefighters
Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.
For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

6.3 Methods and materials for containment and cleaning up
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
Keep away from sources of ignition - No smoking.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

Recommended storage temperature 2 - 8 °C

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
Hydrogen peroxide	7722-84-1	TWA	1.000000 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Upper Respiratory Tract irritation Eye irritation Skin irritation		

		Confirmed animal carcinogen with unknown relevance to humans		
		TWA	1.000000 ppm 1.400000 mg/m3	USA. NIOSH Recommended Exposure Limits
		TWA	1.000000 ppm 1.400000 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		The value in mg/m3 is approximate.		

8.2 Exposure controls

Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection
Tightly fitting safety goggles. Faceshield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a) Appearance — Form: clear, liquid
Colour: colourless

b) Odour — No data available

c)	Odour Threshold	No data available
d)	pH	No data available
e)	Melting point/freezing point	No data available
f)	Initial boiling point and boiling range	No data available
g)	Flash point	No data available
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	No data available
k)	Vapour pressure	No data available
l)	Vapour density	No data available
m)	Relative density	1.110 g/cm3
n)	Water solubility	No data available
o)	Partition coefficient: n-octanol/water	No data available
p)	Auto-ignition temperature	No data available
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	No data available

9.2 Other safety information
No data available

10. STABILITY AND REACTIVITY

10.1 Reactivity
No data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
No data available

10.4 Conditions to avoid
No data available

10.5 Incompatible materials
Zinc, Powdered metals, Iron, Copper, Nickel, Brass, Iron and iron salts.

10.6 Hazardous decomposition products
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
No data available

Inhalation: No data available

Dermal: No data available

No data available

Skin corrosion/irritation
No data available

Serious eye damage/eye irritation
No data available

Respiratory or skin sensitisation
No data available

Germ cell mutagenicity

No data available

Carcinogenicity

IARC: 3 - Group 3: Not classifiable as to its carcinogenicity to humans (Hydrogen peroxide)

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
No data available
No data available

Specific target organ toxicity - single exposure
No data available

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

Additional Information
RTECS: Not available

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Stomach - Irregularities - Based on Human Evidence
Stomach - Irregularities - Based on Human Evidence (Hydrogen peroxide)

12. ECOLOGICAL INFORMATION

12.1 Toxicity
No data available

12.2 Persistence and degradability
No data available

12.3 Bioaccumulative potential
No data available

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Harmful to aquatic life.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 2014 Class: 5.1 (8) Packing group: II
Proper shipping name: Hydrogen peroxide, aqueous solutions
Reportable Quantity (RQ):

Poison Inhalation Hazard: No

IMDG
UN number: 2014 Class: 5.1 (8) Packing group: II EMS-No: F-H, S-Q
Proper shipping name: HYDROGEN PEROXIDE, AQUEOUS SOLUTION

IATA
UN number: 2014 Class: 5.1 (8) Packing group: II
Proper shipping name: Hydrogen peroxide, aqueous solution

15. REGULATORY INFORMATION

SARA 302 Components
The following components are subject to reporting levels established by SARA Title III, Section 302:

	CAS-No.	Revision Date
Hydrogen peroxide	7722-84-1	1993-04-24

SARA 313 Components
This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Reactivity Hazard, Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Hydrogen peroxide	7722-84-1	1993-04-24

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Water	7732-18-5	
Hydrogen peroxide	7722-84-1	1993-04-24

New Jersey Right To Know Components

	CAS-No.	Revision Date
Water	7732-18-5	
Hydrogen peroxide	7722-84-1	1993-04-24

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Acute Tox.	Acute toxicity
Aquatic Acute	Acute aquatic toxicity
Eye Dam.	Serious eye damage
H271	May cause fire or explosion; strong oxidiser.
H302	Harmful if swallowed.
H302 + H332	Harmful if swallowed or if inhaled
H314	Causes severe skin burns and eye damage.
H318	Causes serious eye damage.
H402	Harmful to aquatic life.
Ox. Liq.	Oxidizing liquids
Skin Corr.	Skin corrosion

HMIS Rating

Health hazard:	3
Chronic Health Hazard:	*
Flammability:	0
Physical Hazard	2

NFPA Rating

Health hazard:	3
Fire Hazard:	0
Reactivity Hazard:	2
Special hazard.I:	OX

Further information

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The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 3.12 Revision Date: 03/06/2015 Print Date: 04/10/2015

MSDS FOR OZONE

SAFETY DATA SHEET [formerly MSDS]

1. PRODUCT IDENTIFICATION

Product Name: OZONE

Common Names/Synonyms: Triatomic Oxygen, Trioxygen,

Ozone Generator Manufacturer/Supplier

Ozone Solutions, Inc. www.ozonesolutions.com
451 Black Forest Rd. tech@ozonesolutions.com
Hull, IA 51239
712-439-6880

Product Use: This SDS is limited to ozone produced in gaseous form on site by an ozone generator, in varying concentrations, in either air or aqueous solution, for the purposes of odor abatement, oxidation of organic compounds, or antimicrobial intervention, in a variety of applications.

2. HAZARD IDENTIFICATION

GHS Classifications:

Physical	Health:	Environmental:
Oxidizing Gas	Skin Irritation – Category 3 Eye Irritation – Category 2B Respiratory System Toxicity – Category 1 (Single & Repeated)	Acute Aquatic Toxicity – Category I

NOTE: Severe respiratory toxicity will develop before skin or eye irritation go beyond listed categories. ***Anyone with chronic pulmonary problems, especially asthma, should avoid exposure to ozone.***

WHMIS Classifications (Workplace Hazardous Materials Information System, Canada): **C, D1A, D2A, D2B, F**

Source: CCOHS CHEMINFO Record Number 774

3. COMPOSITION

Chemical name	Ozone
Common names	Triatomic oxygen, trioxygen
Chemical Formula	O_3
CAS Registry Number	10028-15-6

4. FIRST AID MEASURES

Route of Entry		Symptoms	First Aid
Skin Contact	YES	Irritation	Rinse with water
Skin Absorption	NO	NA	NA
Eye Contact	YES	Irritation	Rinse with water, remove contacts
Ingestion	NO	NA	NA
Inhalation	YES	Headache, cough, heavy chest, shortness of breath	Remove to fresh air, provide oxygen therapy as needed

For severe cases, or if symptoms don't improve, seek medical help.

5. FIRE FIGHTING MEASURES

Ozone itself is not flammable. As a strong oxidant it may accelerate, even initiate, combustion, or cause explosions. Use whatever extinguishing agents are indicated for the burning materials.

6. ACCIDENTAL RELEASE MEASURES

Turn off the ozone generator, and ventilate the area. Evacuate until ozone levels subside to a safe level (<0.1 ppm).

7. HANDLING AND STORAGE

Ozone must be contained within ozone-resistant tubing and pipes from the generation point to the application point.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OSHA Permissible Exposure Limit: 8 hour TWA **0.1 ppm**

ANSI/ASTM: 8 hour TWA **0.1 ppm**, STEL **0.3 ppm**

ACGIH: 8 hour TWA **0.1 ppm**; STEL **0.3 ppm**

NIOSH: ELCV **0.1 ppm** light; **0.08 ppm** moderate; **0.05 ppm**, heavy
Light, moderate, heavy work TWA <= 2 hours: **0.2 ppm**
Immediately Dangerous to Life or Health (IDLH) **5 ppm**

Respiratory Protection: Use full face self-contained breathing apparatus for entering areas with a high concentration of ozone.

Engineering control: Use ozone destruct unit for off gassing of ozone.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state	Gas	pH	NA
Molecular Weight	48.0	Decomposition temperature	NA
Appearance	Clear at low concentration, blue at higher concentration	Evaporation rate	NA
Odor	Distinct pungent odor	Flash point	NA
Odor threshold	0.02 to 0.05 ppm; exposure desensitizes	Auto-ignition temperature	NA
Melting point	-193°C/-315°F	Relative density	NA
Boiling point	-112°C/-169°F	Partition coefficient	NA
Vapor pressure	> 1 atm	Flammability	NA
Vapor density	1.6 (air = 1)	Explosive limits	NA
Solubility in water	570 mg/L @20°C & 100% O_3; 0.64 @0°C	Viscosity	NA

10. STABILITY AND REACTIVITY

Ozone is highly unstable and highly reactive. Avoid contact with oxidizable substances. Ozone will readily react and spontaneously decompose under normal ambient temperatures.

11. TOXICOLOGICAL INFORMATION

Likely routes of exposure: inhalation, eyes, skin exposure.

Effects of Acute Exposure: Discomfort, including headache, coughing, dry throat, shortness of breath, pulmonary edema; higher levels of exposure intensify symptoms. Possible irritation of skin and/or eyes.

Effects of Chronic Exposure: Similar to acute exposure effects, with possible development of chronic breathing disorders, including asthma.

LC_{50}: mice, 12.6 ppm for 3 hours; hamsters, 35.5 ppm for 3 hours

Irritancy of Ozone	YES
Sensitization to Ozone	NO
Carcinogenicity (NTP, IARC, OSHA)	NO
Reproductive Toxicity, Teratogenicity, Mutagenicity	Not Proven
Toxicologically Synergistic Products	Increased susceptibility to allergens, pathogens, irritants

12. ECOLOGICAL INFORMATION

The immediate surrounding area may be adversely affected by an ozone release, particularly plant life. Discharge of ozone in water solution may be harmful to aquatic life. Due to natural decomposition, bioaccumulation will not occur, and the area affected will be limited.

13. DISPOSAL CONSIDERATIONS

Off-gassing of ozone should be through an ozone destruct unit which breaks ozone down to oxygen before release into the atmosphere.

14. TRANSPORT INFORMATION

NOT APPLICABLE, as ozone is unstable and either reacts or decomposes, and must be generated at the location and time of use.

15. REGULATORY INFORMATION

SARA Title III Section 302 EHS TPQ: 100 lbs.

SARA Title III Section 304, EHS RQ: 100 lbs.

SARA Title III Section 313: > 10,000 lbs. used/year.

Source: EPA List of Lists

16. OTHER INFORMATION

Half-life of ozone in water at 20°C = 20 min; in dry still air at 24°C = 25 hr; decreases significantly with increase in humidity, presence of contaminants, air movement, and/or increase in temperature.

Preparer: Tim McConnel, Ozone Solutions

Date of Preparation: 5/1/2012

Disclaimer: Ozone Solutions provides this information in good faith, but makes no claim as to its comprehensiveness or accuracy. It is intended solely as a guide for the safe handling of the product by properly trained personnel, and makes no representations or warranties, express or implied, of the merchantability or fitness of the product for any purpose, and Ozone Solutions will not be responsible for any damages resulting from the use of, or reliance upon, this information.

EPA INFORMATION FOR OZONE + HYDROGEN PEROXIDE

7. PEROXONE (OZONE/HYDROGEN PEROXIDE)

Advanced oxidation processes generate highly reactive hydroxyl free radicals to oxidize various compounds in the water. As discussed in Chapter 3, hydroxyl radicals are produced during the spontaneous decomposition of ozone. By accelerating the ozone decomposition rate, the hydroxyl radical concentration is elevated, which increases the oxidation rate. This procedure increases the contribution of indirect oxidation over direct ozone oxidation as discussed in Chapter 3.

Several methods have been used to increase ozone decomposition and produce high concentrations of hydroxyl radicals. One of the most common of these processes involves adding hydrogen peroxide to ozonated water, a process commonly referred to as peroxone.

The Metropolitan Water District of Southern California (MWDSC) conducted extensive research into the use of peroxone to control organics and oxidize taste and odor compounds (e.g., geosmin and 2-methylisoborneol [MIB]) while providing sufficient levels of molecular ozone to guarantee CT values and primary disinfection. While this chapter focuses on peroxone as a disinfectant, similar results are expected from other advanced oxidation processes such as ozone plus UV, ozone at high pH, hydrogen peroxide plus UV, and other combinations.

A key issue with the use of peroxone as a disinfection process is that the process does not provide a measurable disinfectant residual. It is therefore not possible to calculate CT similar to the use of other disinfectants. While no credit can be given for hydroxyl free radicals because it cannot be measured directly, some credit may be considered for any detected ozone in peroxone systems. Peroxone does provide pathogen inactivation, as discussed in this chapter, but equivalent CT values or methods of calculating equipment CT credits have not been established at the date of publication of this guidance document.

7.1 Peroxone Chemistry

The ozone decomposition cycle is similar to that discussed in Chapter 3. However, the added hydrogen peroxide or ultraviolet radiation accelerates the decomposition of ozone and increases the hydroxyl radical concentration. By adding hydrogen peroxide, the net production of hydroxyl free radicals is 1.0 mole hydroxyl radical per mole ozone.

Similar to the discussion of ozone in Chapter 3, oxidation in the peroxone occurs due to two reactions (Hoigné and Bader, 1978):

- Direct oxidation of compounds by aqueous ozone ($O_{3(aq)}$); and
- Oxidation of compounds by hydroxyl radicals produced by the decomposition of ozone.

The two oxidation reactions compete for substrate (i.e., compounds to oxidize). The ratio of direct oxidation with molecular ozone is relatively slow (10^{-5}-$10^{7}M^{-1}sec^{-1}$) compared to hydroxyl radical oxidation (10^{12}-$10^{14}M^{-1}sec^{-1}$), but the concentration of ozone is relatively high. On the other hand, the hydroxyl radical reactions are very fast, but the concentration of hydroxyl radicals under normal ozonation conditions is relatively small.

A key difference between the ozone and peroxone processes is that the ozone process relies heavily on the direct oxidation of aqueous ozone while peroxone relies primarily on oxidation with hydroxyl radical. In the peroxone process, the ozone residual is short lived because the added peroxide greatly accelerates the ozone decomposition. However, the increased oxidation achieved by the hydroxyl radical greatly outweighs the reduction in direct ozone oxidation because the hydroxyl radical is much more reactive. The net result is that oxidation is more reactive and much faster in the peroxone process compared to the ozone molecular process. However, because an ozone residual is required for determining disinfection CT credit, peroxone may not be appropriate as a pre-disinfectant.

The peroxone process utilizes oxidation by hydroxyl radicals. The oxidation potential of the hydroxyl radical and ozone are as follows:

$$OH + e^- \rightarrow OH^- \qquad E^0 = +2.8V$$

$$O_3 + 2H^+ + 2e^- \rightarrow O_2 + H_2O \qquad E^0 = +2.07V$$

$$O_3 + H_2O + 2e^- \rightarrow O_2 + 2OH^- \qquad E^0 = +1.24V$$

In addition to having an oxidation potential of hydroxyl radical higher than ozone, the hydroxyl radical is also much more reactive approaching the diffusion control rates for solutes such as aromatic hydrocarbons, unsaturated compounds, aliphatic alcohols, and formic acid (Hoigné and Bader, 1976).

7.1.1 Oxidation Reactions

Because the radical oxidation is much more effective than direct oxidation with ozone, it has been used extensively to treat difficult to oxidize organics such as taste and odor compounds and chlorinated organics (e.g., geosmin, MIB, phenolic compounds, trichloroethylene [TCE], and perchloroethylene [PCE]).

Neither ozone nor peroxone significantly destroys TOC. Peroxone will oxidize the saturated organics and produce byproducts similar to those found in ozonation; namely, aldehydes, ketones, peroxides, bromate ion, and biodegradable organics (MWDSC and JMM, 1992). However, with peroxone, the

biodegradibility of the water (not the organic compounds) increases, rendering "a portion of the TOC" amenable to removal in biologically active filters.

Peroxone has found a niche in oxidizing difficult-to-treat organics, such as taste and odor compounds including geosmin and MIB (Pereira et al., 1996; Ferguson et al., 1990). In addition, peroxone and other advanced oxidation processes have been shown to be effective in oxidizing halogenated compounds such as 1,1-dichloropropene, trichloroethylene, 1-chloropentane, and 1,2-dichloroethane (Masten and Hoigné, 1992; Aieta et al., 1988; Glaze and Kang, 1988). Hydroxyl radicals will react with all these compounds plus refractory aliphatics such as alcohols and short-chain acids (Chutny and Kucera, 1974).

