RESPONSE PLAN AND REMEDIAL TECHNOLOGY EVALUATION

Former Chemoil Refinery
Site Cleanup Program Number 0453A
Site ID No. 2047W00
Global ID SL 2047W2348

2020 Walnut Avenue
Signal Hill, California

093-CHEMOIL-001

Prepared For:

Signal Hill Enterprises, LLC
1900 South Norfolk Street, Suite 350
San Mateo, California 94403

and

RE | Solutions, LLC
2880 Bryant Street
Denver, Colorado 80211

Prepared By:

SGI environmental | APEX

299 West Hillcrest Drive, Suite 220
Thousand Oaks, CA 91360

July 13, 2017

Prepared and Reviewed By:

Steve Hickey, P.E.
Senior Engineer

ivy inouye

Ivy Inouye
Senior Toxicologist

PROFESSIONAL GEOLOGIST
MARK E. LABRENZ
No. 5961
CERTIFIED HYDROGEOLOGIST
EXP. 11/18
STATE OF CALIFORNIA

Mark Labrenz

Mark Labrenz, P.G.
Principal Geologist

Kirsten L Duey

Kirsten Duey
Project Manager

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EXECUTIVE SUMMARY

This *Response Plan and Remedial Technology Evaluation* (Response Plan) has been prepared by The Source Group, Inc. a division of Apex Companies, LLC (Apex-SGI) to address petroleum constituent subsurface impacts associated with the former Chemoil Refinery located at 2020 Walnut Avenue in Signal Hill, California (the Site). The Site is currently owned by Signal Hill Enterprises, LLC (SHE). Negotiations are underway between SHE and RE | Solutions, LLC (RES) to transfer property ownership for redevelopment purposes. A California Land Reuse and Revitalization Act (CLRRA) Agreement was executed between RES and the Los Angeles Regional Water Quality Control Board (LARWQCB) on March 4, 2017. Activities documented herein are driven by requirements from the LARWQCB with the goal to remediate the Site to acceptable levels to allow property redevelopment for light industrial and commercial purposes.

This Response Plan includes a comprehensive review of characterization activities completed to date, a description of the Conceptual Site Model (CSM), an evaluation of applicable technologies that were considered to remediate the Site, the selected preferred actions, and the conceptual design of response actions.

The Site is characterized by a Vadose Zone from ground surface to the water table at approximately 15 to 43 feet below ground surface (bgs). Flow beneath the Site is generally toward the south. Soil, soil vapor, and underlying groundwater are impacted by historic petroleum releases. The cessation of the property as an oil refinery ceased in the mid-1990s indicating that the primary source of contamination no longer exists at the Site. However residual concentrations of petroleum constituents, including the presence of light non-aqueous phase liquid (LNAPL) remain in the subsurface.

The Site is comprised of three general areas referred to as: 1) the Southwest Parcel, 2) the Northwest Parcel, and 3) the East Parcel. A human health risk assessment (HHRA) was completed for the East Parcel, where subsurface impacts are relatively low. Results of the HHRA indicated that residual concentrations in the subsurface do not pose an unacceptable human health risk to hypothetical future onsite commercial/industrial receptors. Considering the results of the HHRA, and that administrative and institutional controls will be implemented prior to development of the East Parcel, further remedial action is not warranted. The complete East Parcel HHRA is provided with this document as Appendix E.

A CSM was developed for the Site and subsurface data evaluated against site-specific screening levels. Results indicate that the remedial actions or mitigation are required at the Southwest and Northwest Parcels for the following hypothetical receptors and potentially complete exposure pathways:

Hypothetical Receptor	Potentially Complete Exposure Pathway
Future onsite construction/utility worker	Incidental ingestion of soil; Dermal contact with soil; and Inhalation of vapors in outdoor air
Future onsite commercial/industrial worker	Incidental ingestion of soil; Dermal contact with soil; and Inhalation of vapors in indoor air
Current/future offsite commercial/industrial worker	Inhalation of vapors in indoor air
Current/future offsite resident	Inhalation of vapors in indoor air

Based on the CSM, considering the planned redevelopment activities, and considering that subsurface concentrations in the residential area downgradient from the Site do not pose an unacceptable risk, the following Remedial Action Objectives (RAOs) were developed for the Site:

- Reduce and/or maintain human health risks to acceptable levels to allow redevelopment of the Site for light industrial/commercial purposes;
- Prevent soil-related exposures (i.e., incidental ingestion, direct dermal contact, particulate inhalation and outdoor vapor inhalation of VOCs) to constituent concentrations exceeding commercial/industrial screening levels;
- Prevent indoor inhalation as a result of potential vapor intrusion of constituent concentrations exceeding commercial/industrial screening levels;
- Reduce the potential for adsorbed-phase petroleum constituents in soil to leach to groundwater underlying the Site;
- Remove to the extent practical, mobile light, non-aqueous phase liquid (LNAPL) within the three defined LNAPL areas of occurrence; and
- Control the dissolved-phase hydrocarbon groundwater plume to prevent further offsite migration of contaminants at concentrations above levels that present a risk.

Based on an evaluation of technologies to meet the RAOs defined above, the following technologies and controls were selected as the most suitable and cost effective remedial alternatives for the Site:

Proposed Groundwater Treatment Technologies:

1. Implement source area LNAPL removal and off-site disposal;
2. Operate an air sparge barrier at the property boundary; and
3. Implement a downgradient monitored natural attenuation (MNA) program.

Proposed Soil and Soil Vapor Treatment Technology

4. Operate an on-Site soil vapor extraction system focused on treatment in the deeper, more porous section of the vadose zone; and
5. Use engineering and institutional controls to mitigate contaminants in the shallower, less porous section of the vadose zone.

Proposed Engineering and Institutional Controls

6. "Cap" site with building and pavement;
7. Install a vapor mitigation system under all future buildings;
8. Restrict on-site land use through a land use covenant (LUC);
9. Prepare a Site Management Plan (SMP) associated with the LUC; and
10. Implement a Site Redevelopment Soil Management Plan for use during property redevelopment.

Phase I of the SVE system installation and operation will occur immediately following LARWQCB approval of this Response Plan. Conceptual designs for the SVE system, the air sparge barrier, and the LNAPL removal system are provided in this document. Following LARWQCB approval of this Response Plan, the following activities will be conducted:

- Installation of three new MNA wells to provide vertical delineation immediately downgradient from the Site;
- Phase I implementation of the SVE system as a combined pilot study and first phase of remedy implementation to determine design parameters for the full-scale (Phase II) system;
- Completion of an air sparge barrier pilot test and submittal of detailed design report;
- Installation of recovery wells in the LNAPL areas and installation of LNAPL removal system;
- Preparation and submittal of an SMP and LUC; and
- Preparation and submittal of a Site vapor mitigation system design report.

An MNA Plan for off-Site groundwater is provided as an Appendix to this Response Plan. The current groundwater monitoring plan for on-Site wells will be implemented until Site redevelopment occurs. It is expected that the on-Site well network will be modified during redevelopment activities to compensate for future building footprints. A long-term on-Site monitoring program with proposed well locations will be submitted once the redevelopment plan is finalized.

Also included as an Appendix to this Response Plan is a Site Redevelopment Soil Management Plan. The Redevelopment Soil Management Plan will be used to provide guidance for handling potentially contaminated soil during Site redevelopment activities such as grading, overexcavating for geotechnical requirements, or trenching for new underground utilities. The Redevelopment Soil Management Plan provides managers and workers with procedures for internal and agency notifications; excavation/grading oversight; air and safety monitoring; soil segregation and monitoring; soil sampling and analysis; waste characterization and profiling; waste recycling and disposal procedures; and record keeping and reporting requirements in areas of known or encountered impacts.

Assuming LARWQCB approval within 30 days of submittal of this document, a schedule of completion for the activities documented herein is provided in Section 13.

1.0 INTRODUCTION

The Source Group, Inc. a division of Apex Companies, LLC (Apex-SGI) has prepared this *Response Plan and Remedial Technology Evaluation* (Response Plan) on behalf of Signal Hill Enterprises, LLC (SHE) and RE | Solutions, LLC (RES). The purpose of the Response Plan is to identify and present a cleanup strategy for petroleum constituents present in soil, soil vapor, and groundwater. The subject property is the former Chemoil Refinery located at 2020 Walnut Avenue in Signal Hill, California (Site, Figure 1-1). It is currently owned by SHE. SHE and RE | Solutions, LLC (RES) have entered into a Purchase and Sale Agreement to transfer property ownership to RES for redevelopment purposes. A California Land Reuse and Revitalization Act (CLRRA) Agreement was executed between RES and the Los Angeles Regional Water Quality Control Board (LARWQCB) on March 4, 2017. Activities documented herein are driven by requirements from the LARWQCB with the goal to remediate the Site to acceptable levels to allow property redevelopment for light industrial and commercial purposes.

A Site investigation was previously performed to fill identified data gaps necessary to develop a Conceptual Site Model (CSM) that was be used to guide the preparation of this remedial Response Plan. APEX-SGI prepared a *Site Investigation Workplan* (Workplan), dated October 25, 2016, which was approved by LARWQCB on November 23, 2016. The Site investigation was performed from December 2016 through January 2017 and the results and interpretations documented in a *Site Investigation and Site Conceptual Model Report* dated March 29, 2017 (SGI, 2017). Additional Site investigation activities were completed in May 2017 and are documented in Section 3 of this report.

The general outline of this document is as follows:

- Section 2 provides a Site description and background and summarizes the CSM that was derived from data collected by the prior site investigations conducted at the Site.
- Section 3 summarizes results of on-Site drilling activities completed in May 2017.
- Section 4 provides the soil, soil vapor, and groundwater screening levels (SLs) that were developed for the Site and lists the chemicals of potential concern (COPCs) that were determined for each media by comparing Site data to SLs.
- Section 5 summarizes the results of a human health risk assessment (HHRA) that was completed for the East Parcel.
- Section 6 presents the remedial action objectives (RAOs) determined for the Site and presents results of the initial screening of response action technology alternatives.
- Section 7 presents a detailed analysis of the technologies that passed the screening process presented in Section 6. Based on the analysis, the preferred technologies were selected and presented at the end of Section 7 as the proposed response actions for the Site.
- Section 8 provides the design of the proposed soil vapor extraction system.

- Section 9 provides the conceptual design of the groundwater remediation system.
- Section 10 proposes the groundwater monitoring program for the Site.
- Section 11 summarizes the Site Redevelopment Soil Management Plan that will be implemented during any excavation of soils during future development; including utility installation, construction of building foundations, etc.
- Section 12 summarizes the proposed institutional and engineering controls that will be implemented as part of property redevelopment.
- Section 13 details the proposed schedule for activities detailed in this document. The schedule incorporates milestones defined in the CLRRA currently in effect between the LARWQCB and RES.
- Section 11 lists the references used throughout this document in developing the CSM, remedial cleanup objectives, and proposed remedial approach.

Key supplemental documents prepared as part of this Response Plan effort and provided as Attachments are:

- The Derivation of Site Specific Soil Vapor Screening Levels (Appendix D);
- The complete HHRA for the East Parcel (Appendix E);
- The Monitored Natural Attenuation Plan for off-site groundwater (Appendix F); and
- The Site Redevelopment Soil Management Plan which provides guidance to be used during the handling of soil during upcoming property redevelopment (Appendix G).

2.0 SITE DESCRIPTION AND BACKGROUND

2.1 Site Description

The property known as the former Chemoil Refinery is located at 2020 Walnut Avenue in Signal Hill, California (Figure 1-1). The Site was developed as an oil refinery in 1922. The MacMillan-Ring Free Oil Company owned and operated the facility from 1922 until 1988. Chemoil Corporation purchased the refinery in August 1988 and operated it until February 1994. From early 1994 to early 1997, the refinery was shut down with occasional operation of its waste water system. Operation of the waste water system was discontinued and all of the above ground structures were dismantled in early 1997. It has been reported that known below ground structures, including piping, sumps, footings, and foundations, were also removed at that time (S. Testa, verbal communication, October 2016). Since December 2013, the property owner of title has been Signal Hill Enterprises, LLC.

The Site is approximately 8.2 acres, located north of the intersection of East 20th Street, East Wesley Drive, Walnut Avenue, and Alamitos Avenue. The Site is divided into an East Parcel, situated immediately east of Walnut Avenue and a West Parcel, situated immediately west of Walnut Avenue. The East Parcel encompasses approximately 2.4 acres and the West Parcel encompasses approximately 5.8 acres. The West Parcel is further subdivided into the Northwest and Southwest Parcels by East 21st Street. Hereafter, the three parcel areas will be referred to within this document as the East Parcel, the Northwest Parcel, and the Southwest Parcel. A portion of the Southwest Parcel includes the Raymond Tract Parcels, which are currently owned by a separate entity (MPO Walnut Partners, LLC). RES has signed a Letter of Intent and is negotiating a purchase agreement for acquisition of this property. The Raymond Tract Parcels will be addressed in the Response Plan because of the historical lease and operations of Chemoil on those parcels. The division of the Site into the above-indicated parcels is shown on Figure 2-1.

2.2 Surface Topography and Ground Cover

The site currently consists of exposed surface soils, with perimeter chain link fencing and stormwater controls. A few temporary above ground facilities are on-site; associated with on-going groundwater remediation activities. The upper soils range from two to seven feet in depth and are classified as fill, consisting of silty sand with intermittent gravels and some intermixed debris. The upper fill is underlain by a silt or silty fine grained sand.

All three parcels are generally flat, with scattered earthen berms or hummocks, and slope toward the south and southeast from a topographic high of approximately 45 feet above mean sea level at the northern boundary. The parcels are separated by public surface streets with East 21st Street dividing the north and south parcels and North Walnut Avenue dividing the east and west parcels.

2.3 Geology

The Site is located within the Los Angeles Coastal Plain (California Department of Water Resources [CDWR], 1961) of the Peninsular Ranges geomorphic province of southern California (Norris and

Webb, 1990). The Los Angeles Coastal Plain is a deep structural trough that has been filled primarily with unconsolidated Miocene through Recent age sediments or alluvium that are underlain by earlier Cenozoic bedrock. The Los Angeles Coastal Plain is bounded on the north by the Santa Monica Mountains; on the northeast by the low-lying Elysian, Repetto, Merced, and Puente Hills; on the east and southeast by the Santa Ana Mountains and San Joaquin Hills; on the south by the Palos Verdes Hills and the Pacific Ocean; and on the west by the Pacific Ocean (CDWR, 1961).

The geologic structure beneath the Coastal Plain is referred to as the Los Angeles Basin and consists of undifferentiated, pre-Pleistocene bedrock overlain by approximately 2,200 feet of layered, semi-consolidated and unconsolidated water-bearing terrestrial and marine sediments. The uppermost section of these sediments, the early Pleistocene-age San Pedro Formation and the late Pleistocene-age Lakewood Formation, have been warped by geologically-recent tectonic activity into northwest- to southeast-oriented folds that are periodically disrupted by northwest-trending regional faults. The San Pedro Formation and Lakewood Formations vary in thickness from tens to several hundreds of feet thick. Flat-lying Recent (Holocene-age) alluvium, derived from alluvial fans and overflow of river systems, overlie the folded and faulted Pleistocene formations in topographically lower portions of the Coastal Plain. Where present, the Holocene alluvium can be up to 200 feet thick.

The Site is underlain by deposits of unconsolidated, laterally discontinuous sequences of silt and fine to coarse-grained sand. Coarse-grained soils consist of sand (SP) and silty sand (SM); whereas, subordinate fine-grained soils consist of silt (ML and MH) and, to a lesser degree, clay (CL).

2.4 Hydrogeology

The Los Angeles Coastal Plain has been spatially divided by the CDWR into four groundwater basins (West Coast Basin, Central Basin, Santa Monica Basin, and Hollywood Basin) based on the hydrogeologic characteristics of the underlying strata and the locations of bounding geologic structures such as non-water-bearing rock and/or faults that impede groundwater movement. The Site is located within the West Coast Basin.

The West Coast Basin is bordered on the east by the Newport-Inglewood Fault; on the west by Santa Monica Bay; on the north by the Ballona Gap (north of the Los Angeles International Airport), and on the south by the Palos Verdes Hills. Based on lateral distribution and varying hydrogeologic characteristics, five major aquifers have been identified in the geologic formations underlying the West Coast Basin (CDWR, 1961). The aquifers consist of (from oldest to youngest) the Silverado and Lynwood Aquifers of the San Pedro Formation, the Gage Aquifer of the Lakewood Formation, and the Gaspur and Semi-perched Aquifers of the recent Holocene-age Alluvium. In general, the older/deeper Silverado and Lynwood Aquifers are currently designated as drinking water sources and the younger/shallow aquifers (Gage, Gaspur, and Semi-perched) are not currently used for drinking water purposes due to low yield and/or generally poor quality. Shallow groundwater beneath the Site is encountered in the Semi-perched Aquifer in the southern portion of the West Coast Basin. Groundwater quality within the Site vicinity is generally poor due to seawater intrusion and elevated salinity.

Due to Site topography, the difference between depth to water measurements in existing monitoring wells is approximately 30 feet. Depth to water in the northern portion of the Site is approximately 43 feet bgs (well MW-3), whereas depth to water in the southern portion of the Site is approximately 15 feet bgs (well MW-14). As of the June 2016 (Second Quarter) sampling event, groundwater occurred at elevations ranging from 2.09 to 3.94 feet relative to mean sea level. Groundwater flow beneath the Site is generally toward the south with localized variations in flow directions on-Site. The hydraulic gradient calculated based on Second Quarter 2016 groundwater gauging data was 0.0013 foot/foot (AA&AI, 2016b).

2.5 Surface Water

The nearest surface water body to the Site is the Los Angeles River, which is located 1.9 miles west of the Site. The section of the Los Angeles River west of the Site is contained in a north-south trending concrete lined flood control channel. The Los Angeles River accepts treated industrial discharge and stormwater runoff from the greater Los Angeles area.

2.6 Regulatory Background

To date, LARWQCB has been the lead environmental regulatory agency for the Site. Environmental investigations were initiated when LARWQCB issued an Investigative Order to multiple refineries operating within the Los Angeles Basin (Order No. 85-17). Results of the subsequent investigations indicated that soil and underlying groundwater at the Site have been impacted by the discharge of petroleum hydrocarbons. On November 19, 2009, LARWQCB required installation of groundwater monitoring wells and investigations to address on-Site and off-Site data gaps. On December 7, 2012, LARWQCB approved an Interim Remedial Action Plan (IRAP) which proposed a flow-through barrier using an in-situ subsurface metabolic enhancement (SME) system to treated groundwater along the western and southern boundaries of the Site. The SME has been operating since March 2014 and the current groundwater monitoring program has been implemented since 2013.

Over the last year and a half, discussions have been underway between RES and LARWQCB regarding the pending sale and subsequent planned redevelopment for the Site. A CLRRA Agreement was executed between RES and the LARWQCB on March 4, 2017. Under the CLRRA Agreement, RES is required to conduct a Site Assessment addressing data gaps identified by LARWQCB. Site assessment activities were completed and results submitted to LARWQCB in the Site Investigation and Site Conceptual Model Report dated March 29, 2017 (Apex-SGI, 2017). The CLRRA Agreement also requires preparation of a Response Plan to address the cleanup of the Site. The LARWQCB identified that the following response actions are expected:

- Removal of LNAPL;
- Soil excavation in identified areas;
- Groundwater remediation in identified areas;
- Continued operation of the SME barrier system (or installation of an equivalent system);

- Design and installation of a vapor mitigation system;
- Periodic monitoring and reporting; and
- Recording of an environmental land use covenant (LUC) and site management plan (SMP).

This document is meant to fulfill the requirements of the Response Plan required under the CLRRA Agreement and subsequent discussions with LARWQCB.

2.7 Summary of Subsurface Impacts

Soil, soil vapor, and underlying groundwater at the Site are impacted by historic petroleum releases. A detailed presentation of historic data was presented in the Site Investigation and Site Conceptual Model Report (2017 Site Investigation Report) (Apex-SGI, 2017). A summary is briefly summarized below. Note that the extent of contamination described in the sections below are based on a comparison of data to site specific SLs which have been developed for the Site. The development of SLs and the updated final SL values for each media are described in detail in Section 4 of this report.

Tables summarizing available soil, soil vapor, and groundwater analytical data collected to date are provided in Appendix A. Cross sections that were provided in the 2017 Site Investigation Report include key information to understand the distribution of contaminants in the subsurface, including Site lithology, soil concentration data, and groundwater concentration data. For reference, copies of the cross section location map and associate cross sections are provided as Figures 2-2 through 2-4.

2.7.1 Soil

Total Petroleum Hydrocarbons in the gasoline, diesel, and oil range as well as VOCs have been identified in vadose soil for the subject property. VOCs detected include aromatic benzene derivative compounds, typical of petroleum refining facilities. Petroleum related constituents are primarily present in subsurface soil within a significant portion of the Northwest and Southwest Parcels.

TPHg (C4-C12) and TPHd (C13-C22) range are present above the Site-specific screening levels in soil within a significant portion of the Northwest Parcel and Southwest Parcel. Typical of sites where releases originated from the surface, elevated hydrocarbon concentrations in the vadose zone have been detected throughout the vertical soil column to groundwater in some areas of the Site and have been shown to attenuate with depth within other areas of the Site.

Hydrocarbon impact to near surface soils (surface to 5 feet bgs) appears to occur throughout the Northwest and Southwest Parcels, including the previously un-assessed northern portion of the Northwest Parcel. Hydrocarbon fractions in this near surface soil (much of which is fill) ranges from light end (gasoline range) to heavy end (oil range).

Soil data indicate that VOC constituents occur in vadose zone soil at concentrations above SLs across both the Northwest and Southwest Parcels. Benzene is considered the primary risk driver for future Site occupants and is present above SLs through much of the Northwest Parcel. VOC data collected from the Southwest Parcel is limited; further data will be collected as part of implementation of the Response Plan.

Soil data indicate that petroleum constituents detected above SLs in the East Parcel are localized to a small area in the northeast corner.

Figure 2-5 identifies the locations where prior soil analytical data exceeds soil SLs for each parcel.

2.7.2 Soil Vapor

Soil vapor data have been collected from on and off-site locations during investigations in 2006 (Tetra Tech), 2012 (Geosyntec), and 2016 (Apex-SGI). Data indicated that, except for a few isolated locations, detections above applicable screening levels (applicable screening levels are discussed in Section 4 of this report) are limited to on-Site; mitigation of offsite soil vapor is not warranted. Figure 2-6 presents the benzene concentration in soil vapor samples at 5 feet bgs.

2.7.3 Groundwater

Groundwater data collected to date indicate that TPHg, TPH in the C13 to C22 carbon range (similar carbon range to TPH as diesel), BTEX, and naphthalene are generally detected at the highest concentrations in groundwater at the Site. Petroleum constituents were not detected in groundwater underlying the East Parcel at concentrations above SLs.

Grab groundwater samples collected at multiple depths in the Northwest Parcel indicate that the highest concentration of petroleum compounds are generally found in shallow groundwater samples with lower concentrations found in deeper samples. The concentrations found in deeper samples appear to be due to diffusion from upper, higher-concentration areas. The vertical extent of petroleum-impacted groundwater has not been fully defined.

Documentation for the Site indicate the presence of three former LNAPL pools in the mid to late 1980s: 1) near MW-11 where LNAPL continues to be observed, 2) along the western border of the Northwest parcel near BMW-9, and 3) in the southern point of the Southwest parcel in the vicinity of BMW-1. Recent Site investigation activities have defined two areas of the Site where LNAPL is present in the subsurface in the Northwest Parcel (locations included on Figure 2-7). These two areas generally coincide with the two areas where LNAPL was present historically. Recent Site investigation activities also suggest the presence of LNAPL in the Southwest Parcel (location shown on Figure 2-7). The LNAPL presence in the Southwest Parcel is inferred the Southwest Parcel, based upon elevated UVOST™ responses observed during the 2016 site investigation. LNAPL at the Site is observed to be relatively thin with slow recharge rates (Apex-SGI, 2017).

2.8 Conceptual Site Model

A CSM is a representation of the characteristic of the Site to demonstrate the possible and confirmed relationship(s) between the source(s) of contamination, pathways, and receptors. A CSM was developed for the Site and presented in detail in the recent Site Investigation Report (Apex-SGI, 2017). The following hypothetical human receptors were identified based on their proximity to the Site, proposed activities that could possibly result in direct or indirect contact with Site-related chemicals, and anticipated Site use.

- Future Onsite Construction/Utility Trench Worker Receptor;
- Future Onsite Commercial/Industrial Worker Receptor;
- Current/Future Offsite Commercial/Industrial Worker Receptor; and
- Current/Future Offsite Resident Receptor.

The following pathways were considered complete and significant for the hypothetical receptors that were identified for the Site:

Hypothetical Receptor	**Potentially Complete Exposure Pathway**
Future onsite construction/utility worker	Incidental ingestion of soil; Dermal contact with soil; and Inhalation of vapors in outdoor air
Future onsite commercial/industrial worker	Incidental ingestion of soil; Dermal contact with soil; and Inhalation of vapors in indoor air
Current/future offsite commercial/industrial worker	Inhalation of vapors in indoor air
Current/future offsite resident	Inhalation of vapors in indoor air

This CSM completed for the Site that was used to develop the remedial action objectives and remedial approach documented in this Response Plan is summarized schematically on Figure 2-8.

3.0 ADDITIONAL INVESTIGATION ACTIVITIES

Site investigation activities were conducted on May 18, 2017 with the goal of:

1) delineating the vertical migration of dissolved-phase contaminants in groundwater beneath the Site; and
2) collecting a soil sample for physical property analysis to be used for vapor intrusion modeling.

Details regarding implementation and results are provided in the sections that follow.

3.1 Field Preparatory Activities

A Site-specific Health and Safety Plan (HASP) was prepared in compliance with Federal Occupational Safety and Health Administration regulations (OSHA; 29 Code of Federal Regulations, Section 1910.120) and State OSHA regulations (California Code of Regulations, Title 8, Section 5192). Apex-SGI personnel and subcontractors associated with the project were required to be familiar and comply with all provisions of the Site-specific HASP.

A soil boring permit was obtained from the Los Angeles County Department of Public Health (LACDPH). A copy of the approved permit is included in Appendix B.

A Site visit was completed to mark the locations of the proposed soil borings and DigAlert, a one-call notification alert for underground utility providers, was contacted. In addition, Apex-SGI obtained a geophysical services contractor to confirm the locations were clear of any subsurface utilities, pipelines, or other structures.

As an additional precaution, each drilling location was manually cleared using a hand auger to a minimum depth of approximately 5 feet bgs to ensure that no utilities would be impacted by the drilling operations.

3.2 Soil Boring Assessment

A Cone Penetration Testing (CPT) direct-push rig was operated by Gregg Drilling & Testing, Inc., a State of California-licensed (C-57) drilling contractor under the oversight of Apex-SGI. All borings were hand-augered to approximately 5 feet bgs prior to boring advancement using the CPT rig. Soil boring AN-22 was advanced within the southern portion of the Northwest Parcel to attempt to provide vertical delineation of the dissolved phase in groundwater. The target depth was 100 ft bgs. Drilling refusal occurred at 58 ft bgs. A second attempt to push deeper into groundwater was made at step-over boring AN-22a. However, refusal was met again at 58.5 feet bgs. No further attempts were made to push beyond 58.5 feet bgs

The locations of boring AN-22 and AN-22a are depicted on Figures 2-5 and 2-7 and further methodologies are described below. Copies of the CPT logs are available in Appendix C.

Each CPT direct-push boring was abandoned upon completion by grouting the boring with a 5 percent (%) bentonite/Portland cement slurry.

3.2.1 Soil Sampling Methodology and Analytical Program

The following samples were collected and submitted for laboratory analysis:

Physical Property Sampling

One soil sample was collected in a stainless steel sleeve as a continuous core from boring AN-22 at a depth of 4.75 to 5.25 feet bgs and submitted to PTS Laboratories in Santa Fe Springs, for the CAL-EPA DTSC Vapor Intrusion Package which includes the following analyses for soil:

- Moisture content, total porosity, air-filled porosity, water-filled porosity, total porosity, and grain and bulk density using American Petroleum Institute (API) RP40 and ASTM D2216;
- Particle size analysis using ASTM D422/D4464M; and
- Total organic compound using the Walkley-Black method.

Chemical Analytical Sampling

A soil analytical sample from boring AN-22 was collected at 4.5 feet bgs from the hand auger bucket and from boring AN-22a at 10 feet bgs using a CPT equipped with a push soil sampler.

All samples were logged on to a chain-of-custody document for delivery to American Analytics, Inc. in Chatsworth California for the following analysis:

- TPH Carbon Chain (C6-C44) by U.S. Environmental Protection Agency (USEPA) Method 8015M; and
- VOCs and fuel oxygenates by USEPA Method 8260B.

3.2.2 Groundwater Sampling Methodology

A groundwater grab sample was collected from boring AN-22 at a depth of 58 feet bgs using a Hydropunch® groundwater sampling system. At the desired depth interval, a 4-foot long stainless steel screen housed within the drilling rod was exposed to the subsurface, and allowed to fill with groundwater. Groundwater was allowed to equilibrate within the sampling device prior to extraction using small diameter polyethylene tubing and a check valve assembly. The groundwater samples were decanted into analysis-specific laboratory supplied containers, labeled, and handled under standard chain-of-custody procedures for delivery to American Analytics, Inc. for analysis for the following parameters:

- TPH Carbon Chain (C6-C44) by EPA Method 8015M; and
- VOCs and fuel oxygenates by EPA Method 8260B.

3.3 Decontamination Methods

To support the quality of data and to minimize the potential for cross-contamination between sampling events, all reusable downhole equipment used during drilling and sampling was thoroughly contaminated prior to, and in between each use. Decontamination procedures for all reusable sampling equipment included: physical removal of excess soil and debris; thorough washing of all equipment with non-phosphate detergent/potable water solution; and triple rinse with deionized or distilled water.

3.4 Management of Investigation Derived Waste

Investigation-derived waste (IDW) generated during this project, including soil cuttings, decontamination water, and purge water were stored in UN-related, 55 gallon drums and will be profiled and disposed of in accordance with local, State, and Federal regulations.

3.5 Investigation Results

Results were compared with applicable SLs for soil and groundwater as presented on the data summary tables included in Appendix A. Results are summarized below.

3.6 Soil Conditions

CPT results were generally consistent with historical CPT and logging data, which indicate the presence of both coarse-grained and fine-grained soil types to a maximum explored depth of 58.5 feet bgs (AN-22a). Coarser grained deposits interpreted as fill are encountered from surface to 1 foot bgs. In sharp contact with the fill is a fine-grained, low permeability soil that extends to approximately 5 to 7 feet bgs. This unit appears to grade into a coarser-grained soil dominantly consisting of sand to 58.5 feet bgs. These observations are consistent with previous Site investigations.

3.6.1 Soil

Sample results are included in the analytical summary tables provided in Appendix A and summarized below.

Petroleum hydrocarbon and VOCs were detected in soil collected from soil boring AN-22 at 4.5 and soil boring AN-22a at 10 feet bgs. However, only the sample from AN-22a at 10 feet bgs exceeds the final commercial/industrial Site-specific soil SLs. Soil data are consistent with previous Site investigation data for the area. A summary of the results is provided below.

- TPHg (C4-C12) was detected in both samples at concentrations of 190 milligrams per kilogram (mg/kg; AN-22 at 4.5 feet bgs) and 4,900 mg/kg (AN-22a at 10 feet bgs). The soil sample from AN-22a at 10 feet bgs exceeded the final commercial/industrial Site-specific soil SLs;

- TPHd (C13-C22) was detected in both samples at concentrations of 37 mg/kg and 619 mg/kg in samples AN-22 at 4.5 feet bgs and AN-22a at 10 feet bgs, respectively. The soil sample from AN-22a at 10 feet bgs exceeded final commercial/industrial Site-specific soil SLs;
- Benzene was not detected above laboratory reporting limits in any sample analyzed;
- No COPCs were detected above the final commercial/industrial Site-specific soil SLs in boring AN-22; and
- Naphthalene and 1,2,4-trimethylbenzene were the only other COPCs detected above the final commercial/industrial Site-specific soil SLs in boring AN-22a.

Physical property data obtained from PTS Laboratories was used for the vapor intrusion modeling assessment discussed in Section 4.0.

3.6.2 Groundwater

Sample results are included in the analytical summary tables provided in Appendix A and summarized below.

- TPHg (C4-C12) was detected in AN-22 at 58 feet bgs at a concentration of 300 micrograms per liter (µg/L);
- TPHd (C13-C22) was detected in AN-22 at 58 feet bgs at a concentration of 864 µg/L;
- Benzene was not detected above laboratory reporting limit in AN-22 at 58 feet bgs; and
- No other COPCs were detected above the final commercial/industrial Site-specific groundwater SL or the California maximum contaminant levels (MCL) and California notification levels (NL) for groundwater in AN-22 at 58 feet bgs.

3.7 Discussion of Vertical Delineation

Apex-SGI utilized long-term groundwater SLs (discussed in Section 4.0) as target values to determine when vertical delineation has been met. The following long-term groundwater SLs were used, as appropriate:

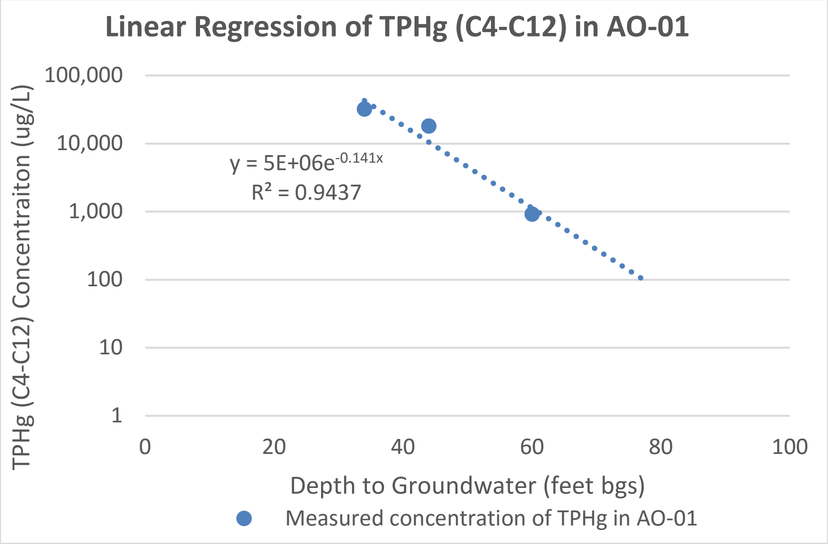
- MCLs, which are health protective drinking water standards to be met by public water systems;
- SWRCB drinking water notification levels, which are health-based advisory levels for nonregulated chemicals in drinking water without MCLs; and
- A value of 100 µg/L for TPHg and TPHd , based on SF RWQCB ESLs for drinking water based on taste and odor (MCLs are not available for TPHg and TPHd).

An evaluation of vertical delineation was used by comparing deep groundwater data collected from borings downgradient from the source area (borings AN-22 and boring AO-01). Groundwater samples from these borings were collected from the following depths:

- Boring AN-22: 58 ft bgs
- Boring AO-01: 34, 44, and 60 ft bgs

Vertical delineation of PAHs and VOCs is considered met at both locations. The benzene concentration at the deepest depth explored in boring AO-01 (60 ft bgs) only slightly exceed the MCL (1 ug/L) at a detected concentration of 1.4 µg/L and benzene concentrations in boring AN-22 were below laboratory detection limits of 0.5 µg/L at 58 ft bgs. Neither TPHg nor TPHd were at or below a concentration of 100 µg/L in borings AN-22 or AO-01 at the deepest depth explored.

Groundwater sampling via direct push methods, such as with a Hydropunch®, is insufficient to fully document the depth of TPHg and TPHd in groundwater at the Site. Therefore, Apex-SGI proposes the installation of three offsite groundwater monitoring wells immediately downgradient from the Site to provide vertical delineation. In order to estimate the approximate depth where the dissolved phase in groundwater may be less than 100 µg/L, a linear regression was performed using the concentration of TPHg (C4-C12) from offsite grab groundwater sample AO-01. Results are shown in the graph below.



Based on the linear regression above, data indicate that at approximately 78 feet bgs, the concentration of TPHg in groundwater can be predicted to attenuate below 100 µg/L.

The three, new proposed groundwater monitoring wells will be installed offsite at locations east (near MW-16) and south (near MW-15) of the proposed groundwater barrier, as shown on Figure 3-1. Two groundwater monitoring wells will be installed and screened at depths of 55 to 65 feet bgs and a third groundwater monitoring well will be screened at a depth of 75 to 85 feet bgs. These data will be used to vertically delineate the dissolved phase in groundwater and complete the design of the groundwater barrier.

4.0 SCREENING LEVELS AND DEVELOPMENT OF SITE SPECIFIC SOIL VAPOR SCREENING LEVELS

The Site Investigation Report included development of soil, soil vapor, and groundwater screening levels (SLs) that were used to evaluate the Site investigation data, to identify COPCs and to determine if further action is warranted. Details regarding the rationale for applicable screening levels were included in the Site Investigation Report. During a meeting at the LARWQCB office on April 27, 2017, LARWQCB requested that California Regional Water Quality Control Board, San Francisco Bay (SFRWQCB) environmental screening levels (ESLs) also be considered during the development of soil and Site-specific soil vapor SLs. Updated SLs incorporating the SFRWQCB ESLs are summarized below in Sections 4.1 through 4.3.

4.1 Updated Soil Screening Levels

Table 4-1 summarizes all SLs that were considered, which include:

- California DTSC modified screening levels (SLs) for residential and commercial/industrial soil (DTSC, 2016). DTSC SLs for soil were developed for direct exposure to soil via ingestion, dermal contact, and inhalation exposure pathways;
- USEPA Regional Screening Levels (RSLs) for residential and industrial soil (USEPA, 2016). USEPA RSLs for soil were developed for direct exposure to soil via ingestion, dermal contact, and inhalation exposure pathways.
- SFRWQCB ESLs for residential and commercial/industrial soil (SFRWQCB, 2016). SFRWQCB ESLs were developed for direct exposure to soil via ingestion, dermal contact, and inhalation exposure pathways.
- Calculated Site-specific SLs for TPH and VOCs for the protection of groundwater pathway, based on the 1996 guidance document. For PAHs, SFRWQCB ESLs and USEPAs RSLs were considered for the soil leaching to groundwater pathway.

Table 4-1 includes final site-specific soil SLs for each exposure scenario/receptor by selecting the lowest available value from each of the SLs bulleted above.

Based on this updated analysis, the COPCs for on-Site soil under a commercial/industrial exposure scenario are as follows:

Sampling Unit (SU)	Commercial/Industrial Exposure Scenario
Direct Contact Exposure Pathways **Protection of Groundwater Exposure Pathway (Groundwater at 20 feet bgs)**	
Soil (Surface to 10 feet bgs)	TPH (C6-C12) TPH (C13-C22) TPHg Benzene Ethylbenzene Naphthalene 1,3,5-Trimethylbenzene 1,2,4-Trimethylbenzene Total Xylenes Benz(a)anthracene Phenanthrene
Protection of Groundwater Exposure Pathway (Groundwater at 20 feet bgs)	
Soil (10 to 20 feet bgs)	TPH (C6-C12) TPH (C13-C22) TPHg Benzene Naphthalene 1,2,4-Trimethylbenzene Chrysene Phenanthrene Pyrene

4.2 Soil Vapor Screening Levels

The DTSC, USEPA, and SFRWQCB publish ESLs and RSLs for soil vapor that are based on default attenuation factors that likely overestimate the attenuation from soil vapor to indoor air for this Site because Site conditions are more reflective of less permeable silts. Site-specific soil vapor SLs were calculated using the DTSC modified version of the Johnson and Ettinger (1991; J/E) model (DTSC, 2014) and considering Site-specific geotechnical data. Results are provided in Table 4-2.

The methods used to develop the Site-specific soil vapor SLs, including assumptions and data used for the model input parameters are detailed in Appendix D. The resulting Site-specific soil vapor SLs developed for this site will be compared to soil vapor data collected from the Site to determine the extent of soil vapor that requires vapor intrusion mitigation measures.