The optimum peroxide:ozone dose ratio to maximize hydroxyl radicals' reaction rate can be determined for a specific oxidation application. For instance, the optimum peroxide:ozone dose ratio for TCE and PCE oxidation in a ground water was determined to be 0.5 by weight (Glaze and Kang, 1988). Tests showed that TCE required lower ozone dosages for the same percentage removal compared to PCE.

LADWP conducted pilot studies and operated a 2,000 gpm full scale AOP demonstration plant in 1995. The peroxide:ozone dose ratio used was 0.5 to 0.6. Ground water containing up to 447 mg/L TCE and 163 mg/L PCE was treated to below the respective MCLs. However, bromate ion was formed in excess of the 0.010 mg/L MCL (Karimi et al., 1997).

7.1.2 Reactions with Other Water Quality Parameters

As with ozone alone, pH and bicarbonate alkalinity play a major role in peroxone effectiveness (Glaze and Kang, 1988). This role is primarily related to bicarbonate and carbonate competition for hydroxyl radical at high alkalinity and carbonate competition for hydroxyl radical at high pH levels. Also, excessive peroxide can also limit the formation of the hydroxyl radical and reduce the effectiveness of peroxone.

Turbidity alone does not appear to play a role in peroxone effectiveness nor does peroxone appear to remove turbidity. Tobiason et al. (1992) studied the impact of pre-oxidation on filtration and concluded that the pre-oxidation did not improve effluent turbidities, but did appear to increase filter run times because of lower head loss or delayed turbidity breakthrough. Filter effluent turbidities were similar for no-oxidant and pre-oxidant trains.

7.1.3 Comparison between Ozone and Peroxone

The key difference between ozone and peroxone is in the primary oxidation mode; that is, direct oxidation or hydroxyl radical oxidation. The reactivities of these compounds create a different effect in the reactions with water constituents and, thus, disinfection effectiveness. Table 7-1 summarizes the

key differences between ozone and peroxone as they relate to their application in drinking water treatment.

Table 7-1. Comparison between Ozone and Peroxone Oxidation

Process	Ozone	Peroxone
Ozone decomposition rate	"Normal" decomposition producing hydroxyl radical as an intermediate product	Accelerated ozone decomposition increases the hydroxyl radical concentration above that of ozone alone.
Ozone residual	5-10 minutes	Very short lived due to rapid reaction.
Oxidation path	Usually direct aqueous molecular ozone oxidation	Primarily hydroxyl radical oxidation.
Ability to oxidize iron and manganese	Excellent	Less effective.
Ability to oxidize taste and odor compounds	Variable	Good, hydroxyl radical more reactive than ozone.
Ability to oxidize chlorinated organics	Poor	Good, hydroxyl radical more reactive than ozone.
Disinfection ability	Excellent	Good, but systems can only receive CT credit if they have a measurable ozone residual.
Ability to detect residual for disinfection monitoring	Good	Poor. Cannot calculate CT value for disinfection credit.

7.2 Generation

The peroxone process requires an ozone generation system as described in Chapter 3 and a hydrogen peroxide feed system. The process involves two essential steps: ozone dissolution and hydrogen peroxide addition. Hydrogen peroxide can be added after ozone (thus allowing ozone oxidation and disinfection to occur first) or before ozone (i.e., using peroxide as a pre-oxidant, followed by hydroxyl radical reactions) or simultaneously. Addition of hydrogen peroxide following ozone is the best way to operate, however a system cannot obtain a CT credit unless the ozone residual is sufficiently high.

There are two major effects from the coupling of ozone with hydrogen peroxide (Duguet et al., 1985):

- Oxidation efficiency is increased by conversion of ozone molecules to hydroxyl radicals; and
- Ozone transfer from the gas phase to the liquid is improved due to an increase in ozone reaction rates.

The most efficient operation is to add ozone first to obtain CT disinfection credit, followed by peroxide for hydroxyl radical oxidation.

Ozonation can be described as occurring in two stages. In the first stage, ozone rapidly destroys the initial oxidant demand present, thereby enhancing the ozone transfer rate into solution from the gas phase. Addition of hydroxyl free radicals to the first stage should be minimized since the hydrogen peroxide competes with ozone-reactive molecules (i.e., initial demand) for the ozone present. In the second stage, organic matter is oxidized, taking place much slower than in the first stage. Adding hydrogen peroxide during the second stage makes it possible to raise the overall oxidation efficiency, since the reaction of hydrogen peroxide with ozone produces hydroxyl radicals enhancing chemical reaction rates. In practice, the addition of hydrogen peroxide to the second stage of ozonation can be achieved by injecting the hydrogen peroxide into the second chamber of an ozone contactor (Duguet et al., 1985). The most efficient operation is to use ozone first to obtain CT credit and peroxone second for micropollutant destruction.

Energy consumption of the peroxone process includes that for ozone generation and application, plus for metering pumps to feed peroxide. The peroxide addition step does not require any more training from an operator than any other liquid chemical feed system. Systems should be checked daily for proper operation and for leaks. Storage volumes should also be checked daily to ensure sufficient peroxide is on hand, and to monitor usage.

APPENDIX I
DTSC RESTRICTIVE COVENANT AGREEMENT TEMPLATE

[Bold items (other than headers) and [brackets] indicate that site specific input is needed and document is not ready for submission until all such input fields have been adequately addressed and brackets removed.]

RECORDING REQUESTED BY:
[Covenantor's name]
[Street Address]
[City], California **[zip code]**

WHEN RECORDED, MAIL TO:

ADDRESS ABOVE, and,

State of California
Department of Toxic Substances Control
[Street Address]
[**City],** California **[zip code]**
Attention: **[Branch Chief]**
[Branch Designation]

SPACE ABOVE THIS LINE RESERVED FOR RECORDER'S USE

COVENANT TO RESTRICT USE OF PROPERTY

ENVIRONMENTAL RESTRICTION

(RE: Parcel Number **[Insert all Assessor's Parcel Numbers])**

DTSC Site Code **[Site Code]**

DTSC Site Name **[Site Name]**

This Covenant and Agreement ("Covenant") is made by and between **[name of Covenantor]** (the "Covenantor"), the current owner of property situated in **[insert city name]**, County of **[insert county name]**, State of California, described in Exhibit "A" and depicted in Exhibit "B," attached, (the "Property"), and the Department of Toxic Substances Control (the "Department"). Pursuant to Civil Code section 1471, the

Department has determined that this Covenant is reasonably necessary to protect present or future human health or safety or the environment as a result of the presence on the land of hazardous materials as defined in Health and Safety Code section 25260. The Covenantor and the Department, collectively referred to as the "Parties," hereby agree, pursuant to Civil Code section 1471, and Health and Safety Code section 25355.5, that the use of the Property be restricted as set forth in this Covenant; and the Parties further agree that the Covenant shall conform with the requirements of California Code of Regulations, title 22, section 67391.1. The provisions of this Covenant shall be for the benefit of, and shall be enforceable by, the United States Environmental Protection Agency ("U.S. EPA"), as a third party beneficiary pursuant to general contract law, including, but not limited to, Civil Code Section 1559.

ARTICLE I

STATEMENT OF FACTS

1.01. The Property. The Property, totaling approximately **[____ acres or ____ square feet]**, is more particularly described and depicted in the attached Exhibits "A" and "B". The Property is located in the area now generally bounded by **[include narrative description of the area]**. The Property is also generally described as **[insert county name]** County Assessor's Parcel **No(s)**: **[list exact Assessor's Parcel number(s) and ensure that the parcel(s) numbers exactly depict the Property.]**

1.02. Hazardous Substances. As defined in section 25316 of the California Health and Safety Code ("H&SC"), (within Chapter 6.8, Division 20 of the H&SC), and in section 101(14) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended ("CERCLA") (42 USC §9601 (14)); and also Title 40 Code of Federal Regulations ("CFR") parts 261.3 and 302.4, hazardous substances remain on portions of the Property. These substances are also hazardous materials as defined in Health and Safety Code section 25260(d). These contaminant(s) include: [**list contaminant(s) and media impacted.**]

1.03. Remediation of the Property. The Property is being remediated pursuant to a Record of Decision ("ROD") for the **[identify OU]** Operable Unit of the [**identify site name**] Superfund Site (the "Site") issued by the U.S. EPA, dated [**list ROD date**]. [**Also indicate any Amendments or Explanation of Significant Differences and their effective date(s).**] Under the ROD, as modified, the U.S. EPA Region IX Superfund Division Director selected remedial actions for the Property pursuant to CERCLA. The Department concurred with this remedy. [**Describe Remedial Actions implemented pursuant to the ROD.** ***Describe the remedial measures implemented at the Property, including, if applicable, installation of a cap and construction and ongoing operation and maintenance of a groundwater treatment system, in order to identify the remaining contaminants and physical remedial measures on the Property that necessitate this Covenant.***]

1.04. ***[Use this paragraph if imposing additional restrictions on a portion of the Property, for example on a capped portion, or if for any other reason it is necessary to precisely identify any portion of the property, such as an area with groundwater monitoring wells. The purpose of this paragraph is to give the precise location of such areas.]*** A limited portion of the Property is more particularly described in Exhibit "C," and referred to as the **("Capped Property" or "Ground Water Monitoring Wells," or "Soil Impound Area," or "etc.")**. ***[Exhibit C must clearly identify the restricted area portion of the Property via a legal description, such as an engineering survey, and, if necessary, an engineering drawing depicting the Cap or other area to be restricted.]*** The **("Capped Property" or "Ground Water Monitoring Wells," or "Soil Impound Area," or "etc." is/are)** located in the area now generally bounded by **(insert description)**. ***[Include language that generally describes the "Capped Property" or "Ground Water Monitoring Wells," or "Soil Impound Area," or "etc.".]***

1.05. Land Use Covenant. A land use covenant is necessary to preclude residential use of the Property given that hazardous substances will remain at the Property following completion of the remediation and to preclude disruption of the selected constructed remedy. As noted above, the ROD provides for a land use covenant to limit future uses of the Property. U.S. EPA, with the concurrence of the Department, has

concluded that the Property, when remedied to the goals presented in the ROD, and when used in compliance with the terms of this Covenant, does not present an unacceptable threat to human safety or the environment. ***[Need to include the risk basis for why the land use covenant is necessary and point to the risk document at the appropriate depository.]***

ARTICLE II
DEFINITIONS

2.01. Department. "Department" means the California Department of Toxic Substances Control and includes its successor agencies, if any.

2.02. U.S. EPA. "U.S. EPA" means the United States Environmental Protection Agency and includes its successor agencies, if any.

2.03. Owner. "Owner" means the Covenantor, its successors in interest, and their successors in interest, including heirs and assigns, which at any time hold title or an ownership interest to all or any portion of the Property.

2.04. Occupant. "Occupant" means Owners and any person or entity entitled by ownership, leasehold, or other legal relationship to the right to occupy any portion of the Property.

2.05. CERCLA Lead Agency. "CERCLA Lead Agency" means the governmental entity having the designated lead responsibility to implement response action under the National Contingency Plan ("NCP"), 40 C.F.R. Part 300. U.S. EPA or a state agency acting pursuant to a contract or cooperative agreement executed under CERCLA section 104(d)(1), 42 U.S.C. 9604(d)(1), or designated pursuant to a CERCLA Memorandum of Agreement entered into under subpart F of the NCP (40 C.F.R. 300.505) may be designated CERCLA Lead Agency.

2.06 Environmental Restrictions. "Environmental Restrictions" means all protective provisions, covenants, restrictions, prohibitions, and terms and conditions as set forth in any section of this Covenant.

2.07 Improvements. "Improvements" include, but are not limited to: buildings, structures, roads, driveways, improved parking areas, wells, pipelines, or other utilities.

2.08 Lease. "Lease" means lease, rental agreement, or any other document that creates a right to use or occupy any portion of the Property.

2.09 Remedial Systems. "Remedial Systems" shall mean the remedial equipment and systems located on the Property, including **[identify remedial equipment, and/or systems].**

ARTICLE III
GENERAL PROVISIONS

3.01. Restrictions to Run with the Land. This Covenant sets forth Environmental Restrictions, that apply to and encumber the Property and every portion thereof no matter how it is improved, held, used, occupied, leased, sold, hypothecated, encumbered, and/or conveyed. This Covenant: (a) Runs with the land pursuant to Health and Safety Code section 25355.5(a) and Civil Code section 1471; (b) Inures to the benefit of and passes with each and every portion of the Property; (c) Is for the benefit of, and is enforceable by the Department; and (d) Is imposed upon the entire Property unless expressly stated as applicable only to a specific portion thereof.

3.02. Binding upon Owners/Occupants. Pursuant to the Health and Safety Code, this Covenant binds all Owners and Occupants of the Property. Pursuant to Civil Code section 1471, all successive owners of the Property are expressly bound hereby for the benefit of the Department.

3.03. Incorporation into Deeds and Leases. The Covenant and its Environmental Restrictions shall be incorporated by reference in each and every deed and lease for any portion of the Property.

3.05. Conveyance of Property. The Owner shall provide written notice to the Department not later than thirty (30) days after any conveyance of any ownership interest in the Property (excluding mortgages, liens, and other non-possessory encumbrances). The written notice shall include the name and mailing address of the new owner of the Property and shall reference the DTSC site name and DTSC site code as listed on page one of this Covenant. The notice shall also include the applicable Assessor's Parcel Number ("APN") listed in Section 1.01. If the new owner's property has been assigned a different APN, each such APN that covers the Property must be provided. The Department shall not, by reason of this Covenant, have authority to approve, disapprove, or otherwise affect proposed conveyance, except as otherwise provided by law or by administrative order.

3.06. Costs of Administering the Covenant. The Department has already incurred and will in the future incur costs associated with the administration of this Covenant. Pursuant to the [Consent Decree] entered by the _____ Court on _____ , [identify parties] are responsible in the first instance to pay all costs incurred by DTSC in the administration of this Covenant. However, where the parties listed above fail to pay all costs incurred by DTSC in the administration of this Covenant, then Owners of the Property shall also be liable to DTSC for these costs. Therefore, the Covenantor hereby covenants for the Covenantor and for all subsequent Owners that, pursuant to California Code of Regulations, title 22, section 67391.1(h), the Owner agrees to pay the Department's costs in administering the Covenant as set forth herein.

ARTICLE IV
RESTRICTIONS

4.01. Prohibited Uses. The Property shall not be used for any of the following purposes:

[Any prohibitions other than 4.01 (a)(b)(c) and (d) below MUST be based on the appropriate decision documents and risk evaluations as set forth in the Statement of Facts above.]

(a) A residence, including any mobile home or factory built housing, constructed or installed for use as residential human habitation.

(b) A hospital for humans.

(c) A public or private school for persons under 21 years of age.

(d) A day care center for children.

4.02. Soil Management. Any contaminated soils or contaminated materials brought to the surface by grading, excavation, trenching or backfilling shall be managed in accordance with all applicable provisions of State and federal law. Such soils and materials shall not be removed from the Property without a Soil Management Plan approved by the Department.

4.03. Prohibited Activities. Unless a change is authorized pursuant to Article VI of this Covenant, the following activities are specifically prohibited without prior written approval from the CERCLA Lead Agency:

(a) **[List activities as required]**

(b)

(c)

4.04. Non-Interference with Remedial Systems.

(a) The Owner and Occupant shall not participate in or allow any activity that would interfere with the operation of the Remedial Systems or other Site-wide response activities at the Property without prior written approval from the CERCLA Lead Agency, such approval not to be unreasonably withheld.

(b) All uses and development of the Property shall preserve the integrity of the Remedial Systems or other Site-wide response activities.

(c) Owner shall provide a copy of this Covenant to all easement holders for all or any portion of the Property.

4.05. Access for the Department and U.S. EPA. The Department shall have reasonable right of entry and access to the Property for inspection, monitoring, and

other activities for the Remedial Systems on the Property consistent with the purposes of this Covenant as deemed necessary by the Department in order to protect the public health or safety, or the environment. Nothing in this instrument shall limit or otherwise affect U.S. EPA's right of entry and access, or U.S. EPA's authority to take response actions, under CERCLA; the National Contingency Plan, 40 Code of Federal Regulations Part 300 (1997) and its successor provisions; or federal law. Nothing in this instrument shall limit or otherwise effect the Department's right of entry and access, or authority to take response actions, under CERCLA; the National Contingency Plan, 40 Code of Federal Regulations Part 300 (1997) and its successor provisions; Chapter 6.8, Division 20 of the California Health and Safety Code; California Civil Code, or other applicable State Law.

4.06 Access for Implementing Operation and Maintenance. The entity, person or persons responsible for implementing the operation and maintenance activities related to the Remedial Systems shall have reasonable right of entry and access to the Property for the purpose of implementing these operation and maintenance activities. Such right of entry and access shall continue until such time as the CERCLA Lead Agency determines that such activities are no longer required.

4.07 Inspection and Reporting Requirements. Pursuant to the Consent Decree as set forth in paragraph 3.06, the Settling Defendants have agreed to perform the necessary inspection and reporting requirements for all the institutional controls in place for the Del Amo Operable Unit 1 site. However, in the event that Settling Defendants fail to perform, when requested in writing by DTSC, the Owner shall conduct an annual inspection and submit an Annual Inspection Report to the Department for its approval by January 15th of each year. The annual report shall describe how all requirements outlined in this Covenant have been met. The annual report, filed under penalty of perjury, shall certify that the Property is being used in a manner consistent with this Covenant. The annual report must include the dates, times, and names of those who conducted and reviewed the annual inspection report. It also shall describe how the observations were performed that were the basis for the statements and conclusions in the annual report (e.g., drive by, fly over, walk in, etc.) If violations are noted, the annual report must detail the steps taken to return to compliance. If the Owner identifies any

violations of this Covenant during the annual inspections or at any other time, the Owner must, within ten (10) days of identifying the violation: determine the identity of the party in violation; send a letter advising the party of the violation of the Covenant; and demand that the violation cease immediately. Additionally, copies of any correspondence related to the enforcement of this covenant shall be sent to the Department and U.S. EPA within ten (10) days of its original transmission.

ARTICLE V
ENFORCEMENT

5.01. Enforcement. Failure of the Covenantor, Owner or Occupant to comply with this Covenant shall be grounds for the Department to require modification or removal of any Improvements constructed or placed upon any portion of the Property in violation of this Covenant. Violation of this Covenant, including but not limited to, failure to submit, or the submission of any false statement, record or report to the Department shall be grounds for the Department to pursue administrative, civil or criminal actions.

5.02 Enforcement Rights of U.S. EPA as a Third Party Beneficiary. U.S. EPA, as a third party beneficiary, has the right to enforce the Environmental Restrictions contained herein.

ARTICLE VI
VARIANCE, TERMINATION, AND TERM

6.01. Variance. Owner, or any other aggrieved person, may apply to the Department for a written variance from the provisions of this Covenant. Such application shall be made in accordance with Health and Safety Code section 25223 and a copy of the application shall be submitted to U.S. EPA simultaneously with the application submitted to the Department. No variance may be granted under this paragraph without prior notice to and an opportunity to comment by U.S. EPA.

6.02 Termination. Owner, or any other aggrieved person, may apply to the Department for a termination or modification of one or more terms of this Covenant as they apply to all or any portion of the Property. Such application shall be made in accordance with Health and Safety Code section 25224 and a copy of the application shall be submitted to U.S. EPA simultaneously with the application submitted to the Department. No termination may be granted under this paragraph without prior notice to and opportunity to comment by U.S. EPA.

6.03 Term. Unless ended in accordance with paragraph 6.02, by law, or by the Department in the exercise of its discretion, after providing notice to and an opportunity to comment by U.S. EPA, this Covenant shall continue in effect in perpetuity.

ARTICLE VII
MISCELLANEOUS

7.01. No Dedication or Taking Intended. Nothing set forth in this Covenant shall be construed to be a gift or dedication, or offer of a gift or dedication, of the Property, or any portion thereof to the general public or anyone else for any purpose whatsoever. Further, nothing in this Covenant shall be construed to effect a taking under State or federal law.

7.02. Notices. Whenever any person gives or serves any Notice ("Notice" as used herein includes any demand or other communication with respect to this Covenant), each such Notice shall be in writing and shall be deemed effective: (1) when delivered, if personally delivered to the person being served or to an officer of a corporate party being served, or (2) three (3) business days after deposit in the mail, if mailed by United States mail, postage paid, certified, return receipt requested:

To Owner: **[Covenantor's name]**
[Street Address]
[City], California [zip code]

To Department: Department of Toxic Substances Control
Attention: **[Unit Chief]**

[Unit]
[Street Address]
[City] CA **[zip code]**

To the U.S. EPA: U.S. Environmental Protection Agency
Region IX
Attention**: [current RPM]**
75 Hawthorne Street
San Francisco, CA 94105-3901

Any party may change its address or the individual to whose attention a Notice is to be sent by giving written Notice in compliance with this paragraph.

7.03. Partial Invalidity. If this Covenant or any of its terms are determined by a court of competent jurisdiction to be invalid for any reason, the surviving portions of this Covenant, or the application of it to any person or circumstance, shall remain in full force and effect as if such portion found invalid had not been included herein.

7.04. Statutory and Regulatory References. All statutory and regulatory references include successor provisions.

7.05. Incorporation of Attachments. All attachments and exhibits to this Covenant are incorporated herein by reference.

7.06. California Law. This Covenant shall be governed, performed and interpreted under the laws of the State of California.

7.07. No Delegation. Nothing set forth in this Covenant shall be construed to be a delegation of any authorities of DTSC under any statute or regulation.

7.08. Recordation. The Covenantor shall record this Covenant, with all referenced Exhibits, in the County of **[name of county]** within ten (10) days of the Covenantor's receipt of a fully executed original.

IN WITNESS WHEREOF, the Parties execute this Covenant.

Covenantor:

By: _____Date:_____

[Covenantor)

Department of Toxic Substances Control

By: _____Date:_____

[Branch Chief]
[Branch]
Department of Toxic Substances Control

EXHIBITS

A – LEGAL PROPERTY DESCRIPTION

B – SURVEY MAP

[If non-interference with the remedy is included as part of the LUC, an exhibit depicting the location of the remedy components (Cap, wells, SVE system, etc.) should also be included and referenced appropriately (e.g. Exhibit C)]

Exhibit A
Legal Property Description
Property Subject to Environmental Restriction

Exhibit B
Survey Map
Property Subject to Environmental Restriction

State of California

County of _____

On _____ before me,

_____

(here insert name and title of the officer/notary),

Personally appeared_____

_____

_____, personally known to me (or proved to me on the basis of satisfactory evidence) to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Signature _____ (Seal)

State of California

County of _____

On _____ before me,

_____

(here insert name and title of the officer/notary),

Personally appeared_____

_____

_____, personally known to me (or proved to me on the basis of satisfactory evidence) to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Signature _____ (Seal)

APPENDIX J
DESIGN SHEET TEMPLATES

SOIL VAPOR EXTRACTION AND OZONE INJECTION SYSTEM INSTALLATION

INDEX OF DRAWINGS:

G-0	DRAWING INDEX AND VICINITY MAP
G-1A	CONSTRUCTION NOTES
G-1B	CONSTRUCTION NOTES
G-2	STANDARD SYMBOLS AND LEGEND SHEET
G-3	REMEDIAL CONSTRUCTION SITE PLAN
G-4A	SOIL VAPOR EXTRACTION SYSTEM PROCESS FLOW DIAGRAM
G-4B	OZONE INJECTION SYSTEM PROCESS FLOW DIAGRAM
G-5A	CONSTRUCTION DETAILS
G-5B	CONSTRUCTION DETAILS
G-5C	CONSTRUCTION DETAILS
G-6	EQUIPMENT LAYOUT (PLAN VIEW)
G-7	ELECTRICAL SINGLE LINE DIAGRAM AND PANEL SCHEDULE

SCOPE OF WORK

INSTALL A SOIL VAPOR EXTRACTION AND OZONE INJECTION (SVE/OI) SYSTEM.

TASKS ASSOCIATED WITH THE INSTALLATION OF THE SVE/OI SYSTEM INCLUDE THE FOLLOWING:

A. TRENCH AND INSTALL BELOW GRADE VAPOR RETURN AND OZONE INJECTION PIPING.

B. BACKFILL TRENCH PER DESIGN SPECIFICATIONS AND RESURFACE TO MATCH EXISTING MATERIAL.

C. INSTALL OVERHEAD ELECTRICAL SERVICE WITH METER PANEL AND MAIN DISCONNECT.

D. INSTALL ELECTRICAL SUBPANEL IN REMEDIAL TREATMENT SYSTEM ENCLOSURE.

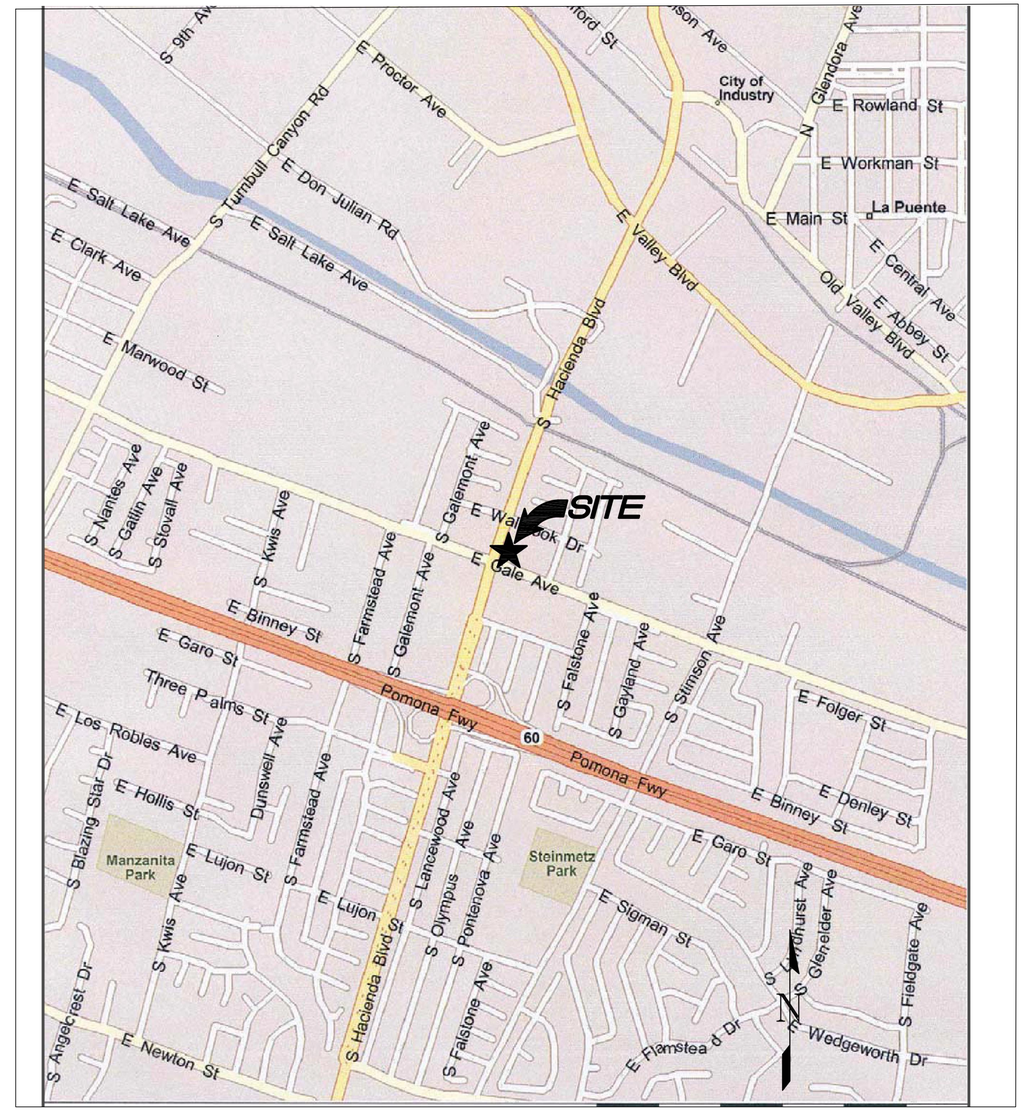
E. INSTALL CHAIN LINK FENCE AND BOLLARDS TO ENCLOSE REMEDIAL TREATMENT SYSTEM.

F. INSTALL SOIL VAPOR EXTRACTION EQUIPMENT, SVE MANIFOLD, ASSOCIATED CONNECTING PIPE, AND MISC. FITTINGS.

G. INSTALL OZONE INJECTION EQUIPMENT AND CONNECT TO OZONE INJECTION MANIFOLD.

H. COMPLETE ELECTRICAL CONNECTIONS TO THE SVE/OI EQUIPMENT

I. TEST OPERATION OF THE SVE/OI SYSTEMS WITH ENGINEER. VERIFY AND VALIDATE ALL SAFETY SHUTDOWN FEATURES.



N

SOURCE:

GOOGLE MAPS
TORRANCE QUADRANGLE

0 mi 0.1 mi 0.2 mi 0.3 mi 0.4 mi

SCALE 1:0.4

REV.	DATE	BY	APP.	DESCRIPTION

DESIGNED DATE
DRAWN BY DATE
CHECKED DATE

PREPARED BY: AECOM
915 WILSHIRE BLVD, SUITE 700
LOS ANGELES, CA 90017
TEL: (213) 996-2200
FAX: (909) 996-2290

CONTRACTORS LICENSE NUMBER:
EXPIRATION DATE:
CLASSIFICATIONS: CERTIFICATIONS:

PROJECT:
FACILITY:
DATE: SHEET: 1 of 12

TITLE: DRAWING INDEX AND VICINITY MAP

DRAWING No. G-0

OWNER:
ENGINEER: AECOM
CONTRACTOR: TO BE DETERMINED

1.0 GENERAL REQUIREMENTS

1. THE ENGINEER AND CONTRACTOR ARE RESPONSIBLE FOR THE SAFETY OF THEIR PERSONNEL AND SUBCONTRACTORS. THE CONTRACTOR WILL DEVELOP A HEALTH AND SAFETY PLAN (HASP) THAT, AT A MINIMUM, CONFORMS TO THE ENGINEER'S SITE HASP. THE PLAN AND APPLICABLE PERMITS SHALL BE ON SITE AT ALL TIMES.

2. THE CONTRACTOR SHALL EXECUTE WORK SO AS TO MINIMIZE ANY DISRUPTIONS TO THE FACILITY OPERATIONS AND PROVIDE AND MAINTAIN ACCESS FOR FACILITY OPERATIONS AS DIRECTED. THE ENGINEER AND CONTRACTOR SHALL BE RESPONSIBLE FOR ALL NOTIFICATIONS OF IMPENDING WORK TO FACILITY PERSONNEL.

3. THE CONTRACTOR SHALL MAKE NOTE OF ANY CHANGES OR DEVIATIONS MADE TO THE DESIGN DRAWINGS. THE ENGINEER SHALL FIELD DOCUMENT THE CONSTRUCTION ACTIVITIES.

4. THE CONTRACTOR SHALL CONSIDER ERGONOMIC FACTORS WHEN LAYING OUT EQUIPMENT LOCATIONS TO ENSURE MAXIMUM ACCESSIBILITY TO EQUIPMENT FOR OPERATION, MAINTENANCE AND SAMPLING ACTIVITIES. THE CONTRACTOR SHALL CONSULT WITH THE ENGINEER FOR RECOMMENDATIONS.

5. THE ENGINEER AND CONTRACTOR SHALL READ AND ABIDE BY ALL SAFETY REGULATIONS AND REQUIREMENTS IN THE SITE SPECIFIC HEALTH AND SAFETY PLAN. CONTRACTOR IS TO COMPLY WITH ALL FEDERAL, STATE, AND LOCAL BUILDING, SAFETY, AND ENVIRONMENTAL LAWS AND ORDINANCES.

6. CONTRACTOR IS RESPONSIBLE FOR PROTECTING THE FOLLOWING ITEMS DURING CONSTRUCTION: PROTECTING THE TREES AND SHRUBS, CONTAINING ANY RUN-ON OR RUN-OFF, CONTROLLING DUST, AND CONTAINING ANY CONTAMINATION GENERATED DURING CONSTRUCTION. ENGINEER WILL COORDINATE PROPER CHARACTERIZATION AND THE CONTRACTOR SHALL DISPOSE ALL EXCAVATED SOIL AND RINSE WATER ON BEHALF OF THE OWNER. THE CONTRACTOR SHALL DISPOSE OF ALL CONSTRUCTION DEBRIS (INCLUDING ASPHALT PAVEMENT AND CONCRETE) OFF SITE.