For comparison purposes, Table 4-2 also includes summarizes California DTSC modified SLs for commercial/industrial air (DTSC, 2016), USEPA RSLs for commercial/industrial air (USEPA, 2016), and SFRWQCB ESLs for commercial/industrial air (SFRWQCB, 2016).

The updated COPCs for on-Site soil vapor under a commercial/industrial exposure scenario are as follows:

Sampling Unit (SU)	Commercial/Industrial Exposure Scenario
Vapor Intrusion into Indoor Air Exposure Pathway	
Soil Vapor	Benzene Ethylbenzene Xylenes 1,2,4-Trimethylbenzene

4.3 Groundwater Screening Levels

Screening levels for groundwater are consistent with the values presented in the Site Investigation Report, and are based on:

- SFRWQCB ESLs for residential and industrial groundwater vapor intrusion into indoor air (SFRWQCB, 2016). The SFRWQCB ESLs for groundwater vapor intrusion were developed for potential volatilization of chemicals from groundwater to indoor air and subsequent direct exposure to indoor air via the inhalation exposure pathway.

Table 4-3 includes final groundwater screening level values. The concentrations of the following constituents exceeded the lowest available groundwater SL; therefore, they were retained as a COPC based on vapor intrusion concerns under a commercial/industrial exposure scenario:

Sampling Unit (SU)	Commercial/Industrial Exposure Scenario
Vapor Intrusion into Indoor Air Exposure Pathway	
Groundwater	Benzene Ethylbenzene Naphthalene

Shallow groundwater beneath the Site is not currently used for drinking water purposes due to low yield and/or generally poor quality. Constituents present in groundwater were not retained as COPCs based on drinking water standards however were compared to applicable values considering long-term groundwater quality objectives. For evaluation of long-term groundwater objectives, the following groundwater SLs were used, as appropriate:

- California maximum contaminant levels (MCLs), which are health protective drinking water standards to be met by public water systems; and
- SWRCB drinking water notification levels, which are health-based advisory levels for nonregulated chemicals in drinking water without MCLs.

The concentrations of the following constituents exceeded the MCLs or notification levels:

Sampling Unit (SU)	Maximum Contaminant Level (MCL)	Notification Level
Groundwater	Benzene 1,2-Dichloroethane cis-1,2-Dichloroethene Ethylbenzene Tetrachloroethylene$^{\text{Note 1}}$	tert-Butyl Alcohol sec-Butylbenzene n-Butylbenzene Naphthalene n-Propylbenzene 1,2,4-Trimethylbenzene

Note [1] Tetrachloroethene (PCE) was not detected at a concentration above the commercial/industrial groundwater SL in any groundwater sample. In only one sample, PCE was detected at 7.7 µg/L, which slightly exceeds the residential groundwater SL of 3.2 µg/L. This grab groundwater sample was collected at 62 feet bgs at boring location AN-20. PCE is generally not a typical constituent of concern at former petroleum sites and there are no known sources of PCE onsite. Additionally, PCE was not detected in soil or soil vapor samples collected at the Site. Since PCE was not detected in multiple media and was only detected at low concentrations in deep groundwater, the PCE in groundwater is not related to former Site uses.

5.0 EAST AREA HUMAN HEALTH RISK ASSESSMENT

A Human Health Risk Assessment (HHRA) was conducted for the East Parcel, where prior investigation data indicate that subsurface impacts are relatively minor. The complete HHRA document is provided in Appendix E. A summary of the analysis conducted and results are summarized below.

Based on previous Site investigations, the following chemical compounds were evaluated in the HHRA:

- Metals;
- Total petroleum hydrocarbons (TPH); including oxygenates and carbon ranges);
- Volatile organic compounds (VOCs); and
- Polycyclic aromatic hydrocarbons (PAHs).

Based on current and likely potential future uses at the East Parcel, the following hypothetical human receptors were evaluated in the HHRA:

- Hypothetical Onsite Construction/Utility Trench Worker Receptor; and
- Hypothetical Onsite Commercial/Industrial Worker Receptor.

The following sections summarize the results of the HHRA.

5.1 Arsenic

In soil from 0 to 10 feet bgs, arsenic was detected at a concentration above the Southern California regional background arsenic concentration of 12 milligrams per kilogram (mg/kg) in 7 of the 27 soil samples. At these 7 locations, arsenic concentrations at the 1 foot bgs depth were below 12 mg/kg. The arsenic concentrations above 12 mg/kg were at 5 and 10 feet bgs, indicating likely background concentrations. Generally, direct contact with soil will occur in the top foot of soil, except under construction exposure scenarios. Although arsenic has been detected at depth at concentrations above the regional background of 12 mg/kg, there is no known subsurface source. Additionally, arsenic concentrations are below background near the surface and the 95-percent upper confidence limit of the mean concentration (95UCL) for arsenic in soil is 12 mg/kg. Therefore, arsenic in soil at the East Parcel is likely background, not related to previous Site use, and does not pose a risk above background to potential onsite receptors.

5.2 Lead

The maximum detected concentration of lead in soil does not exceed the Office of Environmental Health Hazard Assessment (OEHHA) commercial/industrial California Human Health Screening Level (CHHSL) of 320 mg/kg (OEHHA, 2009).

5.3 Other COPCs

For the remaining chemicals of potential concern (COPCs) in soil and soil vapor, the estimated hazard indices (HIs) and excess cancer risks for the potential human receptors are summarized in the following table:

Hypothetical Receptors			
Onsite Construction/Utility Trench Worker		Onsite Commercial/ Industrial Worker	
Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
2	3×10^{-7}	0.3	7×10^{-6}

The following bullets summarize the soil and soil vapor COPCs contributing to HI and excess cancer risk estimates for each receptor.

Hypothetical Onsite Construction/Utility Trench Worker

- Although the total HI exceeds one, the individual HIs for each COPC in soil do not exceed one. Cobalt, nickel, thallium, and vanadium in soil are the primary contributors to the elevated HI. However, the primary critical effects of cobalt, nickel, thallium, and vanadium toxicity do not include the same target organ or system. Since individual HI estimates do not exceed one and the highest individual HIs are not associated with a primary critical effect on the same target organ or system, the COPCs do not pose adverse noncancer effects to the hypothetical onsite construction/utility worker receptor.
- The total excess cancer risk is less than the most stringent end of CalEPA's risk management range of 1×10^{-6} to 1×10^{-4} and is less than 1×10^{-5}, which is generally acceptable for occupational exposures. Therefore, COPCs do not pose a risk to the hypothetical onsite construction/utility trench worker receptor.

Based on the exposure pathways evaluated and the conservative upper-bound assumptions used in this HHRA, potential exposure to Site-related COPCs do not pose an unacceptable human health risk to hypothetical onsite construction/utility trench worker. Furthermore, it should be noted that although hypothetical construction/utility trench worker receptors are included in the HHRA, any hypothetical construction worker receptor will be performing activities consistent with a Site Management Plan (SMP) and a Site Health and Safety Plan (HASP). The SMP, HASP, and best management practices (BMPs) will protect construction worker receptors from exposure to Site-related contaminants.

Hypothetical Onsite Commercial/Industrial Worker

- The total HI does not exceed one; therefore, the COPCs do not pose adverse noncancer effects to the hypothetical onsite commercial/industrial worker receptor.

- The total excess cancer risk is within CalEPA's risk management range and is less than 1 x 10^{-5}, which is generally acceptable for occupational exposures. Therefore, COPCs do not pose a risk to the hypothetical onsite commercial/industrial worker receptor.

Based on the exposure pathways evaluated and the conservative upper-bound assumptions used in this HHRA, potential exposure to Site-related COPCs do not pose an unacceptable human health risk to hypothetical onsite commercial/industrial worker receptors.

5.4 Further Considerations and Conclusions

Administrative and institutional controls will be implemented prior to development of the East Parcel, as required in the California Land Reuse and Revitalization Act Agreement (CLRRA) prepared for the Site. Expected controls include a land use covenant (LUC) and Site Management Plan (SMP). The LUC will prohibit use of underlying groundwater and prohibit unrestricted or sensitive land uses.

Based on results of the HHRA, combined with the administrative and institutional controls planned for the Site, remedial actions are not warranted at the East Parcel prior to development of the Site for industrial/commercial purposes.

6.0 INITIAL RESPONSE ACTION TECHNOLOGY SCREENING

Response actions were developed for the former Chemoil site through evaluation of technologies and process options that are effective, implementable, and have reasonable costs to address site contamination and mitigate potential risks. Established technologies that through past successful use are often referred to as presumptive remedies were identified and screened against General Response Actions (GRAs) to reduce the number of technologies to be carried forward for further analysis. These technologies were then screened against criteria to determine which alternatives would be retained for further evaluation and consideration. This section provides details and results of this initial technology screening process.

6.1 General Response Actions for Contamination in Soil and Groundwater

GRAs are categories of remedial actions that are applied toward the remediation of contaminated sites. This Response Plan has considered the following GRA alternatives:

- No further action;
- Destruction or detoxification of contaminants through alteration of their molecular structures and/or through neutralization;
- Separation, concentration, or volume reduction;
- Immobilization of hazardous substances through changing the physical state of the contaminant or contaminated media;
- On-site or off-site disposal, isolation, or containment at an engineered facility designed to minimize the future release of hazardous substances, pollutants, or contaminants and in accordance with applicable regulations; and
- Institutional and Engineering controls (IECs) to restrict access and/or long-term monitoring to assess changes in contaminant distribution over time.

The GRAs presented above form the basis for identifying technology types and process options for the Site, which are subsequently screened for effectiveness, implementability, and practicality (cost) as detailed in Section 6.3.

6.2 Remedial Action Objectives

The response actions that have been considered for the Site are intended to meet the following Remedial Action Objectives (RAOs):

- Reduce and/or maintain human health risks to acceptable levels to allow redevelopment of the Site for light industrial/commercial purposes;

- Prevent soil-related exposures (i.e., incidental ingestion, direct dermal contact, particulate inhalation and outdoor vapor inhalation of VOCs) to constituent concentrations exceeding commercial/industrial screening levels;
- Prevent indoor inhalation as a result of potential vapor intrusion of constituent concentrations exceeding commercial/industrial screening levels;
- Reduce the potential for adsorbed-phase petroleum constituents in soil to leach to groundwater underlying the Site;
- Remove to the extent practical, mobile light, non-aqueous phase liquid (LNAPL) within the three defined LNAPL areas of occurrence; and
- Control the dissolved-phase hydrocarbon groundwater plume to prevent further offsite migration of contaminants at concentrations above levels that present a risk.

6.3 Initial Response Action Screening

Potential response actions were identified based on the media of concern (soil, soil vapor, and groundwater), the physio-chemical properties of the contaminants, and experience or review of publicly available information regarding the effectiveness of these remedies at other sites with similar affected media and contaminants. Response actions were screened against the following criteria:

- Implementability;
- Effectiveness; and
- Relative Cost.

The results of the screening are presented below and summarized in Table 6-1.

6.3.1 Overall Site Management Response Action Options

6.3.1.1 No Action

This response action requires that no further activity be performed at the site, including remediation or periodic soil and groundwater monitoring. Over time, total petroleum hydrocarbon (TPH) contaminants will naturally attenuate. This option will not be effective in removing exposure pathways, preventing migration of site contaminants, and/or minimizing short- and long-term impacts to surrounding communities and the environment. Additionally, this alternative will not be administratively feasible since it is highly unlikely that approvals will be obtained from Los Angeles RWQCB, or members of the community. Based on these reasons, this response action will not be carried forward for further evaluation.

6.3.1.2 Institutional and Engineering Controls

This response action utilizes institutional and engineering controls (IECs) to prevent completed exposure pathways between contaminated media and potential receptors. Specific to conditions at the Chemoil site, this would include administrative prohibitions of certain uses or construction of engineered features at the site that would minimize exposure of potential receptors to contaminated media. Such actions may include the physical separation of subsurface COCs from potential receptors (by capping with structural improvements or clean imported soils, and the use of engineered barriers to prevent vapor migration into building spaces). Administrative controls can include placing constraints on the property deed, such as a uniform environmental covenant, and/or preparation and implementation of an Environmental Hazards Management Plan (EHMP). Due to the contaminant concentrations detected and the environmental hazards evaluated, this response action alone would not meet the RAOs. However, use of IECs in conjunction with other response actions is common and therefore this response action was retained for further evaluation.

6.3.1.3 Monitored Natural Attenuation

MNA is a process in which soil and/or groundwater is sampled at specified intervals to monitor and measure the natural attenuation of site contaminants. Long term monitoring is included as a component of monitored natural attenuation. TPH contaminants attenuate by multiple mechanisms including biodegradation, geochemical degradation, transport and dilution, diffusion, and volatilization. Trends in contaminant concentrations are plotted and monitored to determine if contaminant plumes are stable, contracting, or expanding. Due to the presence of LNAPL, and relatively high contaminant levels in site soil, MNA alone is not considered applicable to the existing site conditions. However, MNA is a standard approach for the remediation of groundwater and could be combined with other retained response actions. Based on its ease of implementation and relatively low cost, MNA is retained for further evaluation.

6.3.2 In-Situ Treatment Response Action Options

6.3.2.1 Air Sparging

Air sparging is a process whereby pressurized air is injected into the saturated zone to enable adsorbed or dissolved-phase hydrocarbons to volatilize into vapor-phase hydrocarbons. Implementation of air sparging requires use of a soil vapor extraction (SVE) system to mitigate any potential vapor intrusion issues resulting from volatilization of contaminants from groundwater into soil vapor. Air sparging is a proven technology for the remediation of dissolved phase TPH in groundwater and is often a technology of choice for sites such as Chemoil.

Air sparging works best in uniformly sandy soils, where there are relatively few if any preferential pathways for air migration. These are the predominant subsurface conditions in the impacted saturated zone at the Chemoil site. Based on its relatively lower cost and ease of implementability, as well as demonstrated previous success at the site, air sparging is retained for further evaluation.

6.3.2.2 Bioventing

Bioventing delivers oxygen (air) into the subsurface to stimulate natural biological degradation of the hydrocarbons. The process is especially effective for TPH contaminants. The remedial technique is frequently implemented as a separate technology by injecting low pressure air into the vadose zone to create aerobic conditions which stimulates microbial organism populations which then feed on the hydrocarbons, decreasing toxicity through biological degradation that converts TPH to carbon dioxide and water. When soil vapor extraction is implemented on a TPH impacted site (see below) this effect is accomplished by air from the atmosphere which replaces soil vapor as it is extracted from the vadose zone. This option is retained for further evaluation.

6.3.2.3 Chemical Oxidation

In-situ chemical oxidation is a process by which TPH contaminants are degraded through chemical means into carbon dioxide and water. Contaminants in upper groundwater and in the capillary fringe (smear zone), could be destroyed via in-situ chemical oxidation using ozone. The most common method of forming ozone for in-situ oxidation is concentration of oxygen in atmospheric air and transformation of a portion of the oxygen into ozone. This process produces a mixture of approximately 10% ozone and 90% oxygen. The injected ozone quickly decomposes TPH contaminants while the oxygen is available to support aerobic biodegradation of TPH contaminants. Oxygen is also available to migrate vertically into the smear zone as well as the vadose zone to support aerobic biodegradation in these areas. Ozone is a short-lived compound and produces no secondary by-products other than carbon dioxide and water. A complete aerobic biodegradation also produces only carbon dioxide and water, thus both processes are considered benign. The primary drawbacks with in-situ chemical oxidation include:

- Requires a WDR permit from RWQCB (general permit);
- May impact solubility of naturally present metals, including hexavalent chromium;
- The need for direct contact between oxidant and contaminant; and
- The technology is significantly more expensive than air sparging.

Based on these concerns, in-situ chemical oxidation is rejected but may be considered at a later date if the preferred response actions prove to be ineffective during implementation.

6.3.2.4 Soil Vapor Extraction

SVE is a process whereby a vacuum blower connected to vertical or horizontal vadose zone wells is used to induce vacuum in subsurface soils and remove in-situ soil vapor for treatment of the contaminants above ground. Significant quantities of more volatile TPH contaminants can be removed via SVE thus decreasing the time necessary to reduce contaminant. SVE is often used in combination with air sparge systems to remove VOCs resulting from volatilization of contaminants from groundwater into soil vapor. SVE has already been implemented at Chemoil associated with the subsurface metabolism enhancement (SME) system and a significant contamination mass has been removed.

Short-term soil vapor monitoring is a component of this remedy to document soil vapor conditions during active remediation. Monitoring will occur where contaminants in unsaturated soils are expected to be affected by active remediation. Short-term monitoring will be designed to assess the short-term effectiveness of active remediation.

The primary drawback associated with SVE is the cost of vapor treatment, although this cost is considered moderate compared to other options. Based on its relatively lower cost, ease of implementability, and effectiveness at meeting RAOs, SVE is retained for further evaluation.

6.3.2.5 Thermally Enhanced Soil Vapor Extraction

Thermally enhanced SVE is similar to standard SVE except that heat is applied to the soil profile to increase TPH volatilization and removal. Heat is typically applied by electrical resistivity (using arrays of metal cathodes and carbon anodes) or by steam injection. SVE wells placed in and around the thermal injection points to remove volatized COCs. Theoretically, the addition of thermal energy to the soil expedites contaminant volatilization and subsequent extraction, resulting in shorter cleanup times. There are a number of drawbacks associated with thermally enhanced SVE including energy consumption (either electricity of natural gas) which is remarkably high for a large site like Chemoil.

Electro-resistivity thermal enhancement has been most effective in fine grained materials; while the Chemoil site is predominantly coarse grained sediments. Additionally, experience with many previous thermal projects have often indicated through life-cycle cost analyses that standard SVE would have achieved cleanup for significantly less cost than thermally enhanced SVE. Based on these concerns, thermally enhanced SVE is excluded from further evaluation.

6.3.2.6 Light, Non-Aqueous Phase Product Removal

LNAPLs have been observed at several locations within the Chemoil site. Given that these deposits will continue to act as a “source” for dissolved phase TPH entering groundwater for an extended period of time, removal or reduction of the mass of LNAPL to the extent practical is necessary. During the site characterization field investigations, it was observed that the LNAPL is primarily heavy hydrocarbons and recharge into wells after removal was relatively slow. There are several technological approaches available to remove LNAPL from the surface of the water table while minimizing the removal of groundwater. These techniques can greatly reduce the overall mass of fluids being extracted and then requiring treatment. As the LNAPL will be a persistent source of TPH impacts, removal of LNAPL through passive skimming or other extraction methods that preferentially remove TPH is retained for further evaluation.

6.3.3 Ex-Situ Treatment Response Action Options

6.3.3.1 Groundwater Extraction and Treatment

Groundwater extraction through multiple pumping wells distributed over a property and subsequent above ground treatment has been used at many sites for a wide range of contaminants. Experience at many locations has demonstrated that “pump & treat” for many impacted sites is generally considered to be less effective than other approaches (Keely, 1989; MacKay & Cherry, 1989; Voudrais, 2001). This has been found true for TPH impacted sites due to the low solubility of TPH constituents and the propensity for TPH to adsorb to soil particles.

Given the above, it is anticipated that groundwater extraction and treatment would not be able to achieve RAOs within a reasonable cost, and could result in significant negative impacts to the aquifer by inducing salt water intrusion related to the removal of large volumes of groundwater. Consequently, site wide groundwater extraction and treatment of the COCs is excluded from further consideration.

6.3.3.2 Excavation and Off-Site Disposal/Treatment

Excavation and off-site treatment/disposal has been successfully used since the inception of site cleanups as reliable and often cost-effective means of removing contamination from an affected site. Soil is removed using excavators and other heavy equipment. Removed soil is placed in haul trucks and transported to an off-site treatment facility or landfill. The primary advantage of excavation and off-site treatment/disposal is the permanence of the remedy and relatively short time-frame needed for implementation. The primary concerns with this response action are the high capital cost, the associated emissions of greenhouse gases during transport, and the potential safety liabilities associated with the required hundreds of truck trips necessary to remove all contaminated soil and to import clean soil for backfill. Other concerns include the short-term impacts associated with the implementation of this remedial action, as well as the effects and administrative feasibility associated with moving a portion of the impacted soil to a landfill. Although there are significant concerns, particularly with the elevated costs, this remedial action was retained for further evaluation.

6.3.3.3 Excavation and On-Site Biologic Treatment

Excavation and on-site treatment/disposal is the presumptive remedy for treatment of TPH impacted soil in California. Soil is removed using excavators and other heavy equipment and removed soil is transported to an on-site treatment area instead of off-site as indicated in the off-site disposal option, above. The primary concerns with this response action are the high capital cost requirements associated with excavation and the logistics of treating soil on-Site. Other concerns include the short-term impacts (particularly on surrounding residents) associated with the implementation of this remedial action. Due to the fact that the entire property is expected to be developed, there is not a suitable, large area that could serve as the on-site treatment location. Although this lack of space could be addressed by phasing the grading and excavations over several portions of the property, the extended time frame of using that approach significantly increases costs and time to complete remediation. Based on space limitations and other logistical issues, this response action is excluded from further consideration.

6.4 Retained Response Actions

Table 6-1 summarizes the results of the initial screening of response action technologies that were considered. As indicated, the following treatment alternatives were retained for consideration for the indicated media at the Site:

Groundwater

- Air Sparging (combined with SVE)
- LNAPL removal
- Monitored natural attenuation

Soil/Soil Vapor

- SVE
- Bioventing (Note: bioventing is considered a secondary remedial response due to SVE implementation and is not evaluated as a separate response action beyond initial screening).
- Excavation and offsite disposal

Overall Site Management

- Institutional and Engineering Controls

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7.0 DETAILED ANALYSIS AND SELECTION OF PREFERRED RESPONSE ACTIONS

Remedial response actions that passed the initial screening process described in Section 6.0 were considered for further evaluation. A total of six response action technologies were evaluated to determine their suitability for use at this site based on the following nine criteria (USEPA, 1988):

- Overall protection of human health and the environment.
- Compliance with applicable or relevant and appropriate requirements (ARARs). For this evaluation, ARARs were considered to be the RAOs defined in Section 6.2.
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, and/or volume (TMV) through treatment;
- Short-term effectiveness;
- Implementability;
- Cost;
- Regulatory agency acceptance; and
- Community acceptance.

Results are summarized in Table 7-1 and the sections that follow. Estimated capital and annual operating costs for each of the alternatives are provided in Table 7-2.

7.1 Groundwater Response Actions Alternatives

7.1.1 Alternative 1: Air Sparging

Air sparging was ranked “moderate” to “good” against the evaluation criteria. Costs to implement are considered moderate and it is anticipated that installation and startup of an air sparge system could be completed relatively quickly. The injection of air to volatilize TPH contaminants in the saturated zone is a commonly applied technology and permitting of this process is anticipated to be straightforward and not excessively time consuming. However, given the presence of LNAPL onsite, air sparging is not recommended across the Site due to the potential of mobilization and spreading of the LNAPL.

Air sparging could be utilized along the Site boundary, where LNAPL is not present, to reduce groundwater contamination from migrating off the property (this technology is referred to as an air sparge barrier). This response action would minimize the further impacts to groundwater downgradient from the property. Installation would be moderately easy to implement and some of the wells and/or infrastructure of the existing SME system may be used.

The following concerns or issues were identified with using an air sparge barrier to treat groundwater:

- Source areas would not be treated. At a minimum, a method to remove LNAPL from source areas on-Site would be required in conjunction with an air sparge barrier approach;
- Soil vapor concentrations would increase during operation of the air sparge system as a result of volatilization of contamination from groundwater to soil vapor. This issue could be addressed via the use of SVE to control vapor migration; and
- Air sparging would remove volatile contaminants within the saturated zone but would not likely reduce the volume of heavier hydrocarbon (although the volume of heavy hydrocarbons mobilizing off-site is considered to be very low). A benefit of air sparging would be the addition of oxygen into the subsurface which would promote the biodegradation of the heavier hydrocarbon constituents; however, this process generally occurs over longer period of time.

A remedial approach should be considered using an air sparge barrier along the Site boundary in combination with source area removal (i.e. LNAPL recovery and/or installation of vapor barriers beneath future buildings) and downgradient groundwater monitoring. Following the removal of LNAPL to the extent practical by other remedial measures (bailing/skimming), air sparging may be utilized within the source areas at a later date.

7.1.2 Alternative 2: Light, Non-Aqueous Phase Product Removal

LNAPL removal was ranked “moderate” to “good” against the evaluation criteria. Costs to implement are considered low and it is anticipated that installation and startup of an LNAPL removal system could be completed relatively quickly. In addition, these systems are effective in slanted wells, so the LNAPL removal could be incorporated into site development underneath future buildings. Although previous efforts to bail LNAPL from wells has demonstrated the product is viscous and slow to recharge into the well after removal, the recommended system can be operated on a timer, to reduce operation when the well is potentially empty.

The following concerns or issues were identified with using LNAPL recovery to treat groundwater:

- The removed LNAPL would need to be temporarily stored on-site. The storage area would need to be protected from potential damage or vandalism and spill prevention measures put into place;
- The stored LNAPL would need to be periodically collected for transport to a local recycling facility, and site development would need to include accommodation of this product transfer and transport off-site; and
- Dissolved phase groundwater concentrations beneath the site would not be treated with the LNAPL recovery system. Additional response actions, including the addition of a vapor mitigation system beneath future buildings would be needed to negate vapor intrusion concerns from future on-site workers. Additional response actions would be needed to prevent further migration of dissolved phase constituents offsite.

7.1.3 Alternative 3: Monitored Natural Attenuation

MNA was ranked “poor” to “good” against the evaluation criteria. Costs to implement are considered low; however, given the presence of LNAPL beneath the site, the likelihood of regulatory acceptance for MNA across the entire site is low. As discussed in prior reports (Apex-SGI, 2017) existing concentrations in offsite groundwater do not pose a vapor intrusion concern. With the implementation of onsite actions, downgradient offsite concentration area expected to further decrease over time. MNA should be retained and be implemented for the downgradient portion of the groundwater plume in combination with other Response Actions implemented onsite.

As a component of MNA, long-term groundwater monitoring will be conducted to document groundwater conditions and establish groundwater contaminant trends over time.

7.2 Soil and Soil Vapor Response Action Alternatives

7.2.1 Alternative 4: Excavation and Off-site Disposal

Excavation and off-site disposal of soil was ranked “moderate” to “very good” against the evaluation criteria. Costs to implement this approach is very high, estimated at $9,489,200 for the top ten feet. vadose zone soil. This cost does not account for remediation of vadose zone soil below ten feet. Due to the unreasonable cost, this option was discarded from further consideration.

It is understood that during earthwork for grading and foundation or utility installation there is a high potential that some soils will be required to be excavated and off hauled during property redevelopment. A Soil Management Plan to provide guidance for handling potentially impacted soil during redevelopment activities has been provided and is included as an Appendix to the Response Plan.

7.2.2 Alternative 5: Soil Vapor Extraction

SVE was ranked “moderate” to “good” against the evaluation criteria. Costs to implement are considered moderate. All equipment for this alternative is readily available from commercial vendors, and it is anticipated that installation and startup of an SVE system could occur relative easily.

The following concerns or issues were identified with using SVE to treat soil and soil vapor:

- Weekly O&M activities would be required to keep the system functioning and additional maintenance costs would be accrued as the system components continue to age.
- The infrastructure of the SVE system would need to be accommodated in site development.
- Although SVE is an effective method to treat the volatile compounds present in the vadose zone, such as benzene, it has limited effectiveness in removing heavier, less volatile petroleum-related constituents from soil. However, the heavier less-volatile constituents are less mobile in the environment and pose a lower risk to site occupants and underlying groundwater. Under the proposed conceptual remedial approach, heavier end petroleum

constituents within the vadose zone should be reduced through bio-attenuation as air is distributed through the unsaturated formation (bio-venting).

A Response Action using SVE should be considered to treat the volatile constituents present in soil and soil vapor. However, SVE should be considered in combination with other measures to mitigate concerns due to the presence of less volatile compounds in the vadose zone.

7.3 Overall Site Management Response Action Alternatives

7.3.1 Alternative 6: Implement Institutional and Engineering Controls

The implementation of IEC was ranked “moderate to good”. Implementing institutional and engineering controls (IECs) prior to or during vertical construction of the site can successfully meet several of the RAOs identified for the Site. IECs which are planned for the site and required under the approved California Land Reuse Revitalization Act (CLRRA) Agreement include:

- Preparation of an environmental land use covenant (LUC) and associated Site Management Plan (SMP). The LUC will prohibit use of underlying groundwater, prohibit unrestricted or sensitive uses, and require that all uses and development of the site will be consistent with an SMP, acceptable to the Los Angeles RWQCB. The LUC will run with the property should the property be sold in the future; and
- Installation of a vapor mitigation system installed as part of all future buildings constructed on the site.

In addition, planned development of the site includes construction of buildings and/or asphalt paving over more than 90% of the site, which effectively provides a barrier for human and ecological contact with the shallow soil. Areas that are neither paved or covered will a structure will be called with clean, imported fill soil.

Although implementation of IECs will not lessen the toxicity of contaminants in the subsurface, IECs are an effective measure to control potential exposure pathways in the future and should be considered along with other Response Actions.

7.4 Selection of Preferred Response Action

Based on the detailed analysis described above of response actions that passed the screening criteria, a number of remedial technologies were combined to create the preferred remedial approach for the Site. In summary, the following response actions were selected as the most suitable and cost effective alternatives for the Site:

Proposed Groundwater Treatment Technologies:

1. Implement source area LNAPL removal with off-site disposal;
2. Operate an air sparge barrier at the property boundary; and
3. Implement a downgradient monitored natural attenuation (MNA) program.

Proposed Soil and Soil Vapor Treatment Technology

4. Operate an on-Site soil vapor extraction system focused on treatment in the deeper, more porous section of the vadose zone; and
5. Use engineering and institutional controls to mitigate contaminants in the shallower, less porous section of the vadose zone.

Proposed Engineering and Institutional Controls

6. "Cap" the Site with building and pavement;
7. Install vapor mitigation system under all future buildings;
8. Restrict on-site land use through an LUC;
9. Prepare SMP associated with the LUC; and
10. Prepare Soil Management Plan for use during property redevelopment.

The table below, summarizes the RAOs identified for the Site and the associated Response Action technologies.

Remedial Action Objective	Proposed Response Action Technologies
Reduce and/or maintain human health risks to acceptable levels to allow redevelopment of the Site for light industrial/commercial purposes.	- Installation of vapor mitigation system under future buildings. - Preparation of an LUC and SMP to restrict and manage on-Site land use. - Preparation and implementation of a Site Redevelopment Soil Management Plan for use during site redevelopment.
Prevent soil-related exposures (i.e., incidental ingestion, direct dermal contact, particulate inhalation and outdoor vapor inhalation of VOCs) to constituent concentrations exceeding commercial/industrial screening levels.	- "Capping" of site by development of buildings and asphalt/pavement over >90% of site to remove ingestion or dermal contact pathways. - Preparation of an SMP
Prevent indoor inhalation through vapor intrusion of constituent concentrations exceeding commercial/industrial screening levels.	- Installation of vapor mitigation system under future buildings.

Reduce the potential for adsorbed-phase petroleum constituents in soil to leach to groundwater underlying the Site.	- Operation of an SVE system to remove contaminant mass to the extent practicable. - Removal of leaching potential by "capping" of site by development of buildings and asphalt/pavement over >90% of Site. - Implementation of a groundwater monitoring program.
Remove to the extent practical, mobile LNAPL within the three defined LNAPL areas of occurrence.	- LNAPL recovery in all LNAPL areas observed at the site.
Control the dissolved-phase hydrocarbon groundwater plume to prevent further offsite migration of contaminants at concentrations above levels that present a risk.	- Installation of an air sparge barrier on the western and downgradient boundary of the property. - Semi-annual monitoring of offsite groundwater.

A remedial approach has been developed for the Site implementing the above Response Actions and is detailed in the following sections of this document. Figure 7-1 provides an illustration of the overall conceptual remedial approach for the Site.

8.0 SOIL AND SOIL VAPOR REMEDIATION SYSTEM DESIGN

SVE has been selected for the treatment of soil and soil vapor beneath the Northwest and Southwest parcels. SVE will be implemented in the more porous sections (greater than approximately 10 feet bgs) of the vadose zone. Mitigation of contaminants in the shallower, less porous section of the vadose zone will be addressed through engineering and administrative controls (discussion in Section 12.2). Figure 8-1 includes the assumed vadose zone treatment area (to be confirmed during Phase I SVE implementation). It is anticipated that SVE system installation and implementation will occur in the following two phases:

- Phase I will occur immediately following LARWQCB approval of this Response Plan and before property redevelopment. Phase I will include the installation and operation of thirteen SVE wells; ten situated on the Northwest Parcel and three situated on the Southwest Parcel (Figure 8-1). The purpose of the Phase I SVE implementation is to begin soil and soil vapor treatment while collecting data that will be needed to prior to implementing SVE throughout the remainder of the Site.
- Phase II will begin approximately 4 – 8 months (depending on the final redevelopment schedule) after start-up of Phase I. It is expected that all underground components (i.e. wells and conveyance piping) required for Phase II SVE implementation will be constructed prior to or during redevelopment of the Site. Phase II SVE will integrate the future redevelopment plan for the Site and is considered the final and full-scale SVE system design.

Further details are provided in the sections that follow.

8.1 Phase I SVE Implementation

Apex-SGI will oversee construction of the SVE system which will be completed by a licensed subcontractor. The SVE system will include SVE wells, soil vapor conveyance piping, and a trailer or skid mounted soil vapor extraction and treatment unit. Further details are provided in the following section.

8.1.1 Well Layout and Design

The first phase of the SVE implementation includes thirteen, 2-inch diameter vapor extraction wells. The approximate locations of the Phase I SVE wells are shown on Figure 8-1. They will be installed on approximately 60-foot centers, to provide a 30-foot radius of influence (ROI). The wells will be constructed using 2-inch-diameter schedule 40 polyvinyl chloride (PVC) well casings and screened from approximately 15 to up to 30 feet bgs with 0.010-inch machined slot. The sand pack will consist of #2/16 Monterey sand or equivalent. The sand pack will extend from the bottom of the borehole to 6- to 12-inches above the top of the well screen in each boring. Two feet of hydrated bentonite will be placed above the sand pack and neat-cement-grout will be placed to the surface. Actual screen depths may be adjusted in the field based on the drill rig geologist’s observations during logging. It is expected that SVE wells installed in the Southwest Parcel will be shallower than the Northwest Parcel due to the difference in depth to groundwater.

8.1.2 Conveyance Piping

SVE piping will not be installed below grade until site grading occurs as part of Site redevelopment. Phase I SVE conveyance piping will be installed above ground using PVC or flexible vacuum hoses with appropriate vacuum pressure rating. Soil vapor from each SVE well will be conveyed to a common aboveground common SVE manifold. The SVE manifold will be constructed of 4-inch diameter, schedule 40 PVC and will convey the combined vapor stream to a vapor extraction and treatment unit.

8.1.3 Vapor Extraction and Treatment Units

It is anticipated that separate mobile SVE units will be used for the Northwest and Southwest parcels during the Phase I SVE operation. The two units will be portable internal combustion engine (IC) type systems. These systems are regulated under SCAQMD “various locations” permits and are permitted to be operated on a temporary basis for up to one year at a site. This temporary operations will provide several goals:

1. The temporary system and various locations permit status will allow rapid initial deployment of the SVE remediation system following LARWQCB approval of this Response Plan;
2. The above ground conveyance piping and portable treatment system will allow easy reconfiguration of the SVE well field as performance information of the first phase of operation is evaluated; and
3. The temporary, above ground lay-out of the system will allow easier repositioning of the conveyance piping once the locations and building foundation designs of the future development is finalized.

A process flow diagram is provided as Figure 8-2. The system will be operated as described below in Section 8.1.4.

8.1.4 Operation and Maintenance

The Phase I SVE and treatment systems will be mobile units which can operate under a various locations permit for up to one year. Each system will complete an initial performance test to demonstrate the system can operate within the permitted conditions. Ongoing operation and maintenance (O&M) will include weekly to biweekly site visits by a technician to record system performance. During O&M visits, the field technician will perform other maintenance functions in addition to monitoring and sampling of the effluent. These activities include:

- Measuring and recording the vapor flow rates from individual wells;
- Measuring vapor effluent (with a PID) from the thermal abatement system to confirm treated vapor discharge is in compliance with permit limits;

- PID monitoring of individual well vapor streams;
- Checking blower lubrication and general inspection of the system mechanical and automated systems to verify satisfactory operation;
- Housekeeping of the compound and well sites; and
- Measuring of liquid level within the vapor-water separator and offsite disposal of the water when necessary.

Analytical samples of the influent and post treatment effluent vapors will typically be collected monthly and submitted to a certified laboratory for analysis. Results of the monthly analysis and system performance are submitted to the SCAQMD by reports quarterly. The reports provide summary of system performance and demonstrate compliance with permit conditions (e.g., effluent contaminant limits) and are certified by a California Professional Engineer.

8.2 SVE System Design Confirmation Tests

During Phase I SVE System Operation, field tests will be performed to verify the adequacy of the 30 foot ROI well spacing design and to determine design parameters for the Phase II system. The following field tests will be conducted:

- Short-term step vacuum tests to develop the relationship between applied vacuum and vapor flow at the SVE wells. Anticipated vacuum levels of 40 inches of water column (in. WC), 80 in. WC, 120 in. WC, and 160 in. WC will be tested; and
- Longer-term constant vacuum tests to develop the ROI as a function of flow rate and applied vacuum; induced vacuums will be monitored at the nearby SVE wells.

8.2.1 Design Confirmation Test Monitoring

During design confirmation test activities, field personnel will monitor pertinent system parameters, including extraction system flowrates and applied vacuums, knock-out pot water level, elapsed blower operation time, electrical usage, and air emissions.

In addition to collection of the field measurements identified above, vapor stream samples will be collected and analyzed to evaluate system performance. Total volatile organics will be measured periodically during the pilot tests using a photoionization detector (PID). In addition, vapor stream samples from the individual SVE wells will be collected in Tedlar® bags for laboratory submittal. At least three extraction well vapor samples will be collected during each constant vacuum test. The samples will be transported under chain of custody to a California-certified hazardous materials testing laboratory and analyzed for TPHg and VOCs using EPA Method 8260B (GC/MS) or equivalent. Field PID readings will also be compared to laboratory analytical results to develop a correlation between field and laboratory data.

8.3 Supplemental On-Site Soil and Soil Vapor Sampling

Figure 8-1 shows the location of the expected soil and soil vapor treatment area, based on available data. During Phase I activities, additional soil and/or vapor sampling may be conducted and data will be used to confirm the extent of the area where treatment is warranted.

8.4 Phase I Implementation Report and Phase II SVE System Workplan

Following completion of Phase I SVE operation, completion of the SVE design confirmation tests, and supplemental On-Site Soil Vapor Sampling, a Final Phase II SVE Design Workplan (Phase II SVE Workplan) will be prepared that presents the procedures and findings. The Phase II SVE Workplan will include the following:

- Documentation of the Phase I SVE system installation, including SVE well locations, drilling permits, boring logs, SVE well construction details, equipment specifications;
- A summary of operation and maintenance activities completed during Phase I system operation, including tabulated analytical and field results, and estimated mass removal;
- Documentation and results of the design confirmation tests completed, including procedures, tabulated field and analytical results, and the estimated ROI of the SVE wells;
- Documentation of any additional soil or soil vapor sampling conducted, comparison of the data to the SLs and a figure showing the treatment area planned for Phase II SVE operation;
- The building layout planned for redevelopment of the Northwest and Southwest areas; and
- The proposed final design for Phase II implementation based on the information bulleted above and integrating the redevelopment plan; and
- An implementation schedule and a monitoring plan for Phase II implementation.

The Phase II SVE Workplan will be reviewed, signed, and stamped by a California Professional Geologist or Engineer.