7. ANY CONFLICT IS TO BE BROUGHT TO THE ATTENTION OF THE ENGINEER BY THE CONTRACTOR IN WRITING WITHIN 24 HOURS. CLARIFICATION WILL BE PROVIDED IN WRITTEN FORM BY THE ENGINEER.

8. ENGINEER IS RESPONSIBLE FOR PRELIMINARY BUILDING PLAN CHECK FEES, SERVICE APPLICATION FEES AND FOR DISCHARGE PERMITS (AQMD, WDR, ETC.). ALL REQUIRED CONSTRUCTION PERMITS AND INSPECTIONS (INCLUDING ALL FEES AND BONDS) FOR BUILDING, PLUMBING, FIRE, ELECTRICAL, MECHANICAL, AND/OR CIVIL WORK SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

9. IT IS THE CONTRACTOR'S RESPONSIBILITY TO VERIFY ALL DIMENSIONS AND CONDITIONS BEFORE STARTING WORK. THE ENGINEER SHALL BE NOTIFIED OF ANY DISCREPANCY PRIOR TO STARTING WORK.

10. CONSTRUCTION AREAS ARE TO BE CLEARLY MARKED WITH CONES, BARRICADES, OR OTHER APPROVED SAFETY MARKERS TO RESTRICT PUBLIC ACCESS AND PROVIDE A SAFE WORK AREA.

11. CONTRACTOR SHALL PROVIDE ENGINEER AND OWNER WITH A COPY OF SIGNED-OFF BUILDING PERMITS AND "AS BUILT" DRAWINGS (ACCURATELY MARKED-UP COPIES OF ORIGINAL DRAWINGS) WITHIN 30 DAYS OF COMPLETION OF CONSTRUCTION ACTIVITIES.

12. APPROVAL FROM THE BUILDING DEPARTMENT SHALL BE ATTAINED AS REQUIRED.

13. THE CONTRACTOR SHALL WARRANTY ALL MATERIALS AND WORKMANSHIP FOR A PERIOD OF ONE YEAR AFTER PROJECT CLOSEOUT. DEFECTS SHALL BE CORRECTED AT NO COST TO THE ENGINEER OR OWNER. THE ENGINEER SHALL CONDUCT A FOLLOW-UP INSPECTION AND IDENTIFY ANY WARRANTY-RELATED ISSUES ON OR ABOUT NINE MONTHS FOLLOWING THE COMPLETION OF THE CONSTRUCTION.

14. CONTRACTOR SHALL NOTIFY THE ENGINEER IN WRITING OF ANY CONSTRUCTION ISSUES RELATED TO THE DESIGN PRIOR TO START WORK.

15. REMEDIATION EQUIPMENT IS EXPECTED TO OPERATE FOR APPROXIMATELY 3 YEARS.

2.0 SITE WORK

1. THE ENGINEER AND CONTRACTOR SHALL VERIFY THE LOCATION OF TANKS, PIPING, APPURTENANCES AND UTILITIES. THE CONTRACTOR SHALL VERIFY ALL CONDITIONS AND DIMENSIONS THAT AFFECT THE WORK PRIOR TO BEGINNING CONSTRUCTION.

2. THE CONTRACTOR SHALL PROTECT EXISTING ITEMS THAT ARE TO REMAIN IN PLACE, BE REUSED OR REMAIN PROPERTY OF THE PROPERTY OWNER, AND SHALL REPAIR ITEMS THAT ARE TO REMAIN, WHICH ARE DAMAGED DURING THE PERFORMANCE OF THE WORK TO THEIR ORIGINAL CONDITION OR REPLACE AS NEW. LOADING CAPACITIES OF SITE PAVEMENT SHALL NOT BE EXCEEDED.

3. STOCKPILED AND/OR BINNED SOIL SHALL BE PROTECTED FROM WEATHER. IMPACTED SOIL SHALL BE COVERED IN ACCORDANCE WITH LOCAL REGULATORY REQUIREMENTS. STORMWATER RUN-ON AND RUN-OFF CONTROLS SHALL BE PROVIDED FOR TEMPORARY SOIL STOCKPILES AND OPEN EXCAVATIONS. CONSTRUCTION OR DEMOLITION MATERIALS SHALL BE PREVENTED FROM ENTERING STORM DRAINS AND SEWER SYSTEMS.

4. THE CONTRACTOR SHALL RESTORE OR PROVIDE ARCHITECTURAL FINISHES IN AREAS AFFECTED BY CONSTRUCTION ACTIVITIES TO MATCH PRE-CONTRUCTION CONDITIONS. THE WORK IS TO INCLUDE BUT NOT BE LIMITED TO PAVEMENT RESTRIPING, CURB PAINTING LANDSCAPING, AND PATCHING SURFACE IRREGULARITIES. ALL SAW CUTS IN PAVEMENT AND CONCRETE SHOULD BE KEPT TO AN ABSOLUTE MINIMUM AND REPAIRED/FILLED OUTSIDE THE BOUNDARY OF THE CONSTRUCTION AREA.

5. THE ENGINEER AND CONTRACTOR ARE RESPONSIBLE FOR NOTIFYING UNDERGROUND SERVICE ALERT (USA) 48 HOURS PRIOR TO ANY EXCAVATION SITE WORK. ENGINEER IS RESPONSIBLE FOR CONDUCTING A GEOPHYSICAL SURVEY 24 HOURS PRIOR TO ANY EXCAVATION SITE WORK. UPON REQUEST OF CONTRACTOR, STATION AS-BUILTS MAY BE PROVIDED BY ENGINEER OR OWNER IF AVAILABLE. CONTRACTOR IS RESPONSIBLE FOR MAINTAINING INTEGRITY OF ALL UNDERGROUND PIPING AND CONDUITS.

6. EXISTING PAVEMENT IS TO BE SAW CUT PRIOR TO REMOVAL TO PROVIDE A STRAIGHT SQUARE EDGE PRIOR TO RE-PAVING.

7. PRIOR TO BACKFILL OF TRENCHING, ALL PIPE MUST PASS A PRESSURE TEST.VAPOR PROCESS LINES SHALL BE PRESSURE TESTED TO 30 PSI. THERE SHALL BE NO NOTICEABLE CHANGE AFTER ONE HOUR OR ANY AUDIBLE LEAK INDICATIONS. PRESSURE TEST MUST BE WITNESSED BY ENGINEER.

8. TRENCH BEDDING MATERIAL WILL CONSIST OF WELL GRADED CLEAN SAND FREE OF SILT OR CLAY OR NATIVE MATERIAL. BEDDING MATERIAL SHALL BE HANDTAMPED AROUND PIPES, AND PLACED AT A MINIMUM 2 INCHES BELOW THE BOTTOM ROW OF PIPES TO 2 INCHES ABOVE THE TOP ROW OF PIPES. CLEAN NATIVE MATERIAL MAY BE USED TO BACKFILL THE TRENCHING ABOVE THE BEDDING MATERIAL PRIOR TO PLACEMENT OF THE ASPHALT CAP. TRENCHES MUST BE COMPACTED TO 95% OF OPTIMUM DENSITY (BASED ON STANDARD PROCTOR TEST) TO SUPPORT SURFACE MATERIAL AND AVOID SETTLING. CONTRACTOR SHALL PROVIDE OUTSIDE COMPACTION TEST AND REPORT (ONE LOCATION PER 100 FEET OF TRENCH) TO BE SUBMITTED WITH CLOSEOUT DOCUMENTS.

9. CONTRACTOR SHALL PROVIDE ENGINEER WITH AT LEAST 5 BUSINESS DAYS TO CONDUCT WASTE PROFILE SAMPLING OF PETROLEUM IMPACTED SOIL. ENGINEER WILL COORDINATE THE SAMPLING ON BEHALF OF THE OWNER AND THE CONTRACTOR WILL DISPOSE THE MATERIAL. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING TRANSPORTATION AND DISPOSAL OF MATERIALS AND WASHWATERS ASSOCIATED WITH THE EXCAVATION AND DECONTAMINATION.

10. AS REQUIRED, CONTRACTOR SHALL FURNISH AND INSTALL NON-SLIP STEEL TRENCH PLATES TO PROTECT WORKERS AND THE PUBLIC FROM OPEN INACTIVE TRENCHES. ALL OPEN TRENCHES SHALL BE COVERED WITH NON-SLIP STEEL TRENCH PLATES AT THE END OF EACH WORK DAY.

3.0 WELL HEAD INSTALLATION

1. ALL WELLS SHALL BE IDENTIFIED AT THE WELL BOX AND MANIFOLD. CONTRACTOR IS TO PERMANENTLY LABEL ALL SVE AND OI WELLS AT THE WELL-HEAD PIPE WITH PERMANENT INK AND ON TOP OF THE WELL COVER WITH PUNCHED/STAMPED LETTERS AND NUMBERS. LABELING SHOULD BE INCORPORATED ON THE MANIFOLD FOR THE SVE AND OI WELLS.

2. ONCE THE WELLBOXES ARE SET, CONCRETE SHALL BE POURED AROUND THE BOX.CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 2500 PSI AND COLORED TO MATCH EXISTING SURFACE. ONCE CONCRETE IS POURED, SUBCONTRACTOR SHALL ALLOW PROPER TIME FOR CONCRETE TO SET. ADDITIONAL TIME MAY BE REQUIRED IF CONCRETE IS SET IN POOR WEATHER.

3. 32 OZONE INJECTION WELLS WILL BE CONNECTED TO THE PROPOSED OZONE INJECTION SYSTEM AND 11 EXTRACTION WELLS WILL BE CONNECTED TO THE SVE EQUIPMENT. NOTE THAT SVE-2/OI-2 THROUGH SVE-10/OI-10 ARE DUAL-NESTED WELLS.

4.0 CONCRETE

1. CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 2,500 PSI. CONCRETE PAD SHALL HAVE A BROOM FINISH TO PROVIDE SLIPPING RESISTANCE.

2. THE CONCRETE PAD SHALL BE 6-INCHES THICK PER 2014 LACBC SECTION 1907.1.

3. A WELDED WIRE FABRIC (WWF) SHALL BE PLACED IN THE CONCRETE PAD. A 1½ INCH MINIMUM CONCRETE COVER IS REQUIRED PER ACI 318 SECTION 7.7.1.

4. THE SVE SKID WILL BE ANCHORED TO THE CONCRETE PAD WITH L- CHANNELS AND TWO ½ INCH DIAMETER ZINC PLATED WEDGE STUD ANCHORS PER CHANNEL WITH AN EMBEDDED LENGTH OF 3 1/4 INCHES MIN PER ICC ESR-1917 WITH SPECIAL INSPECTION.

5. THE OZONE INJECTION SYSTEM WILL BE TRAILER MOUNTED AND THE TRAILER WHEELS WILL BE CHOCKED.

5.0 PROCESS EQUIPMENT INSTALLATION

1. EQUIPMENT SHALL BE PLACED IN ACCORDANCE WITH THE EQUIPMENT LAYOUT DETAIL (G-6) AND THE PROCESS FLOW DIAGRAM (G-4A AND G-4B). THE ENGINEER SHALL BE NOTIFIED OF ANY DISCREPANCY.

2. CONTRACTOR SHALL EXERCISE DUE CARE TO PROTECT EQUIPMENT FROM THEFT OR DAMAGE.

3. SYSTEM EXHAUST SHALL BE RELEASED TO THE ATMOSPHERE THROUGH A 13 FOOT HIGH STACK. THE STACK OF THE EQUIPMENT SHALL BE PLACED A MINIMUM OF 3 FEET FROM THE PROPERTY LINE.

4. ANY TANKS SHALL BE LABELED STATING CONTENTS OF EACH. A MINIMUM OF 3-INCH LETTERING WILL BE USED TO IDENTIFY AND ALL HOT SURFACES SHALL BE LABELED AND CLEARLY IDENTIFIED.

5. CONTRACTOR SHALL TEST ALL EQUIPMENT PRIOR TO SYSTEM START-UP TO ENSURE PROPER OPERATION.

6.0 FENCES AND GATES (EQUIPMENT ENCLOSURE)

1. THE CONTRACTOR SHALL INSTALL A 6 FOOT HIGH A CHAIN-LINK FENCE ENCLOSURE WITH SLATS OR SCREENING. FENCE INSTALLATION DETAILS ARE SHOWN ON FIGURE G-5B. THE ENCLOSED AREA SHALL BE APPROXIMATELY 23 FEET BY 15 FEET AND SHALL HAVE A DOUBLE SWING GATE. THE ENCLOSURE IS TO BE PROTECTED BY CRASH-POSTS (BOLLARDS) SPACED A MAXIMUM OF 4' ON CENTER. CRASH-POST INSTALLATION SPECIFICATIONS ARE PROVIDED ON SHEET G-5B. THE CONTRACTOR SHALL PROVIDE ONE 4-DIGIT MASTER COMBINATION LOCK

2. CONTRACTOR SHALL POST THE FOLLOWING SIGNS ON THE ENCLOSURE:
   A.) PROPOSITION 65 WARNING (IN CALIFORNIA)
   B.) NO SMOKING
   C.) EMERGENCY CONTACT TELEPHONE NUMBERS FOR THE ENGINEER
   D.) SITE ADDRESS:
   E.) NFPA 704 PLACARD FOR OXYGEN TANK IN OZONE INJECTION SYSTEM TRAILER.
   SIGNS SHALL HAVE UV PROTECTION AND BE PLACED IN TWO LOCATIONS, VISIBLE TO THE PUBLIC. LOCATIONS TO BE APPROVED BY THE ENGINEER.

3. CONTRACTOR SHALL FURNISH AND INSTALL A DRY CHEMICAL FIRE EXTINGUISHER. A MINIMUM 4A 80 BC FIRE EXTINGUISHER, WITH A MAXIMUM TRAVEL DISTANCE OF 50 FEET, SHALL BE PROVIDED. FIRE EXTINGUISHER SHALL BE STORED IN A PLASTIC FIRE EXTINGUISHER CABINET KEPT INSIDE THE ENCLOSURE .

4. CONTRACTOR TO PROVIDE DOCUMENT BOX SPECIFIED ON SHEET G1-B INSIDE THE EQUIPMENT ENCLOSURE IN A VISIBLE LOCATION. OPERATING INSTRUCTIONS, SITE PLANS, AND EMERGENCY CONTACT NUMBERS SHALL BE KEPT IN THIS BOX.

7.0 PIPING AND VALVES

1. DESIGN DETAILS ARE PROVIDED ON SHEETS G-5A THROUGH G-5C (SEE CONSTRUCTION DETAILS). PIPING, VALVES, FLOW METERS, PORTS, ETC. TO BE PROVIDED BY CONTRACTOR ARE ALSO SHOWN ON SHEET G-4A AND G-4B (SEE PROCESS FLOW DIAGRAM).

2. ALL ABOVE GROUND PIPING AND CONDUIT SHALL BE PROPERLY SUPPORTED IN ACCORDANCE WITH LOCAL CODES AND MANUFACTURER'S DIRECTIONS. PIPE SUPPORTS SHALL ALLOW FOR THERMAL EXPANSION AN MINIMIZE LOAD TRANSFER AT CONNECTIONS. ALL PIPING SHALL BE SUPPORTED SO THAT NO LOAD OR STRESS IS TRANSFERRED TO ANY EQUIPMENT. PIPING ROUTED ABOVE GROUND (INSIDE THE ENCLOSURE) SHALL BE SUPPORTED BY UNISTRUT AND SHALL BE INSTALLED PER LOCAL CODE.

3. PROCESS PIPING SHALL BE PRESSURE TESTED IN THE PRESENCE OF THE ENGINEER AND OVER A PERIOD OF 60 MINUTES AS SPECIFIED IN NOTE 7 IN SECTION 2.

4. ALL ABOVE GROUND PIPING AND HOSES SHALL BE IDENTIFIED. THERE SHALL BE CLEAR DIFFERENTIATION BETWEEN VAPOR EXTRACTION AND OZONE INJECTION PROCESS LINES AND ELECTRICAL LINES. PROCESS PIPING SHALL BE LABELED WITH FLOW DIRECTION AND CONTENT PIPING MANIFOLDS SHALL BE PROPERLY LABELED TO SHOW THE SOURCE WELL OF EACH PIPE.