9.0 GROUNDWATER REMEDIATION SYSTEM CONCEPTUAL DESIGN

Based on the evaluation of response action alternatives, Apex-SGI recommends installing an air sparging/vapor extraction system at the western and southern boundaries of the Site to prevent further migration of petroleum impacted groundwater. The purpose of the air sparge system is to remove the volatile compounds from groundwater and to increase the dissolved oxygen content in the groundwater, thereby enhancing aerobic biodegradation of the downgradient petroleum constituents. In addition, a LNAPL remove system was selected as the preferred response action to remove secondary sources of LNAPL that are present in the subsurface. A conceptual design is presented in the sections that follow.

The final design will be completed following LARWQCB approval of this Response Plan and pending the following information:

- Installation and sampling of the three new offsite groundwater monitoring wells, as discussed in Section 3.7;
- An evaluation of the existing SME system to determine whether any components are adequate for conversion for use as part of the air sparge system; and
- Completion of an air sparge pilot test to determine design parameters for the system.

Further details are provided in the sections that follow.

9.1 Air Sparging System for Groundwater Treatment

Currently, a flow-through barrier groundwater treatment system (the SME system) is operating along the western and southern boundaries of the Site. The air sparging system will be installed to replace the SME system and will be installed in a similar location as the SME system. The SME system layout is shown on Figure 9-1 and includes the subsurface following components

- 92 nutrient injection points constructed using 0.75-inch diameter, Schedule 40 PVC blank and 0.020-inch screen slot material. The screened intervals are 5 feet long place approximately 5 feet above the groundwater level;
- 46 gas extraction wells constructed using 1-inch diameter, Schedule 40 PVC blank and 0.020-inch screen slot material. The screened intervals are 5 feet long place approximately 5 to 8 feet above the groundwater level; and
- 92 air injection points constructed using 0.25-inch diameter, nylon tubing connected to a 6-inch long, stainless steel screened air injection point. The air injection points are installed approximately 6 to 8 feet below the groundwater level.

A field evaluation of the above will be made to determine whether any components are adequate for conversion for use as part of the air sparge system. At a minimum, it is expected that new air sparging wells will be required, however the existing gas extraction wells may be adequate for vapor abatement. It is anticipated that the vapor extraction wells will connected to the same SVE system(s) described in Section 8.0.

9.1.1 Field Pilot Testing

Prior to full-scale implementation, an air sparge field pilot tests be performed to gather information to design the air sparging and vapor abatement system. The proposed pilot tests are discussed in detail in the following sections.

9.1.1.1 Installation of Air Sparge Points

As mentioned earlier, a field inspection will be conducted to evaluate use of the existing SME components for conversion to an air sparge system. It is anticipated that new air sparge wells will be needed however the existing gas extraction wells may be used. Three air sparge points will be installed to facilitate field pilot testing. Wells will be placed in order to take advantage of the use of the existing vapor extraction wells and groundwater monitoring wells currently located in the SME barrier. The air sparge points will be constructed of one-inch diameter, schedule 40 PVC. The total depth and screen interval will be determined upon completion of the vertical delineation well installation and sampling discussed in Section 3.7. A threaded cap will be placed on the top and bottom of the casing. Silica sand will be placed in the annulus of the borehole to one foot above the screen. A minimum, ten-foot thick bentonite seal will be placed on top of the filter pack and the remainder of the annulus will be filled with cement slurry.

9.1.1.2 Air Sparge Pilot Test

The purpose of the air sparge pilot test is to determine the radius of influence the air sparge points and vapor abatement wells. This information will be utilized to determine the optimal spacing of the AS points. The radius of influence will generally be defined as the distance from the AS point at which “mounding” of the groundwater is observed and/or significant increases in dissolved oxygen (DO) are measured. Localized mounding of the groundwater around the air sparge point during sparging is expected to occur as a result of air displacing water from the soil matrix in the saturated zone. Air will be injected into each sparge point at a rate of approximately three cubic feet per minute using an n oil-less air compressor. The depth to groundwater and DO will be measured and recorded prior to, and during the pilot test using electronic meters. The pilot test will be terminated once these parameters have stabilized.

9.1.2 Air Sparge System Design Report

An air sparge barrier design report will be submitted summarizing the result of the pilot test and providing design specifications for the full-scale air sparge system.

9.1.3 VOC Abatement

As is typical with this approach, and as mentioned earlier the air sparge system will be utilized in conjunction with a vapor extraction system for vapor recovery of the volatilized compounds. Vapors that are extracted by the vapor extraction system will routed to the SVE system described in Section 8. The Air Sparge System Design Report mentioned in Section 9.1.2 will include the detailed design of the air sparge vapor abatement system.

9.2 Liquid Non-Aqueous Phase Liquid Removal

LNAPL has been identified at two locations under the property (See Figure 8-4). Additional locations may be identified during installation of the remediation well field. LNAPL removal was identified during the Remedial Technology Evaluation as necessary RAO to reduce the source of groundwater impacts and to reduce additional dissolved phase TPH entering groundwater.

Given the relatively high viscosity of the LNAPL encountered and the slow recharge of LNAPL into a well after the product was removed as part of the Site Characterization study, equipment has been selected to allow automatic removal of the LNAPL as it enters the local well. The removed product will be temporarily contained at the site surface and periodically transferred from the surface containment to a hazardous waste licensed transport vehicle for delivery to a local petroleum recycling facility. All transportation of TPH will be done under hazardous waste manifest.

It is anticipated that removal of LNAPL will begin as soon as practical, after the approval of the Response Plan. LNAPL removal is anticipated to continue post site development, until the reduction of LNAPL within the well becomes impractical. To expedite the initial removal and provide a relatively simple removal technology with the goal of minimizing system maintenance; a subsurface skimmer system utilizing an aqua-phobic belt skimmer (similar to the Ambar™ sub-surface hydrocarbon removal system, or equivalent) will be installed at a well located within each LNAPL deposit identified within the site. Figure 9-2 provides a schematic design of the oil skimmer and surface storage technology.

10.0 GROUNDWATER MONITORING PLAN

The current groundwater monitoring program is conducted pursuant to the LARWQCB letter dated June 7, 2013 (LARWQCB, 2013). Groundwater monitoring is conducted semi-annually, typically in June and December each year, as summarized in the following table. Groundwater monitoring well locations are shown on Figure 2-1.

Event	**Wells Sampled**	**Analysis**
Quarter 1/Quarter 2 Semi-Annual Event	MW-8, MW-9, MW-11, MW-12, MW-14, MW-15, MW--16, MW-17, MW-19, BMW-2, BMW-5, BMW-8, and BMW-11	VOCs (including fuel oxygenates) by EPA Method 8260B TPH, including TPHg and TPHd by EPA Method 8015M SVOCs by EPA Method 8270C
Quarter 3/Quarter 4 Semi-Annual Event	MW-1, MW-1A, MW-2, MW-3, MW-8, MW-9, MW-10, MW-11, MW-12, MW-13, MW-14, MW-15, MW-16, MW-17, MW-18, MW-19, BMW-2, BMW-5, BMW-8, and BMW-11	VOCs (including fuel oxygenates) by EPA Method 8260B TPH, including TPHg and TPHd by EPA Method 8015M SVOCs by EPA Method 8270C

It is expected that the on-Site well network will be modified during redevelopment activities to compensate for the future building footprints. Apex-SGI will submit a long-term on-Site monitoring program with proposed well locations once the redevelopment plan is finalized. In the meantime, the current groundwater monitoring program will be implemented.

10.1 Offsite MNA Program

As detailed in Section 7.1.3, MNA is proposed for the offsite area downgradient from the Site. An MNA monitoring program is provided in Appendix F.

11.0 SITE REDEVELOPMENT SOIL MANAGEMENT PLAN

As a component of site redevelopment, grading and potential excavation of the Site will be required to assure that geotechnical parameters within the near surface soil are achieved and/or for the establishment of underground utility trenches. A Site Redevelopment Soil Management Plan was prepared to provide guidance for handling potentially contaminated soil, should it be entered. The Site Redevelopment Soil Management Plan provides management and workers with procedures for internal and agency notifications; excavation/grading oversight; air and safety monitoring; soil segregation and monitoring; soil sampling and analysis; waste characterization and profiling; waste recycling and disposal procedures; and record keeping and reporting procedures in areas of known or encountered impacts. A copy of the Site Redevelopment Soil Management Plan is included as Appendix G.

12.0 INSTITUTIONAL AND ENGINEERING CONTROLS

Implementation of IECs were selected as a preferred Response Action for the Site and are required as part of the CLRRA Agreement prepared for the Site.

Expected controls include an environmental LUC and an associated SMP. The LUC will prohibit use of underlying groundwater, prohibit unrestricted or sensitive land uses, and require that all uses and development of the Site be consistent with the SMP. The CCLRA specifies that an SMP will be prepared as part of the Response Plan. As discussed in Section 11, Apex-SGI has included a Site Redevelopment Soil Management Plan as Appendix G. A full SMP for use after redevelopment occurs will be submitted to the LARWQCB at later date, pending the completion of the building layout and final redevelopment plan and prior to vertical development of each portion of the property.

Engineering controls that will be included as a requirement of the SMP will include vapor mitigation system(s) that will be installed as part of the future buildings constructed for the Site. Activity use limitations, such as controls for certain activities like excavation, will be included as part of the SMP along with requirements that mitigation measures are inspected and maintained.

Further details are provided below.

12.1 Institutional Controls

Institutional controls will include an SMP that will set forth all mitigation measures, including engineering and institutional controls and activity and use limitations (such as controls for certain site activities, such as excavation), as may be required to protect human health and the environment after the Response Plan has been implemented. The SMP will provide specific procedures for performing intrusive activities (such as excavation) including monitoring for air emissions. The SMP will also specify engineering controls that are required at the site. Inspections and maintenance of engineering controls will also be described and a recommended schedule for performing these activities will be included.

Institutional controls will include an LUC that limits current and future use of the Site to commercial and/or industrial use only. The LUC will run with the property should the property owner decide to sell the property in the future. The use restriction could be retracted in the future if the current or a future owner, can show that COCs at the Site have decreased to levels suitable for more sensitive uses (i.e. residential, school, hospital).

An additional condition of the LUC will restrict use of groundwater. No pumping or use of groundwater will be permitted, other than for environmental remediation purposes. Property water needs for irrigation, drinking, washing, or industrial activities will be provided by the local utility service via its closed pipe system.

12.2 Engineering Controls

Engineering controls that will be included in the SMP will include the following:

- Soil capping with clean fill in landscape areas that are not effectively “capped” by future buildings and paved parking areas;
- Vapor barriers (Geo-Seal ™ or equivalent systems) with passive sub-slab depressurization (SSD) will be installed beneath building envelopes to mitigate indoor vapor intrusion. The SSD system will be designed to achieve reduced sub-slab air pressure relative to indoor air pressure, thus enhancing the separation effect of the vapor barrier. The SSD system will consist of several horizontal, perforated pipes placed within a gravel layer beneath the building’s concrete slab. The perforated pipes will be connected to solid pipelines that are routed to the building roof top through walls. Vacuum pressure will be applied to the SSD system by attic turbine ventilators attached to the tops of the closed pipes above the roof line, which will pull accumulated vapors from beneath the building. The complete vapor barrier and SSD design will be finalized as part of the final vertical construction design of the proposed buildings.
- A positive pressure HVAC systems operated in closed environments (offices) to further reduce the potential of vapor intrusion.

The SMP and LUC will be submitted to the LARWQCB within four months of RES acquisition of the property. In addition, RES will submit a vapor mitigation system engineering design and specification plan to LARWQCB a minimum of 60 days prior to installation and construction of the buildings.

13.0 SCHEDULE

A scheduled of planned activities through Site Development is presented below.

Activity	**Target Completion Date**
Submittal of Response Plan	July 14, 2017
LARWQCB Approval of Response Plan	August 14, 2017
RES Acquisition of Property	September 4, 2017
Installation of Offsite additional MNA Wells	September 2017
Redevelopment Design Layout Complete	October 24, 2017
Phase I SVE Implementation	October – December 2017
Evaluation of SME system components, air sparge pilot test, and submit air sparge system design report	September 2017 – December 2017
Installation of wells in LNAPL Areas and install LNAPL removal system	November 2017 – December 2017
Submittal of Site Vapor Mitigation System Design Report	November 1, 2017
Finalize on-site monitoring well network and submit long-term Groundwater Monitoring Plan.	January 2018
Submittal of SMP and LUC	January, 2018
Final Phase II SVE Design Workplan	February 2018
Site Redevelopment Begins (East Parcel)	April 2018
Site Redevelopment Begins (Northwest and Southwest Parcels)	May 2018

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15.0 LIMITATIONS

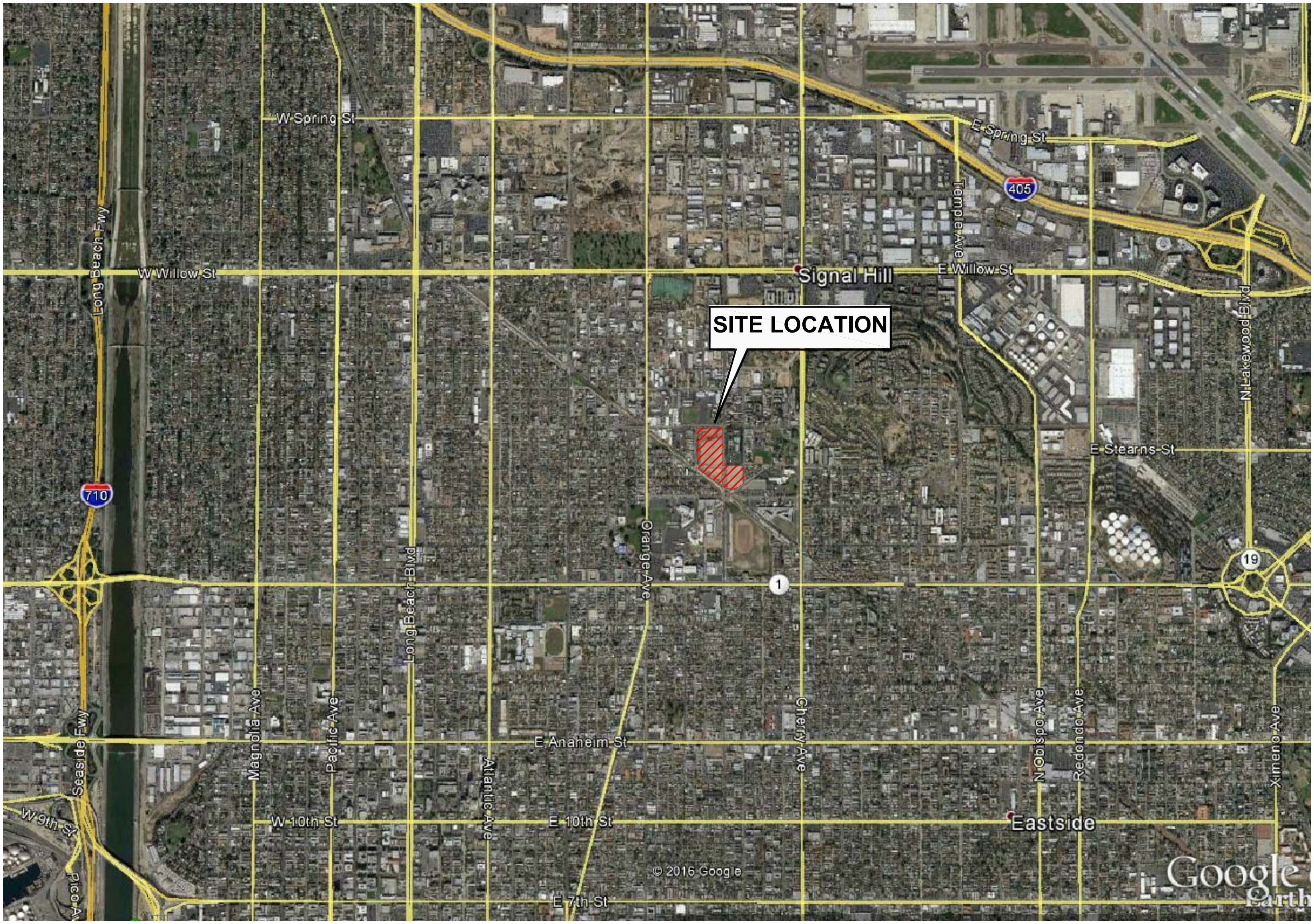
This document has been prepared for the exclusive use of SHE, RES, and their representatives as it pertains to the affected property as described above. Any interpretation of the data represents our professional opinions, and is based in part on information supplied by the client. These opinions and information are based on currently available data and are arrived at in accordance with currently accepted hydrogeologic and engineering practices at this time and location.

The data presented in this transmittal are intended only for the purpose, site location, and project indicated. This report is not a definitive study of contamination at the site and should not be interpreted as such. The data reported are limited by the scope of the work as defined by the request of the client, the time, availability of access to the site, and information passed to Apex-SGI.

There are no representations or guarantees that the sampling points are representative of the entire site. Data collected in response to this work may reflect the conditions at specific locations at a specific point in time and does not reflect subsurface variations that may exist between sampling points. These variations cannot be anticipated nor can they be entirely accounted for even with exhaustive additional testing. No other interpretations, warranties, guarantees, expressed or implied, are included or intended in the contents of this transmittal.

As required, all proposed work will be performed under the direct supervision of a Professional Geologist or Registered Civil Engineer as defined in the Registered Geologist Act of the California Code of Regulations.

FIGURES



299 WEST HILLCREST DR. SUITE 220
THOUSAND OAKS, CA 91360

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

SITE LOCATION MAP

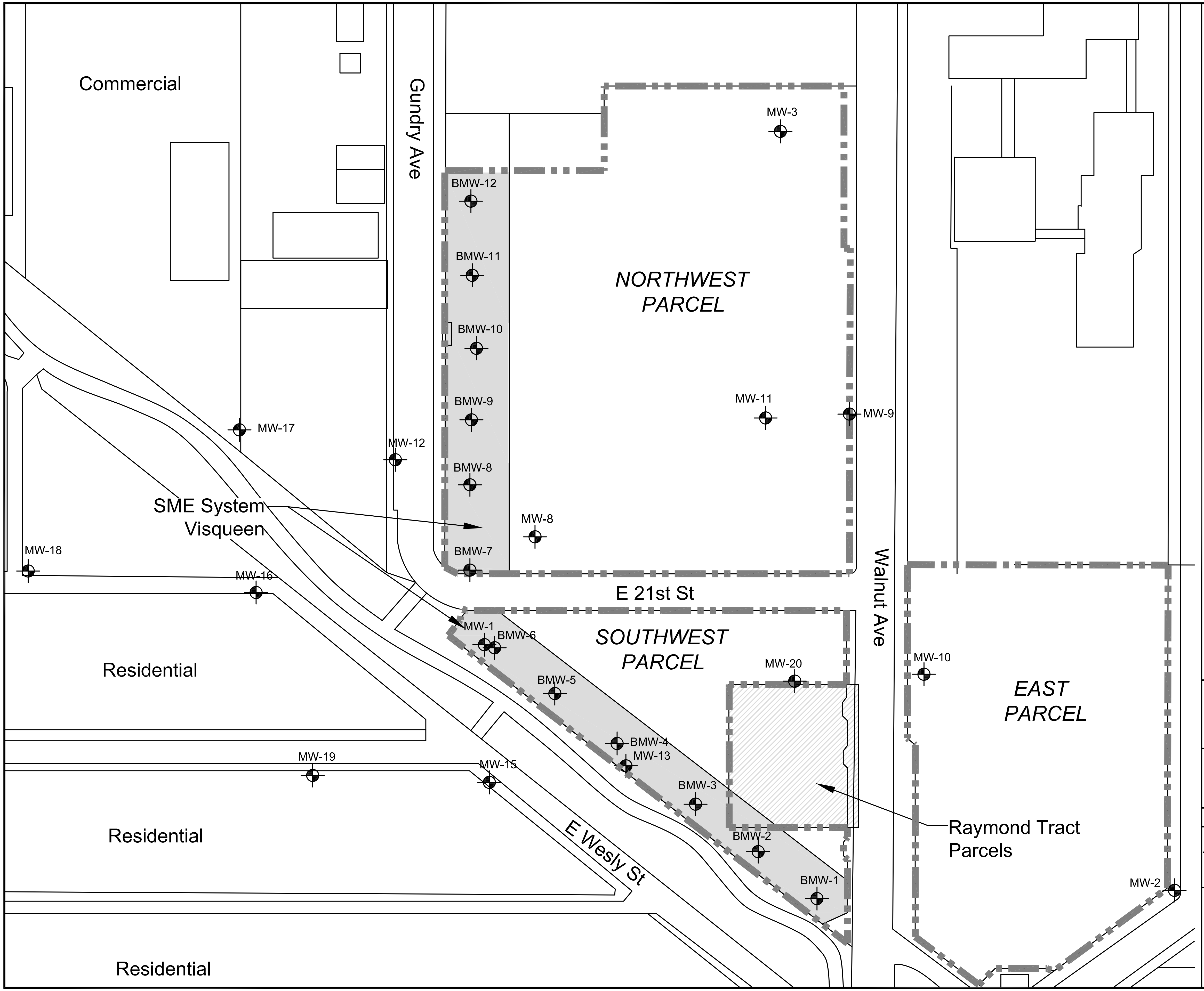
PROJECT NO.	DATE	DR.BY:	APP. BY:
093-CHEMOIL-001	05/30/17	ZA	KD

0 2500 5000
HORIZONTAL SCALE IN FEET

N

FIGURE 1-1

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\Figures\Fig.1-1-Site Location Map.dwg, 6/12/2017 5:30:52 PM



LEGEND

▬ ▪ ▪ ▬	Site Boundary
MW-16 ⊕	Groundwater Monitoring Well Locations
SME	Subsurface Metabolic Enhancement

SITE MAP

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

PROJECT NO.	DATE	DRAWN BY:	APP. BY:
01-CHEMOIL-001	02/08/17	ZA	KD

0 100 200
HORIZONTAL SCALE IN FEET

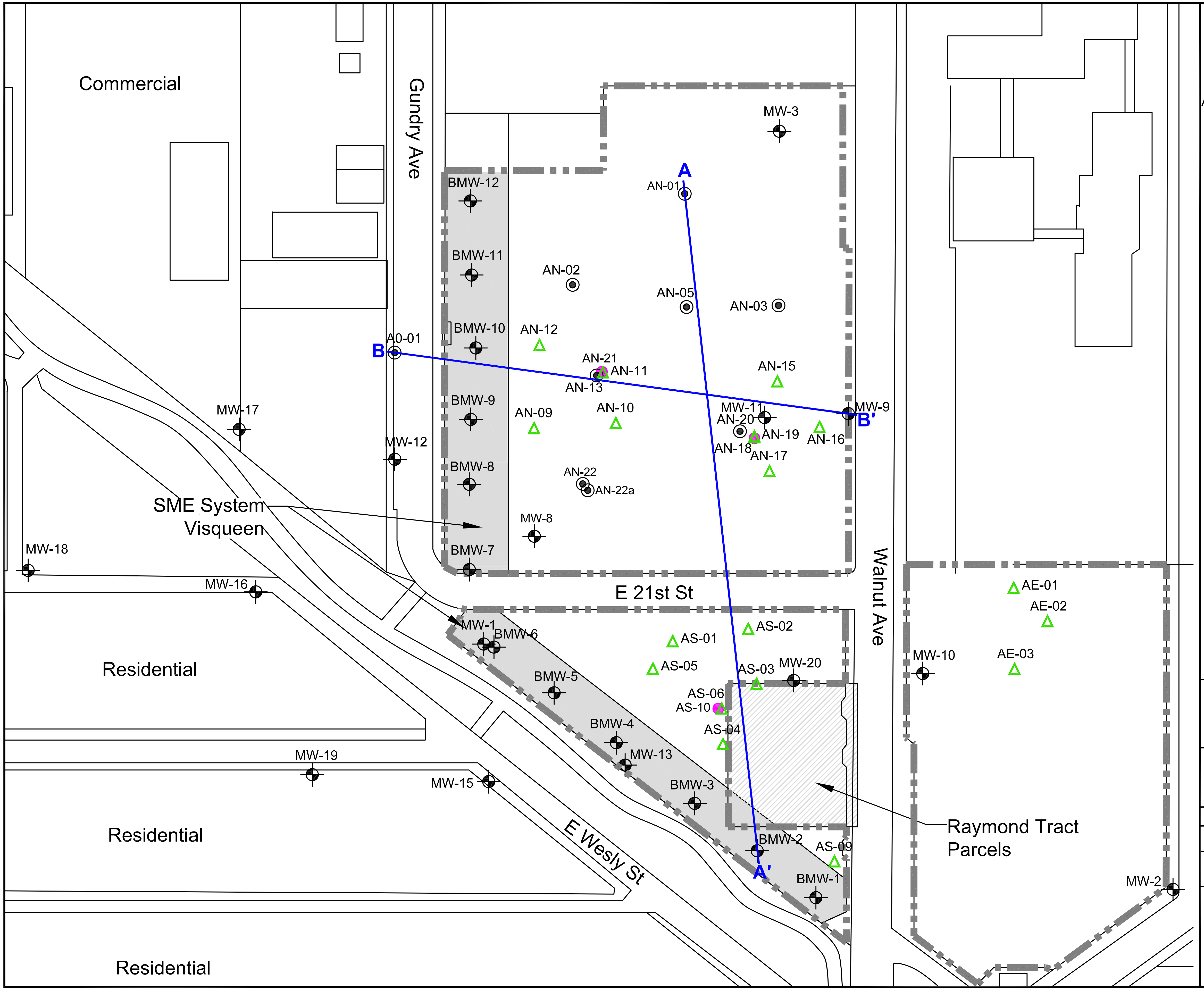
SGI environmental APEX
299 WEST HILLCREST DR., SUITE 220
THOUSAND OAKS, CA 91360

N

FIGURE 2-1

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\Figures\Fig.2-1-Site Map.dwg, 6/12/2017 5:33:58 PM

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\Figures\Fig.2-2,2-3,2-4-Cross Section Locations &Cross sections A-A' & B-B'.dwg, 7/14/2017 2:47:54 PM



LEGEND

▬ ▪ ▪ ▬	Site Boundary
MW-16 ⊕	Groundwater Monitoring Well Location
AN-20 ◉	Soil Boring and Grab Groundwater Location (Apex, 2017)
AN-10 △	2016 UVOST™ Boring Location
AN-21 ●	2016 MIP© Boring Location
UVOST	Ultra-Violet Optical Screening Tool
SME	Subsurface Metabolism Enhancement

CROSS-SECTION LOCATION MAP

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0 100 200
HORIZONTAL SCALE IN FEET

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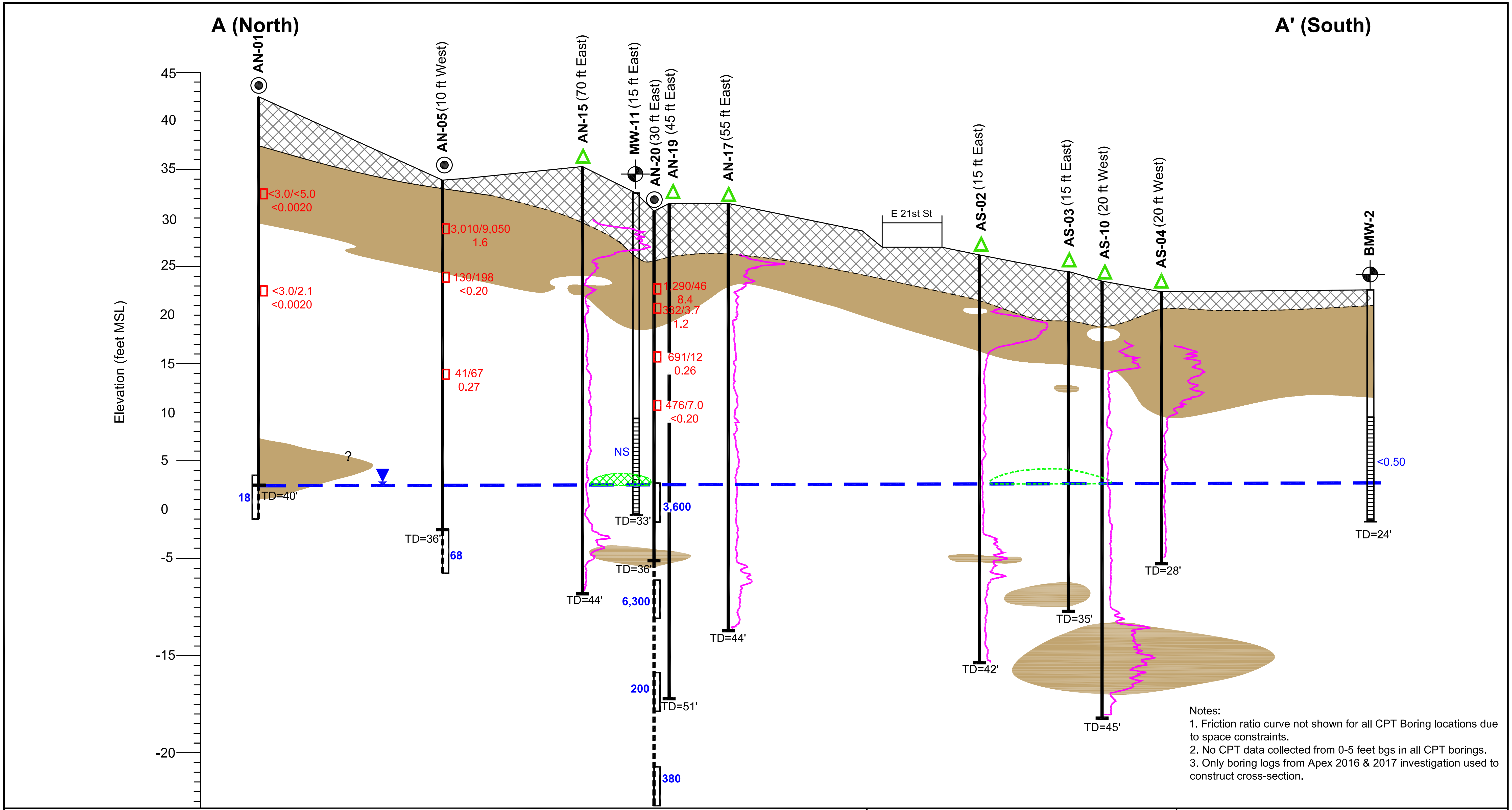
299 WEST HILLCREST DR., SUITE 220
THOUSAND OAKS, CA 91360

N

FIGURE
2-2



Notes:
1. Friction ratio curve not shown for all CPT Boring locations due to space constraints.
2. No CPT data collected from 0-5 feet bgs in all CPT borings.
3. Only boring logs from Apex 2016 & 2017 investigation used to construct cross-section.

LEGEND

▨ Fill

🟫 Fine Grained Material

☐ Coarse Grained Material

— Lithologic Contact (Dashed Where Inferred)

MSL Mean Sea Level

TD Total Depth of Logged Boring In Feet

▯ Grab Groundwater Sample

68 Benzene Concentration in Groundwater (micrograms per Liter)

<0.50 Not Detected Above Indicated Reporting Limit

NS Not Sampled

⋮ Soil Not Logged. Boring Advanced For Grab Groundwater Sample Only

▤ Screened Interval, Monitoring Well Sample

— — Potentiometric Surface

△ CPT Boring (Apex, 2016)

◉ Soil Boring and Grab Groundwater Location (Apex, 2017)

⊕ Monitoring Well Location

▼ Approximate Groundwater Elevation Measured in December 2016 Monitoring event by (AA&AI, 2016b)

Friction Ratio From CPT Report (Apex, 2016)

▨ Free Product Observed

◯ Suspected Area of Free Product

☐ 41/67 — TPH(C5-C12) Concentration in Soil (milligrams per kilogram)
41/67 — TPH(C13-C22) Concentration in Soil (milligrams per kilogram)
0.27 — Benzene Concentration in Soil (milligrams per kilogram)
Soil Sample

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

CROSS-SECTION A-A'

PROJECT NO.	DATE	DRAWN BY:	APP. BY:
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0 60 120
HORIZONTAL SCALE IN FEET

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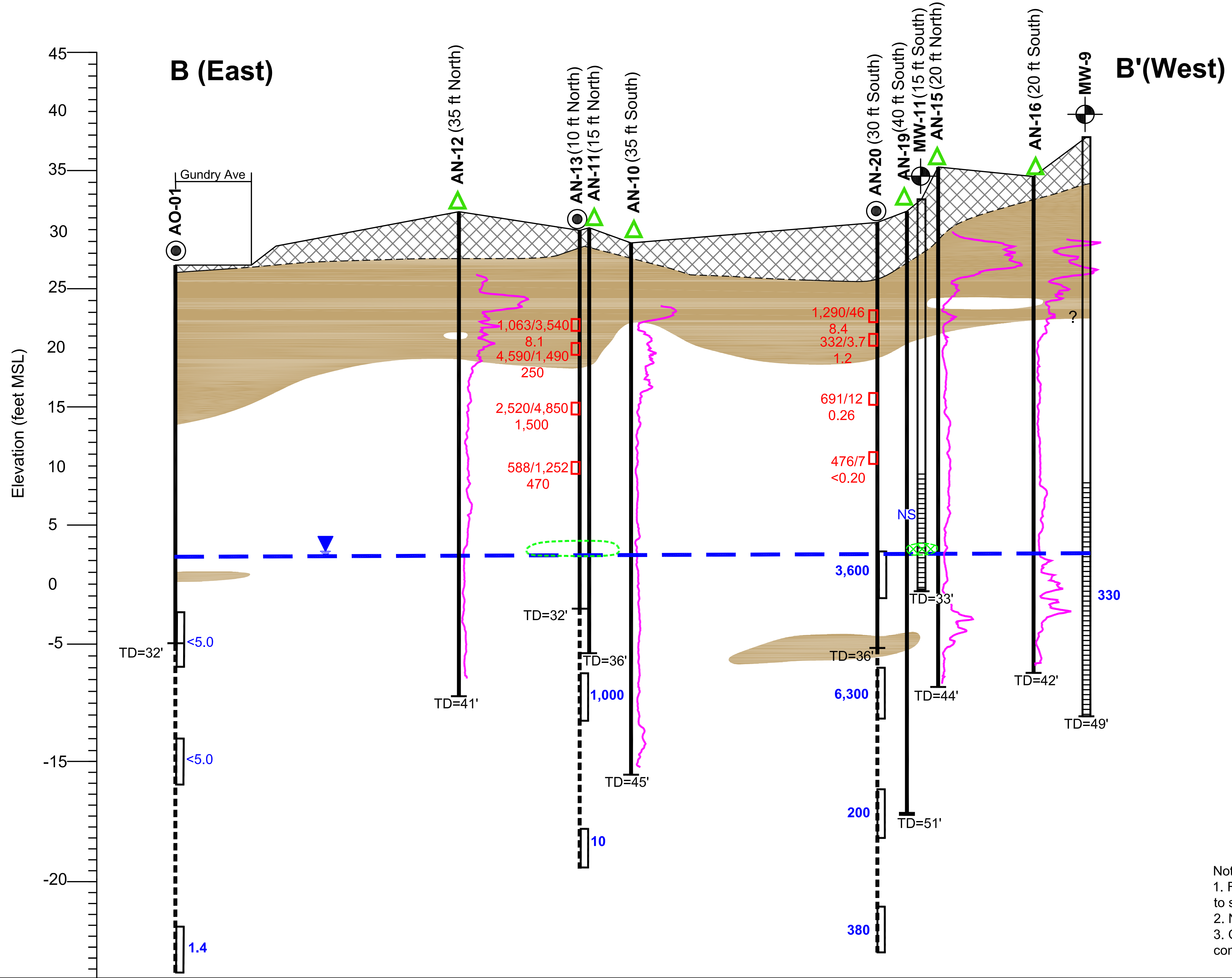
APEX
299 WEST HILLCREST DR., SUITE 220
THOUSAND OAKS, CA 91360

N

FIGURE
2-3

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\Figures\Fig.2-2,2-3,2-4-Cross Section Locations &Cross sections A-A' & B-B'.dwg, 6/12/2017 5:55:02 PM

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\Figures\Fig.2-2,2-3,2-4-Cross Section Locations &Cross sections A-A' & B-B'.dwg, 6/12/2017 5:53:11 PM



Notes:
1. Friction ratio curve not shown for all CPT Boring locations due to space constraints.
2. No CPT data collected from 0-5 feet bgs in all CPT borings.
3. Only boring logs from Apex 2016 & 2017 investigation used to construct cross-section.

LEGEND

▨	Fill
🟫	Fine Grained Material
☐	Coarse Grained Material
—	Lithologic Contact (Dashed Where Inferred)
MSL	Mean Sea Level
TD	Total Depth of Logged Boring
▯	Grab Groundwater Sample
200	Benzene Concentration in Groundwater (micrograms per Liter)
	Not Detected Above Indicated Reporting Limit
NS	Not Sampled
⁞	Soil Not Logged. Boring Advanced For Grab Groundwater Sample Only
▤	Screened Interval, Monitoring Well Sample
▬ ▬	Potentiometric Surface
△	CPT Boring (Apex, 2016)
◉	Soil Boring and Grab Groundwater Location (Apex, 2017)
⊕	Monitoring Well Location
▼	Approximate Groundwater Elevation Measured in December 2016 Monitoring event by (AA&AI, 2016b)
〰	Friction Ratio From CPT Report (Apex, 2016)
▩	Free Product Observed
◌	Suspected Area of Free Product

☐ 2,520/4,850
1,500
Soil Sample
TPH(C5-C12) Concentration in Soil (milligrams per kilogram)
TPH(C13-C22) Concentration in Soil (milligrams per kilogram)
Benzene Concentration in Soil (milligrams per kilogram)

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

PROJECT NO.	DATE	DRAWN BY:	APP. BY:
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0 60 120
HORIZONTAL SCALE IN FEET

CROSS-SECTION B-B'

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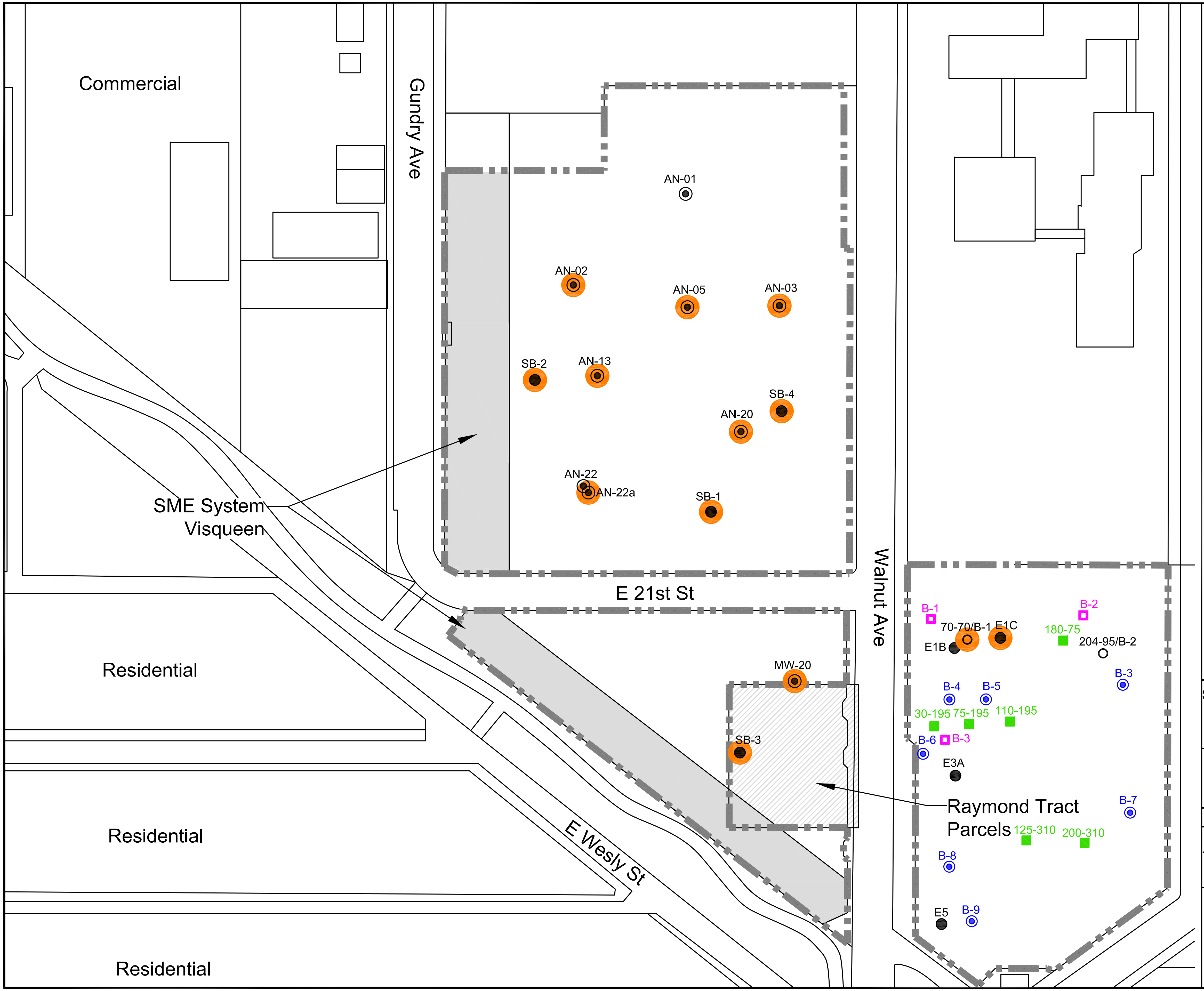
N

FIGURE
2-4

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\Figures\Fig.2-5-Summary of Soil COPC Concentrations Above Screening levels.dwg, 6/12/2017 5:27:58 PM



LEGEND

▬ ▪ ▪ ▬	Site Boundary
AN-01 ◉	Soil Sample Locations (APEX, 2017)
SB-4 ●	Soil Sample Locations (Tetratech, 2006)
SME	Subsurface Metabolism Enhancement
●	Concentration of any COPC is above its applicable final soil screening level, Commercial/Industrial Scenario
B-7 ◉	TEC Push-Drive Soil Boring (TEC, 2001)
B-3 ▫	Former EEI (1988) Soil Boring (TEC, 2001)
200-30 ■	Former TSG (1999) Soil Boring (TEC, 2001)
70-70/B1 ○	Combined TSG/TEC Boring Location (TEC, 2001)
COPC	Chemical Of Potential Concern
BGS	Below Ground Surface

SUMMARY OF SOIL COPC CONCENTRATIONS ABOVE SCREENING LEVELS
0 to 40 FEET BGS

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2020 WALNUT AVENUE
SIGNAL HILL, CA

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0 100 200
HORIZONTAL SCALE IN FEET

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THOUSAND OAKS, CA 91360

N

FIGURE
2-5

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\Figures\Fig.2-6-Summary of Benzene Concentratiosn in Soil Vapor-5 ft BGS.dwg, 7/14/2017 9:56:31 AM

LEGEND

▬ ▪ ▪ ▬	Site Boundary
Wnt-4 ●	Soil Vapor Sampling Locations, (TEC, 2009/2010)
AN-06 ▣	Soil Vapor Sample Locations, (APEX, 2017)
E1 ●	Soil Vapor Sample Locations, (Tetratech, 2006)
SV-20 ◆	Soil Gas Sampling Locations, (Geosyntec, 2012)
<50	Indicated Compound Not Detected at Concentration at or Above the Laboratory Reporting Limit Shown
*	Data Not Used in Contouring due to Proximity of SME System Which Began Operation After Collection of Samples
bgs	Below Ground Surface
ND	Not Detected
NS	Not Sampled
—	Isoconcentration Contour, Dashed Where Inferred
🟨	Concentrations > 909 µg/m³
🟥	Concentrations > 10,000 µg/m³
µg/m³	Micrograms per Cubic Meter

Note:
1. Concentration of benzene in micrograms per cubic meter (µg/m³)
2. 909 µg/m³ = Site-specific soil vapor screening level for commercial/industrial land use.