5. ALL UNDERGROUND SVE PROCESS PIPING SHALL BE A MINIMUM OF SCHEDULE 40 PVC WITH SLIP CEMENTED FITTINGS. ABOVE GRADE PVC PIPING AND OZONE TUBING WILL HAVE UV PROTECTION WHERE EXPOSED TO DAYLIGHT. ALL UNDERGROUND OZONE INJECTION CONDUIT PIPING SHALL BE SCHEDULE 40 PVC WITH SLIP CEMENTED FITTINGS.

6. IN-LINE VALVES SHALL BE PVC. ALL VALVING AND SHUT-OFFS SHALL BE IDENTIFIED WITH SIGNS AND TAGS AND SHALL BE INSTALLED AS SHOWN IN DETAILED DRAWINGS.

7. VACUUM AND PRESSURE GAGE SPECIFICATIONS ARE PROVIDED ON SHEET G-4A AND G-5B.

8. TO THE EXTENT PRACTICABLE, VAPOR EXTRACTION LINES SHALL BE SLOPED BACK TO EXTRACTION WELL AT TO AVOID CONDENSATION ACCUMULATION.

9. ALL PROCESS LINES AND CONDUITS SHALL BE FREE OF DIRT AND DEBRIS. ALL PROCESS LINES SHALL BE CLEANED PRIOR TO INSTALLATION.

10. LONG TURN TEE WYE AND ELBOW FITTINGS WILL BE USED TO INSTALL OZONE TUBING THROUGH CONDUIT.

11. ALL LATERAL LINES CONNECTING THE OZONE INJECTION WELLS TO THE CONDUIT LINE SHALL BE 1-INCH SCHEDULE 40 PVC CONDUIT. OZONE TUBING WILL BE PLACED INSIDE CONDUIT. 3 CONDUIT LINES WILL ENTER THE REMEDIAL COMPOUND AS SHOWN ON DETAIL 1 ON SHEET G-5A.

REV.	DATE	BY	APP.	DESCRIPTION

DESIGNED DATE
DRAWN BY DATE
CHECKED DATE

PREPARED BY: AECOM
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CONTRACTORS LICENSE NUMBER:
EXPIRATION DATE:
CLASSIFICATIONS: CERTIFICATIONS:

PROJECT:
FACILITY:
DATE: SHEET: 2 of 15

TITLE: CONSTRUCTION NOTES
DRAWING No. G-1A

8.0 ELECTRICAL

1. SEE G-7 ELECTRICAL SINGLE LINE DIAGRAM AND PANEL SCHEDULE ARE PROVIDED ON SHEET G-7.
2. METER PANEL AND MAIN DISCONNECT SHALL BE RATED NEMA 3R.
3. CONTROL PANELS SUPPLIED BY CONTRACTOR SHALL BE RATED NEMA 4.
4. ELECTRICAL CONTROL WIRING SHALL BE RUN IN SEPARATE CONDUIT FROM ANY OTHER POWER CONVEYANCE WIRES.
5. CONTRACTOR TO PROVIDE APPROPRIATE ELECTRICAL CONDUIT/WIRING TO THE UNIT.
6. ALL ELECTRICAL WORK SHALL BE INSTALLED IN ACCORDANCE WITH ALL LOCAL ORDINANCES AND THE CURRENT (2014) NATIONAL ELECTRICAL CODE (NEC).
7. ELECTRICAL WIRING SHALL BE APPROPRIATELY IDENTIFIED AND PERMANENTLY MARKED.
8. VAPOR TREATMENT AND OZONE INJECTION TREATMENT UNITS ARE TO BE PROPERLY GROUNDED .
9. ALL ELECTRICAL EQUIPMENT SHALL BE UL LISTED
10. ANY BELOW GRADE ELECTRICAL CONDUIT MUST MEET THE SEAL OFF REQUIREMENTS OF LA COUNTY BUILDING AND SAFETY ELECTRICAL CODE

9.0 SPECIFICATION LIST

TO BE PROVIDED BY OWNER:

1. SOIL VAPOR EXTRACTION SYSTEM: ELECTRIC CATALYTIC OXIDIZER WITH POSITIVE DISPLACEMENT BLOWER, 250 SCFM, MAX 12 INCHES OF MERCURY, 10HP MOTOR, OXYGEN INJECTION CAPABLE, 230 VOLT, 3 PHASE, 113 AMPS.
2. OZONE INJECTION EQUIPMENT: 6 POUNDS PER DAY OZONE INJECTION SYSTEM. MAXIMUM FLOW OF 38 CFM AND 125 PSI, 20 PORT MANIFOLD, ROTARY SCREW COMPRESSOR , 10HP MOTOR, OXYGEN INJECTION CAPABLE, 208/230 VOLT, 3 PHASE, 60 AMPS.

TO BE PROVIDED BY CONTRACTOR (INCLUDING THE FOLLOWING ITEMS AND ANYTHING ELSE SHOWN IN DESIGN PACKAGE):

3. 200 AMP DISTRIBUTION PANEL AND MAIN DISCONNECT SWITCH.
4. SINGLE NESTED OZONE INJECTION WELL BOXES, TOTAL OF 23, 18-INCH ROUND X 13-INCH DEEP WELL BOX WITH TRAFFIC RATED LID, EMCO-WHEATON MODEL A0717-18B OR EQUAL.
5. DUAL NESTED WELL BOXES, TOTAL OF 9, 18-INCH ROUND X 13-INCH DEEP WELL BOX WITH TRAFFIC RATED LID, EMCO-WHEATON MODEL A0717-018B OR EQUAL.
6. SINGLE NESTED EXTRACTION WELL BOXES, TOTAL OF 2 12-INCH X 12-INCH ROUND WELL BOX WITH TRAFFIC RATED LID, EMCO-WHEATON MODEL A0721-001 OR EQUAL.
7. PULL BOX, TOTAL OF 3, 24-INCH BY 24-INCH DEEP SQUARE WELL BOX WITH TRAFFIC RATED LID, EMCO-WHEATON MODEL A0717-724ABW OR EQUAL.
8. DOCUMENT STORAGE BOX, NEMA 6 FIBERGLASS BOX, 15.5-INCH BY 13.5-INCH BY 6.3 -INCHES, MCMASTER-CARR MODEL 6917K36.
9. FIRE EXTINGUISHER, DRY CHEMICAL FIRE EXTINGUISHER, WITH 20 LB. CAPACITY, RATED FOR CLASS A, B. AND C FIRES, 2-A:40-B:C, MCMASTER-CARR MODEL 6430 T7 OR EQUAL.
10. FIRE EXTINGUISHER CABINET, PLASTIC FIRE EXTINGUISHER CABINET FOR 20 LB. DRY CHEMICAL FIRE EXTINGUISHER, RED, MCMASTER-CARR MODEL 6457 T63 OR EQUAL.
11. COMBINATION PADLOCK, MASTER LOCK MODEL NUMBER 175LH OR EQUAL.
12. LINK CHAIN, CUT-RESISTANT SECURITY STRAIGHT LINK CHAIN, ROUNDED STEEL WELDED CHAIN, 3/8-INCH TRADE SIZE, 0.37-INCH DIAMETER, MCMASTER-CARR MODEL 8949T34, OR SIMILAR.
13. CHAIN LINK FENCE (WITH SLATS OR SCREENING AND 0.113-INCH OPENING) AND CRASH POSTS
14. CHOCKS FOR THE OZONE TRAILER WHEELS.

10.0 MISCELLANEOUS NOTES

1. THE KNOCK OUT POT WILL BE EQUIPPED WITH A HIGH AND A HIGH-HIGH LEVEL SWITCH THAT WILL SHUT DOWN THE SYSTEM TO PREVENT ANY SPILLAGE
2. A COPY OF THE CONTRACTORS LICENSE CAN BE PROVIDED UPON REQUEST.
3. OPERATING INSTRUCTIONS AND A SITE PLAN WILL BE PROVIDED IN THE SITE MATERIALS ENCLOSURE.
4. ALL VALVING AND SHUT-OFFS SHALL BE PROPERLY IDENTIFIED WITH LABELS.
5. ALL EMERGENCY SHUT-OFFS AND VALVING SHALL BE CONSPICUOUSLY LABELED.
6. ALL WELL CAPS SHALL BE IDENTIFIED.
7. ALL ABOVE GROUND PIPING AND HOSES SHALL BE IDENTIFIED.
8. EMERGENCY CONTACT NUMBERS SHALL BE IN THE SITE MATERIALS ENCLOSURE AND ON THE ACCESS GATE.
9. THERE WILL BE NO OPEN FLAMES ASSOCIATED WITH THE REMEDIATION EQUIPMENT.
10. THE SYSTEM IS EXPECTED TO OPERATE AT APPROXIMATELY 650 DEGREE FAHRENHEIT. THE EXHAUST STACK HAS A 8-INCH DIAMETER THAT WILL BE LOCATED APPROXIMATELY 9 FEET FROM THE PROPERTY LINE AND GREATER THAN 10 FEET FROM THE NEAREST BUILDING OPENING.
11. THE PROPOSED STACK HEIGHT IS 13 FEET.
12. THE SOIL VAPOR EXTRACTION SYSTEM WILL SHUT ITSELF DOWN WHEN A HIGH OR LOW TEMPERATURE IS REACHED AND WHEN THE KNOCK OUT POT HAS REACHED A HIGH LEVEL.
13. THE PROPOSED MEANS OF MONITORING ON-SITE EQUIPMENT IS THROUGH WEEKLY SITE VISITS. DURING THIS TIME THE REMEDIATION EQUIPMENT WILL BE MONITORED TO CONFIRM THAT IT IS OPERATING CORRECTLY.
14. A SITE/EQUIPMENT ACCESS GATE SHALL BE PROVIDED, WHICH SHALL BE LOCATED IN A NON-HAZARDOUS LOCATION. A MINIMUM GATE WIDTH OF 3 FEET SHALL BE PROVIDED AND THE GATE WILL BE KEPT LOCKED AT ALL TIMES WHILE THE SITE IS UNATTENDED.
15. EMERGENCY CONTACT INFORMATION WITH 24-HOUR ACCESS PHONE NUMBER AND ADDRESS OF THE SITE WILL BE PROVIDED. THE CONTACT PHONE NUMBER WILL BE AN ATTENDED PHONE NUMBER WITH A PERSON ANSWERING THE PHONE.
16. A MINIMUM RATING 2-A:40-B:C FIRE EXTINGUISHER SHALL BE INSTALLED IN AN ALL WEATHER FIRE EXTINGUISHER CABINET. EXTINGUISHER SHALL BE TAGGED WITH A CURRENT STATE FIRE MARSHALL TAG.
17. ALL EQUIPMENT AND PLUMBING SHALL REFLECT SOUND ENGINEERING, QUALITY CONSTRUCTION, AND PROPER INSTALLATION. EQUIPMENT AND PLUMBING SHALL BE MAINTAIN IN GOOD WORKING ORDER, FREE FROM EXCESSIVE WEAR, NOISE GENERATION, CORROSION, RUST, WEATHERING, LEAKAGE, ODOR OR DEGRADATION.

SITE SYMBOLS

MW-1R	GROUNDWATER MONITORING WELL LOCATION AND DESIGNATION
OI-1	OZONE INJECTION WELL
	PROPOSED METER PANEL AND MAIN DISCONNECT
	DISTRIBUTION PANEL
	FIXED PROTECTION POST
	REMOVABLE PROTECTION POST
OI-2	PROPOSED OZONE INJECTION WELL LOCATION
SVE-5/OI-27	PROPOSED DUAL NESTED SOIL VAPOR EXTRACTION AND OZONE INJECTION WELL
SVE-1	PROPOSED SOIL VAPOR EXTRACTION WELL
MW-3R	EXISTING GROUNDWATER WELL/ PROPOSED EXTRACTION WELL
	PULL BOX

LINE TYPES

- PROPERTY LINE
- PROPOSED TRENCHING FOR OZONE INJECTION AND SOIL VAPOR EXTRACTION WELLS
- FENCE LINE
- PROPOSED ABOVE GROUND ELECTRICAL LINE
- BELOW GRADE VAPOR RETURN LINES
- ABOVE GRADE VAPOR RETURN LINES
- BELOW GRADE OZONE CONVEYANCE LINES

ELECTRICAL SYMBOLS

- GROUND ROD
- CIRCUIT BREAKER
- METER
- RECEPTACLE
- LIGHT POLE
- PROPOSED POWER POLE

INSTRUMENTATION, CONTROLS & EQUIPMENT

- VACUUM GAUGE
- LOCAL DEVICE
- TRANSFER PIMP
- SAMPLE PORT
- VACUUM RELIEF VALVE
- AIR RELIEF VALVE
- FLAME ARRESTOR
- HEAT EXCHANGER
- ELECTRIC HEATER
- PROCESS FILTER
- AIR FILTER
- BLOWER
- WYE STRAINER
- FLOW METER
- ROTARY CLAY COMPRESSOR
- PRESSURE RELIEF VALVE
- SOLENOID VALVE

VALVES, FITTINGS & PIPING

- BALL VALVE
- CHECK VALVE
- GATE VALVE

SOIL VAPOR EXTRACTION SYSTEM PROCESS FLOW LEGEND:

APS-1	AIR PRESSURE SWITCH - PROCESS
B-1	BLOWER - POSITIVE DISPLACEMENT ROOTS 56 URAI (250CFM)
BF-1	BUTTERFLY VALVE - DILUTION (3")
BF-2	BUTTERFLY VALVE - PROCESS (3")
BV-1	BALL VALVE - AUTO DRAIN (1")
BV-2	BALL VALVE - MANUAL DRAIN (2")
CP-1	CONTROL PANEL - NEMA 4 (48 x 36)
CR-1	CHART RECORDER - 4 CHANNEL
CV-1	CHECK VALVE - AUTO DRAIN (1")
DC-1	DILUTION CONTROLLER
DEM-1	DEMSTER ELEMENT - KO POT
DM-1	DRIVE MOTOR - DILUTION/ISOLATION
EX-1	EXCHANGER (304SS) - 60% EFFICIENCY
FS-1	FLOW SENSOR - PITOT TUBE (3")
FT-1	FLOW TRANSMITTER - DIFFERENTIAL
HE-1	HEATING ELEMENT
HHLS-1	HIGH HIGH LIQUID LEVEL SWITCH
HLS-1	HIGH LIQUID LEVEL SWITCH
HM-1	HOUR METER
IF-1	INLET AIR FILTER - 3"
LC-1	LIMIT CONTROLLER - HIGH TEMPERATURE
LLS-1	LOW LIQUID LEVEL SWITCH
MT-1	MOTOR - LIQUID TRANSFER PUMP (1HP)
MT-2	MOTOR - PROCESS BLOWER (10HP)
MT-3	MOTOR - COOLING FAN
OX-1	OXIDIZER - ELECTRIC CATALYTIC (250 CFM)
PC-1	PLATINUM CATALYST CELL
SEP-1	SEPARATOR - LIQUID (100 GALLON)
PG-1	PRESSURE GAUGE (0-30" WC)
SE-1	SOUND ENCLOSURE - PROCESS BLOWER
SIL1-2	SILENCERS (INLET/OUTLET)
SP-1	SAMPLE PORT - INFLUENT
SP-2	SAMPLE PORT - EFFLUENT
TC-1	TEMPERATURE CONTROLLER
TP-1	TRANSFER PUMP -50 GPM 52" HEAD LOSS
TS-1	TEMPERATURE SENSOR - CATALYST INLET
TS-2	TEMPERATURE SENSOR - CATALYST OUTLET
TS-3	TEMPERATURE SENSOR - HEAT EX. OUTLET
VFD-1	VARIABLE FREQUENCY DRIVE (10HP)/REMOTE DISPLAY
VG-1	VACUUM GAUGE - PROCESS INLET (0-30" HG)
VG-2	VACUUM GAUGE - BLOWER INLET (0-30" HG)

OZONE INJECTION SYSTEM PROCESS FLOW LEGEND:

AC	AIR COMPRESSOR - ROTARY SCREW INGERSOL RAND (38 CFM/125PSI
AOA	AMBIENT OZONE ALARM
BC	BOOST COMPRESSOR - 80 PSI
BS	BLEND SPOOL - SS
BV	BALL VALVE
CD	COOLING DRYER/FILTER
CP	CONTROL PANEL
CV	CHECK VALVE
DD	DESICCANT DRYER
FR	FLOW REGULATOR
O2	OXYGEN CONCENTRATOR
O3	OZONE GENERATOR
OS	OIL FILTER/SEPARATOR
PG	PRESSURE GAUGE
PLC	PLC CONTROL - INTERFACE
PS	PRESSURE SWITCH
RFG	REGULATOR
SV	SOLENOID VALVE

REV.	DATE	BY	APP.	DESCRIPTION

DESIGNED DATE
DRAWN BY DATE
CHECKED DATE

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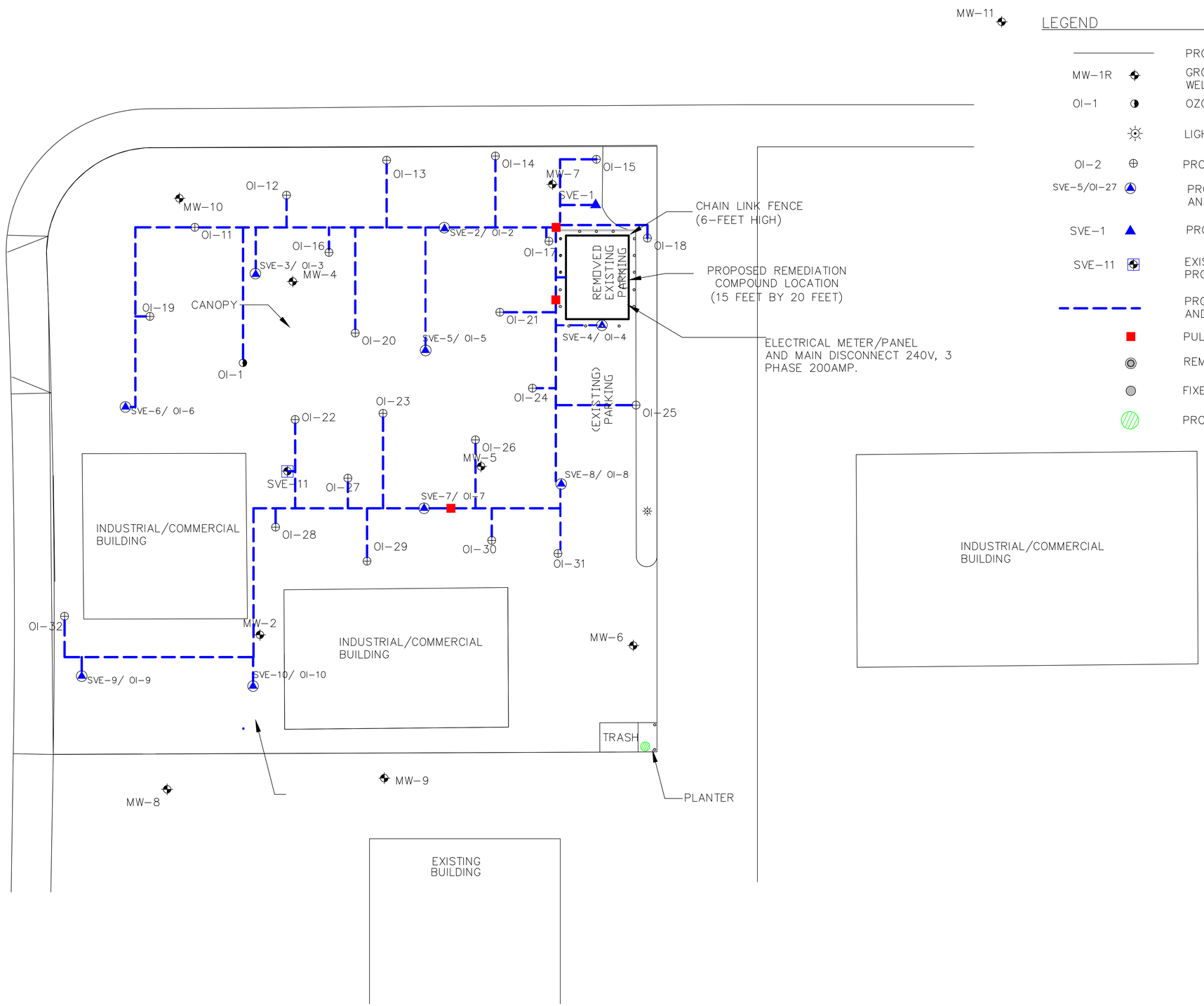
CLASSIFICATIONS: CERTIFICATIONS:

PROJECT:
FACILITY:
DATE: SHEET: 4 of 12

TITLE: STANDARD SYMBOL AND LEGEND SHEET
DRAWING No. G-2



LEGEND

	PROPERTY LINE
MW-1R	GROUNDWATER MONITORING WELL LOCATION AND DESIGNATION
OI-1	OZONE INJECTION WELL
	LIGHT POLE
OI-2	PROPOSED OZONE INJECTION WELL LOCATION
SVE-5/OI-27	PROPOSED DUAL NESTED SOIL VAPOR EXTRACTION AND OZONE INJECTION WELL
SVE-1	PROPOSED SOIL VAPOR EXTRACTION WELL
SVE-11	EXISTING GROUNDWATER WELL/ PROPOSED EXTRACTION WELL
	PROPOSED TRENCHING FOR OZONE INJECTION AND SOIL VAPOR EXTRACTION WELLS
	PULL BOX
	REMOVEABLE BOLLARD
	FIXED BOLLARD
	PROPOSED POWER POLE

N
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0 12 24
SCALE (FEET)

REV.	DATE	BY	APP.	DESCRIPTION

DESIGNED DATE
DRAWN BY DATE
CHECKED DATE

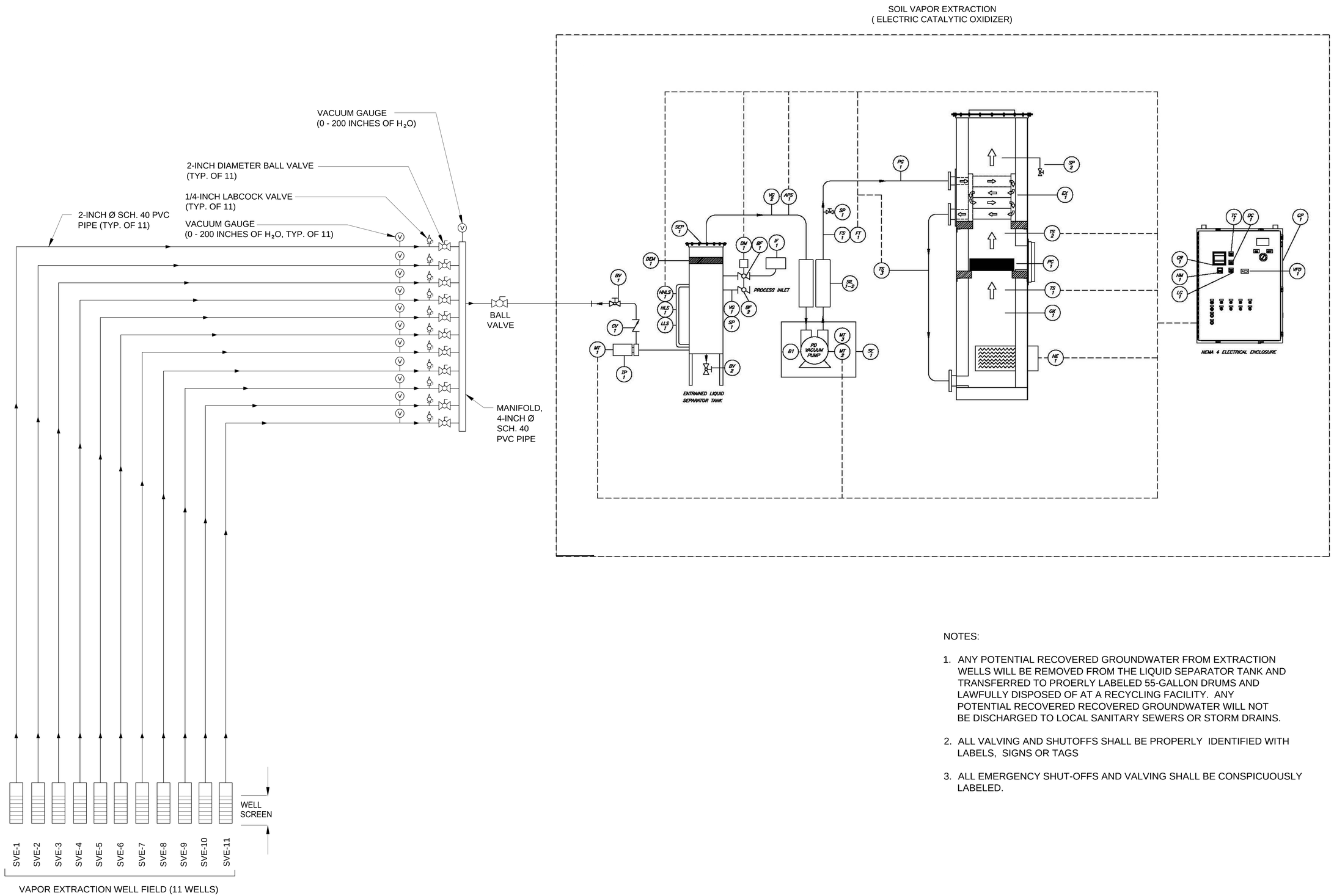
PREPARED BY: AECOM
915 WILSHIRE BLVD, SUITE 700
LOS ANGELES, CA 90017
TEL: (213) 996-2200
FAX: (909) 996-2290

CONTRACTORS LICENSE NUMBER:
EXPIRATION DATE:
CLASSIFICATIONS: CERTIFICATIONS:

PROJECT:
FACILITY:
DATE: SHEET: 4 of 12

TITLE: **REMEDIAL CONSTRUCTION SITE PLAN**

DRAWING No. **G-3**



NOTES:

1. ANY POTENTIAL RECOVERED GROUNDWATER FROM EXTRACTION WELLS WILL BE REMOVED FROM THE LIQUID SEPARATOR TANK AND TRANSFERRED TO PROERLY LABELED 55-GALLON DRUMS AND LAWFULLY DISPOSED OF AT A RECYCLING FACILITY. ANY POTENTIAL RECOVERED RECOVERED GROUNDWATER WILL NOT BE DISCHARGED TO LOCAL SANITARY SEWERS OR STORM DRAINS.
2. ALL VALVING AND SHUTOFFS SHALL BE PROPERLY IDENTIFIED WITH LABELS, SIGNS OR TAGS
3. ALL EMERGENCY SHUT-OFFS AND VALVING SHALL BE CONSPICUOUSLY LABELED.

REV.	DATE	BY	APP.	DESCRIPTION

DESIGNED DATE
DRAWN BY DATE
CHECKED DATE

PREPARED BY: AECOM
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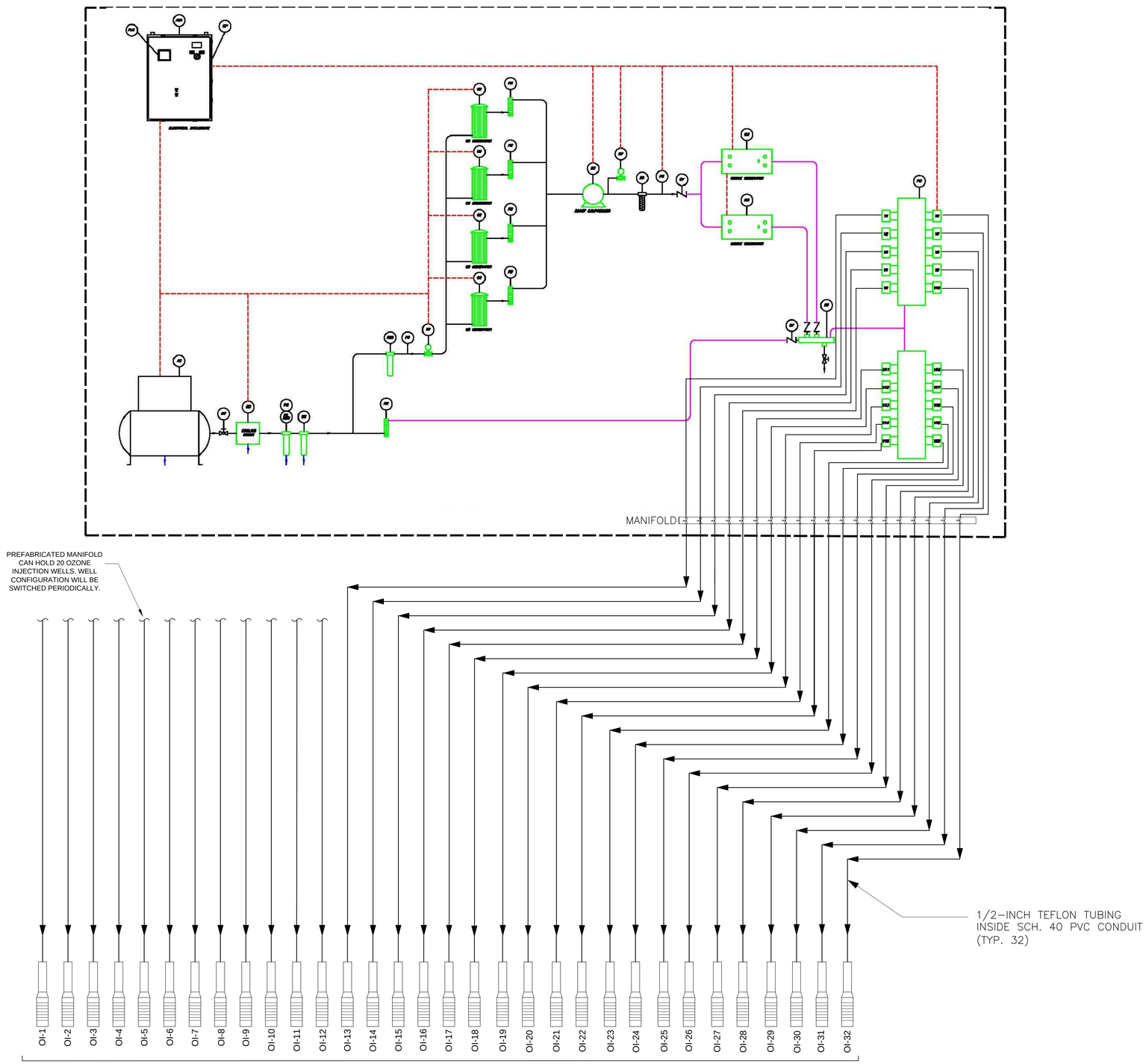
CONTRACTORS LICENSE NUMBER:
EXPIRATION DATE:
CLASSIFICATIONS: CERTIFICATIONS:

PROJECT:
FACILITY:
DATE: SHEET: 6 of 12

TITLE: **SOIL VAPOR EXTRACTION SYSTEM PROCESS FLOW DIAGRAM**

DRAWING No. **G-4A**

OZONE INJECTION SYSTEM



OZONE INJECTION WELLS (32)

NOTES:

1. ALL VALVING AND SHUT-OFFS SHALL BE IDENTIFIED WITH SIGNS OR TAGS
2. ALL EMERGENCY SHUT-OFFS AND VALVING SHALL BE CONSPICUOUSLY LABELED.