SUMMARY OF BENZENE CONCENTRATIONS IN SOIL VAPOR AT 5 FEET BGS

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2020 WALNUT AVENUE
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0 150 300
HORIZONTAL SCALE IN FEET

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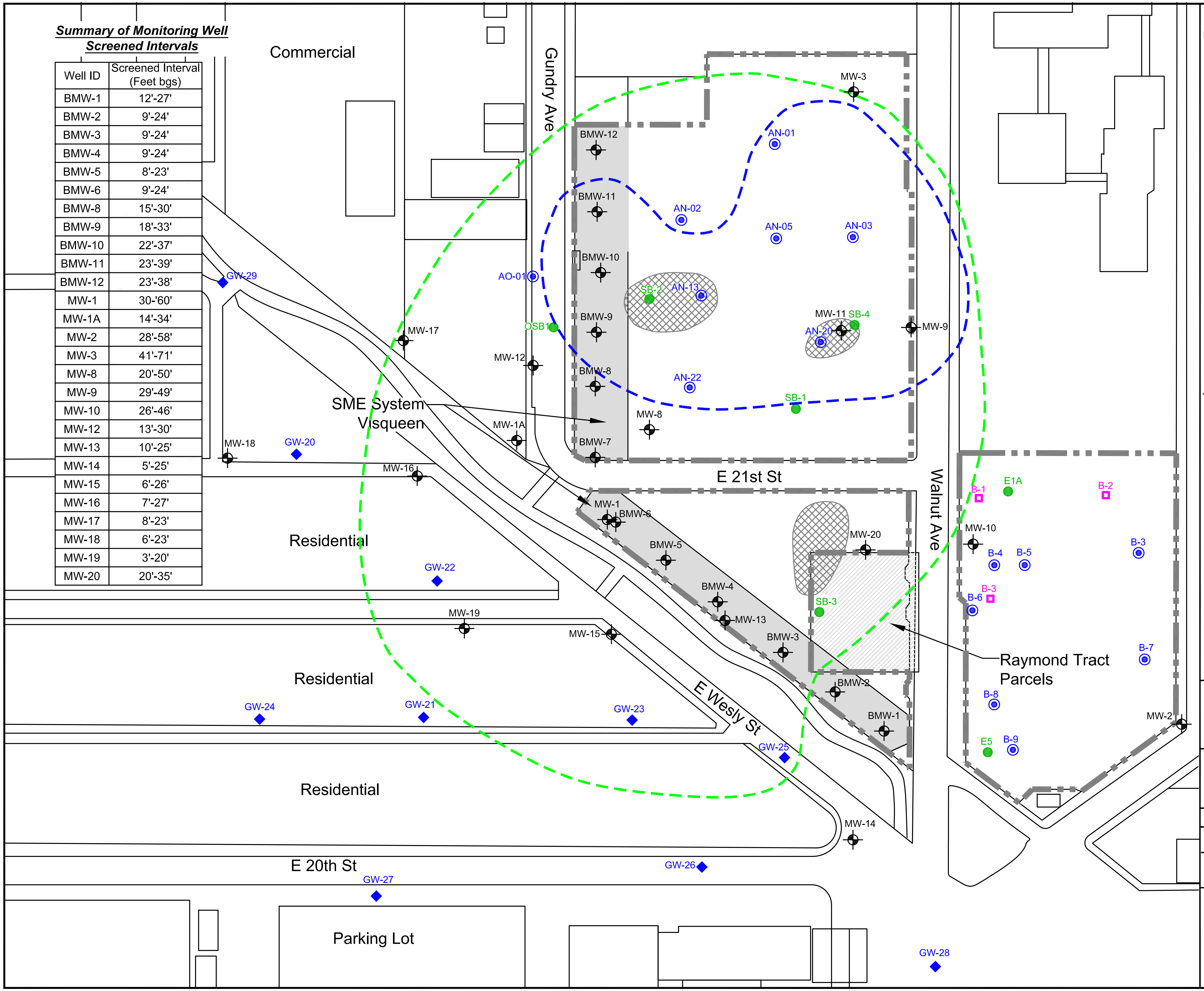
N

FIGURE 2-6

Summary of Monitoring Well Screened Intervals

Well ID	Screened Interval (Feet bgs)
BMW-1	12'-27'
BMW-2	9'-24'
BMW-3	9'-24'
BMW-4	9'-24'
BMW-5	8'-23'
BMW-6	9'-24'
BMW-8	15'-30'
BMW-9	18'-33'
BMW-10	22'-37'
BMW-11	23'-39'
BMW-12	23'-38'
MW-1	30-'60'
MW-1A	14'-34'
MW-2	28'-58'
MW-3	41'-71'
MW-8	20'-50'
MW-9	29'-49'
MW-10	26'-46'
MW-12	13'-30'
MW-13	10'-25'
MW-14	5'-25'
MW-15	6'-26'
MW-16	7'-27'
MW-17	8'-23'
MW-18	6'-23'
MW-19	3'-20'
MW-20	20'-35'



LEGEND

▬ ▪ ▪ ▬	Site Boundary
MW-16 ⌖	Groundwater Monitoring Well Locations
AN-01 ◎	Grab Groundwater Sample Locations, APEX, 2017
SB-2 ●	Grab Groundwater Sample Locations, Tetra Tech, 2006. Samples Collected for First Encountered Groundwater.
GW-29 ◆	Grab Groundwater Sample Locations, Geosyntec, 2012
B-3 ▣	Former EEI (1988) Soil Boring (TEC, 2001)
bgs	Below Ground Surface
µg/L	Micrograms per Liter
SME	Subsurface Metabolism Enhancement
▨	Area of Observed or Suspected LNAPL
LNAPL	Light Non-Aqueous Phase Liquid
TPHg (C4-C12)	Total Petroleum Hydrocarbons As Gasoline, Carbon Chain Range C4-C-12
🟩 – –	Approximate Extent of TPHg(C4-C12) Plume With Concentrations >100 µg/L in Groundwater
🟦 – –	Approximate Extent of Benzene Plume With Concentrations >10 µg/L in Groundwater

TPHg (C4-C12), BENZENE, AND LNAPL EXTENTS IN GROUNDWATER

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

PROJECT NO.	DATE	DRAWN BY:	APP. BY:
093-CHEMOIL-001	05/18/17	ZA	KD

0 120 240
HORIZONTAL SCALE IN FEET

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299 WEST HILLCREST DR., SUITE 220
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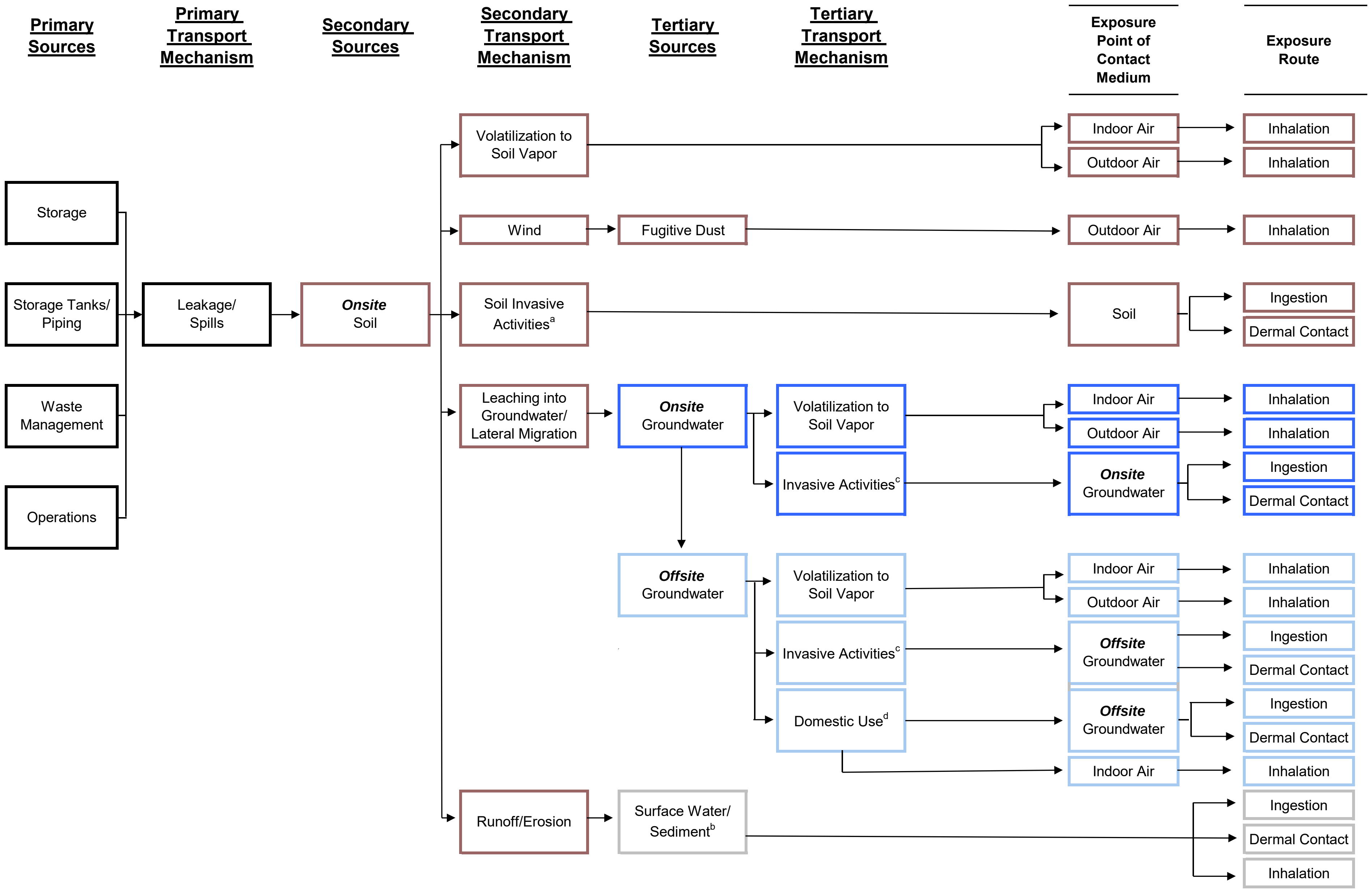
N

FIGURE
2-7

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\Figures\Fig.2-7-TPHg, Benzene & LNAPL Extents in GW.dwg, 7/11/2017 2:54:55 PM



		Hypothetical Receptors			
		Onsite		Offsite	
Exposure Point of Contact Medium	Exposure Route	Future Construction/ Utility Trench Worker	Future Commercial/ Industrial Worker	Current/Future Commercial/ Industrial Worker	Current/Future Resident
Indoor Air	Inhalation	☐	■	■	■
Outdoor Air	Inhalation	■	▨	▨	▨
Outdoor Air	Inhalation	▨	▨	☐	☐
Soil	Ingestion	■	■	☐	☐
Soil	Dermal Contact	■	■	☐	☐
Indoor Air	Inhalation	☐	■	☐	☐
Outdoor Air	Inhalation	■	▨	☐	☐
Onsite Groundwater	Ingestion	☐	☐	☐	☐
Onsite Groundwater	Dermal Contact	☐	☐	☐	☐
Indoor Air	Inhalation	☐	☐	■	■
Outdoor Air	Inhalation	☐	☐	▨	▨
Offsite Groundwater	Ingestion	☐	☐	☐	☐
Offsite Groundwater	Dermal Contact	☐	☐	☐	☐
Offsite Groundwater	Ingestion	☐	☐	☐	☐
Offsite Groundwater	Dermal Contact	☐	☐	☐	☐
Indoor Air	Inhalation	☐	☐	☐	☐
	Ingestion	☐	☐	☐	☐
	Dermal Contact	☐	☐	☐	☐
	Inhalation	☐	☐	☐	☐

☐ CSM components related to soil.

☐ CSM components related to onsite groundwater.

☐ CSM components related to offsite groundwater.

☐ CSM components related to surface water.

■ Receptor likely to be exposed via this route, so pathway is considered potentially complete.

▨ Receptor may be exposed via this route, so pathway is considered potentially complete; however, pathway is considered minor.

☐ Pathway is incomplete, no further evaluation required.

[a] Soil invasive activities may extend to 10 feet below ground surface (bgs) and include construction and development for commercial/industrial land use.

[b] No surface water bodies were identified within a one-half mile radius of the site.

[c] Surface invasive activities are not expected to extend beyond 10 feet bgs during construction and development. Due to Site topography, depth to water in existing monitoring wells ranges from approximately 15 feet bgs in the southern portions of the Site to 43 feet bgs in the northern portions of the Site.

[d] Groundwater quality within the Site vicinity is generally poor due to seawater intrusion and elevated salinity. Shallow groundwater is not currently used and is not likely to be developed for beneficial use. Risk management measures can be implemented to ensure that groundwater is not used. The nearest public water supply well is located downgradient approximately 850 feet south of the Site (Los Angeles County Department of Public Works Well 420), however is used for groundwater monitoring purposes only.

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CALIFORNIA

HUMAN HEALTH CONCEPTUAL SITE MODEL

PROJECT NO.	DATE	DRAWN BY	APP. BY
093-CHEMOIL-001	03/07/17	II	KD

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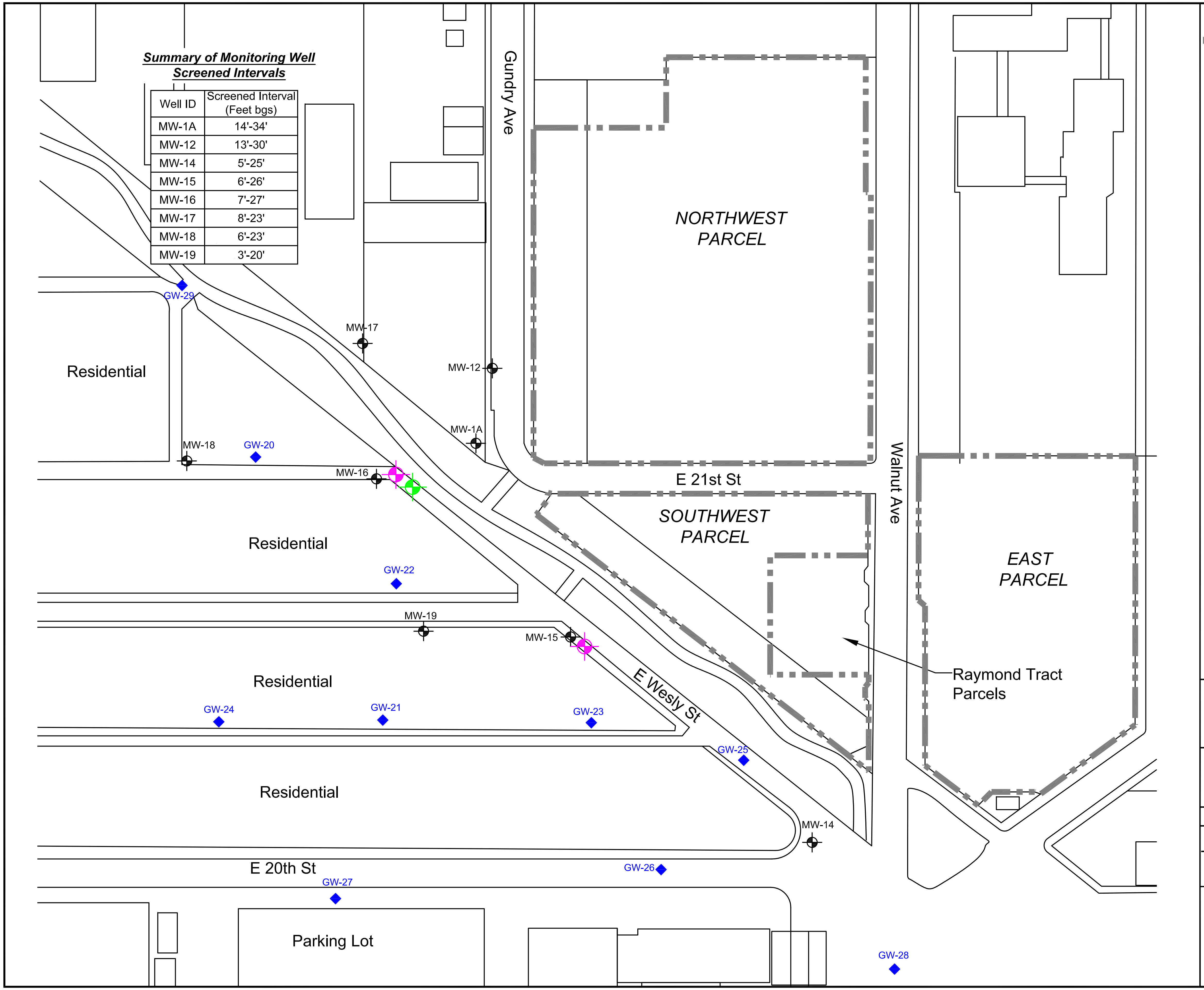
299 WEST HILLCREST DRIVE, SUITE 220
THOUSAND OAKS, CA 91360

FIGURE 2-8

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\Figures\Fig.3-1-Proposed Monitoring Well Location.dwg, 7/11/2017 12:27:41 PM



Summary of Monitoring Well Screened Intervals

Well ID	Screened Interval (Feet bgs)
MW-1A	14'-34'
MW-12	13'-30'
MW-14	5'-25'
MW-15	6'-26'
MW-16	7'-27'
MW-17	8'-23'
MW-18	6'-23'
MW-19	3'-20'

LEGEND

▪ ▪ ▪	Site Boundary
MW-16 ⊕	Off-Site Groundwater Monitoring Well Locations
GW-29 ◆	Grab Groundwater Sample Locations, Geosyntec, 2012
⊕	Proposed New Monitoring Well, 55-65 Feet BGS Screen
⊕	Proposed New Monitoring Well, 75-85 Feet BGS Screen
BGS	Below Ground Surface

PROPOSED NEW OFFSITE MONITORING WELL LOCATIONS

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

PROJECT NO.	DATE	DRAWN BY:	APP. BY:
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0 120 240
HORIZONTAL SCALE IN FEET

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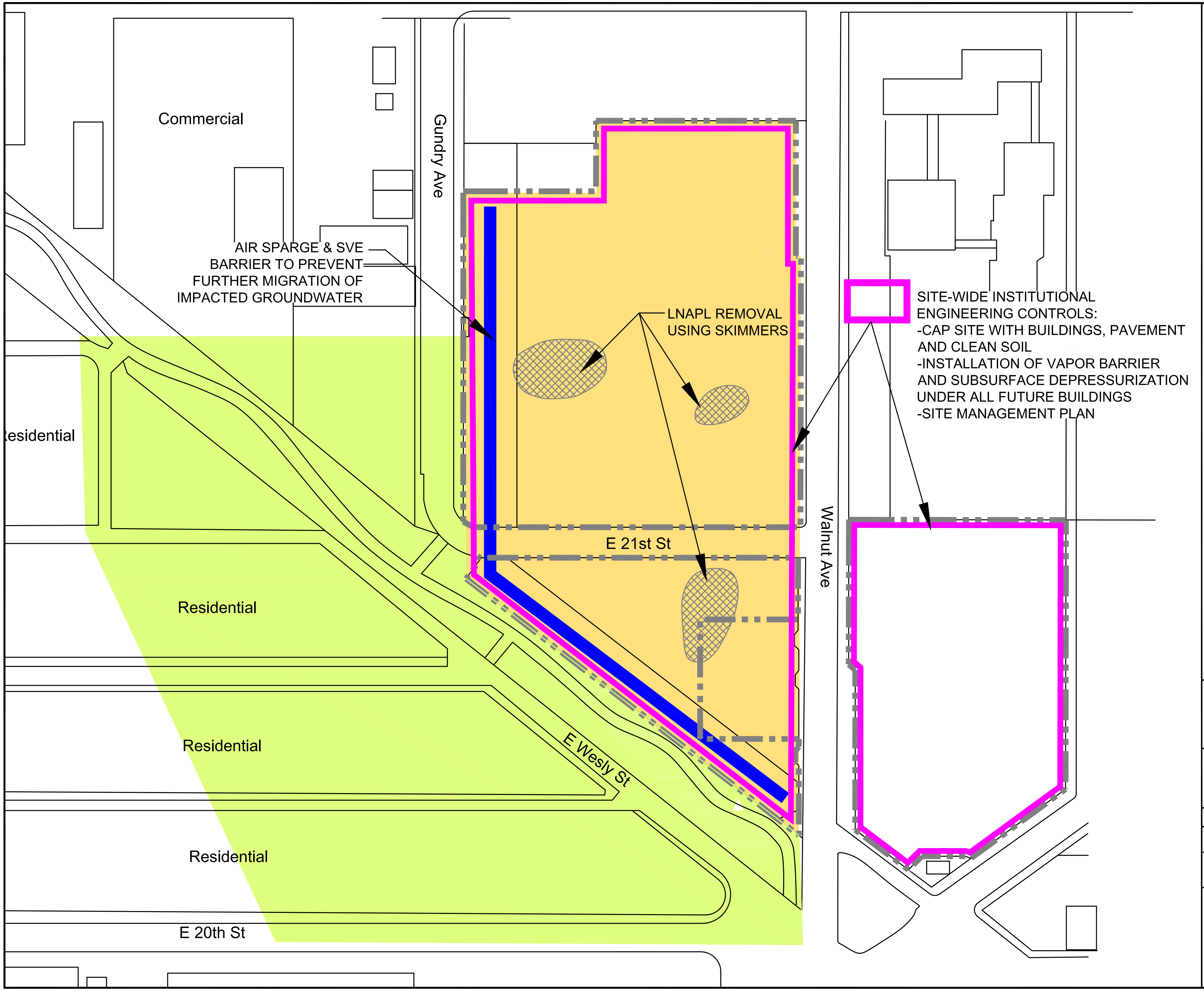
APEX
299 WEST HILLCREST DR., SUITE 220
THOUSAND OAKS, CA 91360

N

FIGURE 3-1



LEGEND

▬ ▪ ▪ ▬	Site Boundary
▨	Area of Observed or Suspected LNAPL
🟩	Downgradient MNA in Residential Area
🟨	SVE To Treat Vadose Zone Areas With Detections Above Site-Specific Screening Levels
SVE	Soil Vapor Extraction
MNA	Monitored Natural Attenuation
LNAPL	Light Non-Aqueous Phase Liquid

CONCEPTUAL REMEDIAL APPROACH

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

PROJECT NO.	DATE	DRAWN BY:	APP. BY:
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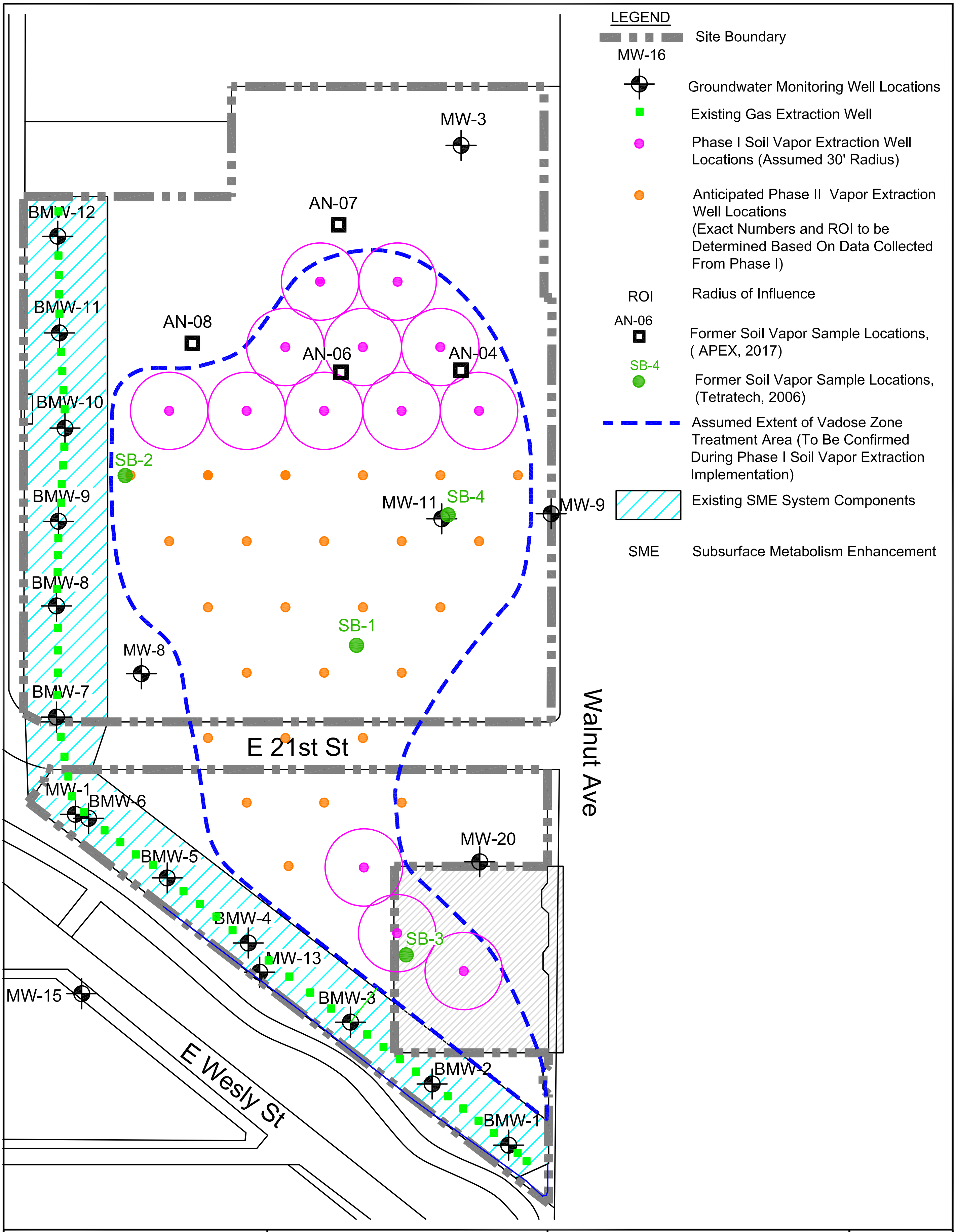
0 120 240
HORIZONTAL SCALE IN FEET

SGI environmental APEX

299 WEST HILLCREST DR., SUITE 220
THOUSAND OAKS, CA 91360

N

FIGURE
7-1



S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\Figures\Fig.8-1-Proposed SVE Well Layout.dwg, 7/14/2017 3:31:25 PM

SGI environmental
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THOUSAND OAKS, CA 91360

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

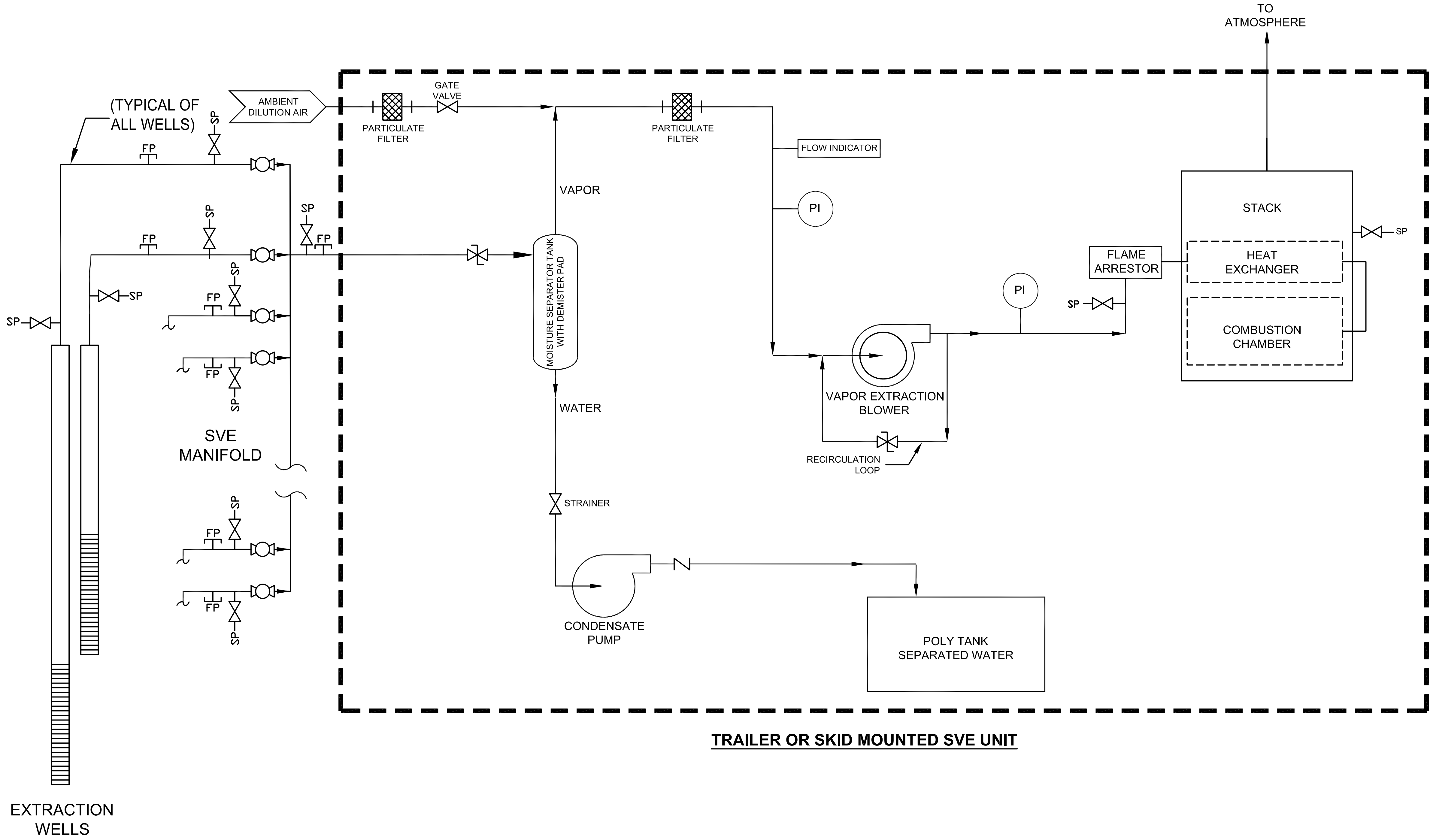
PROJECT NO.	DATE	DR.BY:	APP. BY:
01-CHEMOIL-001	05/08/17	ZA	KD

PROPOSED SVE WELL LAYOUT

0 100 200
HORIZONTAL SCALE IN FEET

N

FIGURE 8-1



LEGEND

SP—⋈—	SAMPLE PORT
FP ┬┐	FLOW MEASUREMENT PORT
⋈	GLOBE VALVE
N	CHECK VALVE
⋈	BALL VALVE (HAND OPERATED)
PI	PRESSURE INDICATOR (LOCAL GAUGE)

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2020 WALNUT AVENUE
SIGNAL HILL, CA

SOIL VAPOR EXTRACTION SYSTEM PROCESS FLOW DIAGRAM

PROJECT NO.	DATE	DRAWN BY:	APP. BY:
093-CHEMOIL-001	6/07/2017	ZA	KD

0 0 0
NOT TO SCALE

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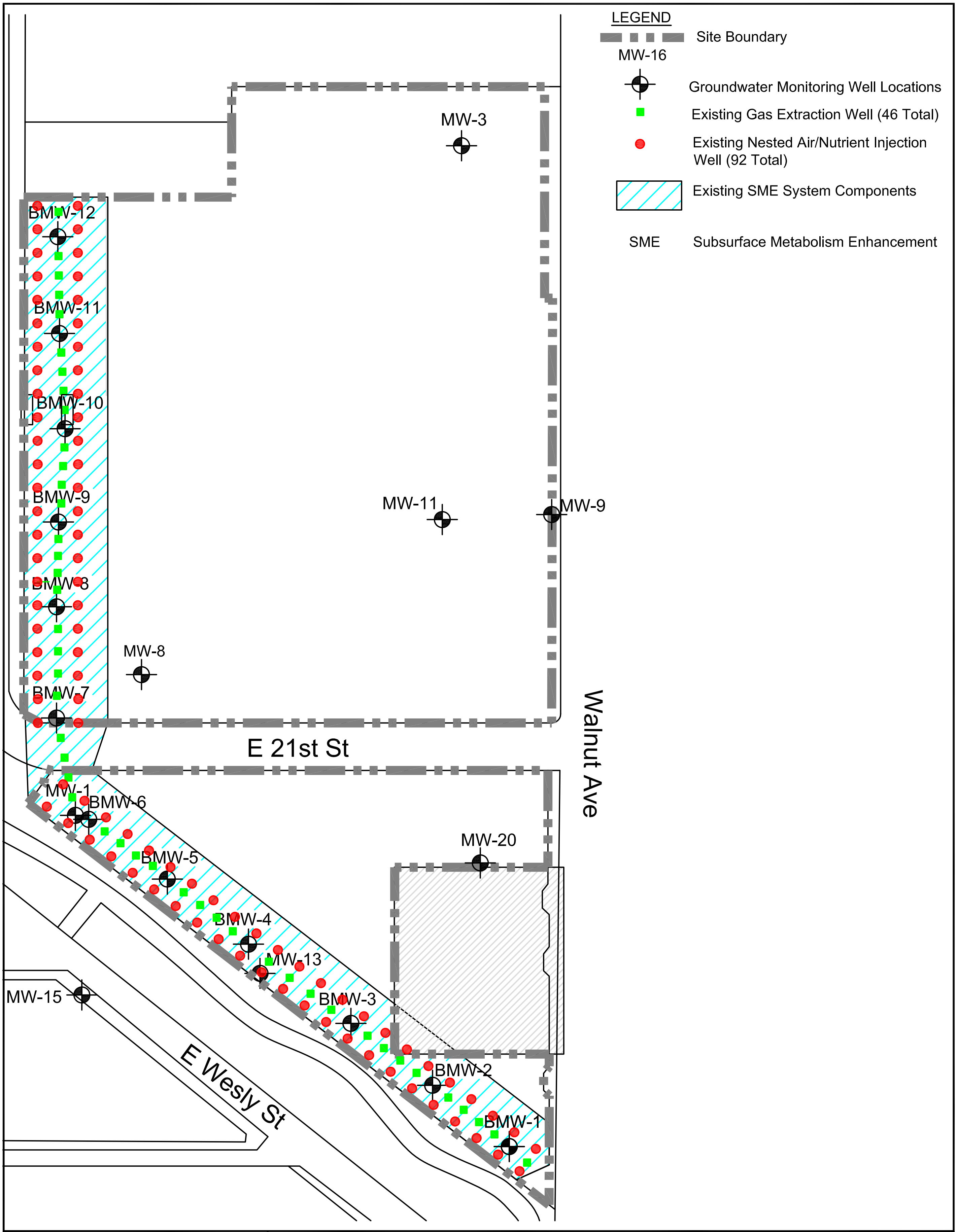
299 WEST HILLCREST DR., SUITE 220
THOUSAND OAKS, CA 91360

FIGURE
8-2

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\Figures\Fig.8-2-Typical SVE Process Flow Diagram.dwg, 7/11/2017 12:34:44 PM