REV.	DATE	BY	APP.	DESCRIPTION

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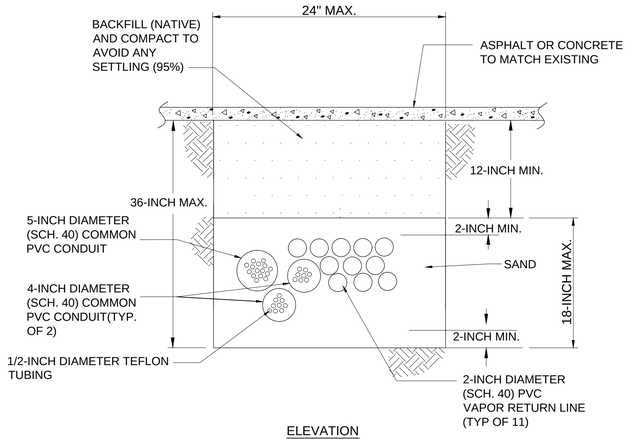
EXPIRATION DATE:

PROJECT:
FACILITY:
DATE:
SHEET: 7 of 12

TITLE: **OZONE INJECTION SYSTEM PROCESS FLOW DIAGRAM**

DRAWING No. **G-4B**



ELEVATION
(SHOWING BACK FILL)

NOTES:

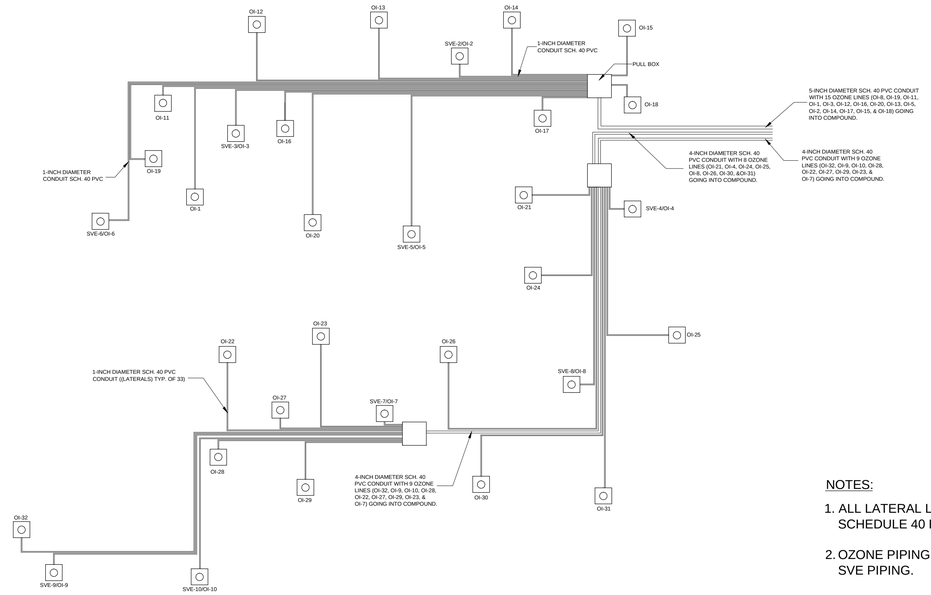
1. 2-INCH MINIMUM SAND BEDDING ALONG SIDE OF TRENCH

2. SLURRY COAT OVER ASPHALT IS REQUIRED.

3. PROCESS LINES SHALL SLOPE TOWARDS WELLS TO MINIMIZE CONDENSATION BUILD-UP

4. DOWEL IF TRENCH IS IN CONCRETE (#4 X 18" DOWEL @ 12" ON CENTER ALONG BOTH SIDES OF TRENCH.

1 G-5A — TRENCHING DETAIL
NOT TO SCALE

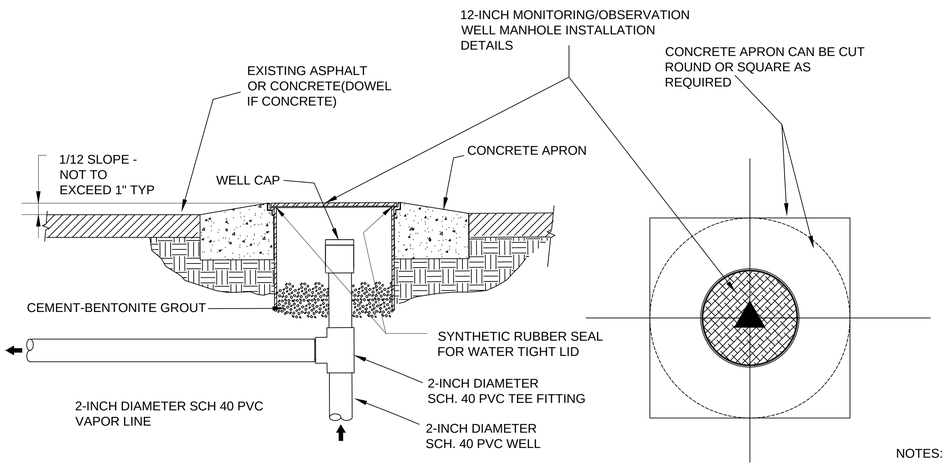


NOTES:

1. ALL LATERAL LINES USE 1" DIAMETER SCHEDULE 40 PVC. CONDUIT

2. OZONE PIPING LAYOUT DOES NOT SHOW SVE PIPING.

2 G-5A — OZONE PIPE AND TUBING LAYOUT
NOT TO SCALE



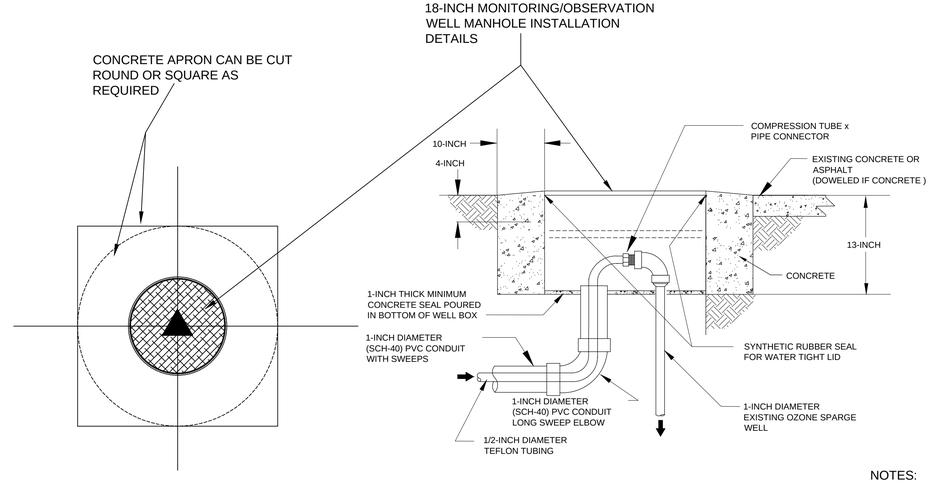
ELEVATION

PLANVIEW

NOTES:

1. DUAL-NESTED SVE/OI WELLS WILL REQUIRE AN 18-INCH WELL BOX.

3 G-5A — TYPICAL SVE WELL HEAD DETAIL
NOT TO SCALE



ELEVATION

PLANVIEW

NOTES:

1. DUAL-NESTED SVE/OI WELLS WILL REQUIRE AN 18-INCH WELL BOX.

4 G-5A — TYPICAL OZONE INJECTION WELL HEAD DETAIL
NOT TO SCALE

REV.	DATE	BY	APP.	DESCRIPTION

DESIGNED DATE
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915 WILSHIRE BLVD, SUITE 700
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TEL: (213) 996-2200
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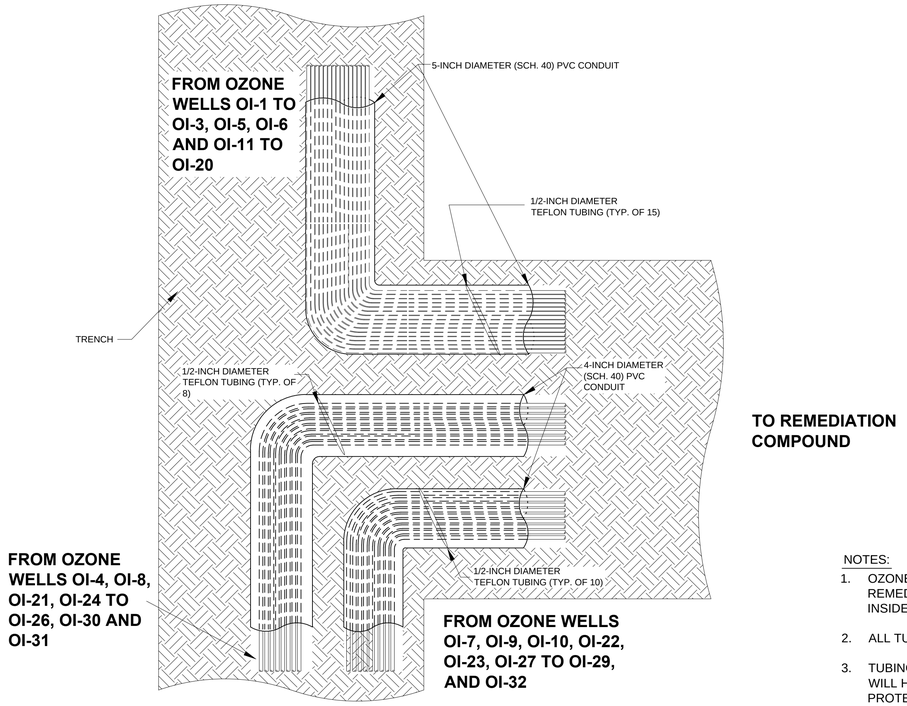
CONTRACTORS LICENSE NUMBER:
EXPIRATION DATE:
CLASSIFICATIONS: CERTIFICATIONS:

PROJECT:
FACILITY:
DATE: SHEET: 8 of 12

TITLE: **CONSTRUCTION DETAILS**
DRAWING No. **G-5A** -

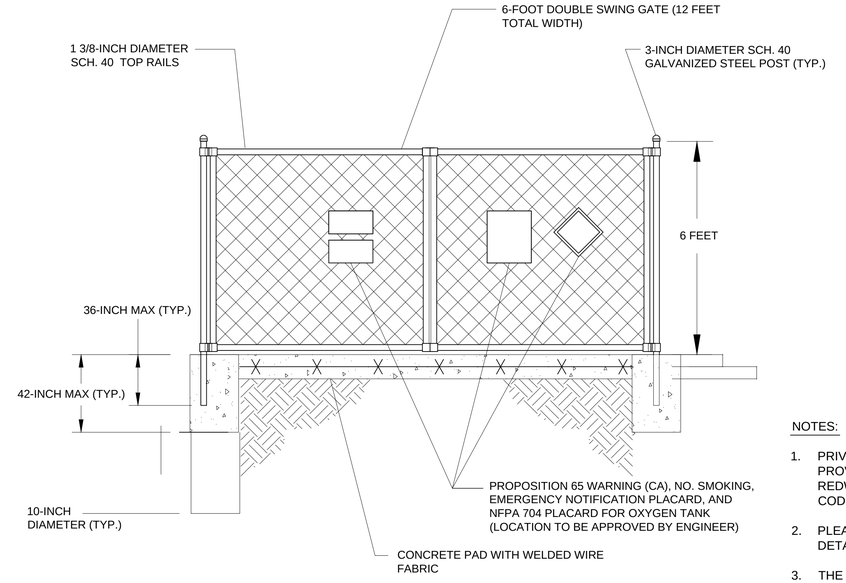


NOTES:

1. OZONE CONDUIT WILL STUB-UP INSIDE REMEDIAL COMPOUND. TUBING WILL REMAIN INSIDE CONDUIT.
2. ALL TUBING WILL BE LABELED.
3. TUBING NOT CONNECTED TO EQUIPMENT WILL HAVE REMOVABLE PLUGS TO PROTECT THE TUBING

5 / G-5B — TRENCH DETAIL ENTERING COMPOUND

NOT TO SCALE

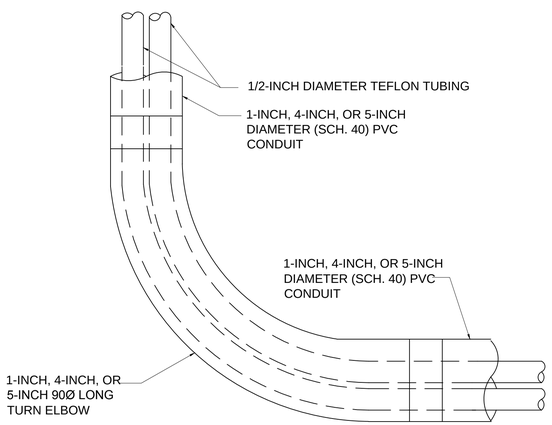


NOTES:

1. PRIVACY SLATS OR SCREENS SHALL BE PROVIDED AND SHALL BE PLASTIC, METAL, OR REDWOOD TO MATCH EXISTING DECOR OR LOCAL CODES.
2. PLEASE REFER TO DETAIL 13 FOR CONCRETE PAD DETAIL.
3. THE OZONE SPARGE UNIT IS 64-INCHES TALL AND WILL BE WELL UNDER THE CHAIN LINK FENCE HEIGHT.
4. THE 2 NORTHERN FENCE POSTS WILL BE OFF CENTERED IN THE FOOTINGS SO AS TO MAXIMIZE SPACE INSIDE OF THE ENCLOSURE.

6 / G-5B — DOUBLE SWING GATE ENCLOSURE DETAIL

NOT TO SCALE

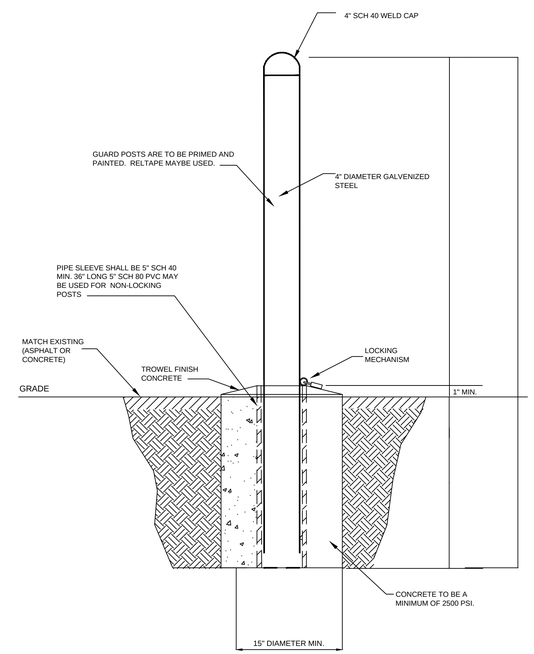


NOTE:

1. LONG TURN ELBOW TO BE USED AT CHANGE IN TRENCH DIRECTION WHERE NO JUNCTION BOX IS PROPOSED.

7 / G-5B — TYPICAL 90Ø LONG TURN ELBOW DETAIL (PLAN VIEW)

NOT TO SCALE



8 / G-5B — REMOVABLE GUARDPOST

NOT TO SCALE

REV.	DATE	BY	APP.	DESCRIPTION

DESIGNED DATE
DRAWN BY DATE
CHECKED DATE

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LOS ANGELES, CA 90017
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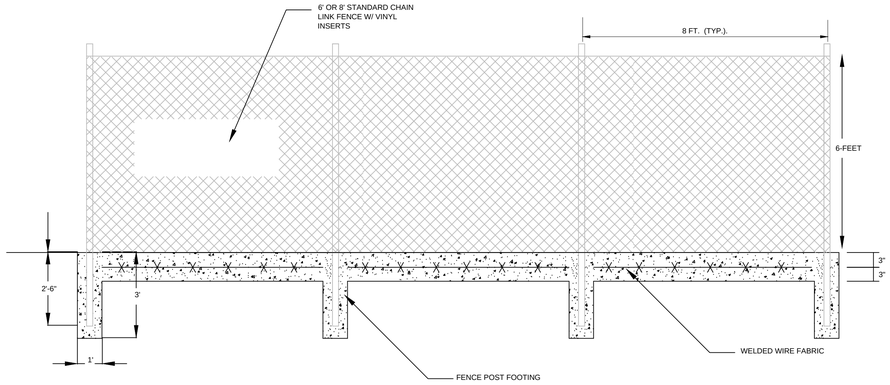
CONTRACTORS LICENSE NUMBER:
EXPIRATION DATE:
CLASSIFICATIONS: CERTIFICATIONS:

PROJECT:
FACILITY:
DATE: SHEET: 9 of 12

TITLE: **CONSTRUCTION DETAILS**

DRAWING No. **G-5B**

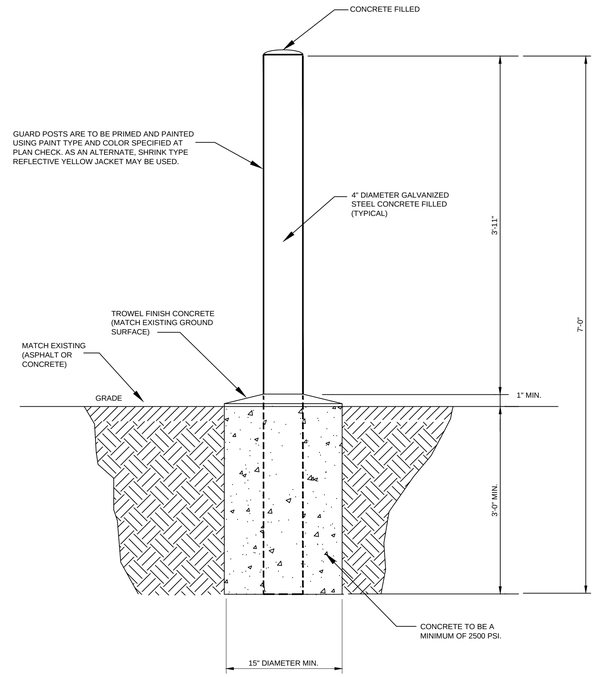


NOTES:

1. FENCE SHALL BE TYPICAL 11.5 GAUGE, 2-INCH MESH CHAIN LINK FABRIC
2. FENCE END POSTS SHALL BE 2-3/8-INCH DIAMETER STRUCTURAL GRADE GALVANIZED STEEL. FENCE SUPPORT POSTS SHALL BE 1-7/8-INCH DIAMETER STRUCTURAL GRADE GALVANIZED STEEL.
3. TOP RAIL SHALL BE 1-5/8-INCH DIAMETER GALVANIZED STEEL.
4. BOTTOM TENSION WIRE SHALL BE A MINIMUM OF 9 GAUGE GALVANIZED WIRE.
5. A 8-FOOT DOUBLE SWING GATE WILL BE INSTALLED. GATE POSTS FOR GATES WIDER THAN 6' SHALL BE 2-7/8" OD SCH. 40 STEEL
6. PRIVACY SLATS OR SCREEN SHALL BE PROVIDED AND SHALL BE VINYL MATCHING EXISTING DECOR OR LOCAL CODES.