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SGI environmental
APEX

299 WEST HILLCREST DR., SUITE 220
THOUSAND OAKS, CA 91360

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

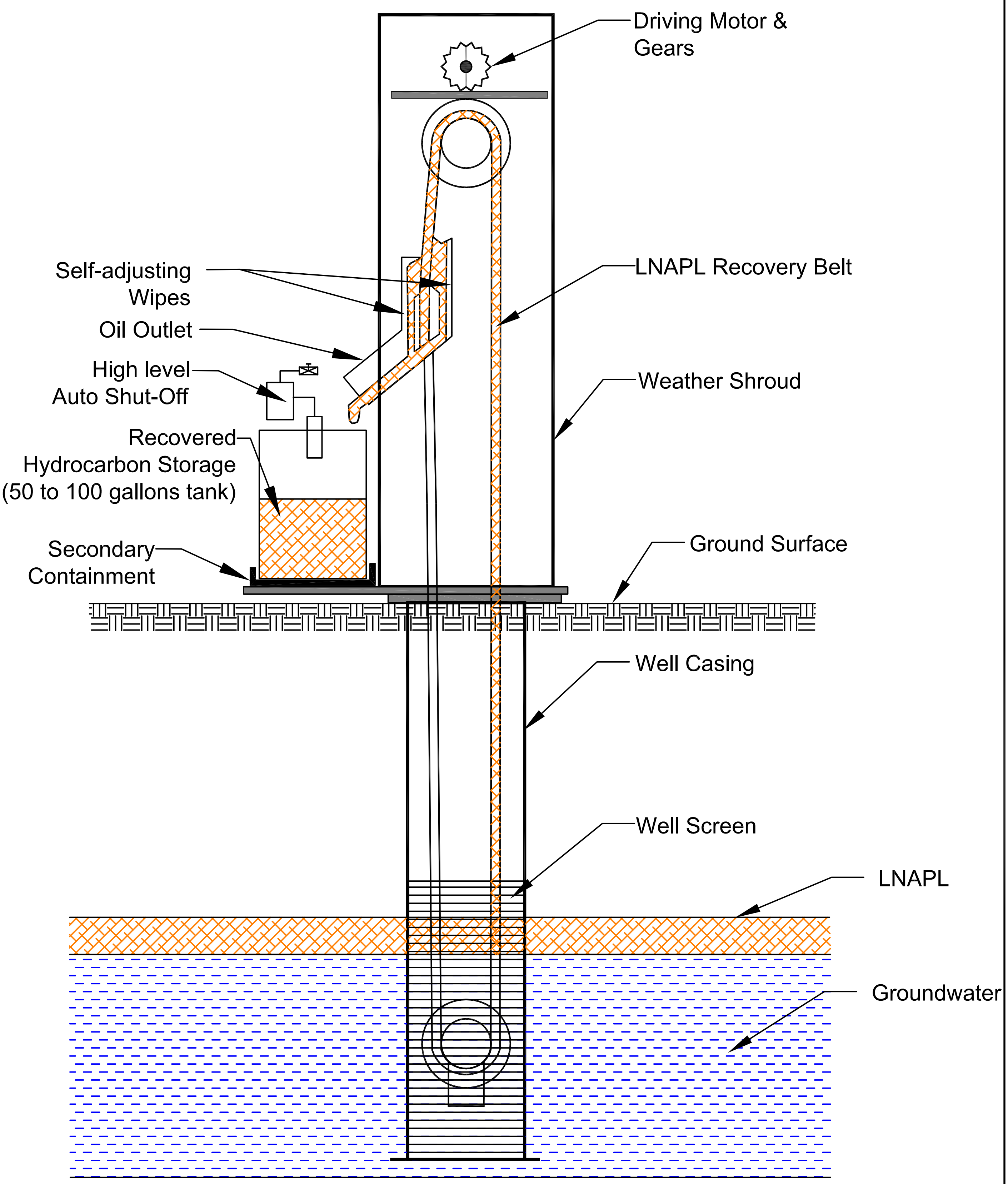
EXISTING SME SYSTEM LAYOUT

PROJECT NO.	DATE	DR.BY:	APP. BY:
01-CHEMOIL-001	05/08/17	ZA	KD

0 100 200
HORIZONTAL SCALE IN FEET

N

FIGURE 9-1



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SGI environmental APEX

299 WEST HILLCREST DR. SUITE 220
THOUSAND OAKS, CA 91360

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

PROJECT NO.	DATE	DR.BY:	APP. BY:
093-CHEMOIL-001	05/31/17	ZA	SH

SCHEMATIC DESIGN OF LNAPL REMOVAL AND STORAGE SYSTEM

NOT TO SCALE

FIGURE 9-2

TABLES

Table 4-1
Summary of Soil Screening Levels
Former ChemOil Refinery
Signal Hill, California

Chemical	Direct Contact with Soil					Protection of Groundwater, Aquifer is Not a Source of Drinking Water				Final Screening Levels [7]		
	Residential		Construction	Commercial/Industrial				Groundwater at 20 feet bgs [5]		Residential	Construction	Commercial/ Industrial
								100X LARWQCB Soil SLs [6] (0 to 10 ft bgs)	100X LARWQCB Soil SLs [6] (10 to 20 ft bgs)			
	SFBRWQCB ESL [1] (mg/kg)	USEPA RSL/DTSC SL [2] (mg/kg)	SFBRWQCB ESL [1] (mg/kg)	SFBRWQCB ESL [1] (mg/kg)	USEPA RSL/DTSC SL [2] (mg/kg)	SFBRWQCB ESL [3] (mg/kg)	USEPA RSL [4] (mg/kg)	LARWQCB Soil SL [5] (mg/kg)	LARWQCB Soil SL [5] (mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Total Petroleum Hydrocarbons (TPH)												
TPHg (C4-C12)	7.4E+02	8.2E+01	2.8E+03	3.9E+03	4.2E+02	- -	- -	1.0E+03	1.0E+03	8.2E+01	1.0E+03	4.2E+02
TPH (C5-C12)	7.4E+02	8.2E+01	2.8E+03	3.9E+03	4.2E+02	- -	- -	1.0E+03	1.0E+03	8.2E+01	1.0E+03	4.2E+02
TPH (C13-C22)	2.3E+02	9.6E+01	8.8E+02	1.1E+03	4.4E+02	- -	- -	1.0E+04	1.0E+04	9.6E+01	8.8E+02	4.4E+02
TPH (C23-C44)	1.1E+04	2.5E+03	3.2E+04	1.4E+05	3.3E+04	- -	- -	5.0E+04	5.0E+04	2.5E+03	3.2E+04	3.3E+04
Volatile Organic Compounds (VOCs)												
Acetone	5.9E+04	6.1E+04	2.6E+05	6.3E+05	6.7E+05	- -	- -	1.6E+02	1.5E+02	1.5E+02	1.5E+02	1.5E+02
Benzene	2.3E-01	3.3E-01	2.4E+01	1.0E+00	1.4E+00	- -	- -	6.2E-01	1.5E-01	1.5E-01	1.5E-01	1.5E-01
(8) TBA	NV	1.3E+05	NV	NV	1.5E+06	- -	- -	1.3E+00	1.2E+00	1.2E+00	1.2E+00	1.2E+00
tert-Butylbenzene	NV	2.2E+03	NV	NV	1.2E+04	- -	- -	2.8E+01	2.6E+01	2.6E+01	2.6E+01	2.6E+01
sec-Butylbenzene	NV	2.2E+03	NV	NV	1.2E+04	- -	- -	2.8E+01	2.6E+01	2.6E+01	2.6E+01	2.6E+01
n-Butylbenzene	NV	1.2E+03	NV	NV	6.4E+03	- -	- -	2.8E+01	2.6E+01	2.6E+01	2.6E+01	2.6E+01
Ethylbenzene	5.1E+00	5.8E+00	4.8E+02	2.2E+01	2.5E+01	- -	- -	6.8E+01	3.2E+01	5.1E+00	3.2E+01	2.2E+01
Isopropylbenzene	NV	1.9E+03	NV	NV	9.9E+03	- -	- -	8.4E+01	7.7E+01	7.7E+01	7.7E+01	7.7E+01
(9) 4-Isopropyltoluene	NV	1.9E+03	NV	NV	9.9E+03	- -	- -	8.4E+01	7.7E+01	7.7E+01	7.7E+01	7.7E+01
MTBE	4.2E+01	4.7E+01	3.7E+03	1.8E+02	2.1E+02	- -	- -	1.3E+00	1.3E+00	1.3E+00	1.3E+00	1.3E+00
Naphthalene	3.3E+00	3.8E+00	3.5E+02	1.4E+01	1.7E+01	- -	- -	1.8E+00	1.7E+00	1.7E+00	1.7E+00	1.7E+00
n-Propylbenzene	NV	3.8E+03	NV	NV	2.4E+04	- -	- -	2.8E+01	2.6E+01	2.6E+01	2.6E+01	2.6E+01
Toluene	9.7E+02	1.1E+03	4.1E+03	4.6E+03	5.4E+03	- -	- -	2.5E+01	1.6E+01	1.6E+01	1.6E+01	1.6E+01
1,3,5-TMB	NV	2.1E+02	NV	NV	1.1E+03	- -	- -	3.6E+01	3.3E+01	3.3E+01	3.3E+01	3.3E+01
1,2,4-TMB	NV	5.8E+01	NV	NV	2.4E+02	- -	- -	3.6E+01	3.3E+01	3.3E+01	3.3E+01	3.3E+01
o-Xylene	NV	6.5E+02	NV	NV	2.8E+03	- -	- -	NV	NV	6.5E+02	0.0E+00	2.8E+03
(10) m,p-Xylenes	NV	5.5E+02	NV	NV	2.4E+03	- -	- -	NV	NV	5.5E+02	0.0E+00	2.4E+03
Total Xylenes	5.6E+02	5.8E+02	2.4E+03	2.4E+03	2.5E+03	- -	- -	2.3E+02	1.8E+02	1.8E+02	1.8E+02	1.8E+02
Polycyclic Aromatic Hydrocarbons (PAHs)												
Acenaphthene	3.6E+03	3.6E+03	1.0E+04	4.5E+04	4.5E+04	1.9E+01	5.5E+00	NV	NV	5.5E+00	5.5E+00	5.5E+00
(11) Acenaphthylene	3.6E+03	3.6E+03	1.0E+04	4.5E+04	4.5E+04	1.3E+01	5.5E+00	NV	NV	5.5E+00	5.5E+00	5.5E+00
Anthracene	1.8E+04	1.8E+04	5.0E+04	2.3E+05	2.3E+05	2.8E+00	5.8E+01	NV	NV	2.8E+00	2.8E+00	2.8E+00
Benz(a)anthracene	1.6E-01	1.6E-01	1.6E+01	2.9E+00	2.9E+00	1.2E+01	4.2E-03	NV	NV	4.2E-03	4.2E-03	4.2E-03
Benzo(a)pyrene	1.6E-02	1.6E-02	1.6E+00	2.9E-01	2.9E-01	1.3E+02	4.0E-03	NV	NV	4.0E-03	4.0E-03	4.0E-03
Benzo(b)fluoranthene	1.6E-01	1.6E-01	1.6E+01	2.9E+00	2.9E+00	6.4E+02	4.1E-02	NV	NV	4.1E-02	4.1E-02	4.1E-02
Benzo(g,h,i)perylene	NV	NV	NV	NV	NV	2.7E+01	NV	NV	NV	2.7E+01	2.7E+01	2.7E+01
Benzo(k)fluoranthene	1.6E+00	1.6E+00	1.5E+02	2.9E+01	2.9E+01	3.7E+01	4.0E-01	NV	NV	4.0E-01	4.0E-01	4.0E-01
Chrysene	1.5E+01	1.6E+01	1.5E+03	2.6E+02	2.9E+02	2.3E+01	1.2E+00	NV	NV	1.2E+00	1.2E+00	1.2E+00
Dibenzo(a,h)anthracene	1.6E-02	1.6E-02	1.6E+00	2.9E-01	2.9E-01	1.4E+02	1.3E-02	NV	NV	1.3E-02	1.3E-02	1.3E-02
Fluoranthene	2.4E+03	2.4E+03	6.7E+03	3.0E+04	3.0E+04	6.0E+01	8.9E+01	NV	NV	6.0E+01	6.0E+01	6.0E+01
Fluorene	2.4E+03	2.4E+03	6.7E+03	3.0E+04	3.0E+04	8.9E+00	5.4E+00	NV	NV	5.4E+00	5.4E+00	5.4E+00
Indeno(1,2,3-cd)pyrene	1.6E-01	1.6E-01	1.6E+01	2.9E+00	2.9E+00	7.0E+01	1.3E-01	NV	NV	1.3E-01	1.3E-01	1.3E-01
Naphthalene	3.3E+00	3.8E+00	3.5E+02	1.4E+01	1.7E+01	- -	- -	1.8E+00	1.7E+00	1.7E+00	1.7E+00	1.7E+00
(12) Phenanthrene	1.8E+04	1.8E+04	5.0E+04	2.3E+05	2.3E+05	1.1E+01	5.8E+01	NV	NV	1.1E+01	1.1E+01	1.1E+01
Pyrene	1.8E+03	1.8E+03	5.0E+03	2.3E+04	2.3E+04	8.5E+01	1.3E+01	NV	NV	1.3E+01	1.3E+01	1.3E+01
Metals												
Lead	8.0E+01	8.0E+01	1.6E+02	3.2E+02	3.2E+02	NV	NV	NV	NV	8.0E+01	1.6E+02	3.2E+02

Notes:

C4-C12 = Carbon range.
ft bgs = feet below ground surface.
mg/kg = milligram per kilogram.
NV = No published value.
100X = One hundred times.
TBA = tert-Butyl alcohol.
MTBE = Methyl-tert-butyl ether.
TMB = Trimethylbenzene.
TPHg = TPH as gasoline.
USEPA RSL = U.S. Environmental Protection Agency Regional Screening Level (USEPA, 2016).
LARWQCB Soil SL = Los Angeles Regional Water Quality Control Board Soil Screening Level (LARWQCB, 1996).
DTSC SL = Department of Toxic Substances Control Screening Level (DTSC, 2016).
SFBRWQCB ESL = San Francisco Bay Regional Water Quality Control Board Environmental Screening Level (SFBRWQCB, 2016)

[1] SFBRWQCB ESLs for soil for direct contact exposure pathways. Screening levels for TPH (C5-C12), TPH (C13-C22), and TPH (C23-C44) represent ESLs for TPH gasoline (C5-C12), TPH diesel (C10-C24), and TPH motor oil (C24-C36), respectively

[2] USEPA RSLs/DTSC SLs for soil for direct contact exposure pathways represents the lowest of the available DTSC SL or USEPA RSL. Screening levels for TPH (C5-C12), TPH (C13-C22), and TPH (C23-C44) represent lowest of aliphatic and aromatic USEPA RSLs for TPH Low (C5-C8), TPH Middle (C9-C18), and TPH High (C17-C32), respectively.

[3] SFBRWQCB ESL respresents soil SL for protection of groundwater, assuming groundwater aquifer is not a source of drinking water. Screening levels for TPH (C5-C12), TPH (C13-C22), and TPH (C23-C44) represent ESLs for TPH gasoline (C5-C12), TPH diesel (C10-C24), and TPH motor oil (C24-C36), respectivel

[4] USEPA RSL respresents soil SL for protection of groundwater, assuming groundwater aquifer is not a source of drinking water. Screening levels for TPH (C5-C12), TPH (C13-C22), and TPH (C23-C44) represent lowest of aliphatic and aromatic USEPA RSLs for TPH Low (C5-C8), TPH Middle (C9-C18), and TPH High (C17-C32), respective

[5] LARWQCB SL respresents soil SL for protection of groundwater at 20 ft bgs, assuming groundwater aquifer is not a source of drinking water. As recommended by LARWQCB (1996), for non-drinking water aquifers, screening level for TPH carbon ranges represent the LARWQCB SLs for TPH where distance above groundwater is greater than 150 feet (>150 feet). Values from LARWQCB (1996) for PAHs were not available.

[6] As recommended by LARWQCB (1996), for non-drinking water aquifers, benzene, toluene, ethylbenzene, and xylene (BTEX) screening levels are set at 100 times (100X) respective maximum contaminant levels (MCLs) as preliminary levels to be protection of human health and the environment. This method was applied to all VOCs.

[7] Final screening level represents the lowest available screening level for each exposure scenario/receptor

[8] If screening level for tert-butyl alcohol was not available; therefore, the value for sec-butyl alcohol was used

[9] If screening level for 4-Isopropyltoluene was not available; therefore, the value for Isopropylbenzene was used.

[10] Screening level for m,p-xylenes represents the value for m-xylene.

[11] If screening level for acenaphthylene was not available; therefore, the value for acenaphthene was used.

[12] If screening level for phenanthrene was not available; therefore, the value for anthracene was used.

References:

DTSC. 2016. Human Health Risk Assessment (HHRA) Note Number 3, DTSC-modified Screening Levels (DTSC SLs). Human and Ecological Risk Office (HERO). June.
LARWQCB. 1996. Interim Site Assessment & Cleanup Guidebook. California Regional Water Quality Control Board, Los Angeles and Ventura Counties, Region 4. May 1996.
SFBRWQCB. 2016. Environmental Screening Levels (ESLS). San Francisco Bay Regional Water Quality Control Board. Revision 3. February.
USEPA. 2016. Regional Screening Levels (TR=1E-06, HQ=1). May.

Table 4-2
Summary of Soil Vapor Screening Levels
Former ChemOil Refinery
Signal Hill, California

Chemical	Vapor Intrusion to Indoor Air [6]				Site-Specific, Risk-Based Screening Levels [3]	
	Residential		Commercial/Industrial		Residential	Commercial/ Industrial
	SFBRWQCB ESL [1] µg/m^3	USEPA RSL/DTSC SL [2] µg/m^3	SFBRWQCB ESL [1] µg/m^3	USEPA RSL/DTSC SL [2] µg/m^3	µg/m^3	µg/m^3
Volatile Organic Compounds (VOCs)						
Benzene	48	97	420	840	104	909
Cyclohexane	NV	6,300,000	NV	52,000,000	7,226,599	60,703,429
Ethylbenzene	560	1,100	4,900	9,800	1,438	12,565
(4) 4-Ethyltoluene	NV	420,000	NV	3,600,000	367,842	3,089,871
(5) Heptane	NV	730,000	NV	6,200,000	894,431	7,513,217
n-Hexane	NV	730,000	NV	6,200,000	894,431	7,513,217
MTBE	5,400	11,000	47,000	94,000	12,970	113,307
Naphthalene	41	83	360	720	115	1,006
Toluene	160,000	310,000	1,300,000	2,600,000	367,842	3,089,871
1,2,4-TMB	NV	7,300	NV	62,000	10,168	85,410
1,3,5-TMB	NV	42,000	NV	360,000	51,110	429,320
m,p-Xylenes	NV	100,000	NV	880,000	133,688	1,122,976
o-Xylene	NV	100,000	NV	880,000	132,951	1,116,790
Total Xylenes	52,000	100,000	440,000	880,000	132,951	1,116,790

Notes:

µg/m^3

NV = No published value.

SFBRWQCB ESL = San Francisco Bay Regional Water Quality Control Board Environmental Screening Level (SFBRWQCB, 2016)

USEPA RSL = U.S. Environmental Protection Agency Regional Screening Level (USEPA, 2016).

DTSC SL = Department of Toxic Substances Control Screening Level (DTSC, 2016).

MTBE = Methyl-tert-butyl ether.

TMB = Trimethylbenzene.

[1] SFBRWQCB ESLs for soil gas vapor intrusion for residential and commercial/industrial land use.

[2] USEPA RSLs/DTSC SLs soil gas screening level is calculated by dividing the air screening level for residential air and industrial air by the DTSC (011) default attenuation factor for new building construction of 0.001 and 0.0005, respectively. The most stringent (i.e. lowest) indoor air screening level from DSTC SLs (DTSC, 2016) and USEPA RSLs (USEPA, 2016) was used.

[3] Site-specific risk-based screening levels are calculated from Site vapor intrusion modeling and are based on five foot depth of compliance.

[4] Screening level for 4-ethyltoluene was not available; therefore, the value for isopropylbenzene was used.

[5] Screening level for heptane was not available; therefore, the value for hexane was used.

[6] Vapor intrusion to indoor air values from SFBRWQCB ESLs and USEPA RSLs/DTSC SLs were not selected as the Site screening levels; however, they are shown for comparision purposes.

References:

DTSC. 2011. Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air. California Environmental Protection Agency. October.
DTSC. 2016. Human Health Risk Assessment (HHRA) Note Number 3, DTSC-modified Screening Levels (DTSC SLs). Human and Ecological Risk Office (HERO). June.
SFBRWQCB. 2016. Environmental Screening Levels (ESLS). San Francisco Bay Regional Water Quality Control Board. Revision 3. February.
USEPA. 2016. Regional Screening Levels (TR=1E-06, HQ=1). May.

Table 4-3
Summary of Groundwater Screening Levels
Former ChemOil Refinery
Signal Hill, California

Chemical	Groundwater Vapor Intrusion [1]		Final Screening Levels [2]			Long-Term Groundwater Goal
	Residential	**Commercial/Industrial**	**Residential**	**Construction**	**Commercial/ Industrial**	**Drinking Water Standards [3,4]**
	SFBRWQCB ESL (µg/L)	SFBRWQCB ESL (µg/L)	(µg/L)	(µg/L)	(µg/L)	California MCL/ *Notification Level* (µg/L)
Total Petroleum Hydrocarbons (TPH)						
TPHg (C4-C12)	NV	NV	NV	NV	NV	1.0E+02
TPH (C5-C12)	NV	NV	NV	NV	NV	1.0E+02
TPH (C13-C22)	NV	NV	NV	NV	NV	1.0E+02
TPH (C23-C44)	NV	NV	NV	NV	NV	5.0E+04
Volatile Organic Compounds (VOCs)						
Acetone	4.5E+07	3.7E+08	4.5E+07	NV	3.7E+08	NV
Benzene	1.4E+00	1.2E+01	1.4E+00	NV	1.2E+01	1.0E+00
TBA	NV	NV	NV	NV	NV	*1.2E+01*
sec-Butylbenzene	NV	NV	NV	NV	NV	*2.6E+02*
tert-Butylbenzene	NV	NV	NV	NV	NV	*2.6E+02*
n-Butylbenzene	NV	NV	NV	NV	NV	*2.6E+02*
1,2-Dichloroethane	7.4E+00	6.4E+01	7.4E+00	NV	6.4E+01	5.0E-01
cis-1,2-Dichloroethene	1.4E+02	1.1E+03	1.4E+02	NV	1.1E+03	6.0E+00
Ethylbenzene	1.6E+01	1.4E+02	1.6E+01	NV	1.4E+02	3.0E+02
Isopropylbenzene	NV	NV	NV	NV	NV	*7.7E+02*
4-Isopropyltoluene	NV	NV	NV	NV	NV	NV
Naphthalene	2.5E+01	2.2E+02	2.5E+01	NV	2.2E+02	*1.7E+01*
n-Propylbenzene	NV	NV	NV	NV	NV	*2.6E+02*
Tetrachloroethylene	3.7E+00	3.2E+01	3.7E+00	NV	3.2E+01	5.0E+00
Toluene	4.3E+03	3.7E+04	4.3E+03	NV	3.7E+04	1.5E+02
1,3,5-TMB	NV	NV	NV	NV	NV	*3.3E+02*
1,2,4-TMB	NV	NV	NV	NV	NV	*3.3E+02*
2-Butanone (MEK)	5.5E+06	4.6E+07	5.5E+06	NV	4.6E+07	NV
MTBE	1.5E+03	1.3E+04	1.5E+03	NV	1.3E+04	1.3E+01
o-Xylene	1.6E+03	1.3E+04	NV	NV	NV	1.8E+03
m,p-Xylenes	1.6E+03	1.3E+04	NV	NV	NV	1.8E+03
total Xylenes	1.6E+03	1.3E+04	1.6E+03	NV	1.3E+04	1.8E+03
Polycyclic Aromatic Hydrocarbons (PAHs						
Acenaphthene	NV	NV	NV	NV	NV	NV
Acenaphthylene	NV	NV	NV	NV	NV	NV
Anthracene	NV	NV	NV	NV	NV	NV
Benz(a)anthracene	NV	NV	NV	NV	NV	NV
Benzo(a)pyrene	NV	NV	NV	NV	NV	2.0E-01
Benzo(b)fluoranthene	NV	NV	NV	NV	NV	NV
Benzo(g,h,i)perylene	NV	NV	NV	NV	NV	NV
Benzo(k)fluoranthene	NV	NV	NV	NV	NV	NV
Chrysene	NV	NV	NV	NV	NV	NV
Dibenzo(a,h)anthracene	NV	NV	NV	NV	NV	NV
Fluoranthene	NV	NV	NV	NV	NV	NV
Fluorene	NV	NV	NV	NV	NV	NV
Indeno(1,2,3-cd)pyrene	NV	NV	NV	NV	NV	NV
Naphthalene	2.5E+01	2.2E+02	2.5E+01	NV	2.2E+02	*1.7E+01*
Phenanthrene	NV	NV	NV	NV	NV	NV
Pyrene	NV	NV	NV	NV	NV	NV

Notes:

µg/L = microgram per liter.

MCL = Maximum Contaminant Level.

NV = No value published.

SFBRWQCB ESL = San Francisco Bay Regional Water Quality Control Board Groundwater Screening Level for Vapor Intrusion (SFBRWQCB, 2016).

C4-C12 = Carbon range.
MEK = Methyl ethyl ketone.
TMB = Trimethylbenzene.
TBA = tert-Butyl alcohol.
MTBE = Methyl-t-butyl ether.
TPHg = TPH as gasoline.

[1] SFBRWQCB ESL for groundwater vapor intrusion, assuming deep groundwater (≥10 feet bgs), sand scenario for resident and commercial/industrial land use. No values for TPH mixtures were available.

[2] Final screening level represents the lowest available groundwater screening level for vapor intrusion for each exposure scenario/receptor.

[3] California MCLs are enforceable standards. California notification levels shown in italic font. Notification levels are advisory in nature and not enforceable standards. No values for TPH mixtures were available

[4] In the absence of MCLs or notification levels for TPH mixtures, the lesser of the SFBRWQCB ESLs for groundwater gross contamination level and groundwater odor nuisance level was used. For TPH (C4-C12) and TPH (C5-C12), the odor nuisance level for TPH as gasoline was used. For TPH (C13-C22), the odor nuisance level for TPH as diesel was used. For TPH (C23-C44), the gross contamination level for TPH as motor oil was used.

References:

SFBRWQCB. 2016. Environmental Screening Levels (ESLS). San Francisco Bay Regional Water Quality Control Board. Revision 3. February.

TABLE 6-1
INITIAL TECHNOLOGY SCREENING

Former Chemoil Refinery
Soil and Groundwater Remediation
2020 Walnut Avenue, Signal Hill, California

Remedial Action Alternative	General Approach	Implementability	Effectiveness	Relative Cost	Applicable Site Media	Retain or Reject
Overall Site Management						
No Action	No Action	Good	None	None	None	Reject
Institutional & Engineering Controls	Incorporate Institutional and Engineering Controls during site development	Good, Engineering Controls can be installed during site development and will reduce risk of soil vapor exposure. Institutional Controls will reduce risk of exposure to groundwater and direct soil contact.	Good. Engineering and Institutional Controls have been proven to reduce exposure risks.	Low to moderate- depending on Engineering Controls employed.	Groundwater, Soil Vapor, Soils - By reducing exposure risk	Retain, will be used in conjunction with active remedial technologies during site development and future land use.
Monitored Natural Attenuation	Monitor groundwater conditions. Verify progress of natural biological degradation over time.	Good. Low cost option. Monitoring can be accomplished via exisitng wells.	Poor. Natural attenuation will require many years to be achieve RAOs.	Low. Costs are limited to periodic well sampling and laboratory analysis.	Groundwater, Soil Vapor, Soils - by biological degradation.	Retain, will be used in conjunction with active remedial technologies during site development and future land use.
In-Situ Treatment Options						
Air Sparging	Air injection into subsurface via compressor(s) injecting air into separate AS wells.	Good, AS is well understood and equipment is readily available.	Good - Air can strip volatile chemicals from groundwater. Bioremediation (by injecting oxygen) will be stimulated for TPH.	Moderate. Moderate capital and low operations and maintenance (O&M) costs.	Groundwater	Retain
Bioventing	Low pressure air injection into subsurface to stimulate natural biological attenuation over time.	Moderate. Will require additonal well points to introduce air. Alternatively, atmopheric air will enter vadose zone due to vacuum pressure caused by SVE.	Moderate. Introducing air will stimulate aerobic conditions and biological degradation.	Moderate. Additional wells and system to introduce air vadose zone will need to be operated.	Soils, soil vapor	Retain, consider additional benefit from SVE and air sparging
Chemical Oxidation	Generate on-site oxidation agent and inject into subsurface. Destroys CoCs be direct contact with oxidation agent.	Moderate. Would require numerous injection points, multiple injection events, and high amounts of oxidant over very large area.	Limited, interbedded sands and silts would lead to preferential pathways, preventing direct contact with all contaminants.	High. Oxidant generation equipment is relatively low cost, but would require extensive injection wells and conveyance piping with potentially high O&M.	Groundwater, soil vapor, adsorbed CoCs on soil particles	Reject as initial selection, may become option if AS system proves ineffective.
Soil Vapor Extraction	Extraction of subsurface vapor and contaminants for above ground treatment.	Good. Slower removal of low volatility hydrocarbons. Would use readily available remediation systems.	Good in unsaturated zone. SVE with Air Sparging (within flow through barrier) will accelerate effectiveness in groundwater.	Moderate. Moderate capital and low O&M costs.	Groundwater, soil vapor, adsorbed CoCs on soil particles	Retain
Thermal Enhanced Soil Vapor Extraction	Combine SVE with in-situ heating of subsurface soils	Moderate. Uses heating electrodes which require large amounts of energy (electricity or natural gas) to volatilize CoCs, and also requires steam and vapor recovery systems.	Accelerated treatment. Heat conducts preferentially in fine-grained soils.	Very high capital and utility costs. Much higher costs than SVE alone.	Groundwater, soil vapor, adsorbed CoCs on soil particles.	Reject, due to high cost and utility demands.
Light Non- Aquous Phase Liquid Removal	Remove LNAPL directly while minimizing groundwater removal	Moderate. Equipment is readiliy available. LNAPL has been observed to recharge slowly into extaction wells at the site.	Moderate. Slow recharge of LNAPL into wells indicates removal will take significant time.	Moderate. Equipment costs are moderate, O&M costs are relatively low.	Groundwater	Retain
Ex-Situ Treatment Options						
Dissolved Phase Groundwater Extraction	Extract groundwater via multiple wells and treat water above ground. Treated water would be discharged to local storm drain.	Moderate. Equipment is readiliy available. Low concentrations of CoCs in groundwater would lead to slow removal of CoCs.	Moderate. Substantial volumes of groundwater would be removed with low corresponding mass of CoCs due to low concentrations in groundwater.	High capital costs. Substantial volumes of groundwater would have to be removed, treated and discharged. Removed mass of CoCs would be very low compared to water discharged.	Groundwater	Reject
Excavation and Off-Site Disposal	Excavate impacted soils and transport to appropriate disposal facility.	Moderate. Excavation is practical, large volumes would generate substantial local traffic for soil transportation and replacement backfill.	Good- Would remove contaminants within excavations.	Very high due local traffic impacts, large volumes, and treatment/disposal costs.	Soil and Soil Vapor, excavation below groundwater not practical	Retain
Excavation and Enhanced On-site Bioremediation	Excavate impacted soils and treat on-site with vapor and sufactant enhanced bioremediation.	Moderate. Excavation is practical, lack of abundant local space (not being excavated) on-site makes construction of bioremediation infrastructure impractical.	Good- Would remove contaminants within excavations.	High, excavation and soil treatment costs as well as analytical costs to verify soil treatment. Needs abundant surface space to set-up treatment area.	Soil and Soil Vapor, excavation below groundwater not practical	Reject, due to time constraints & potential 1166 issues.

TABLE 7-1
ANALYSIS OF RETAINED RESPONSE ACTION TECHNOLOGIES
Former Chemoil Refinery
Soil and Groundwater Remediation
2020 Walnut Avenue, Signal Hill, California

Response Action Alternative	Description	Overall Protection of Human Health and the Environment	Compliance with Remedial Action Objectives (RAOs)	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume	Short-Term Effectiveness (STE)	Implementability	Costs	State Acceptance	Community Acceptance
GROUNDWATER RESPONSE ACTION ALTERNATIVES										
Alternative1: Air Sparging	In-situ remedial treatment of hydrocarbon compounds in groundwater. Air sparge in groundwater plume to strip TPH and inject oxygen to enhance natural bacteria degradation of hydrocarbons. Air sparge not recommended in source area onsite due to the presence of LNAPL however can be installed along the downgradient boundary of the property to mitigate off-site migration of dissolved TPH. SVE wells will be required in conjunction with air sparge technology.	**GOOD** This action addresses the dissoved hydrocarbons to protect off-site human and ecological receptors. There is potential for air sparging to increase risk of inhalation exposure by off-gassing volatile contaminants; therefore SVE should be inplemented in conjunction with our sparging.	**GOOD** This action complies with the RAO to prevent further migration of contaminants offsite.	**GOOD** Combined sparging and vapor extraction will mobilize contaminents from groundwater for removal from subsurface and treatment with aboveground equipment. The addition of oxygen through air sparging also promotes biodegradation of petroleum constituents. Degradation will continue after active injection activities.	**GOOD** Reduces mobile (volatile) constituents in groundwater, decreases the hydrocarbon mass, and degrades organic compounds to less to non-toxic daughter products. Organic contaminant reduction will continue to occur slowly by intrinsic biodegradation, adsorption, and dispersion over a long period.	**MODERATE** Quickly removes most volatile constituents. Over time less volatile organic compounds are degraded.	**GOOD** This alternative uses proven technology and required equipment is readily available from local suppliers. Requires installation of additional remediation and monitoring wells within the downgradient boundary to create flow through barrier. Requires installation of aboveground or underground horizontal conveyance piping.	**MODERATE** Primary costs are remediation wells, equipment for supplying oxygen to the subsurface, above ground vapor treatment equipment, operation and maintenance of equipment, and monitoring. Energy costs are moderate to operate equipment. Operational and monitoring costs would extent for a relatively long time, depending on natural degradation rates of source hydrocarbons contributing to dissolved TPH plume.	**LIKELY** Approach adds protection of human health and environment through the removal of contaminants with proven technologies.	**LIKELY** A proven technology for petroleum constituents which will provide protection to off-site, down gradient residents and sesitive receptors over time.
Altenative 2: LNAPL Removal	Extract LNAPL hydrocarbon compounds on groundwater surface by mechanical means. At least one recovery well and dedicated LNAPL removal system will be installed at each LNAPL deposit identified. Removed product and incidental water will be temporarily stored in above ground tank and then transported off-site (under manifest) to appropriate local recycling facility.	**GOOD** This action removes free product that provides source material for on-going dissolved TPH in groundwater. Active remediation to protect human and ecological receptors. Goundwater will be improved.	**GOOD** This action complies with the RAOs to remove LNAPL to the extent practicable.	**GOOD** Reduces source material contributing to groundwater impacts.	**VERY GOOD** Decreases the hydrocarbon mass. Residual contaminants will decrease by intrinsic biodegradation, adsorption, and dispersion over a period of time.	**MODERATE** Removes hydrocarbon mass relatively quickly. A downgradient treatment barrier will be required to prevent offiste migration until LNAPL removal is complete.	**VERY GOOD** This alternative uses proven, reliable technology. Requires installation of a recovery well within the LNAPL deposit. Requires installation of aboveground temporary storage tank.	**LOW** Short-term costs are very low compared to other remedial systems. Monitoring costs would extend for a period of time, depending on natural degradation rates of residual hydrocarbons.	**LIKELY** Approach adds protection of human health and environment through the removal of contaminants with proven technologies.	**LIKELY** Provides added protection to local environment over relatively short time. Recycling of recovered product is desired condition during remediation.
Alternative 3: Monitored Natural Attenuation (MNA)	Long-term monitoring of groundwater. Onsite MNA is not currently applicable due to the requirement for active remediation to remove secondary sources. Offsite MNA should be considered downgradient from the site during and following active onsite remediation.	**GOOD** Implemented downgradient from the site, this action would indicate if groundwater concentrations were increasing to unacceptable levels.	**MODERATE** Will confirm RAO that down gradient groundwater plume does not pose a risk to human health or the envrionment.	**MODERATE** Natural attenuation progresses slowly, but has been proven to be effective for TPH contaminants.	**POOR** Natural attenuation reduces toxicity very slowly and has no significant impact on reducing mobility.	**MODERATE** MNA is being considered for a portion of the groundwater plume that does not pose a risk to human health or the envrionment. This method will be effective in determing whether subsurface conditions change.	**GOOD** Groundwater monitoring for COCs is already being implemented to confirm effectiveness of remediation efforts to reduce off-site migration of CoCs and natual attentuation of residual contaminants.	**LOW** Longterm monitoring itself is a relatively low cost.	**Likely** Approach when combined with other response actions is protective of human health and environment, providing protection to off-site groundwater.	**Likely** Provides confirmation of protection of off-site receptors.

TABLE 7-1
ANALYSIS OF RETAINED RESPONSE ACTION TECHNOLOGIES
Former Chemoil Refinery
Soil and Groundwater Remediation
2020 Walnut Avenue, Signal Hill, California

Response Action Alternative	Description	Overall Protection of Human Health and the Environment	Compliance with Remedial Action Objectives (RAOs)	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume	Short-Term Effectiveness (STE)	Implementability	Costs	State Acceptance	Community Acceptance
SOIL AND SOIL VAPOR RESPONSE ACTION ALTERNATIVES										
Alternative 4: Excavation and Offsite Disposal	Excavation of portions of impacted soils (i.e., soils exceeding the screening levels) in the upper ten feet of the vadose zone with normal excavation equipment, disposal and/or treatment of excavated soils off-site, import of "clean" soil for backfill.	**VERY GOOD** This approach is considered the most reliable to remove subsurface contamination. Remediation would be accomplished within one year.	**GOOD** Provides significant mass removal and capping of residual contaminants. Although presence of residual contaminants in lower vadose zone saturated zone will require additional response actions to achieve RAOs.	**VERY GOOD** Provides substantial mass removal of contaminants and capping of residual contaminants which reduces exposure risk to future site occupants.	**MODERATE TO GOOD** Remediation of soil by removal and off-site treatment or containment at approved facility effectively cleans up contaminant impacts, eliminating mass and reducing mobility of contaminants. However, based on the scope assumed in this cost estimate, vadose zone soil would remtain in place below the assumed excavation depth of ten feet below grade.	**VERY GOOD** Remediation effort will have immediate results for hydrocarbon removal from the site. Equipment and transportation related emissions will have short-term increase as will the potential for exposure from volatization and fugitive dust during the excavation and handling of soil. Compliance with local air regulations, permitting and safety protocols will be required.	**VERY GOOD** Easily implemented while this site is vacant and using conventional equipment. Space at the site will ease soil management and loading for transporation. Excavation below water table with is considered impractical due to saturated soils difficulty dewatewring impacted groundwater. Substantial truck traffic generated to remove and replace soil with imported backfill will be disruptive to local residents.	**VERY HIGH** Short-term costs are relatively high due to labor, equipment, transportation and disposal.	**Likely** Approach is highly protective of human health and environment, providing protection to groundwater.	**Likely** Soil remediation achieved through excavation is established technology. Provides protection of groundwater and environmental receptors.
Alternative 5: Soil Vapor Extraction	In-situ remedial treatment of hydrocarbon compounds in soil. SVE to both removal TPH mass and stimulate bioventing. SVE well points can be installed within specific source areas of concern for mass removal.	**GOOD** This action enhances the previously observed natural degradation and effectiveness of SVE that is occuring at the site to protect human and ecological receptors.	**GOOD** This action complies with RAO to remove contaminant mass in vadose zone.	**MODERATE** Mass removal will effectively reduce source of groundwater contamination. The addition of oxygen for enhanced intrinsic biodegradation is applicable to organic constituents. Injection of air may follow preferential pathways and not contact all areas of contamination.	**GOOD** Decreases the hydrocarbon mass and degrades organic compounds to less to non-toxic daughter products. Will enhance the intrinsic biodegradation, adsorption, and dispersion.	**MODERATE** Enances current SVE mass removal activities and stimulates naturally occuring hydrocarbon bio-degradation.	**GOOD** This alternative uses proven technology and required equipment is readily available from local suppliers. Requires installation of additional remediation and monitoring wells in and around treatment areas. Requires installation of aboveground or underground horizontal conveyance piping. Both the mass removal by vapor extraction and aerobic enhancement approach is applicable to hydrocarbon constituents.	**MODERATE** Primary costs are remediation wells, abtatement equipment for treating extracted vapors, equipment for supplying oxygen to the subsurface, operation and maintenance of equipment, and monitoring. Energy costs are moderate to operate equipment. Operational and monitoring costs would extent for a relatively long time, depending on natural degradation rates of hydrocarbons.	**LIKELY** Approach adds protection of human health and environment through the removal of contaminants with proven technologies.	**LIKELY** Provides added protection to local environment over time. Ongoing remediation and IECs would have moderate impacts on future use of the property.
OVERALL SITE MANAGEMENT RESPONSE ACTION ALTERNATIVES										
Alternative 6: Implement Engineering and Institutional Controls	- Cap site with buildings, pavement, or clean soil - Reduce vapor intrusion concerns with vapor barrier and sub-surface depressurization beneath future buildings - Restrict on-site land use through land use covenant (LUC) - Prepare Site Management Plan associated with LUC - Prepare soil management plan to provide guidance during Site redevelopment	**GOOD** This approach would remove the most highly impacted soils and reduce exposure risk to residual contaminants. IECs would be necessary as significant contamination mass would be left in place and capped by backfill or other barriers. Anticipate long-term monitoring following implementation and other remediation measures to address potential off-site migration of CoCs.	**GOOD** Complies. Management, safety, and monitoring plans are required to address excavated soil handling and on-going exposure minimization measures (IECs). Site Management Plan For IEC inspections an maintenance is also required.	**MODERATE** Reduces risk of exposure to future site occupants from residual on-site contaminants.	**MODERATE** Remediation of highest impacted soil by removal reduces contaminant mass. Remediation of residual dissolved contaminants in groundwater by natural attenuation also eliminates chemical toxicity, mobility, and volume of groundwater plume. Capping the residual contamination in soil and implementing IECs will reduce exposure risks for future site occupants.	**MODERATE** Remediation effort will have immediate results for partial hydrocarbon removal from the site. Equipment and on-site treatment related emissions will have short-term increase as will the potential for exposure from volatization, fugitive dust during the excavation and handling of soil. Compliance with local air regulations, coastal permitting and safety protocols will be required.	**GOOD** Soil capping and soil vapor barriers are a readily available and understood technology. Imported soil will be transported to the site per local authority guidelines. Groundwater monitoring for COCs required for longterm term to confirm eeffectiveness of remediation efforts to reduce off-site migration of CoCs and natual attentuation of residual contaminants.	**MODERATE** Short-term costs are moderately high due to labor and equipment during both soil removal and installing engineering controls during building construction. Longterm monitoring and O&M of IECs and groundwater management systems(s) to prevent off-site migration of CoCs are also a significant cost.	**Likely** Approach is protective of human health and environment, providing protection to off-site groundwater.	**Likely** Provides protection of off-site groundwater and on-site receptors. Engine emissions and fugitive dust will be mitigated through construction management requirements. Short term traffic impacts during soil removal and backfill delivery. Ongoing longterm monitoring and IECs would impact future use of the property.

TABLE 7-2
TECHNOLOGY ALTERNATIVES COST COMPARISON
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

ESTIMATED TOTAL AND UNIT COSTS						
Technology Alternative	**1 - AS & SVE - Flow Through Barrier**	**2 - LNAPL Recovery**	**3 - Monitored Natural Attenuation**	**4 - On-site SVE**	**5 - Institutional & Engineering Controls**	**6 - Excavate & Off-site Disposal** Note 1
Capital Costs						
Drill and install wells for 1) on-site SVE and 2) AS and SVE Flow Through Barrier	$125,000	--	$50,000	$205,000	--	--
Purchase and installation of AS and SVE system	$250,000	--	--	$250,000	--	--
Drill and install three (3) LNAPL recovery wells at $5,000 each	--	$15,000	--	--	--	--
Install conveyance piping for AS and SVE (6,800 ft for on-site SVE and (2,300 ft for barrier) at $30 / ft	$69,000	--	--	$204,000	--	--
Utility service connection (electrical and/or natural gas)	$75,000	$5,000	--	$75,000	--	--
Purchase, deliver, and install three (3) Subsurface Skimmer Units at $14,000 each	--	$42,000	--	--	--	--
Install Geo-Seal™ (116,000 ft^2 building footprints at $4 / ft)	--	--	--	--	$464,000	--
Soil excavation and loading (56,000 yd^3 in place at $51.10 / yd^3)	--	--	--	--	--	$2,861,600
Soil transport and disposal (84,000 tons at $78.90 / ton)	--	--	--	--	--	$6,626,600
Total Capital Costs	**$519,000**	**$62,000**	**$50,000**	**$734,000**	**$464,000**	**$9,488,200**
O&M						
Engineered controls annual inspections and maintenance (For 10 years at $8,000 / year - includes indoor air sampling)	--	--	--	--	$80,000	--
LNAPL transport and recycling - estimate includes 1,000 gals at each LNAPL recovery well, manifest fees and trucking (For 5 years at $2,500 / year)	--	$12,500	--	--	--	--
Annual utility usage: -electrical ($0.14 / KWh); and/or -natural gas ($1.15 / therm)	$175,000	$600	--	$225,000	--	--
Long-term monitoring, natural attenuation residual TPH (10 years)	--	--	$800,000	--	--	--
SVE and Flow Through Barrier AS and SVE O&M (Weekly for 4 years at $200,000 / year, split between systems)	$400,000	--	--	$400,000	--	--
Total O&M Costs	**$575,000**	**$13,100**	**$800,000**	**$625,000**	**$80,000**	**$0**
Total Costs						
Total Cost (Capital and O&M)	**$1,094,000**	**$75,100**	**$850,000**	**$1,359,000**	**$544,000**	**$9,488,200**
Total Cost **(Excludes excavation & off-site disposal)**	**$3,922,100**					--

Notes:

AS = Air sparge	ft^2 = Square foot
SVE = Soil vapor extraction	yd^3 = Cubic yard
LNAPL = Light non-aqueous phase liquid.	O&M = Operations & maintenance
ft = Foot	kWh = kilowatt-hour

Note 1 Technology identified in shaded column was not selected for final proposed Response Actions.

APPENDIX A

HISTORICAL ANALYTICAL DATA – SOIL, SOIL VAPOR, AND GROUNDWATER

HISTORICAL SOIL DATA

NORTHWEST AND SOUTHWEST PARCELS

Table A-1

Summary of Soil Analytical Results - Hydrocarbon Chain Characterization, Northwest and Southwest Parcels

Former ChemOil Refinery
Signal Hill, California

Boring	Sample Date	Depth	Hydrocarbon Chain Identification																TPH (C5-C12)$^{\text{Note 1}}$	TPH (C13-C22)$^{\text{Note 2}}$	TPH (C23-C44)$^{\text{Note 3}}$
		ft bgs	C6-C8 mg/kg	C8-C10 mg/kg	C10-C12 mg/kg	C12-C14 mg/kg	C14-C16 mg/kg	C16-C18 mg/kg	C18-C20 mg/kg	C20-C22 mg/kg	C22-C24 mg/kg	C24-C26 mg/kg	C26-C28 mg/kg	C28-C32 mg/kg	C32-C34 mg/kg	C34-C36 mg/kg	C36-C40 mg/kg	C40-C44 mg/kg	mg/kg	mg/kg	mg/kg
Final Screening Level ^{4} Soil Commerical/Industrial			**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**420**	**440**	**33,000**
NORTHWEST PARCEL																					
AN-01	1/4/2017	10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0	<5.0	<8.0
	1/4/2017	20	<1.0	<1.0	<1.0	**2.0**	**1.1**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0	**2.1**	<8.0
AN-02	1/4/2017	6.5	<50	<50	**430**	**1,600**	**2,000**	**1,300**	**880**	**1,800**	**2,900**	**4,200**	**5,000**	**8,700**	**2,100**	**1,600**	**1,800**	**1,400**	**430**	**6,780**	**26,250**
	1/4/2017	10	<1.0	<1.0	<1.0	**1.7**	**1.9**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0	**2.8**	<8.0
	1/4/2017	30	**6.0**	**70**	**140**	**170**	**120**	**64**	**36**	**10**	**6.7**	**3.4**	**1.3**	**1.7**	<1.0	<1.0	<1.0	<1.0	**216**	**315**	**10**
AN-03	1/5/2017	5.5	**260**	**3,100**	**2,700**	**810**	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	**6,060**	**405**	<400
	1/5/2017	10	**46**	**650**	**750**	**320**	**23**	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**1,446**	**183**	<80
	1/5/2017	20.5	**2.6**	**84**	**140**	**51**	**1.4**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**227**	**27**	<8.0
AN-05	1/5/2017	5	**380**	**930**	**1,700**	**1,700**	**3,000**	**2,600**	**1,400**	**1,200**	**780**	**200**	**140**	**140**	**22**	**11**	<10	<10	**3,010**	**9,050**	**892**
	1/5/2017	10	**4.9**	**33**	**92**	**92**	**59**	**49**	**23**	**21**	**13**	**6.0**	**6.4**	**5.7**	<1.0	<1.0	<1.0	<1.0	**130**	**198**	**25**
	1/5/2017	20	<1.0	**10**	**31**	**43**	**25**	**9.3**	**6.3**	**4.9**	**2.8**	**2.6**	**1.6**	**2.8**	<1.0	<1.0	<1.0	<1.0	**41**	**67**	**8**
AN-13	1/9/2017	5.5	**23**	**150**	**890**	**1,400**	**1,200**	**790**	**640**	**210**	**120**	**72**	**13**	**12**	<10	<10	<10	<10	**1,063**	**3,540**	**157**
	1/9/2017	9	**680**	**810**	**3,100**	**4,900**	**3,800**	**2,600**	**1,800**	**840**	**430**	**220**	**44**	**24**	<10	<10	<10	<10	**4,590**	**11,490**	**503**
	1/9/2017	15	**310**	**610**	**1,600**	**2,300**	**1,700**	**970**	**700**	**330**	**160**	**93**	**21**	**18**	<10	<10	<10	<10	**2,520**	**4,850**	**212**
	1/9/2017	20	**28**	**170**	**390**	**550**	**440**	**250**	**190**	**97**	**40**	**22**	<10	<10	<10	<10	<10	<10	**588**	**1,252**	**42**
AN-20	1/18/2017	8	**100**	**760**	**430**	**92**	<10	<10	<10	<10	<10	<10	<10	**16**	**10**	<10	**10**	<10	**1,290**	**46**	**36**
	1/18/2017	10	**24**	**230**	**78**	**7.3**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**332**	**3.7**	<8.0
	1/18/2017	15	**31**	**450**	**210**	**24**	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**691**	**12**	<80
	1/18/2017	20	**16**	**320**	**140**	**14**	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**476**	**7**	<80
AN-22	5/18/2017	4.5	<1.0	**24**	**88**	**62**	**6.0**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**112**	**37**	<8.0
AN-22a	5/18/2017	10	**620**	**2,400**	**2,500**	**1,100**	**62**	**7.0**	<5.0	<5.0	<5.0	<5.0	<5.0	**5.9**	<5.0	<5.0	<5.0	<5.0	**5,520**	**619**	**5.9**
SB1	5/16/2006	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**3,112**	**14,726**	**1,053**
	5/16/2006	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**440**	**3,731**	**231**
	5/16/2006	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2,410**	**4,567**	**185**
	5/16/2006	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1,958**	**3,614**	**147**
	5/16/2006	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2,243**	**6,048**	**268**
	5/16/2006	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1,562**	**561**	**17**
	5/16/2006	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1,296**	**1,910**	**71**
SB-2	5/15/2016	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2,592**	**6,314**	**7,337**
	5/15/2016	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<4.5	<25	<48
	5/15/2016	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<4.5	<25	<48
	5/15/2016	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<4.5	<25	<48
	5/15/2016	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**3.2**	<25	<48
	5/15/2016	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2.7**	<25	<48
	5/15/2016	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**3,252**	**2,931**	**30**
SB-4	5/16/2016	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**11,782**	**1,052**	<48
	5/16/2016	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**3,134**	**401**	<48
	5/16/2016	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**6,737**	**457**	<48
	5/16/2016	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**5,814**	**462**	<48
	5/16/2016	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1,752**	**638**	<48
	5/16/2016	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**3,799**	**363**	<48
	5/16/2016	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**11,840**	**4,942**	<238
	5/16/2016	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**5,769**	**594**	<48

Table A-1
Summary of Soil Analytical Results - Hydrocarbon Chain Characterization, Northwest and Southwest Parcels
Former ChemOil Refinery
Signal Hill, California

Boring	Sample Date	Depth	Hydrocarbon Chain Identification																TPH (C5-C12)[Note 1]	TPH (C13-C22)[Note 2]	TPH (C23-C44)[Note 3]
			C6-C8	C8-C10	C10-C12	C12-C14	C14-C16	C16-C18	C18-C20	C20-C22	C22-C24	C24-C26	C26-C28	C28-C32	C32-C34	C34-C36	C36-C40	C40-C44			
		ft bgs	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Final Screening Level [4] Soil Commerical/Industrial			**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**420**	**440**	**33,000**
SOUTHWEST PARCEL																					
MW-20	1/10/2017	7	<1.0	**17**	**24**	**30**	**35**	**32**	**30**	**22**	**17**	**16**	**15**	**31**	**13**	**6.6**	**16**	**5.1**	**41**	**134**	**111**
	1/10/2017	11	<5.0	**130**	**230**	**310**	**250**	**230**	**230**	**160**	**160**	**130**	**140**	**320**	**130**	**68**	**140**	**81**	**360**	**1,025**	**1,089**
	1/10/2017	19	<10	**390**	**1,200**	**2,000**	**1,600**	**1,200**	**840**	**400**	**180**	**120**	**51**	**71**	**16**	**12**	**10**	<10	**1,590**	**5,040**	**370**
SB-3	5/15/2016	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2,939**	**5,094**	**1,375**
	5/15/2016	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1,124**	**335**	**16**
	5/15/2016	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**7,026**	**3,014**	**206**
	5/15/2016	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2,261**	**11,577**	**793**
	5/15/2016	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**3,483**	**3,561**	**250**

Notes:

TPH = Total petroleum hydrocarbons, by EPA Method 8015M.
C4-C12 = Carbon range.
ft bgs = feet below ground surface.
mg/kg = milligram per kilogram.
NV = No value.
- = Data not presented herein. Refer to Tetra Tech, 2006.
<X.XX = Not detected above indicated reporting limit (RL).

Bold values were reported above laboratory detection limits.
▨ **Shaded and bold value exceeds Table 4-1: Final Screening Levels for Soil - Commercial/Industrial Scenario (Apex-SGI, 2017).**

[1] TPH (C5-C12) was calculated based on summing detected results from C6-C8, C8-C10, and C10-C12.
[2] TPH (C13-C22) was calculated based on summing detected results of one half C12-C13 and the results between C14 and C22.
[3] TPH (C23-C44) was calculated based on summing the results of one half C22-C24 and the results between C24 and C44.
[4] Final Screening Level, Soil Commercial/Industrial is from Table 4-1: Final Screening Levels for Soil - Commercial/Industrial Scenario (Apex-SGI, 2017).

References:

The Source Group, Inc., a division of Apex Companies, LLC (Apex-SGI). 2017. Response Plan and Remedial Technology Evaluation, Former Chemoil Refinery, Signal Hill, California. June.
Tetra Tech. 2006. Environmental Due Diligence Site Assessment Results, Former Chemoil Refinery Property, Signal Hill, California. August 8.

Table A-2
Summary of Soil Analytical Results - Volatile Organic Compounds, Northwest and Southwest Parcels
Former ChemOil Refinery
Signal Hill, California

Boring	Sample Date	Depth ft bgs	TPHg (C4-C12) mg/kg	Acetone mg/kg	Benzene mg/kg	TBA mg/kg	tert-Butylbenzene mg/kg	sec-Butylbenzene mg/kg	n-Butylbenzene mg/kg	Ethylbenzene mg/kg	Isopropylbenzene mg/kg	4-Isopropyltoluene mg/kg	MTBE mg/kg	Naphthalene mg/kg	n-Propylbenzene mg/kg	Toluene mg/kg	1,3,5-TMB mg/kg	1,2,4-TMB mg/kg	o-Xylene mg/kg	m,p-Xylenes mg/kg	Total Xylenes mg/kg
		Final Screening Level [1] Soil Commerical/Industrial	**420**	**150**	**0.15**	**1.2**	**26**	**26**	**26**	**22**	**77**	**77**	**1.3**	**1.7**	**26**	**16**	**33**	**33**	**2,800**	**2,400**	**176**
NORTHWEST PARCEL																					
AN-01	1/4/2017	10	<0.50	<0.050	<0.0020	<0.020	<0.0050	<0.0050	<0.0050	<0.0020	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.0020	<0.0050	<0.0050	<0.0020	<0.0020	<0.0040
	1/4/2017	20	<0.50	<0.050	<0.0020	<0.020	<0.0050	<0.0050	<0.0050	<0.0020	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.0020	<0.0050	<0.0050	<0.0020	<0.0020	<0.0040
AN-02	1/4/2017	6.5	**370**	<0.10	**0.089**	<0.040	<0.010	<0.010	**0.011**	**0.12**	**0.020**	**0.011**	<0.010	**0.05**	**0.021**	**0.0052**	**0.014**	**0.070**	**0.015**	**0.022**	**0.037**
	1/4/2017	10	**1.5**	**0.065**	<0.0020	<0.020	<0.0050	<0.0050	<0.0050	<0.0020	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.0020	<0.0050	<0.0050	<0.0020	<0.0020	<0.0040
	1/4/2017	30	**380**	<0.10	<0.0040	<0.040	**0.016**	**0.20**	**0.14**	**0.0045**	**0.24**	<0.010	<0.010	**1.6**	**0.53**	<0.0040	<0.010	<0.010	<0.0040	<0.0040	<0.0080
AN-03	1/5/2017	5.5	**19,000**	<20	**1.7**	<8.0	<2.0	**10**	**8.8**	**28**	**13**	**16**	<2.0	**19**	**19**	<0.80	**250**	**170**	**36**	**210**	**246**
	1/5/2017	10	**6,800**	<50	<2.0	<20	<5.0	**7.1**	<5.0	**8.7**	<5.0	<5.0	<5.0	<10	**15**	<2.0	**7.9**	**12**	<2.0	**3.7**	**3.7**
	1/5/2017	20.5	**250**	<5.0	<0.20	<2.0	<0.50	**0.73**	<0.50	<0.20	<0.50	**0.75**	<0.50	**1.6**	<0.50	<0.20	<0.50	<0.50	<0.20	<0.20	<0.40
AN-05	1/5/2017	5	**3,800**	<5.0	**1.6**	<2.0	<0.50	**3.7**	**6.7**	**7.8**	**3.1**	**4.3**	<0.50	**13**	**6.2**	<0.20	**8.7**	**32**	**1.4**	**12**	**13.4**
	1/5/2017	10	**510**	<5.0	<0.20	<2.0	<0.50	<0.50	**0.77**	**0.93**	<0.50	<0.50	<0.50	**1.7**	**0.79**	<0.20	**0.77**	**2.6**	<0.20	**0.56**	**0.56**
	1/5/2017	10 (DUP)	**620**	<5.0	<0.20	<2.0	<0.50	<0.50	**0.85**	**0.79**	<0.50	<0.50	<0.50	**1.9**	**0.65**	<0.20	**0.74**	**2.7**	<0.20	**0.52**	**0.52**
	1/5/2017	20	**2,700**	<5.0	**0.27**	<2.0	<0.50	**1.7**	**2.5**	**6.5**	**2.1**	**1.5**	<0.50	**6.4**	**3.8**	<0.20	**2.2**	**8.9**	<0.20	**2.0**	**2.0**
AN-13	1/9/2017	5.5	**8.1**	<0.10	<0.0040	<0.040	<0.010	**0.034**	**0.048**	<0.0040	**0.012**	<0.010	<0.010	**0.11**	**0.033**	<0.0040	<0.010	<0.010	<0.0040	<0.0040	<0.0080
	1/9/2017	9	**250**	<0.10	**0.17**	<0.040	<0.010	**0.20**	**0.29**	**0.96**	**0.38**	<0.010	<0.010	**2.9**	**0.40**	<0.0040	<0.010	<0.010	**0.0080**	<0.0040	**0.0080**
	1/9/2017	15	**1,500**	<5.0	**0.42**	<2.0	<0.50	**2.7**	**4.0**	**7.9**	**4.3**	<0.50	<0.50	**16**	**5.4**	<0.20	<0.50	<0.50	<0.20	<0.20	<0.40
	1/9/2017	20	**470**	<5.0	<0.20	<2.0	<0.50	**0.90**	**1.0**	**2.0**	**1.0**	<0.50	<0.50	**5.2**	**1.8**	<0.20	<0.50	<0.50	<0.20	<0.20	<0.40
AN-20	1/18/2017	8	**5,500**	<10	**8.4**	<4.0	<1.0	**5.5**	**9.4**	**27**	**12**	**8.5**	<1.0	**9.9**	**15**	**9.2**	**16**	**54**	**36**	**70**	**106**
	1/18/2017	10	**1,200**	<5.0	**1.2**	<2.0	<0.50	**1.9**	**2.6**	**6.6**	**3.0**	**2.6**	<0.50	**2.2**	**4.3**	**0.26**	**4.6**	**13**	**5.0**	**15**	**20**
	1/18/2017	15	**920**	<5.0	**0.26**	<2.0	<0.50	**1.5**	**2.3**	**3.9**	**1.9**	**2.2**	<0.50	**1.6**	**3.0**	<0.20	**3.5**	**10**	**1.3**	**7.4**	**8.7**
	1/18/2017	20	**940**	<5.0	<0.20	<2.0	<0.50	**1.1**	**1.8**	**1.9**	**0.79**	**1.6**	<0.50	**1.2**	**1.9**	<0.20	**2.0**	**7.4**	**0.43**	**2.7**	**3.1**
AN-22	5/18/2017	4.5	**190**	<2.5	<0.10	<1.0	<0.25	<0.25	**0.3**	<0.10	<0.25	**0.28**	<0.25	**0.51**	<0.25	<0.10	**0.33**	**0.81**	<0.10	<0.10	<0.20
AN-22a	5/18/2017	10	**4,900**	<10	<0.40	<4.0	<1.0	**6.4**	**5.0**	**12**	**6.8**	**9.7**	<1.0	**16**	**13**	<0.40	**15**	**35**	<0.40	**6.6**	**6.6**
SB1	5/16/2006	4	--	ND	**0.486**	<0.100	**0.104**	**1.300**	<0.025	**1.310**	**0.528**	ND	ND	**16.800**	**1.000**	**0.263**	**0.0261J**	**2.770**	**0.218**	**0.200**	**0.418**
	5/16/2006	10	--	ND	**0.076**	**0.0888J**	<0.005	**0.012**	<0.005	**0.182**	**0.037**	ND	ND	**0.124**	**0.037**	**0.0030J**	**0.0050J**	**0.012**	**0.0048J**	**0.0067J**	**0.0115 J**
	5/16/2006	15	--	ND	**0.121**	<0.200	**0.121**	**2.070**	<0.050	**2.500**	**2.450**	ND	ND	**9.960**	**3.390**	**0.467**	**1.700**	**7.710**	**0.229**	**0.890**	**1.119**
	5/16/2006	20	--	ND	**0.142**	<0.120	**0.073**	**1.270**	<0.030	**1.270**	**1.650**	ND	ND	**6.040**	**2.260**	**0.297**	**0.957**	**4.380**	**0.136**	**0.518**	**0.654**
	5/16/2006	25	--	ND	**0.202**	<0.100	**0.079**	**1.330**	<0.025	**2.530**	**1.840**	ND	ND	**6.190**	**2.430**	**0.308**	**0.800**	**3.850**	**0.149**	**0.560**	**0.709**
	5/16/2006	30	--	ND	**0.236**	<0.080	**0.066**	**1.050**	<0.020	**1.780**	**1.550**	ND	ND	**5.140**	**2.000**	**0.230**	**0.775**	**3.530**	**0.134**	**0.513**	**0.647**
	5/16/2006	35	--	ND	**0.110**	<0.220	**0.0692J**	**1.040**	<0.055	**1.150**	**1.980**	ND	ND	**4.060**	**2.300**	**0.566**	**0.211**	**1.250**	**0.0915J**	**0.279**	**0.3705**
SB2	5/15/2006	5	--	ND	**11.300**	<0.100	**0.068**	**0.533**	<0.025	**9.970**	**1.480**	ND	ND	**0.431**	**1.260**	**0.472**	**0.290**	**1.020**	**0.184**	**0.640**	**0.824**
	5/15/2006	10	--	ND	**0.173**	<0.020	<0.005	<0.005	<0.005	**0.024**	<0.005	ND	ND	<0.005	<0.005	0.002J	<0.005	<0.005	<0.002	<0.002	<0.002
	5/15/2006	16	--	ND	**0.0084J**	<0.020	<0.005	<0.005	<0.005	**0.0079J**	<0.005	ND	ND	<0.005	<0.005	<0.002	<0.005	<0.005	<0.002	<0.002	<0.002
	5/15/2006	20	--	ND	**0.0063J**	<0.020	<0.005	<0.005	<0.005	**0.0047J**	<0.005	ND	ND	**0.011**	<0.005	<0.002	<0.005	<0.005	<0.002	<0.002	<0.002
	5/15/2006	25	--	ND	**0.0049J**	<0.020	<0.005	<0.005	<0.005	**0.0063J**	<0.005	ND	ND	**0.0081J**	<0.005	<0.002	<0.005	<0.005	<0.002	<0.002	<0.002
	5/15/2006	30	--	ND	**0.018**	<0.020	<0.005	**0.017**	**0.013**	**0.111**	**0.039**	ND	ND	**0.079**	**0.054**	**0.0033J**	<0.005	**0.018**	<0.002	**0.003J**	**0.003J**
	5/15/2006	35	--	ND	**3.280**	<0.080	**0.162**	**2.110**	<0.020	**13.300**	**3.300**	ND	ND	**10.800**	**4.920**	**0.307**	**2.970**	**10.300**	**0.240**	**0.945**	**1.185**
SB4	5/16/2006	5	--	ND	**5.900**	<0.200	**0.590**	**10.700**	<0.050	**17.700**	**10.900**	ND	ND	**21.900**	**18.000**	**0.488**	**0.151**	**60.000**	**0.157**	**7.290**	**7.447**
	5/16/2006	10	--	ND	**3.470**	<0.200	**0.304**	**5.140**	<0.050	**13.900**	**5.140**	ND	ND	**6.400**	**8.350**	**0.855**	**9.700**	**29.600**	**6.230**	**35.200**	**41.430**
	5/16/2006	15	--	ND	**0.979**	<0.080	**0.150**	**2.050**	<0.020	**5.570**	**2.160**	ND	ND	**4.770**	**3.640**	**1.470**	**6.340**	**18.100**	**7.180**	**23.000**	**30.180**
	5/16/2006	20	--	ND	**7.270**	<0.260	**0.631**	**11.100**	<0.065	**19.600**	**10.700**	ND	ND	**24.300**	**17.900**	**1.930**	**9.080**	**61.000**	**3.080**	**19.600**	**22.680**
	5/16/2006	25	--	ND	**0.092**	<0.180	**0.113**	**1.540**	<0.045	**2.270**	**1.310**	ND	ND	**4.880**	**2.170**	**0.711**	**4.640**	**13.800**	**3.650**	**11.200**	**14.850**
	5/16/2006	30	--	ND	**10.800**	<0.200	**0.322**	**5.200**	<0.050	**18.800**	**6.110**	ND	ND	**19.900**	**10.300**	**0.478**	**13.600**	**44.500**	**3.350**	**40.000**	**43.350**
	5/16/2006	35	--	ND	**4.080**	<0.100	**0.558**	**7.970**	<0.025	**20.900**	**8.270**	ND	ND	**36.800**	**14.500**	**3.390**	**27.200**	**79.400**	**26.600**	**90.300**	**116.900**
	5/16/2006	40	--	ND	**1.200**	<0.200	**0.289**	**3.970**	<0.050	**8.280**	**3.760**	ND	ND	**11.200**	**6.020**	**1.860**	**12.300**	**34.800**	**12.100**	**38.300**	**50.400**

Table A-2
Summary of Soil Analytical Results - Volatile Organic Compounds, Northwest and Southwest Parcels
Former ChemOil Refinery
Signal Hill, California

Boring	Sample Date	Depth ft bgs	TPHg (C4-C12) mg/kg	Acetone mg/kg	Benzene mg/kg	TBA mg/kg	tert-Butylbenzene mg/kg	sec-Butylbenzene mg/kg	n-Butylbenzene mg/kg	Ethylbenzene mg/kg	Isopropylbenzene mg/kg	4-Isopropyltoluene mg/kg	MTBE mg/kg	Naphthalene mg/kg	n-Propylbenzene mg/kg	Toluene mg/kg	1,3,5-TMB mg/kg	1,2,4-TMB mg/kg	o-Xylene mg/kg	m,p-Xylenes mg/kg	Total Xylenes mg/kg
Final Screening Level [1] Soil Commerical/Industrial			**420**	**150**	**0.15**	**1.2**	**26**	**26**	**26**	**22**	**77**	**77**	**1.3**	**1.7**	**26**	**16**	**33**	**33**	**2,800**	**2,400**	**176**
SOUTHWEST PARCEL																					
MW-20	1/10/2017	7	**11**	<0.10	<0.0040	<0.040	<0.010	**0.037**	**0.017**	**0.019**	**0.043**	<0.010	<0.010	**0.052**	**0.062**	<0.0040	<0.010	<0.010	<0.0040	<0.0040	<0.0080
	1/10/2017	11	**260**	<5.0	<0.20	<2.0	<0.50	**0.66**	<0.50	<0.20	<0.50	<0.50	<0.50	<1.0	**1.1**	<0.20	<0.50	<0.50	<0.20	<0.20	<0.40
	1/10/2017	19	**600**	<5.0	<0.20	<2.0	<0.50	**2.3**	**1.7**	<0.20	**2.1**	<0.50	<0.50	**12**	**3.5**	<0.20	<0.50	<0.50	<0.20	<0.20	<0.40
SB3	5/15/2006	5	--	ND	ND	ND	**0.606**	**6.230**	**3.000**	**8.990**	**7.800**	ND	ND	**19.000**	**12.500**	**0.257**	ND	**0.050**	**0.051**	**0.051J**	**1.02**
	5/15/2006	10	**--**	ND	**0.373**	ND	**0.102**	**0.792**	ND	**3.230**	**1.200**	ND	ND	**4.200**	**1.700**	**3.900**	**4.530**	**10.900**	**5.760**	**20.400**	**26.160**
	5/15/2006	15	**--**	ND	**0.086**	ND	**0.926**	**8.200**	ND	**15.600**	**9.770**	ND	ND	**50.700**	**15.200**	**0.966**	**12.500**	**96.500**	**7.600**	**23.700**	**31.300**
	5/15/2006	20	**--**	ND	**0.0462J**	ND	**0.587**	**5.970**	ND	ND	**7.160**	ND	ND	**30.600**	**10.100**	**0.449**	**1.220**	**60.000**	**1.450**	**9.000**	**10.450**
	5/15/2006	25	--	ND	ND	ND	**0.477**	**5.060**	ND	**0.268**	**6.930**	ND	ND	**23.100**	**10.600**	**0.284**	**0.490**	**45.100**	**0.103**	**9.200**	**9.303**

Notes:

VOC = Volatile organic compounds , fuel oxygenates, and TPHg, by EPA Method 8260B.
TPHg = Total petroleum hydrocarbons as gasoline.
TBA = tert-Butyl alcohol.
MTBE = Methyl-tert-butyl ether.
TMB = Trimethylbenzene.
ft bgs = feet below ground surface.
mg/kg = milligram per kilogram.
ND = Not detected at laboratory reporting limit. See Tetra Tech, 2006 for laboratory reporting limit.
<X.XX = Not detected above indicated reporting limit (RL).
J = Analyte was detected; however, analyte concentration is an estimated value which is between the method detection limit and the practical quantitation limit.
-- = Not analyzed.

Bold values were reported above laboratory detection limits.

▨ **Shaded and bold value exceeds Table 4-1: Final Screening Levels for Soil - Commercial/Industrial Scenario (Apex-SGI, 2017).**

[1] Final Screening Level, Soil Commercial/Industrial is from Table 4-1: Final Screening Levels for Soil - Commercial/Industrial Scenario (Apex-SGI, 2017).

References:

The Source Group, Inc., a division of Apex Companies, LLC (Apex-SGI). 2017. Response Plan and Remedial Technology Evaluation, Former Chemoil Refinery, Signal Hill, California. June.
Tetra Tech. 2006. Environmental Due Diligence Site Assessment Results, Former Chemoil Refinery Property, Signal Hill, California. August 8.

Table A-3

Summary of Soil Analytical Results - Polycyclic Aromatic Hydrocarbons and Lead, Northwest and Southwest Parcels

Former ChemOil Refinery
Signal Hill, California

Boring	Sample Date	Depth ft bgs	Acenaphthene mg/kg	Acenaphthylene mg/kg	Anthracene mg/kg	Benz(a)anthracene mg/kg	Benzo(a)pyrene mg/kg	Benzo(b)fluoranthene mg/kg	Benzo(g,h,i)perylene mg/kg	Benzo(k)fluoranthene mg/kg	Chrysene mg/kg	Dibenzo(a,h)anthracene mg/kg	Fluoranthene mg/kg	Fluorene mg/kg	Indeno(1,2,3-cd)pyrene mg/kg	Naphthalene mg/kg	Phenanthrene mg/kg	Pyrene mg/kg	Lead mg/kg
Final Screening Level [1] Soil Commerical/Industrial			**5.5**	**5.5**	**2.8**	**0.0042**	**0.004**	**0.041**	**27**	**0.4**	**1.2**	**0.013**	**60**	**5.4**	**0.13**	**1.7**	**11**	**13**	**320**
NORTHWEST PARCEL																			
AN-01	1/4/2017	10	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.040	<0.010	<0.010	<0.010	--
	1/4/2017	20	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.040	<0.010	<0.010	<0.010	--
AN-02	1/4/2017	6.5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<20	<5.0	<5.0	<5.0	**34**
	1/4/2017	10	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.040	<0.010	<0.010	<0.010	--
	1/4/2017	30	**0.043**	**0.022**	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	**0.090**	<0.040	**0.67**	**0.084**	<0.010	--
AN-03	1/5/2017	5.5	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.80	**24**	<0.20	<0.20	**4.4**
	1/5/2017	10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.40	**3.0**	<0.10	<0.10	--
	1/5/2017	20.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.20	**0.43**	<0.050	<0.050	--
AN-05	1/5/2017	5	<0.50	<0.50	**2.0**	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	**0.57**	**3.7**	<2.0	**11**	**9.2**	**1.2**	**6.8**
	1/5/2017	10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.40	**0.76**	**0.20**	<0.10	--
	1/5/2017	20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<2.0	**4.0**	**0.69**	<0.50	--
AN-13	1/9/2017	5.5	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.33**	<0.40	**0.62**	**0.34**	<0.10	--
	1/9/2017	9	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	**2.2**	<2.0	**14**	**2.0**	<0.50	**5.1**
	1/9/2017	15	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	**1.4**	<2.0	**15**	**1.2**	<0.50	--
	1/9/2017	20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	**0.65**	<2.0	**3.2**	**0.55**	<0.50	--
AN-20	1/18/2017	8	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.40	**7.3**	<0.10	<0.10	--
	1/18/2017	10	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.040	**0.59**	<0.010	<0.010	--
	1/18/2017	15	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.040	**0.96**	<0.010	<0.010	--
	1/18/2017	20	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.040	**0.86**	<0.010	<0.010	--
SB1	5/16/2006	4	**0.794**	ND	**0.114**	ND	ND	ND	ND	ND	ND	ND	**0.097**	**3.680**	ND	**17.300**	**26.500**	**1.240**	--
	5/16/2006	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/16/2006	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/16/2006	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/16/2006	25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/16/2006	30	**0.033**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.104**	ND	**0.226**	**0.424**	ND	--
	5/16/2006	35	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB2	5/15/2006	5	**0.122**	ND	**0.160**	ND	ND	ND	ND	ND	**1.083**	ND	**0.063**	**1.340**	ND	ND	**4.050**	**0.712**	**4.20J**
	5/15/2006	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/15/2006	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**4.90J**
	5/15/2006	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/15/2006	25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/15/2006	30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	5/15/2006	35	--	--	--	--	--	--	--	--	--		--	--		--	--	--	--
SB4	5/16/2006	5	**0.159**	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.010	**0.068**	ND	**3.300**	**1.040**	ND	**22.1**
	5/16/2006	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/16/2006	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**4.00J**
	5/16/2006	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/16/2006	25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/16/2006	30	**0.045**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.0180J**	ND	**3.130**	**0.059**	ND	ND
	5/16/2006	35	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/16/2006	40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table A-3
Summary of Soil Analytical Results - Polycyclic Aromatic Hydrocarbons and Lead, Northwest and Southwest Parcels
Former ChemOil Refinery
Signal Hill, California

Boring	Sample Date	Depth	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Lead
		ft bgs	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Final Screening Level [1] Soil Commerical/Industrial			**5.5**	**5.5**	**2.8**	**0.0042**	**0.004**	**0.041**	**27**	**0.4**	**1.2**	**0.013**	**60**	**5.4**	**0.13**	**1.7**	**11**	**13**	**320**
SOUTHWEST PARCEL																			
MW-20	1/10/2017	7	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.040	<0.010	<0.010	<0.010	**4.9**
	1/10/2017	11	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.80	**0.24**	<0.20	<0.20	<0.20
	1/10/2017	19	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.40	**8.3**	**0.80**	<0.10	<0.10
SB3	5/15/2006	4	**0.409**	ND	ND	**1.010**	ND	ND	ND	ND	**0.688**	ND	**0.048**	**0.870**	ND	**11.100**	**7.630**	**7.630**	**0.522**
	5/15/2006	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/15/2006	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/15/2006	20	**0.564**	ND	**0.900**	ND	ND	ND	ND	ND	**0.832**	ND	**0.089**	**4.350**	ND	**52.900**	**30.900**	**30.900**	**10.700**
	5/15/2006	25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

PAH = Polycyclic aromatic hydrocarbons, by EPA Method 8270C.

Total lead, by EPA Method 6010B.

ft bgs = feet below ground surface.

mg/kg = milligram per kilogram.

ND = Not detected at laboratory reporting limit. See Tetra Tech, 2006 for laboratory reporting limit.

<X.XX = Not detected above indicated reporting limit (RL).

-- = Not analyzed.

Bold values were reported above laboratory detection limits.

▨ **Shaded and bold value exceeds Table 4-1: Final Screening Levels for Soil - Commerical/Industrial Scenario (Apex-SGI, 2017).**

[1] Final Screening Level, Soil Commercial/Industrial is from Table 4-1: Final Screening Levels for Soil - Commercial/Industrial Scenario (Apex-SGI, 2017)

References:

The Source Group, Inc., a division of Apex Companies, LLC (Apex-SGI). 2017. Response Plan and Remedial Technology Evaluation, Former Chemoil Refinery, Signal Hill, California. June.

Tetra Tech. 2006. Environmental Due Diligence Site Assessment Results, Former Chemoil Refinery Property, Signal Hill, California. August 8.