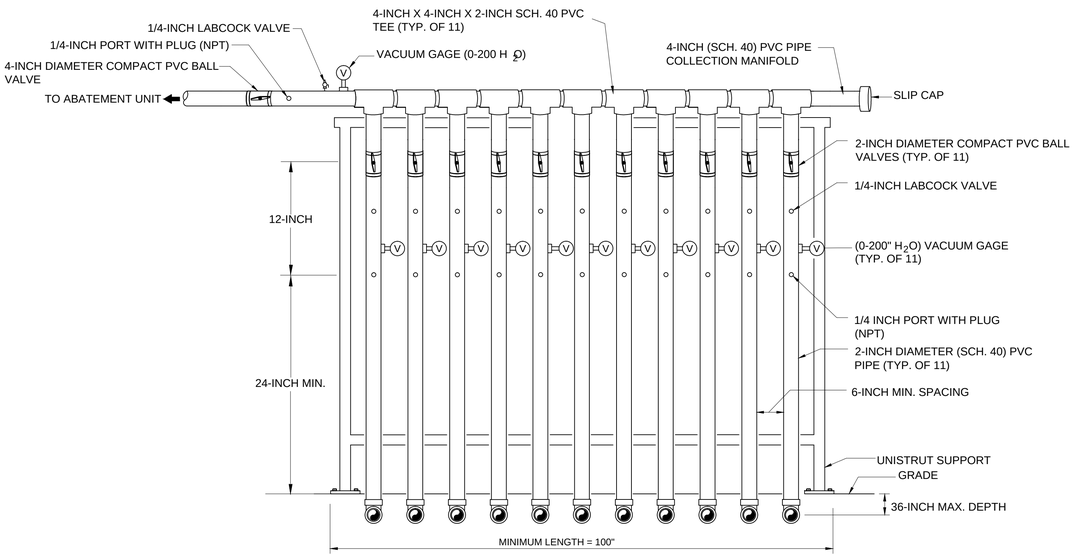
9 / G-5C — CHAIN LINK COMPOUND PERIMETER FENCE

NOT TO SCALE



10 / G-5C — FIXED GUARD POST

NOT TO SCALE

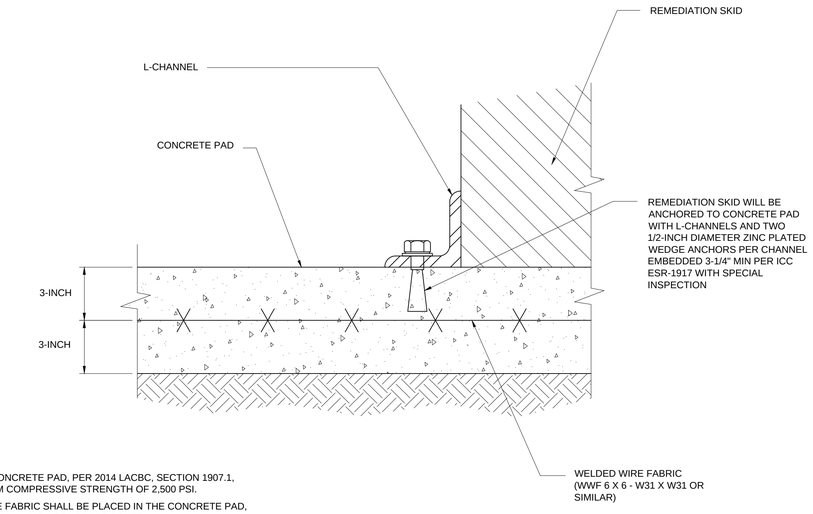


NOTES:

1. OZONE TUBING WILL DAYLIGHT IN REMEDIAL COMPOUND AND CONNECT DIRECTLY TO OZONE INJECTION EQUIPMENT. OZONE TUBING WILL REMAIN ENCLOSE IN SCH. 40 PVC CONDUIT ABOVE GROUND.

11 / G-5C — VAPOR EXTRACTION MANIFOLD DETAIL

NOT TO SCALE



NOTES:

1. 6-INCH THICK CONCRETE PAD, PER 2014 LACBC, SECTION 1907.1, WITH A MINIMUM COMPRESSIVE STRENGTH OF 2,500 PSI.
2. A WELDED WIRE FABRIC SHALL BE PLACED IN THE CONCRETE PAD, WITH A MINIMUM 1 ½-INCH CONCRETE COVER.

12 / G-5C — EQUIPMENT SKID SLED ANCHOR BOLT DETAIL

NOT TO SCALE

REV.	DATE	BY	APP.	DESCRIPTION

DESIGNED — DATE
DRAWN BY — DATE
CHECKED — DATE

PREPARED BY: AECOM
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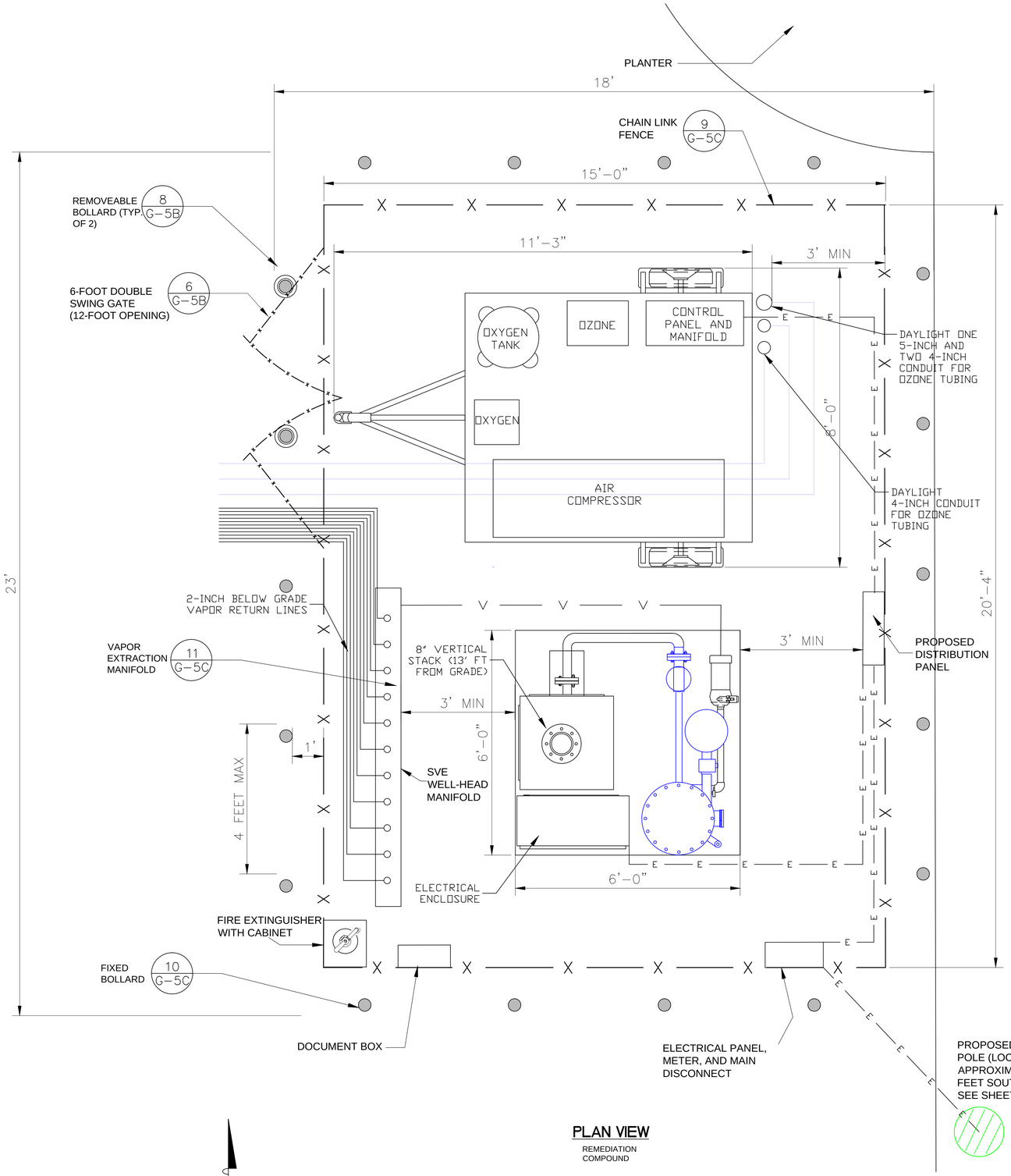
CONTRACTORS LICENSE NUMBER:
EXPIRATION DATE:

PROJECT:
FACILITY:
DATE:
SHEET: 10 of 12

TITLE: **CONSTRUCTION DETAILS**

DRAWING No. **G-5C**



PLAN VIEW

REMEDIATION COMPOUND

LEGEND

- FENCE LINE
- PROPERTY BOUNDARY
- PROPOSED ABOVE GROUND ELECTRICAL LINE
- BELOW GRADE VAPOR RETURN LINES
- ABOVE GRADE VAPOR RETURN LINES
- BELOW GRADE OZONE CONVEYANCE LINES
- LIGHT
- PROPOSED POWER POLE

NOTES:

CONTRACTOR TO PROVIDE APPROPRIATE ELECTRICAL CONDUIT/WIRING TO THE UNIT.

IN COMPLIANCE WITH CALIFORNIA MECHANICAL CODE SECTION 504.5 THE STACK IS LOCATED GREATER THAN 3 FEET FROM THE PROPERTY LINE AND THREE FEET FROM OPENINGS INTO BUILDING.

N

0 1.5 3

SCALE (FEET)

REV.	DATE	BY	APP.	DESCRIPTION

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CONTRACTORS LICENSE NUMBER:

EXPIRATION DATE:

CLASSIFICATIONS: CERTIFICATIONS:

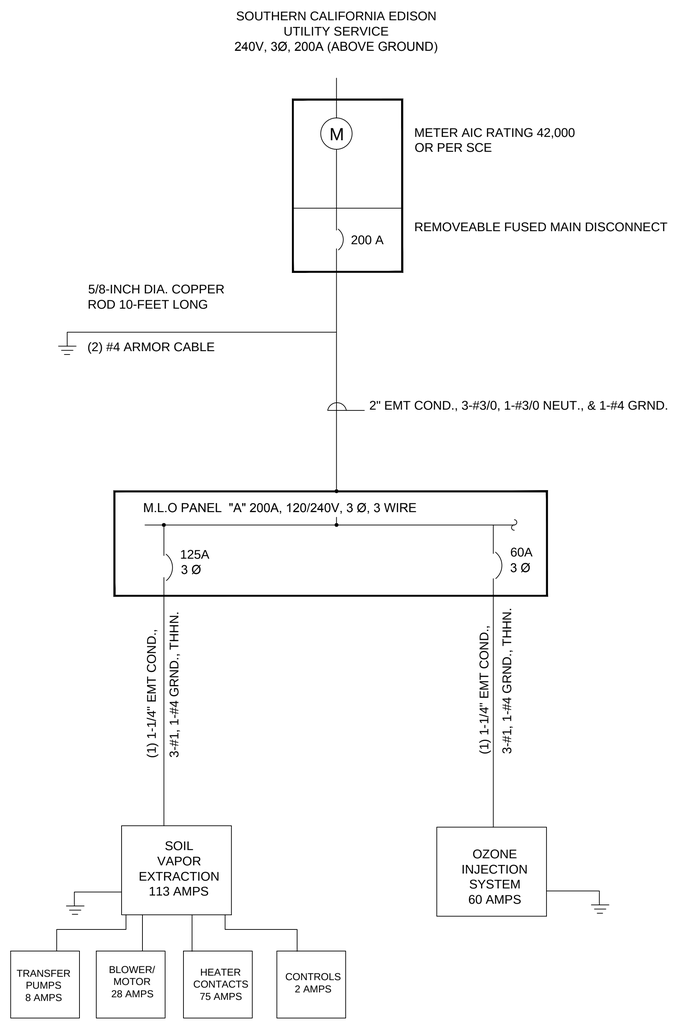
PROJECT:

FACILITY:

DATE: SHEET: 11 of 12

TITLE: **EQUIPMENT LAYOUT (PLAN VIEW)**

DRAWING No. **G-6** -



NOTES:

1. CONTRACTOR SHALL FURNISH AND INSTALL ALL NECESSARY EQUIPMENT FOR ELECTRICAL SERVICE.
2. ALL ELECTRICAL WORK SHALL BE INSTALLED IN ACCORDANCE WITH ALL LOCAL ORDINANCES AND THE CURRENT (2011) NATIONAL ELECTRICAL CODE (NEC).
3. ELECTRICAL WIRING SHALL BE APPROPRIATELY IDENTIFIED AND PERMANENTLY MARKED.
4. ELECTRICAL CONTROL WIRING SHALL BE RUN IN SEPARATE CONDUIT FROM ANY OTHER POWER CONVEYANCE WIRES.
5. VAPOR TREATMENT UNIT IS TO BE PROPERLY GROUNDED - USING A SEPARATE COPPER ROD.
6. GROUND RODS TO BE PLACED 6 FEET MINIMUM APART.
7. ANY BELOW GRADE ELECTRICAL CONDUIT MUST MEET THE SEAL OFF REQUIREMENTS OF LA COUNTY BUILDING AND SAFETY ELECTRICAL CODE

LOAD CALCULATIONS

LOAD WITH HIGHEST AMPERAGE IS SVE HEATER CONTACTS WITH 75 AMPS.

75 AMPS x 1.25 = 93.75 AMPS

COMPONENT	AMPERAGE
SVE HEATER CONTACT	75 AMPS x 1.25 = 93.75 AMPS
SVE BLOWER/ MOTOR	28 AMPS
SVE CONTROLS	2 AMPS
SVE TRANSFER PUMPS	8 AMPS
OZONE INJECTION SYSTEM	60 AMPS
TOTAL	191.75 AMPS

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CONTRACTORS LICENSE NUMBER:
EXPIRATION DATE:
CLASSIFICATIONS: CERTIFICATIONS:

PROJECT:
FACILITY:
DATE: SHEET: 12 of 12

TITLE: ELECTRICAL SINGLE LINE DIAGRAM AND PANEL SCHEDULE
DRAWING No. G-7