HISTORICAL SOIL DATA

EAST PARCEL

Table A-4
Summary of Analytical Results for Total Petroleum Hydrocarbons (TPH) in Soil, East Parcel
Former ChemOil Refinery
Signal Hill, California

Sample ID	Consultant	Data Qualifiers	Sample Date	Sample Depth	TPHg	TPHd	U. S. EPA Method 8015 - TPH																	Total TPH[1]		
							C06-C08	C08-C10	C10-C12	C12-C14	C14-C16	C16-C18	C18-C20	C20-C22	C22-C24	C24-C26	C26-C28	C28-C32	C32-C34	C34-C38	C38-C40	C40-C44	Total	C5-C12 (Note 2)	C13-C22 (Note 3)	C23-C44 (Note 4)
				feet bgs	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Depth Range: 0 to 10 feet bgs																										
B-1	EEI	(a) (b) (c)	1988	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-1	EEI	(a) (b) (c) (d)	1988	10	--	ND<10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-2	EEI	(a) (b) (c)	1988	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-2	EEI	(a) (b) (c)	1988	10	--	**11,000 ***	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-3	EEI	(a) (b) (c)	1988	2	**2,000**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-3	EEI	(a) (b) (c)	1988	10	--	**1,100**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-3	EEI	(a) (b) (c)	1988	10	--	**410 ***	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
110-95-1	TSG	(a) (b) (c) (d) (e)	1999	1	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	**13**	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	**13**	ND<1	ND<1	**6.5**
110-95-5	TSG	(a) (b) (c) (d) (e)	1999	5	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	**8.8**	ND<1	ND<1	ND<1	**2.6**	ND<1	**11**	ND<1	ND<1	**11.4**
110-95-10	TSG	(a) (b) (c) (d) (e)	1999	10	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
125-310-1	TSG	(a) (b) (c) (d) (e)	1999	1	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	**11**	**14**	**27**	**24**	**24**	**25**	**7.4**	**11**	ND<1	ND<1	**143**	ND<1	**25**	**104.9**
125-310-5	TSG	(a) (b) (c) (d) (e)	1999	5	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	**15**	ND<1	ND<1	**1.9**	ND<1	ND<1	ND<1	ND<1	**17**	ND<1	ND<1	**9.4**
125-310-10	TSG	(a) (b) (c) (d) (e)	1999	10	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
180-75-1	TSG	(a) (b) (c) (d) (e)	1999	1	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
180-75-5	TSG	(a) (b) (c) (d) (e)	1999	5	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
180-75-10	TSG	(a) (b) (c) (d) (e)	1999	10	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
200-310-1	TSG	(a) (b) (c) (d) (e)	1999	1	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	**15**	ND<1	ND<1	**1.9**	ND<1	ND<1	ND<1	ND<1	**17**	ND<1	ND<1	**9.4**
200-310-5	TSG	(a) (b) (c) (d) (e)	1999	5	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
200-310-10	TSG	(a) (b) (c) (d) (e)	1999	10	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
204-95-1	TSG	(a) (b) (c) (d) (e)	1999	1	ND<1	--	ND<20	ND<20	ND<20	ND<20	ND<20	ND<20	ND<20	**42**	**91**	**180**	**240**	**450**	**270**	**220**	**430**	**200**	**2,123**	ND<20	**42**	**2,036**
204-95-5	TSG	(a) (b) (c) (d) (e)	1999	5	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	**14**	ND<1	ND<1	ND<1	**3.0**	**4.8**	**22**	ND<1	ND<1	**21.8**
204-95-10	TSG	(a) (b) (c) (d) (e)	1999	10	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	**28**	ND<1	ND<1	ND<1	**4.0**	**2.1**	**34**	ND<1	ND<1	**34.1**
30-195-1	TSG	(a) (b) (c) (d) (e) (g)	1999	1	**24**	--	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10
30-195-5	TSG	(a) (b) (c) (d) (e) (g)	1999	5	**30**	--	ND<1	**6.3**	**3.0**	ND<1	ND<1	**3.5**	**3.9**	**1.8**	**1.2**	ND<1	**7.1**	ND<1	**1.1**	ND<1	ND<1	ND<1	**28**	**9.3**	**9.2**	**8.8**
30-195-10	TSG	(a) (b) (c) (d) (e) (g)	1999	10	**8.8**	--	ND<1	**6.1**	**1.3**	ND<1	ND<1	**5.3**	**6.9**	**2.8**	**2.9**	**1.7**	**2.1**	ND<1	ND<1	ND<1	ND<1	ND<1	**29**	**7.4**	**15.0**	**5.3**
70-70-1	TSG	(a) (b) (c) (d) (e)	1999	1	**10**	--	ND<20	ND<20	ND<20	ND<20	**510**	**820**	**650**	**320**	**220**	**260**	**590**	**960**	**550**	**470**	**700**	**240**	**6,290**	ND<20	**2,300**	**3,880**
70-70-5	TSG	(a) (b) (c) (d) (e)	1999	5	**7.2**	--	ND<10	ND<10	ND<10	**50**	**310**	**270**	**170**	**59**	**76**	**53**	**56**	**110**	**85**	**52**	**74**	**22**	**1,387**	ND<10	**834**	**490**
70-70-10	TSG	(a) (b) (c) (d) (e)	1999	10	**370**	--	ND<10	**230**	**310**	**580**	**2,300**	**2,300**	**1,300**	**350**	**290**	**470**	**570**	**890**	**470**	**400**	**550**	**170**	**11,180**	**830**	**6,540**	**3,665**
75-195-1	TSG	(a) (b) (c) (d) (e)	1999	1	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	**10**	ND<1	ND<1	**7**	ND<1	ND<1	ND<1	ND<1	**17**	ND<1	ND<1	**12**
75-195-5	TSG	(a) (b) (c) (d) (e)	1999	5	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	**10**	ND<1	**7.7**	ND<1	ND<1	ND<1	**2.0**	**1.1**	**21**	ND<1	ND<1	**15.8**
75-195-10	TSG	(a) (b) (c) (d) (e)	1999	10	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
B-6-1	TEC	(a) (b) (c)	2001	1	--	**45**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-6-10	TEC	(a) (b) (c)	2001	10	--	**10**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-8-1	TEC	(a) (b) (c)	2001	1	--	**46**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-9-1	TEC	(a) (b) (c)	2001	1	--	**220**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E1B	Tetra Tech		06/01/06	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48
E1C	Tetra Tech		06/01/06	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**94**	**201**	**92**
E3A	Tetra Tech		06/01/06	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48
E5	Tetra Tech		06/01/06	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48
E5	Tetra Tech		06/01/06	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48
Depth Range: Greater than 10 feet bgs																										
70-70-15	TSG	(a) (b) (c) (d) (e)	1999	15	**370**	--	66	980	2,200	3,300	2,900	2,400	1,700	860	1,200	910	720	740	120	350	88	78	18,612	**4896**	**9,510**	**3,606**
70-70-20	TSG	(a) (b) (c) (d) (e)	1999	20	**760**	--	ND<5	1,800	3,300	8,100	4,300	3,400	2,700	1,400	1,800	1,100	1,300	960	210	480	93	120	31,063	**9150**	**15,850**	**5,163**
70-70-25	TSG	(a) (b) (c) (d) (e)	1999	25	ND<1	--	ND<1	1.2	4.7	11	10	9.1	12	11	16	11	12	8.6	3.7	5.4	2.5	ND<1	118	**11.4**	**47.6**	**51.2**
B-2-40	TEC	(a) (b) (c) (d)	2001	40	--	ND<10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-9-15	TEC	(a) (b) (c)	2001	#VALUE!	--	**27**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-9-20	TEC	(a) (b) (c)	2001	20	--	**17**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E1B	Tetra Tech		06/01/06	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48
E1B	Tetra Tech		06/01/06	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**5.72**	**7.59 J**	**5.04 J**
E1C	Tetra Tech		06/01/06	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1,829**	**2,540**	**2,162**
E1C	Tetra Tech		06/01/06	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**4,999**	**13,030**	**8,238**
E5	Tetra Tech		06/01/06	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48
E5	Tetra Tech		06/01/06	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48

Table A-4

Summary of Analytical Results for Total Petroleum Hydrocarbons (TPH) in Soil, East Parcel

Former ChemOil Refinery
Signal Hill, California

Notes:
mg/kg = milligrams per kilogram.
bgs = below ground surface.
U.S. EPA = United States Environmental Protection Agency.
TPH = Total Petroleum Hydrocarbons.
TPHg = total petroleum hydrocarbons as gasoline.
TPHd = total petroleum hydrocarbons as diesel.
ND = not detected.
ND< = less than the laboratory reporting limit in data from Tetra Tech, 2006 samples or analytical detection limit in data from Testa, 2001.
* = Carbon range C8-C30
Consultant listed is the consultant that collected the data. Data from EEI, TSG, and TEC are recorded from TEC, 2001 report.
EEI = Engineering Enterprises, Inc.
TSG = The Source Group, Inc.
TEC = Testa Environmental Corporation
-- = sample not analyzed for compound.
- = Data not presented herein. Refer to Tetra Tech, 2006.
[1] For use in the risk assessment, laboratory analytical results for carbon data within the specific TPH carbon ranges were summed to represent a total TPH value for each carbon range.
[2] TPH (C5-C12) was calculated based on summing detected results from C6-C8, C8-C10, and C10-C12.
[3] TPH (C13-C22) was calculated based on summing detected results of one half C12-C14 and the results between C14 and C22.
[4] TPH (C23-C44) was calculated based on summing the results of one half C22-C24 and the results between C24 and C44.

Data qualifiers from TEC, 2001:
(a) Sample date is unknown. The date listed is the date reported.
(b) Table 5-3 in TEC, 2001 does not indicate the whether this is soil or groundwater data. The table is inferred to be soil data based on the report text.
(c) Table 5-3 in TEC, 2001 does not indicate what units these data are presented in. Units are inferred from the report text.
(d) <1 was not defined in this table. All <1 symbols were assumed to indicate "not detected above the analytical detection limit".
(e)The sum totals of TPH presented in TEC, 2001 did not sum up and were recalculated for this report.
(f) The carbon ranges for TPHg and TPHd were not defined except where indicated.
(g) TSG boring 130-195 is not shown on any figure in TEC, 2001. It is assumed to be boring 130-95 on all figures in TEC, 2001.

References:
TEC. 2001. Report on Additional Subsurface Assessment, Former Chemoil Refinery - Eastern Parcel, Signal Hill, California. December 14.
Tetra Tech. 2006. Environmental Due Diligence Site Assessment Results, Former Chemoil Refinery Property, Signal Hill, California. August 8.

Table A-5
Summary of Analytical Results for Volatile Organic Compounds (VOCs) in Soil, East Parcel
Former ChemOil Refiney
Signal Hill, California

Sample ID	Consultant	Data Qualifiers	Sample Date	Sample Depth	U.S. EPA Method 8260B - VOCs								
					Benzene	n-Butylbenzene	sec-Butylbenzene	tert-Butylbenzene	Ethylbenzene	Isopropylbenzene	Naphthalene	Toluene	Total Xylenes
				feet bgs	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Depth Range: 0 to 10 feet bgs													
B-1	EEI	(a) (b) (c)	1988	2	--	--	--	--	--	--	--	--	--
B-1	EEI	(a) (b) (c)	1988	10	--	--	--	--	--	--	--	--	--
B-2	EEI	(a) (b) (c)	1988	2	--	--	--	--	--	--	--	--	--
B-2	EEI	(a) (b) (c)	1988	10	--	--	--	--	--	--	--	--	--
B-3	EEI	(a) (b) (c)	1988	2	--	--	--	--	--	--	--	--	--
B-3	EEI	(a) (b) (c)	1988	10	--	--	--	--	--	--	--	--	--
B-3	EEI	(a) (b) (c)	1988	10	--	--	--	--	--	--	--	--	--
110-95-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
110-95-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
110-95-10	TSG	(a) (b) (c)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
125-310-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
125-310-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
125-310-10	TSG	(a) (b) (c)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
180-75-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
180-75-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
180-75-10	TSG	(a) (b) (c)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
200-310-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
200-310-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
200-310-10	TSG	(a) (b) (c)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
204-95-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
204-95-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
204-95-10	TSG	(a) (b) (c)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
30-195-1	TSG	(a) (b) (c) (e)	1999	1	ND<0.005	--	--	--	**0.017**	--	--	ND<0.005	**0.014**
30-195-5	TSG	(a) (b) (c) (e)	1999	5	ND<0.005	--	--	--	**0.52**	--	--	**0.0068**	**0.13**
30-195-10	TSG	(a) (b) (c) (e)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
70-70-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	**0.024**	--	--	ND<0.005	**0.045**
70-70-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	**0.013**	--	--	ND<0.005	**0.058**
70-70-10	TSG	(a) (b) (c)	1999	10	**0.057**	--	--	--	**0.82**	--	--	**0.29**	**3.4**
75-195-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
75-195-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
75-195-10	TSG	(a) (b) (c)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
B-6-1	TEC	(a) (b) (c)	2001	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
B-6-10	TEC	(a) (b) (c)	2001	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
B-8-1	TEC	(a) (b) (c)	2001	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
B-9-1	TEC	(a) (b) (c)	2001	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
Depth Range: Greater than 10 feet bgs													
E1B	Tetra Tech		06/01/06	5	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
E1C	Tetra Tech		06/01/06	5	ND<0.002	ND<0.005	ND<0.005	ND<0.005	**0.0088 J**	ND<0.005	**0.0050 J**	ND<0.002	ND<0.002
E3A	Tetra Tech		06/01/06	10	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
E5	Tetra Tech		06/01/06	5	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
E5	Tetra Tech		06/01/06	10	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
70-70-15	TSG	(a) (b) (c)	1999	15	ND<0.005	--	--	--	**0.33**	--	--	**0.33**	**4.2**
70-70-20	TSG	(a) (b) (c)	1999	20	ND<0.005	--	--	--	**0.25**	--	--	**0.80**	**8.1**
70-70-25	TSG	(a) (b) (c)	1999	25	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
B-2-40	TEC	(a) (b) (c) (d)	2001	40	ND<0.005	**5.1**	**10**	--	ND<0.005	--	--	ND<0.005	**7.2**
B-9-15	TEC	(a) (b) (c)	2001	15	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
B-9-20	TEC	(a) (b) (c)	2001	20	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01

Table A-5
Summary of Analytical Results for Volatile Organic Compounds (VOCs) in Soil, East Parcel
Former ChemOil Refiney
Signal Hill, California

Sample ID	Consultant	Data Qualifiers	Sample Date	Sample Depth	U.S. EPA Method 8260B - VOCs								
					Benzene	n-Butylbenzene	sec-Butylbenzene	tert-Butylbenzene	Ethylbenzene	Isopropylbenzene	Naphthalene	Toluene	Total Xylenes
				feet bgs	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
E1B	Tetra Tech		06/01/06	15	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
E1B	Tetra Tech		06/01/06	25	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
E1C	Tetra Tech		06/01/06	15	ND<0.012	**1.100**	**3.100**	**0.175**	ND<0.012	**2.600**	**4.320**	**0.114**	ND<0.012
E1C	Tetra Tech		06/01/06	25	ND<0.012	**1.190**	**4.760**	**0.281**	**0.0594 J**	**4.020**	**9.080**	**0.136**	**0.0458 J**
E5	Tetra Tech		06/01/06	15	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
E5	Tetra Tech		06/01/06	20	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002

Notes:

mg/kg = milligram per kilogram.
bgs = below ground surface.
U.S. EPA = United States Environmental Protection Agency.
VOCs = volatile organic compounds.
ND = not detected.
ND< = less than the laboratory reporting limit in data from Tetra Tech, 2006 samples or analytical detection limit in data from TEC, 2001.
Consultant listed is the consultant that collected the data. Data from EEI, TSG, and TEC are recorded from TEC, 2001 report.
EEI = Engineering Enterprises, Inc.
TSG = The Source Group, Inc.
TEC = Testa Environmental Corporation
-- = sample not analyzed for compound.
J = analyte was detected; however, analyte concentration is an estimated value between the method detection limit and the practical quantitation limit.

Data qualifiers from TEC, 2001:

(a) Sample date is unknown. The date listed is the date reported.

(b) The analytical method for benzene, toluene, ethylbenzene and xylenes (BTEX) is unknown for all samples reported in TEC, 2001. Table 5-1 lists the method for as U.S. EPA Method 8020; however, the report text states the method is U.S. EPA Method 8260B. It is assumed the analytical method used is U.S. EPA Method 8260B.

(c) The analytical method for n-Butylbenzene and sec-butylbenzene are unknown. The report text indicates the analytical method for VOCs is U.S. EPA Method 8260 for all samples collected by TEC, 2001, so it is assumed that this is the actual analytical method used to analyze VOCs.

(d) Two concentrations are listed for xylenes in sample B-2-40. The higher concentration was assumed to be correct and is listed in this table.

(e)TSG boring 130-195 is not shown on any figure in TEC, 2001. It is assumed to be boring 130-95 on all figures in TEC, 2001.

References:

TEC. 2001. Report on Additional Subsurface Assessment, Former Chemoil Refinery - Eastern Parcel, Signal Hill, California. December 14.
Tetra Tech. 2006. Environmental Due Diligence Site Assessment Results, Former Chemoil Refinery Property, Signal Hill, California. August 8.

Table A-6

Summary of Analytical Results for Polycyclic Aromatic Hydrocarbons (PAHs) in Soil, East Parcel

Former ChemOil Refinery
Signal Hill, California

Boring	Sample Date	Sample Depth	U.S. EPA Method 8270C - PAHs															
			Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
		feet bgs	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
E1B	6/1/2006	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E1B	6/1/2006	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E1B	6/1/2006	25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E1C	6/1/2006	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E1C	6/1/2006	15	**0.221**	ND	ND	ND	ND	ND	ND	ND	**1.59**	ND	**0.036**	**0.387**	ND	**1.19**	**1.95**	**1.95**
E1C	6/1/2006	25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E3A	6/1/2006	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E5	6/1/2006	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E5	6/1/2006	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E5	6/1/2006	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E5	6/1/2006	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
mg/kg = milligram per kilogram.
ft bgs = feet below ground surface.
PAHs = Polycyclic aromatic hydrocarbons.
U.S. EPA = United States Environmental Protection Agency.
ND = Not detected at laboratory reporting limit. See Tetra Tech, 2006 for laboratory reporting limit.
-- = Not analyzed.

References:
Tetra Tech. 2006. Environmental Due Diligence Site Assessment Results, Former Chemoil Refinery Property, Signal Hill, California. August 8.

Table A-7
Summary of Analytical Results for Metals in Soil, East Parcel
Former ChemOil Refinery
Signal Hill, California

Sample ID	Consultant	Data Qualifiers	Sample Date	Sample Depth	U.S. EPA Method 6010B - Metals																
					Antimony	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Cobalt**	**Copper**	**Lead**	**Mercury**	**Molybdenum**	**Nickel**	**Selenium**	**Silver**	**Thallium**	**Vanadium**	**Zinc**
				feet bgs	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Depth Range: 0 to 10 feet bgs																					
B-1-1	TEC	(a) (b) (c) (d)	2001	1	**0.50**	**4.5**	**50**	ND<0.15	ND<0.15	**10**	**4.0**	**8.0**	**2.0**	ND<0.10	ND<0.25	**5.0**	ND<0.25	ND<0.15	**0.42**	**17**	**23**
B-1-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**13**	**92**	ND<0.15	ND<0.15	**20**	**11**	**21**	**4.0**	ND<0.10	**0.36**	**17**	ND<0.25	ND<0.15	**0.50**	**46**	**46**
B-1-10	TEC	(a) (b) (c) (d)	2001	10	**0.50**	**12**	**86**	ND<0.15	ND<0.15	**20**	**10**	**19**	ND<0.25	**3.0**	ND<0.25	**17**	ND<0.25	ND<0.15	**0.50**	**38**	**41**
B-2-1	TEC	(a) (b) (c) (d)	2001	1	**1.0**	**9.5**	**120**	ND<0.15	ND<0.15	**40**	**7.0**	**48**	**100**	--	**0.50**	**64**	ND<0.25	ND<0.15	**0.50**	**120**	**200**
B-2-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**10**	**450**	ND<0.15	ND<0.15	**18**	**10**	**15**	**3.0**	**0.11**	ND<0.25	**18**	ND<0.25	ND<0.15	**1.0**	**31**	**38**
B-2-10	TEC	(a) (b) (c) (d)	2001	10	**0.50**	**8.0**	**56**	ND<0.15	ND<0.15	**8.5**	**4.5**	**9.0**	**1.5**	ND<0.10	ND<0.25	**7.5**	ND<0.25	ND<0.15	**0.33**	**20**	**27**
B-3-1	TEC	(a) (b) (c) (d)	2001	1	**0.39**	**5.0**	**58**	ND<0.15	ND<0.15	**9.5**	**4.5**	**8.0**	1.5	ND<0.10	**0.33**	**6.0**	ND<0.25	ND<0.15	**0.50**	**18**	**22**
B-3-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**12**	**100**	ND<0.15	ND<0.15	**19**	**10**	**16**	**3.0**	ND<0.10	**0.41**	**14**	ND<0.25	ND<0.15	**1.0**	**41**	**41**
B-3-10	TEC	(a) (b) (c) (d)	2001	10	**1.0**	**16**	**150**	ND<0.15	ND<0.15	**25**	**12**	**26**	**4.5**	ND<0.10	**0.50**	**20**	ND<0.25	ND<0.15	**1.5**	**48**	**48**
B-4-1	TEC	(a) (b) (c) (d)	2001	1	**0.50**	**10**	**76**	ND<0.15	ND<0.15	**18**	**8.0**	**16**	**3.0**	ND<0.10	**0.36**	**12**	ND<0.25	ND<0.15	**1.0**	**36**	**41**
B-4-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**18**	**90**	ND<0.15	ND<0.15	**28**	**13**	**31**	**4.5**	ND<0.10	**0.50**	**22**	ND<0.25	ND<0.15	**2.0**	**53**	**56**
B-4-10	TEC	(a) (b) (c) (d)	2001	10	ND<0.25	**4.5**	**44**	ND<0.15	ND<0.15	**8.0**	**4.0**	**7.5**	**1.0**	ND<0.10	**0.26**	**6.5**	ND<0.25	ND<0.15	ND<0.25	**16**	**23**
B-5-1	TEC	(a) (b) (c) (d)	2001	1	**0.50**	**4.5**	**54**	ND<0.15	ND<0.15	**10**	**4.5**	**7.0**	**2.0**	ND<0.10	**0.42**	**6.0**	ND<0.25	ND<0.15	**1.0**	**17**	**24**
B-5-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**9.0**	**73**	ND<0.15	ND<0.15	**15**	**8.0**	**12**	**2.5**	ND<0.10	**0.50**	**12**	ND<0.25	ND<0.15	**1.0**	**30**	**38**
B-5-10	TEC	(a) (b) (c) (d)	2001	10	**0.50**	**18**	**140**	ND<0.15	ND<0.15	**32**	**13**	**31**	**5.5**	**0.12**	**0.50**	**23**	ND<0.25	ND<0.15	**1.5**	**52**	**57**
B-6-1	TEC	(a) (b) (c) (d)	2001	1	**0.36**	**4.0**	**30**	ND<0.15	ND<0.15	**7.5**	**3.5**	**3.0**	**0.50**	ND<0.10	**0.35**	**5.5**	ND<0.25	ND<0.15	**0.50**	**15**	**22**
B-6-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**10**	**68**	ND<0.15	ND<0.15	**16**	**8.0**	**14**	**3.0**	ND<0.10	**0.42**	**12**	ND<0.25	ND<0.15	**1.0**	**32**	**45**
B-6-10	TEC	(a) (b) (c) (d)	2001	10	**0.50**	**17**	**310**	ND<0.15	ND<0.15	**25**	**12**	**26**	**5.0**	ND<0.10	**0.50**	**20**	ND<0.25	ND<0.15	**1.0**	**48**	**48**
B-7-1	TEC	(a) (b) (c) (d)	2001	1	**0.45**	**5.0**	**56**	ND<0.15	ND<0.15	**9.0**	**4.5**	**7.5**	**3.0**	ND<0.10	**0.35**	**5.5**	ND<0.25	ND<0.15	**0.50**	**16**	**23**
B-7-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**9.0**	**88**	ND<0.15	ND<0.15	**16**	**6.5**	**12**	**3.0**	ND<0.10	**0.49**	**10**	ND<0.25	ND<0.15	**0.50**	**27**	**38**
B-7-10	TEC	(a) (b) (c) (d)	2001	10	**1.0**	**18**	**98**	ND<0.15	ND<0.15	**26**	**14**	**31**	**6.0**	ND<0.10	**0.50**	**22**	ND<0.25	ND<0.15	**1.5**	**52**	**54**
B-8-1	TEC	(a) (b) (c) (d)	2001	1	**0.50**	**4.5**	**47**	ND<0.15	ND<0.15	**9.5**	**4.5**	**6.5**	**1.5**	ND<0.10	**0.49**	**4.5**	ND<0.25	ND<0.15	**0.50**	**17**	**22**
B-8-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**12**	**73**	ND<0.15	ND<0.15	**22**	**10**	**17**	**3.5**	ND<0.10	**0.42**	**15**	ND<0.25	ND<0.15	**1.5**	**40**	**50**
B-8-10	TEC	(a) (b) (c) (d)	2001	10	**1.0**	**16**	**76**	ND<0.15	ND<0.15	**25**	**12**	**28**	**4.5**	ND<0.10	**0.50**	**20**	ND<0.25	ND<0.15	**1.5**	**48**	**50**
B-9-1	TEC	(a) (b) (c) (d)	2001	1	**0.50**	**7.0**	**72**	ND<0.15	ND<0.15	**12**	**6.0**	**12**	**5.5**	ND<0.10	**0.47**	**8.0**	ND<0.25	ND<0.15	**0.50**	**22**	**39**
B-9-5	TEC	(a) (b) (c) (d)	2001	5	**1.0**	**9.0**	**84**	ND<0.15	ND<0.15	**16**	**7.5**	**12**	**3.0**	ND<0.10	**0.46**	**11**	ND<0.25	ND<0.15	**0.50**	**29**	**40**
B-9-10	TEC	(a) (b) (c) (d)	2001	10	**0.50**	**7.0**	**140**	ND<0.15	ND<0.15	**10**	**7.0**	**12**	**3.0**	ND<0.10	**0.37**	**10**	ND<0.25	ND<0.15	**1.0**	**19**	**26**
Depth Range: Greater than 10 feet bgs																					
B-1-15	TEC	(a) (b) (c) (d)	2001	15	**0.41**	**5.0**	**54**	ND<0.15	ND<0.15	**5.5**	**3.6**	**6.0**	**1.0**	ND<0.10	ND<0.25	**5.0**	ND<0.25	ND<0.15	ND<0.25	**12**	**18**
B-1-20	TEC	(a) (b) (c) (d)	2001	20	ND<0.25	**3.0**	**15**	ND<0.15	ND<0.15	**5.0**	**1.5**	**1.5**	**0.50**	ND<0.10	ND<0.25	**2.5**	ND<0.25	ND<0.15	ND<0.25	**9.5**	**10**
B-1-25	TEC	(a) (b) (c) (d)	2001	25	ND<0.25	**5.0**	**22**	ND<0.15	ND<0.15	**7.0**	**3.5**	**3.0**	**0.50**	ND<0.10	**0.50**	**4.5**	ND<0.25	**5.0**	**0.50**	**15**	**18**
B-1-30	TEC	(a) (b) (c) (d)	2001	30	ND<0.25	**5.0**	**24**	ND<0.15	ND<0.15	**8.0**	**3.0**	**3.5**	**0.50**	ND<0.10	**0.37**	**4.5**	ND<0.25	ND<0.15	**0.48**	**16**	**18**
B-1-35	TEC	(a) (b) (c) (d)	2001	35	**0.42**	**10**	**26**	ND<0.15	ND<0.15	**7.0**	**3.5**	**6.5**	**1.0**	ND<0.10	**0.50**	**5.0**	ND<0.25	ND<0.15	**0.45**	**20**	**22**
B-2-15	TEC	(a) (b) (c) (d)	2001	15	**0.50**	**9.5**	**63**	ND<0.15	ND<0.15	**16**	**8.0**	**12**	**2.0**	ND<0.10	**0.50**	**12**	ND<0.25	**0.50**	**1.0**	**32**	**36**
B-2-20	TEC	(a) (b) (c) (d)	2001	20	**0.38**	**6.0**	**50**	ND<0.15	ND<0.15	**10**	**6.0**	**10**	**1.5**	ND<0.10	**0.44**	**8.0**	ND<0.25	ND<0.15	**0.50**	**24**	**29**
B-2-25	TEC	(a) (b) (c) (d)	2001	25	ND<0.25	**2.5**	**24**	ND<0.15	ND<0.15	**6.5**	**3.0**	**5.5**	**1.0**	ND<0.10	**0.29**	**4.5**	ND<0.25	ND<0.15	**0.25**	**12**	**16**
B-2-30	TEC	(a) (b) (c) (d)	2001	30	**0.47**	**8.0**	**35**	ND<0.15	ND<0.15	**9.0**	**4.5**	**4.5**	**1.0**	ND<0.10	**0.30**	**5.5**	ND<0.25	ND<0.15	**0.50**	**18**	**25**
B-2-35	TEC	(a) (b) (c) (d)	2001	35	**0.32**	**5.5**	**28**	ND<0.15	ND<0.15	**8.0**	**4.5**	**4.0**	**0.50**	ND<0.10	**0.34**	**5.0**	ND<0.25	ND<0.15	**0.45**	**18**	**26**
B-2-40	TEC	(a) (b) (c) (d)	2001	40	**0.50**	**5.5**	**32**	ND<0.15	ND<0.15	**9.0**	**5.5**	**5.0**	**0.50**	ND<0.10	**0.31**	**6.0**	ND<0.25	ND<0.15	**0.50**	**20**	**30**
B-3-15	TEC	(a) (b) (c) (d)	2001	15	**0.39**	**3.5**	**38**	ND<0.15	ND<0.15	**6.5**	**3.5**	**6.0**	**1.0**	ND<0.10	**0.27**	**5.5**	ND<0.25	ND<0.15	**0.36**	**14**	**16**
B-3-20	TEC	(a) (b) (c) (d)	2001	20	**0.43**	**5.5**	**50**	ND<0.15	ND<0.15	**10**	**5.5**	**10**	**1.5**	ND<0.10	ND<0.25	**8.0**	ND<0.25	ND<0.15	**0.50**	**22**	**26**
B-3-25	TEC	(a) (b) (c) (d)	2001	25	**0.26**	**5.0**	**29**	ND<0.15	ND<0.15	**9.5**	**4.5**	**3.5**	**1.0**	ND<0.10	**0.50**	**6.0**	ND<0.25	ND<0.15	**0.50**	**16**	**25**
B-3-33	TEC	(a) (b) (c) (d)	2001	33	**0.42**	**8.0**	**34**	ND<0.15	ND<0.15	**8.0**	**5.0**	**5.0**	**0.50**	ND<0.10	ND<0.25	**5.5**	ND<0.25	ND<0.15	**0.50**	**19**	**28**
B-4-15	TEC	(a) (b) (c) (d)	2001	15	**0.42**	**4.5**	**43**	ND<0.15	ND<0.15	**9.0**	**4.5**	**7.0**	**3.0**	ND<0.10	**0.46**	**5.0**	ND<0.25	ND<0.15	**0.50**	**18**	**21**
B-4-20	TEC	(a) (b) (c) (d)	2001	20	**0.34**	**3.5**	**33**	ND<0.15	ND<0.15	**6.0**	**2.5**	**5.5**	**1.0**	ND<0.10	**0.29**	**4.0**	ND<0.25	ND<0.15	ND<0.25	**13**	**14**
B-4-25	TEC	(a) (b) (c) (d)	2001	25	**0.38**	**4.0**	**36**	ND<0.15	ND<0.15	**7.0**	**3.5**	**3.0**	**2.0**	ND<0.10	ND<0.25	**5.0**	ND<0.25	ND<0.15	**0.50**	**14**	**20**
B-5-15	TEC	(a) (b) (c) (d)	2001	15	**0.45**	**6.0**	**82**	ND<0.15	ND<0.15	**10**	**6.0**	**11**	**1.5**	ND<0.10	ND<0.25	**8.5**	ND<0.25	ND<0.15	**0.50**	**21**	**29**
B-5-20	TEC	(a) (b) (c) (d)	2001	20	ND<0.25	**3.0**	**20**	ND<0.15	ND<0.15	**5.0**	**2.0**	**4.0**	**1.0**	ND<0.10	**0.30**	**3.5**	ND<0.25	ND<0.15	**0.28**	**10**	**12**

Table A-7
Summary of Analytical Results for Metals in Soil, East Parcel
Former ChemOil Refinery
Signal Hill, California

Sample ID	Consultant	Data Qualifiers	Sample Date	Sample Depth	U.S. EPA Method 6010B - Metals																
					Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
				feet bgs	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
B-5-25	TEC	(a) (b) (c) (d)	2001	25	**0.40**	**4.0**	**29**	ND<0.15	ND<0.15	**6.5**	**3.5**	**3.0**	**0.50**	ND<0.10	**0.38**	**4.5**	ND<0.25	ND<0.15	**0.41**	**14**	**20**
B-6-15	TEC	(a) (b) (c) (d)	2001	15	**0.31**	**6.0**	**40**	ND<0.15	ND<0.15	**8.5**	**5.0**	**12**	**8.0**	ND<0.10	**0.26**	**8.0**	ND<0.25	ND<0.15	**0.49**	**18**	**28**
B-6-20	TEC	(a) (b) (c) (d)	2001	20	**0.25**	**5.0**	**27**	ND<0.15	ND<0.15	**5.5**	**3.0**	**5.0**	**1.0**	ND<0.10	ND<0.25	**3.5**	ND<0.25	ND<0.15	**0.34**	**12**	**14**
B-6-25	TEC	(a) (b) (c) (d)	2001	25	ND<0.25	**3.0**	**23**	ND<0.15	ND<0.15	**7.0**	**2.0**	**3.5**	**1.5**	ND<0.10	**0.25**	**2.5**	ND<0.25	ND<0.15	ND<0.25	**9.5**	**12**
B-7-15	TEC	(a) (b) (c) (d)	2001	15	**0.46**	**7.5**	**61**	ND<0.15	ND<0.15	**11**	**6.5**	**15**	**2.5**	**0.12**	**0.40**	**10**	ND<0.25	ND<0.15	**0.50**	**24**	**32**
B-7-20	TEC	(a) (b) (c) (d)	2001	20	**0.50**	**6.5**	**62**	ND<0.15	ND<0.15	**12**	**6.5**	**13**	**3.0**	ND<0.10	**0.26**	**9.5**	ND<0.25	ND<0.15	**0.50**	**24**	**31**
B-7-25	TEC	(a) (b) (c) (d)	2001	25	**0.36**	**4.5**	**34**	ND<0.15	ND<0.15	**8.0**	**4.0**	**3.0**	**1.0**	ND<0.10	**0.30**	**55**	ND<0.25	ND<0.15	**0.47**	**15**	**20**
B-8-15	TEC	(a) (b) (c) (d)	2001	15	**0.50**	**7.5**	**62**	ND<0.15	ND<0.15	**12**	**7.5**	**14**	**2.0**	ND<0.10	ND<0.25	**11**	ND<0.25	ND<0.15	**1.0**	**26**	**37**
B-8-20	TEC	(a) (b) (c) (d)	2001	20	**0.50**	**4.5**	**29**	ND<0.15	ND<0.15	**5.0**	**2.5**	**4.0**	**1.0**	ND<0.10	ND<0.25	**3.5**	ND<0.25	ND<0.15	ND<0.25	**12**	**13**
B-8-25	TEC	(a) (b) (c) (d)	2001	25	**1.0**	**12**	**100**	ND<0.15	ND<0.15	**25**	**14**	**24**	**5.0**	ND<0.10	**0.37**	**20**	ND<0.25	ND<0.15	**1.5**	**32**	**62**
B-9-15	TEC	(a) (b) (c) (d)	2001	15	**0.50**	**7.0**	**66**	ND<0.15	ND<0.15	**10**	**6.0**	**10**	**2.0**	ND<0.10	**0.38**	**8.5**	ND<0.25	ND<0.15	**0.50**	**22**	**26**
B-9-20	TEC	(a) (b) (c) (d)	2001	20	**0.50**	**4.5**	**26**	ND<0.15	ND<0.15	**5.5**	**2.5**	**5.0**	**1.5**	**0.12**	ND<0.25	**3.5**	ND<0.25	ND<0.15	**0.31**	**12**	**14**

Notes:

mg/kg = milligram per kilogram.

bgs = below ground surface.

U.S. EPA = United States Environmental Protection Agency.

ND = not detected.

ND< = less than analytical detection limit listed.

TEC = Testa Environmental Corporation

-- = sample not analyzed for compound.

Data qualifiers from TEC, 2001:

(a) Sample date is unknown. The date listed is the date reported.

(b) Table 5-2 in TEC, 2001 does not indicate the whether this is soil or groundwater data. The units listed on the table indicate this is groundwater data (milligrams per liter), but the report text indicates this table is soil data. The table is inferred to be soil data based on the report text and the units are assumed to be milligrams per kilogram.

(c) The consultant is inferred from the report text and figures.

(d) No analytical method is listed on Table 5-2 in TEC, 2001. The report text lists the analytical method for soil as U.S. EPA Method 6010B; therefore, it is assumed this is the correct listed method.

References:

TEC. 2001. Report on Additional Subsurface Assessment, Former Chemoil Refinery - Eastern Parcel, Signal Hill, California. December 14.

HISTORICAL SOIL VAPOR DATA

NORTHWEST, SOUTHWEST, AND EAST PARCELS

Table A-8

Summary of Soil Vapor Analytical Results - Volatile Organic Compounds, Northwest, Southwest and East Parcels

Former ChemOil Refinery
Signal Hill, California

Boring	Sample Date	Depth feet bgs	Benzene µg/m^3	Cyclohexane µg/m^3	Ethylbenzene µg/m^3	4-Ethyltoluene[2] µg/m^3	Heptane[3] µg/m^3	n-Hexane µg/m^3	Methyl tert-Butyl Ether µg/m^3	Naphthalene µg/m^3	Toluene µg/m^3	1,2,4-Trimethylbenzene µg/m^3	1,3,5-Trimethylbenzene µg/m^3	m,p-Xylenes µg/m^3	o-Xylene µg/m^3	Xylenes µg/m^3
Site-Specific, Risk-Based Screening Level [1] Soil Vapor Commerical/Industrial			**909**	**60,703,429**	**12,565**	**3,089,871**	**7,513,217**	**7,513,217**	**113,307**	**1,006**	**3,089,871**	**85,410**	**429,320**	**1,122,976**	**1,116,790**	**1,116,790**
NORTHWEST PARCEL																
AN-04	1/17/2017	5	**194,875.66**	**2,478,331.29**	**208,431.90**	**103,239.26**	**819,713.70**	**458,216.77**	<43,263.80	<62,905.52	<45,222.09	**167,149.28**	**93,399.18**	**955,312.88**	**191,062.58**	**1,146,375.46**
AN-06	1/17/2017	5	**271,548.06**	**2,099,697.34**	**28,255.15**	<29,496.93	**393,462.58**	**634,453.99**	<21,631.90	<31,452.76	<22,611.04	<29,496.93	<29,494.48	<52,107.98	<26,053.99	<78,161.97
AN-07	1/17/2017	5	<6.39	<6.88	<8.68	<9.83	<8.20	<7.05	<7.21	<10.48	<7.54	<9.83	<9.83	<17.37	<8.68	<26.05
AN-08	1/17/2017	5	<6.39	<6.88	<8.68	<9.83	<8.20	<7.05	<7.21	<10.48	<7.54	<9.83	<9.83	<17.37	<8.68	<26.05
	1/17/2017	5 (DUP)	<6.39	<6.88	<8.68	<9.83	<8.20	<7.05	<7.21	<10.48	<7.54	<9.83	<9.83	<17.37	<8.68	<26.05
SB1	5/30/2006	5	<820	--	**2,100**	--	--	--	<820	--	<820	**4,300**	<1,230	<1,640	<800	<2,460
	5/30/2006	15	**24,000**	--	**26,900**	--	--	--	<800	--	<800	**4,380**	<1,200	**10,800**	<800	**10,800**
SB2	5/30/2006	5	**242,000**	--	**15,200**	--	--	--	<820	--	<820	<1,230	<1,230	<1,640	<820	<2,460
	5/30/2006	19.5	**230,000**	--	**108,000**	--	--	--	<800	--	<800	<1,200	<1,200	<1,600	<800	<2,400
SB4	5/30/2006	5	**10,100**	--	**6,810**	--	--	--	**1,680**	--	<800	**10,300**	**5,490**	**9,040**	<800	**9,040**
	5/30/2006	16.5	**802,000**	--	**159,000**	--	--	--	<800	--	**70,800**	**7,770**	**5,830**	**221,000**	**41,100**	**262,100**
SOUTHWEST PARCEL																
SB3	5/18/2006	15	**3,400**	--	**31,900**	--	--	--	<800	--	<800	**2,490**	**1,720**	<1,600	<800	<2,400
	5/18/2006	15	**2,500**	--	**22,300**	--	--	--	<800	--	<800	**3,460**	**3,370**	<1,600	<800	<2,400
	5/18/2006	15	**2,940**	--	**48,400**	--	--	--	<800	--	<820	**3,500**	**3,070**	<1,600	<800	<2,400
	5/30/2006	5	**12,100**	--	**25,600**	--	--	--	<820	--	<820	<1,230	<1,230	<1,640	<800	<2,440
	5/30/2006	15	**7,140**	--	**60,600**	--	--	--	<800	--	<800	<1,200	<1,200	<1,600	<800	<2,400
EAST PARCEL																
E1	6/2/2006	15	<796	--	**10,800**	--	--	--	<796	--	<796	<1,194	<1,194	<1,592	<796	<2,388

Notes:

VOCs measured by EPA Method TO-15.

µg/m^3 = microgram per cubic meter.

DTSC SL= Department of Toxic Substances Control Screening Level (DTSC, 2016).

USEPA RSL= U.S. Environmental Protection Agency Regional Screening Level (USEPA, 2016).

<X.XX = Not detected at or above the indicated laboratory reporting limit.

NV = No published value.

ND = Not detected at laboratory reporting limit. See Tetra Tech, 2006 for laboratory reporting limit.

- = Not analyzed.

DUP = Duplicate sample.

Bold values were reported above laboratory detection limits.

▨ **Shaded and bold value exceeds Table 4-2: Summary of Soil Vapor Screening Levels - Site-Specific, Risk-Based Screening Levels - Commercial/Industrial Scenario (Apex-SGI, 2017).**

[1] Final Screening Level, Soil Vapor Commercial/Industrial is from Table 4-2: Summary of Soil Vapor Screening Levels, Site-Specific, Risk-Based Screening Levels - Commercial/Industrial Scenario (Apex-SGI, 2017)

References:

The Source Group, Inc., a division of Apex Companies, LLC (Apex-SGI). 2017. Response Plan and Remedial Technology Evaluation, Former Chemoil Refinery, Signal Hill, California. June.

Tetra Tech. 2006. Environmental Due Diligence Site Assessment Results, Former Chemoil Refinery Property, Signal Hill, California. August 8.

HISTORICAL SOIL VAPOR DATA

OFFSITE

Table 4
Analytical Results of Volatile Organic Compounds in Soil Vapor
Former Chemoil Refinery
Signal Hill, California

Sample Location	Sample Depth (ft bgs)	Sample Date	Concentration ($\mu g/m^3$)																			
			EPA Method TO-15 Volatile Organic Compounds																			
			Acetone	Benzene	Bromo-dichloro-methane	cis-1,2-Dichloro-ethene	Carbon Disulfide	Chloroform	Chloro-methane	Dibromo-chloro-methane	Dichloro-difluoro-methane	Ethanol	Ethyl-benzene	Methyl-tert Butyl Ether (MTBE)	Naphthalene	o-Xylene	p/m-Xylene	Tert-Butyl Alcohol (TBA)	Tetrachloro-ethene	Toluene	Trichloro-fluoro-methane	Vinyl-Chloride
Residential CHHSLs			**NA**	**36.2**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**420**	**4,000**	**31.9**	**317,000**	**317,000**	**NA**	**180**	**135,000**	**NA**	**13.3**
Residential ESLs			**330,000**	**42**	**69**	**3,700**	**NA**	**230**	**NA**	**NA**	**NA**	**NA**	**490**	**4,700**	**36**	**1,000**	**1,000**	**NA**	**210**	**31,000**	**NA**	**16**
GW/SV-20-5	5	05/30/12	54	3.2	3.6	<2	<6.2	200	<1	<4.3	2.5	<9.4	<2.2	<7.2	<26	<2.2	<8.7	<6.1	9.3	2.7	68	<1.3
GW/SV-20-10	10	05/30/12	6.9	<1.6	<3.4	<2	<6.2	220	<1	<4.3	<2.5	<9.4	<2.2	<7.2	<26	<2.2	<8.7	<6.1	7.3	<1.9	69	<1.3
GW/SV-21-5	5	06/13/12	45	2.4	<3.4	<2	<6.2	6.3	<1.3	<4.3	<2.5	<9.4	<2.2	<7.2	<26	<2.2	<8.7	<6.1	<3.4	<1.9	<5.6	<1.3
GW/SV-21-10	10	06/13/12	100	<3.3	<6.8	<4	<13	<5.0	<2.7	<8.7	<5.0	60	<4.4	<15	<53	<4.4	<18	<12	<5.5	<3.8	<5.5	<2.6
GW/SV-22-5	5	05/30/12	<220	<74	<150	<92	<290	<110	<48	<200	<110	<440	<100	<330	<1200	<100	<400	<280	<160	<87	<260	<59
GW/SV-22-10	10	05/30/12	1,400	<160	<340	<200	<620	<240	<100	<430	<250	<940	1000	<720	<2600	240	<870	1500	<340	510	<560	<130
GW/SV-22-10/Dup	10	05/30/12	1,800	<160	<340	<200	<620	310	<100	<430	<250	<940	970	<720	<2600	240	<870	<610	<340	320	<560	<130
GW/SV-23-5	5	06/13/12	38	<1.6	<3.4	<2	<6.2	<2.4	<1.3	<4.3	<2.5	<9.4	<2.2	<7.2	<26	<2.2	<8.7	<6.1	<3.4	2.9	<5.6	<1.3
GW/SV-23-10	10	06/13/12	100	34	<3.4	<2	71	<2.4	<1.3	<4.3	<2.5	<9.4	3.8	<7.2	<26	<2.2	<8.7	<6.1	7.4	14	<5.6	<1.3
GW/SV-23-10/Dup	10	06/13/12	95	11	<11	<6.3	51	<7.8	<4.2	<14	<7.9	<30	<6.9	<23	<83	<6.9	<28	<19	<11	11	<18	<4.1
GW/SV-24-5	5	06/13/12	13	<1.6	<3.4	<2	<6.2	<2.4	<1.3	<4.3	<2.5	<9.4	<2.2	<7.2	<26	<2.2	<8.7	<6.1	<3.4	2.4	<5.6	<1.3
GW/SV-24-10	10	06/13/12	22	4.1	<3.4	<2	<6.2	17	<1.3	<4.3	<2.5	<9.4	<2.2	<7.2	<26	<2.2	<8.7	<6.1	9.9	<1.9	<5.6	<1.3
GW/SV-25-5	5	05/30/12	16	19	<3.4	<2	<6.2	3.5	<1	<4.3	<2.5	<9.4	11	<7.2	<26	14	30	<6.1	<3.4	20	<5.6	<1.3
GW/SV-25-10	10	05/30/12	<4.8	1.9	<3.4	<2	<6.2	<2.4	<1	<4.3	<2.5	<9.4	<2.2	9	<26	<2.2	<8.7	<6.1	<3.4	<1.9	<5.6	<1.3
GW/SV-26-5	5	05/31/12	17	3.6	<3.4	4.2	<6.2	<2.4	<1	<4.3	<2.5	<9.4	<2.2	<7.2	<26	<2.2	<8.7	<6.1	25	3.3	<5.6	<1.3
GW/SV-26-10	10	05/31/12	14	<1.6	<3.4	<2	<6.2	<2.4	<1	<4.3	<2.5	<9.4	<2.2	<7.2	<26	<2.2	<8.7	<6.1	28	<1.9	<5.6	<1.3
GW/SV-27-5	5	05/31/12	45	9.3	<3.4	<2	<6.2	5.2	<1	<4.3	2.6	<9.4	3.3	<7.2	<26	4.6	12	<6.1	67	16	<5.6	<1.3
GW/SV-27-10	10	05/31/12	21	2.8	<3.4	3.3	<6.2	22	<1	<4.3	<2.5	<9.4	<2.2	<7.2	<26	<2.2	<8.7	<6.1	84	2	<5.6	2.9
GW/SV-28-5	5	05/31/12	25	3.9	7.5	<2	<6.2	12	<1	<4.3	<2.5	<9.4	<2.2	<7.2	<26	2.9	<8.7	<6.1	<3.4	5.2	<5.6	<1.3
GW/SV-28-10	10	05/31/12	29	2.3	<3.4	<2	<6.2	11	<1	<4.3	<2.5	12	<2.2	<7.2	<26	<2.2	<8.7	<6.1	<3.4	<1.9	<5.6	<1.3
GW/SV-29-5	5	05/31/12	220	11	5.2	<2	13	14	1.2	4.8	3.3	13	2.8	<7.2	<26	4.2	9.4	<6.1	6.8	11	13	<1.3
GW/SV-29-10	10	05/31/12	15	<1.6	<3.4	<2	<6.2	<2.4	<1	<4.3	2.9	<9.4	<2.2	<7.2	<26	<2.2	<8.7	<6.1	150	<1.9	15	<1.3

Notes:

1. Soil vapor samples collected in batch-certified 1-liter summa canisters and analyzed by CalScience Environmental Laboratories, Inc. of Garden Grove, California using EPA Method TO-15.
2. Except for the target petroleum-based chemicals of potential concern (COPCs), only constituents detected in at least one sample are presented. A full list of analytes from EPA Method TO-15 is presented in the analytical laboratory reports.

Abbreviations:

ft bgs = feet below ground surface
< indicates that the compound was not detected at or above the laboratory reporting limit shown.
NA = Not Available
CHHSLs = California Human Health Screening Levels (CHHSLs) for volatile chemicals in soil vapor below residential buildings constructed without engineered fill below sub-slab gravel (California Environmental Protection Agency, 2005).
ESLs = Environmental Screening Levels for residential uses, Update to Environmental Screening Levels for Sites with Impacted Soil and Groundwater, Regional Water Quality Control Board, San Francisco Bay, Table E-4 Shallow Soil Gas Screening Levels for Evaluation of Potential Vapor Intrusion Concerns, May 2008.

Table 4
Analytical Results of Volatile Organic Compounds in Soil Vapor
Former Chemoil Refinery
Signal Hill, California

Sample Location	Sample Depth (ft bgs)	Sample Date	Concentration (µg/m^3)						Concentration (% Volume)					
			EPA Method TO-15 Volatile Organic Compounds						Fixed Gases					
			1,1,1-Trichloro-ethane	1,2,4-Trimethyl-benzene	1,3,5-Trimethyl-benzene	2-Butanone	4-Ethyl-toluene	4-Methyl-2-Pentanone	Carbon Dioxide	Carbon Monoxide	Helium	Oxygen + Argon ^{3}	Methane	Nitrogen
Residential CHHSLs			**991,000**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Residential ESLs			**230,000**	**420**	**230,000**	**520,000**	**NA**	**310,000**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
GW/SV-20-5	5	05/30/12	<2.7	<7.4	<2.5	10	<2.5	<6.1	3.75	<0.5	<0.01	16.6	<0.5	79.6
GW/SV-20-10	10	05/30/12	<2.7	<7.4	<2.5	4.9	<2.5	<6.1	<0.5	<0.5	<0.01	21.9	<0.5	78.1
GW/SV-21-5	5	06/13/12	<2.7	<7.4	<2.5	8.7	<2.5	<6.1	<0.5	<0.5	<0.01	21.1	<0.5	78.4
GW/SV-21-10	10	06/13/12	<5.6	<15	<5.0	8.7	<5.0	<13	7.12	<0.5	<0.01	4.76	<0.5	84.8
GW/SV-22-5	5	05/30/12	<130	<340	<110	<200	<110	<280	10.7	<0.5	<0.01	4.52	28.1	56.6
GW/SV-22-10	10	05/30/12	<270	<740	<250	<440	<250	<610	15.9	<0.5	<0.01	2.2	35.2	46.6
GW/SV-22-10/Du	10	05/30/12	<270	<740	<250	<440	<250	<610	15.8	<0.5	<0.01	2.38	34.9	47
GW/SV-23-5	5	06/13/12	<2.7	<7.4	<2.5	9.1	<2.5	<6.1	0.939	<0.5	<0.01	21	<0.5	78
GW/SV-23-10	10	06/13/12	<2.7	<7.4	<2.5	40	<2.5	<6.1	1.23	<0.5	<0.01	14.4	1.43	82.9
GW/SV-23-10/Du	10	06/13/12	<8.7	<23	<7.8	29	<7.8	<20	1.14	<0.5	<0.01	16.1	6.18	76.5
GW/SV-24-5	5	06/13/12	<2.7	<7.4	<2.5	<4.4	<2.5	<6.1	0.866	<0.5	<0.01	20.9	<0.5	78.2
GW/SV-24-10	10	06/13/12	<2.7	<7.4	<2.5	9.3	<2.5	<6.1	3.56	<0.5	<0.01	18.5	<0.5	78
GW/SV-25-5	5	05/30/12	<2.7	8	2.8	18	<2.5	<6.1	9.96	<0.5	<0.01	5.64	3.61	80.8
GW/SV-25-10	10	05/30/12	<2.7	<7.4	<2.5	8.1	<2.5	<6.1	11.9	<0.5	<0.01	2.54	5.64	79.9
GW/SV-26-5	5	05/31/12	<2.7	<7.4	<2.5	<4.4	<2.5	<6.1	7.19	<0.5	<0.01	9.4	<0.5	83.4
GW/SV-26-10	10	05/31/12	<2.7	<7.4	<2.5	<4.4	<2.5	<6.1	6.78	<0.5	<0.01	9.89	<0.5	83.3
GW/SV-27-5	5	05/31/12	3.6	<7.4	<2.5	13	<2.5	<6.1	4.49	<0.5	<0.01	11.6	<0.5	83.9
GW/SV-27-10	10	05/31/12	<2.7	<7.4	<2.5	10	<2.5	<6.1	4.89	<0.5	<0.01	12.1	<0.5	83
GW/SV-28-5	5	05/31/12	<2.7	<7.4	<2.5	6.9	<2.5	<6.1	3.06	<0.5	0.0215	19.3	<0.5	77.7
GW/SV-28-10	10	05/31/12	<2.7	<7.4	<2.5	8.3	<2.5	<6.1	10.1	<0.5	<0.01	11.9	<0.5	78
GW/SV-29-5	5	05/31/12	7	30	8.6	64	4.2	8.4	<0.5	<0.5	<0.01	18	<0.5	82
GW/SV-29-10	10	05/31/12	<2.7	<7.4	<2.5	6.2	<2.5	<6.1	1.58	<0.5	<0.01	15.2	<0.5	83.2

Notes:

1. Soil vapor samples collected in batch-certified 1-liter summa canisters and analyzed by CalScience Environmental Laboratories, Inc. of Garden Grove, California using EPA Method TO-15.
2. Except for the target petroleum-based chemicals of potential concern (COPCs), only constituents detected in at least one sample are presented. A full list of analytes from EPA Method TO-15 is presented in the analytical laboratory reports.
3. Oxygen and Argon gasses are reported together because they convolute with each other and are difficult to separate in the laboratory testing. Typically, Argon is present in insignificant quantities.

Abbreviations:

ft bgs = feet below ground surface

< indicates that the compound was not detected at or above the laboratory reporting limit shown.

NA = Not Available

CHHSLs = California Human Health Screening Levels (CHHSLs) for volatile chemicals in soil vapor below residential buildings constructed without engineered fill below sub-slab gravel (California Environmental Protection Agency, 2005).

ESLs = Environmental Screening Levels for residential uses, Update for Sites with Impacted Soil and Groundwater, Regional Water Quality Control Board, San Francisco Bay, Table E-4 Shallow Soil Gas Screening Levels for Evaluation of Potential Vapor Intrusion Concerns, May 2008.

TABLE 7-2a

SUMMARY OF SOIL GAS SURVEY DATA - SOUTHERN PERIMETER (a)

Location: Along the southern perimeter of the Western Parcel from west to east.

Parameter			Soil Gas Probe No.													
			SGP-1-5 (b)	SGP-1-15	SGP-2-5	SGP-2-15	SGP-3-5	SGP-3-15	SGP-4-5	SGP-4-15	SGP-5-5	SGP-5-15	SGP-6-5	SGP-6-15	SGP-7-5	SGP-7-15
	CHHSLs Residential Land Use	CHHSLs Commerical/Industrial Land Use														
Benzene	36.2	122	**220**	36	ND	ND	**53**	ND	**82**	ND	**77**	ND	**2,100**	ND	**76**	ND
	36.2	122	**430**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	980*	3,300**	780	ND	ND	**1,500**	ND	580	**990**	ND	220	ND	ND	110	ND	ND
	980*	3,300**	960	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	980*	3,300**	180	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	NLE	NLE	780	90	ND	580	ND	6,900	1,300	10,000	450	6,500	910	17,000	950	17,000
	NLE	NLE	150	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MTBE	4,000	13,400	ND	ND	60	410	3,400	ND	ND	ND	ND	ND	ND	ND	ND	ND
	4,000	13,400	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Propylbenzene	NLE	NLE	80	ND	ND	ND	ND	5,900	640	ND	280	4,200	740	12,000	6,300	6,200
sec-Butylbenzene	NLE	NLE	ND	ND	ND	ND	1,600	ND	260	3,100	140	2,700	240	3,400	170	3,000
	NLE	NLE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tert-Butylbenzene	NLE	NLE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	135,000	378,000	290	ND	ND	950	ND	ND	1,000	ND	ND	ND	ND	ND	ND	ND
	135,000	378,000	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	NLE	NLE	220	220	ND	130	ND	ND	ND	ND	150	ND	ND	ND	ND	ND
	NLE	NLE	190	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene	NLE	NLE	50	ND	ND	60	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	319,000	887,000	50	300	ND	5,200	ND	ND	3,230	ND	150	ND	ND	190	60	ND
	319,000	887,000	1,040	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	319,000	887,000	180	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:

(a) All units in micrograms per cubic meter (ug/m3).

(b) SGP-1-5 = soil gas probe - probe number - depth in feet below ground surface.

(c) ND = Not detected at or above parameter's respective analytical detection level.

(d) D = Duplicate.

NLE = no level established.

* RWQCB Region 2; Environmental Screening Level, lowest residential.

** RWQCB Region 2; Environmental Screening Level, lowest commercial/industrial.

TABLE 7-2b
SUMMARY OF SOIL GAS SURVEY DATA - WESTERN PERIMETER (a)

Location: Along Gundry Avenue immediately west of the Western Parcel.

Parameter			Soil Gas Probe No.														
	CHHSLs Residential Land Use	CHHSLs Commerical/I ndustrial Land Use	Gdy-1-5 (b)	Gdy-1-15	Gdy-2-5	Gdy-2-15	Gdy-3-5	Gdy-3-15	Gdy-4-5	Gdy-4-15	Gdy-5-5	Gdy-5-15	Gdy-6-5	Gdy-6-15	Gdy-7-5	Gdy-7-15	Gdy-7-15 (c)
Benzene	36.2	122	89	ND	ND	ND	ND	ND	51	ND	ND	ND	ND	ND	ND	ND	NA
Cyclohexane	NLE	NLE	NA(e)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	260
Ethylbenzene	980*	3,300**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
Isopropylbenzene	NLE	NLE	100	9,200	ND	630	ND	1,100	ND	1,900	ND	ND	ND	ND	ND	16,000	NA
	NLE	NLE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
MTBE	4,000	13,400	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
n-Propylbenzene	NLE	NLE	ND	570	ND	ND	ND	670	ND	1,200	ND	ND	ND	ND	ND	5,900	NA
sec-Butylbenzene	NLE	NLE	ND	2,300	ND	1,800	580	3,000	ND	3,900	ND	2,100	ND	ND	ND	2,800	NA
	NLE	NLE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
Tert-Butylbenzene	NLE	NLE	ND	510	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
Toluene	135,000	378,000	250	ND	ND	ND	ND	ND	280	510	93	ND	ND	ND	ND	820	NA
1,2,4-Trimethylbenze	NLE	NLE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
1,3,5-Trimethylbenze	NLE	NLE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
Xylenes	319,000	887,000	120	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

NOTES:
(a) All units in micrograms per cubic meter (ug/m3).
(b) Gdy-1-5 = Gundry Avenue - probe number - depth in feet below ground surface.
(c) EPA TO-15 analysis
(d) ND = Not detected at or above parameter's analytical detection level.
(e) NA = Not analyzed
(f) D = Duplicate sample.
* RWQCB Region 2; Environmental Screening Level, lowest residential
** RWQCB Region 2; Environmental Screening Level, lowest commercial/industrial

TABLE 7-2c

SUMMARY OF SOIL GAS SURVEY DATA - EASTERN PERIMETER(a)

Location: Along Walnut Avenue immediately west of the Western Parcel

Parameter			Soil Gas Probe Number							
	CHHSLs Residential Land Use	CHHSLs Commerical/Industrial Land Use	Wnt-1-5 (b)	Wnt-1-15	Wnt-1-15 (c)	Wnt-2-5	Wnt-2-15	Wnt-3-5	Wnt-3-15	Wnt-4-5
Benzene	36.2	122	43	ND	**6**	ND	ND	**51**	ND	ND
Cyclohexane	NLE	NLE	ND	ND	68	ND	ND	ND	ND	ND
cis-1,2-Dichloroethane	NLE	NLE	ND	ND	39	ND	ND	ND	ND	ND
1,1-Dichloroethane	1,500	5,100	ND	ND	**3**	ND	ND	ND	ND	ND
1,2-Dichloroethane	94	3,100	ND	ND	**4**	ND	ND	ND	ND	ND
Ethylbenzene	980*	3,300**	61	ND	**21**	ND	**1,600**	ND	620	260
Heptane	NLE	NLE	ND	ND	34	ND	ND	ND	ND	ND
Isopropylbenzene	NLE	NLE	ND	75	ND	23,000	ND	280	81,000	ND
MTBE	4,000	13,400	ND	ND	ND	ND	**47,000**	ND	ND	ND
n-Propylbenzene	NLE	NLE	ND	ND	ND	2,200	8,700	ND	17,000	ND
Propylene	NLE	NLE	ND	ND	190	ND	ND	ND	ND	ND
sec-Butylbenzene	NLE	NLE	ND	ND	ND	1,300	1,800	ND	8,900	ND
Tert-Butylbenzene	NLE	NLE	ND	ND	ND	ND	ND	ND	630	ND
Toluene	135,000	378,000	150	88	**290**	840	600	130	740	130
1,1,1-Trichloroethane	NLE	NLE	ND	ND	33	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	NLE	NLE	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene	NLE	NLE	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	319,000	887,000	255	130	26	ND	ND	ND	ND	960

NOTES:

(a) All units in micrograms per cubic meter (ug/m3).

(b) Wnt-1-5 = Walnut Avenue - probe number - depth in feet below ground surface.

(c) EPA TO-15 analysis

(d) ND = Not detected at or above parameter's analytical detection level.

(e) NA = Not analyzed

NLE = no level established

* RWQCB Region 2; Environmental Screening Level, lowest residential

** RWQCB Region 2; Environmental Screening Level, lowest commercial/industrial

TABLE 7-2d

SUMMARY OF SOIL GAS SURVEY DATA - NORTHERN PERIMETER (a)

Parameter			Soil Gas Probe Number							
	CHHSLs Residential Land Use	CHHSLs Commerical/Industrial Land Use	Hill-1-5 (b)	Hill-1-15	Hill-2-15	Hill-2-15	Hill-3-5	Hill-3-15	Hill-4-5	Hill-4-15
Benzene	36.2	122	50	ND	ND	ND	86	ND	ND	ND
Ethylbenzene	980*	3,300**	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	NLE	NLE	ND	ND	ND	ND	ND	ND	ND	ND
MTBE	4,000	13,400	ND	ND	ND	ND	ND	ND	ND	ND
n-Propylbenzene	NLE	NLE	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene	NLE	NLE	ND	ND	ND	ND	ND	ND	ND	ND
Tert-Butylbenzene	NLE	NLE	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	135,000 135,000	378,000 378,000	180 ND	ND ND	ND ND	68 69	250 ND	130 ND	ND ND	ND ND
1,2,4-Trimethylbenzene	NLE NLE	NLE NLE	ND ND	ND ND	ND ND	110 99	ND ND	ND ND	ND ND	ND ND
1,3,5-Trimethylbenzene	NLE	NLE	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	319,000	887,000	ND	ND	ND	ND	120	ND	ND	ND

NOTES:
(a) All units in micrograms per cubic meter (ug/m3).
(b) Hill-1-5 = Hill Street - probe number - depth in feet below ground surface.
(c) ND = Not detected at or above parameter's respective analytical detection level.
NLE = no level established.
* RWQCB Region 2; Environmental Screening Level, lowest residential.
** RWQCB Region 2; Environmental Screening Level, lowest commercial/industrial.

TABLE 7-3

ANALYTICAL RESULTS FOR OFF SITE SOIL GAS SURVEY (a) - SOUTH OF SITE

Location: Adjacent to southern perimeter, off-site, along Wesley Drive

Parameter			Soil Gas Probe No. - Depth below ground surface in feet (b)												
			SGP-WD-1-5 (b)	SGP-WD-2-5	SGP-WD-2-5	SGP-WD-2-10	SGP-WD-3-5	SGP-WD-3-10	SGP-WD-4-5	SGP-WD-4-10	SGP-WD-4-10	SGP-WD-5-5	SGP-WD-5-10	SGP-WD-6-5	SGP-WD-6-10
	CHHSLs Residential Land Use	CHHSLs Commerical/I ndustrial Land Use			EPA TO-15						EPA TO-15				
Acetone	NLE (c)	NLE	ND (d)	ND	270	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	NLE	NLE	ND	ND	52	ND	ND	ND	ND	ND	ND	D	ND	ND	ND
Benzene	36.2	122	56(39)	47(DUP 47)(e)	47	ND	ND	ND	ND	ND	ND	39	ND	71	53
Chlorobenzene	NLE	NLE	ND	ND	180	ND	ND	ND	ND	ND	2,500	ND	ND	ND	ND
Ethylbenzene	NLE	NLE	ND	ND	81	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	NLE	NLE	ND	ND	ND	62	ND	4,900	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	NLE	NLE	ND	ND	77	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MTBE	4,000	13,400	ND	ND	ND	150	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene	NLE	NLE	ND	ND	ND	ND	ND	1,500	ND	510	ND	ND	ND	ND	ND
Toluene(1V)	135,000	378,000	77	ND	NA (f)	ND	ND	ND	ND	ND	NA	ND	ND	200	ND
Toluene 1V (3V)(7V)	135,000	378,000	77(160)(140)	160(DUP 160)	170	71	ND	ND	66	530	ND	130	ND	ND	130
1,1,1-Trichloroethane	NLE	NLE	100	350(DUP 340)	250	50	ND	ND	270	ND	ND	380	ND	420	170
Xylenes -m,p	319,000	887,000	ND	130(DUP 120)	120	ND	ND	ND	ND	ND	ND	ND	ND	100	ND
Xylenes -o	315,000	879,000	ND	ND	43	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons (ug/L; C4-C12)			ND (50)	ND (50)		99	5,400	5,300	380	9,100		180	160	ND(50)	100

NOTES:

(a) All units in micrograms per cubic meter (ug/m3).

(b) SGP-WD-1-5 = soil gas probe - Wesley Drive- probe number - depth in feet below ground surface.

(c) NLE = No level established.

(d) ND = Not detected at or above parameter's respective analytical detection level.

(e) DUP = Duplicate.

(f) NA = Not analyzed.

Legend

○ Monitoring Well

▲ Soil Gas Probe (TEC, 2009 and 2010)

✙ Soil, Soil Gas, and Grab Goundwater Sampling Locations (Geosyntec, 2012)

NOTE:
Approximate locations of monitoring well and soil gas probes from
Testa Environmental Corporation's (TEC) June 2011 Report
on Phase II and Phase III Additional Site Characterization

N

0 300 600
Feet

Soil, Soil Gas, and Grab Groundwater Sampling Locations

Former Chemoil Refinery
2020 Walnut Avenue, Signal Hill, CA

Geosyntec
consultants

WA 1617	July 2012	Figure 2

P:\GIS\Chemoil\Project\2012Jun_InvRep\Figure2.mxd

Figure 1 - Phase I and II Boring Locations, Former Chemoil Refinery, Signal Hill, California

HISTORICAL GROUNDWATER DATA

NORTHWEST AND SOUTHWEST PARCELS

Table A-9
Summary of Groundwater Analytical Results - Hydrocarbon Chain Characterization, Northwest and Southwest Parcels
Former ChemOil Refinery
Signal Hill, California

Boring	**Sample Date**	**Depth**	**Hydrocarbon Chain Identification**																**TPH (C6-C12)$^{\text{Note 1}}$**	**TPH (C13-C22)$^{\text{Note 2}}$**	**TPH (C23-C44)$^{\text{Note 3}}$**	**TPH (C6-C44)**
			C6-C8	**C8-C10**	**C10-C12**	**C12-C14**	**C14-C16**	**C16-C18**	**C18-C20**	**C20-C22**	**C22-C24**	**C24-C26**	**C26-C28**	**C28-C32**	**C32-C34**	**C34-C36**	**C36-C40**	**C40-C44**				
		ft bgs	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
California MCL[4] / *Notification Level* [5]			**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**100**	**100**	**50,000**	**NV**
Final Screening Level Groundwater Commerical/Industrial [6]			**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**
AN-01	1/4/2017	40	<1.0	**1.1**	**20**	**70**	**45**	**37**	**27**	**20**	**8.6**	**5.1**	**2.2**	**3.4**	<1.0	<1.0	<1.0	<1.0	**21**	**164**	**15**	**240**
AN-02	1/5/2017	38	**14**	**200**	**420**	**520**	**400**	**220**	**96**	**50**	**23**	**11**	<10	<10	<10	<10	<10	<10	**634**	**1026**	**22.5**	**2,000**
AN-03	1/5/2017	40	**0.78**	**4.6**	**9.4**	**9.0**	**5.8**	**2.5**	**1.7**	**1.1**	**0.41**	**0.29**	**0.36**	**0.14**	<0.10	<0.10	<0.10	<0.10	**15**	**16**	**1.00**	**36**
AN-05	1/5/2017	40	**1.6**	**14**	**35**	**44**	**35**	**21**	**12**	**6.4**	**2.7**	**1.3**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**51**	**96**	**2.7**	**170**
AN-13	1/9/2017	41	**1.3**	**8.0**	**26**	**33**	**25**	**14**	**7.0**	**3.3**	**1.2**	**0.50**	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	**35**	**66**	**1.1**	**120**
	1/9/2017	54	<0.10	**0.62**	**4.2**	**4.1**	**0.69**	**0.28**	**0.17**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**4.8**	**3.2**	<0.90	**10**
AN-20	1/18/2017	32	**7.0**	**25**	**18**	**15**	**12**	**3.7**	**1.1**	**0.58**	**0.12**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**50**	**25**	**0.06**	**83**
	1/18/2017	42	**14**	**48**	**49**	**30**	**9.4**	**1.4**	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	**111**	**26**	<2.5	**150**
	1/18/2017	62	**0.36**	**1.2**	**1.4**	**1.5**	**0.23**	**0.092**	**0.081**	**0.12**	**0.047**	**0.030**	**0.64**	**0.072**	<0.010	<0.010	**0.026**	<0.010	**2.96**	**1.273**	**0.77**	**5.9**
AN-22	5/18/2017	58	**0.013**	**0.065**	**0.25**	**0.34**	**0.4**	**0.160**	**0.073**	**0.061**	**0.047**	**0.025**	**0.036**	**0.019**	<0.010	<0.010	<0.010	<0.010	**0.328**	**0.864**	**0.104**	**1.5**
SOUTHWEST PARCEL																						
MW-20	1/18/2017	20-35	<0.050	**0.10**	**0.81**	**1.5**	**3.1**	**1.8**	**0.80**	**0.60**	**0.38**	**0.11**	**0.10**	**0.073**	<0.050	<0.050	<0.050	<0.050	**0.91**	**7.05**	**0.47**	**9.4**
WEST OF GUNDRY AVENUE, OFFSITE																						
AO-1	1/10/2017	34	**4.3**	**17**	**15**	**5.5**	**0.91**	**0.13**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**36**	**3.8**	<1.0	**44**
	1/10/2017	44	**2.1**	**7.7**	**6.2**	**2.4**	**0.57**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**16**	**1.8**	<1.10	**19**
	1/10/2017	60	**0.035**	**0.19**	**0.61**	**0.78**	**0.55**	**0.44**	**0.33**	**0.27**	**0.18**	**0.084**	**0.57**	**0.097**	**0.022**	**0.030**	**0.013**	<0.010	**0.8**	**2.0**	**0.86**	**4.2**

Notes:

TPH = Total petroleum hydrocarbons measured by EPA Method 8015M.
C4-C12 = Carbon range.
ft bgs = feet below ground surface.
mg/L = milligram per liter.
NV = No value.
<X.XX = Not detected above indicated reporting limit (RL).

Bold values were reported above laboratory detection limits.

[1] TPH$_{C4\text{-}C12}$ was calculated based on summing detected results from C6-C8, C8-C10, and C10-C12.
[2] TPH$_{C13\text{-}C22}$ was calculated based on summing detected results of one half C12-C13 and the results between C14 and C22.
[3] TPH$_{C23\text{-}C44}$ was calculated based on summing the results of one half C22-C24 and the results between C24 and C44.
[4] California MCLs shown in bold font. MCLs are enforceable standards. No values for TPH mixtures were available.
[5] California notification levels shown in italic font. Notification levels are advisory in nature and not enforceable standards. No values for TPH mixtures were available.
[6] Final Screening Level, Groundwater Commercial/Industrial is from Table 4-3: Final Screening Levels for Groundwater - Commercial/Industrial Scenario (Apex-SGI, 2017).

References:

The Source Group, Inc., a division of Apex Companies, LLC (Apex-SGI). 2017. Response Plan and Remedial Technology Evaluation, Former Chemoil Refinery, Signal Hill, California. June.

Table A-10
Summary of Groundwater Analytical Results - Volatile Organic Compounds, Northwest and Southwest Parcels
Former ChemOil Refinery
Signal Hill, California

Boring	Sample Date	Depth ft bgs	TPHg (C4-C12) µg/L	Acetone µg/L	Benzene µg/L	TBA µg/L	sec-Butylbenzene µg/L	tert-Butylbenzene µg/L	n-Butylbenzene µg/L	1,2-Dichloroethane µg/L	cis-1,2-Dichloroethene µg/L	Ethylbenzene µg/L	Isopropylbenzene µg/L	4-Isopropyltoluene µg/L	Naphthalene µg/L	n-Propylbenzene µg/L	Tetrachloroethylene µg/L	Toluene µg/L	1,3,5-TMB µg/L	1,2,4-TMB µg/L	2-Butanone (MEK) µg/L	MTBE µg/L	o-Xylene µg/L	m,p-Xylenes µg/L	total Xylenes µg/L
California MCL[1] / *Notification Level*[2]			**100**	**NV**	**1**	*12*	*260*	*260*	*260*	**0.5**	**6.0**	**300**	*770*	**NV**	*17*	*260*	**5**	**150**	*330*	*330*	**NV**	**13**	**1,750**	**1,750**	**1,750**
Final Screening Level Groundwater Commerical/Industrial [3]			**NV**	**3.7E+08**	**12**	**NV**	**NV**	**NV**	**NV**	**64**	**1,100**	**140**	**NV**	**NV**	**220**	**NV**	**32**	**37,000**	**NV**	**NV**	**4.60E+07**	**13,000**	**NV**	**NV**	**13,000**
NORTHWEST PARCEL																									
AN-01	1/4/2017	40	**53,000**	<100	**18**	<100	**28**	<5.0	**24**	<5.0	<5.0	<5.0	**57**	<10	**560**	**63**	<5.0	<5.0	<5.0	<5.0	<100	<20	<5.0	<10	<15
AN-02	1/5/2017	38	**81,000**	<100	<5.0	**110**	**180**	**18**	**160**	<5.0	<5.0	<5.0	**290**	<10	**1,300**	**380**	<5.0	<5.0	<5.0	<5.0	<100	<20	<5.0	<10	<15
AN-03	1/5/2017	40	**35,000**	<100	**990**	<100	**420**	**48**	**370**	<5.0	**7.6**	**91**	**710**	**16**	**1,600**	**850**	<5.0	<5.0	**9.0**	**19**	<100	<20	**13**	**34**	**47**
AN-05	1/5/2017	40	**170,000**	<100	**68**	**140**	**66**	<5.0	**73**	<5.0	<5.0	**9.2**	**110**	<10	**830**	**150**	<5.0	<5.0	<5.0	<5.0	<100	<20	<5.0	<10	<15
AN-13	1/9/2017	41	**12,000**	<500	**1,000**	<500	<25	<25	**27**	<25	<25	**370**	**85**	<50	**380**	**110**	<25	<25	<25	<25	<500	<100	<25	<50	<75
	1/9/2017	54	**240**	<10	**10**	<10	**1.1**	<0.50	**1.4**	**38**	<0.50	**5.7**	**1.6**	<1.0	**12**	**2.1**	<0.50	<0.50	<0.50	<0.50	<10	<2.0	<0.50	<1.0	<1.5
AN-20	1/18/2017	32	**19,000**	<1000	**3,600**	<1000	<50	<50	<50	<50	**120**	**1,000**	**120**	<100	<200	**130**	<50	<50	**99**	**410**	<1,000	<200	<50	**460**	**460**
	1/18/2017	42	**26,000**	<1000	**6,300**	<1000	<50	<50	<50	<50	**150**	**1,200**	**130**	<100	**380**	**160**	<50	<50	**220**	**680**	<1,000	<200	<50	**1,400**	**1,400**
	1/18/2017	52	**3,900**	**120**	**200**	<10	**6.2**	<0.50	**5.9**	<0.50	**5.0**	**83**	**19**	**7.4**	**16**	**22**	**3.2**	**2.2**	**24**	**63**	**18**	<2.0	**8.4**	**130**	**138**
	1/18/2017	62	**8,400**	**160**	**380**	<50	**11**	<2.5	**11**	<2.5	**5.6**	**300**	**57**	**14**	**72**	**63**	**7.7**	**13**	**63**	**190**	<50	<10	**24**	**320**	**344**
AN-22	5/18/2017	58	**300**	<10	<0.50	<10	**1.2**	<0.52	**1.1**	<0.50	<0.50	**0.70**	**1.8**	<1.0	**2.6**	**2.3**	<0.50	<0.50	<0.50	**0.96**	<10	<2.0	<0.50	<1.0	<1.5
SOUTHWEST PARCEL																									
MW-20	1/18/2017	20-35	**360**	<10	<0.50	**100**	**3.5**	<0.50	**1.2**	<0.50	<0.50	**1.1**	**6.8**	<1.0	**120**	**10**	**0.74**	<0.50	<0.50	<0.50	<10	<2.0	<0.50	<1.0	<1.5
WEST OF GUNDRY AVENUE, OFFSITE																									
AO-01	1/10/2017	34	**32,000**	<100	<5.0	<100	**45**	<5.0	**42**	<5.0	<5.0	**320**	**150**	**41**	**160**	**200**	<5.0	<5.0	**65**	**310**	<100	<20	<5.0	<10	<15
	1/10/2017	44	**18,000**	<100	<5.0	<100	**65**	<5.0	**83**	<5.0	<5.0	**590**	**150**	**78**	**180**	**190**	<5.0	<5.0	**210**	**520**	<100	<20	**32**	**850**	**882**
	1/10/2017	60	**920**	**33**	**1.4**	<10	**1.8**	<0.50	**1.9**	<0.50	**1.6**	**13**	**4.1**	**1.8**	**5.7**	**4.9**	<0.50	<0.50	**5.6**	**16**	<10	<2.0	**0.97**	**22**	**23**

Notes:

Volatile organic compounds, fuel oxygenates, and TPHg measured by EPA Method 8260B.
ft bgs = feet below ground surface.
µg/L = microgram per liter.
TPHg = Total petroleum hydrocarbons as gasoline.
TBA = tert-Butyl alcohol.
MTBE = Methyl-t-butyl ether.
TMB = Trimethylbenzene.
NV = No value published.
<X.XX = Not detected above indicated reporting limit (RL).
-- = Not analyzed.
Bold values were reported above laboratory detection limits.
▨ **Shaded and bold value exceeds lowest of Table 4-3: Final Screening Levels for Groundwater - Commercial/Industrial Scenario (Apex-SGI).**

[1] California MCLs shown in bold font. MCLs are enforceable standards.
[2] California notification levels shown in italic font. Notification levels are advisory in nature and not enforceable standards.
[3] Final Screening Level, Groundwater Commercial/Industrial is from Table 4-3: Final Screening Levels for Groundwater - Commercial/Industrial Scenario (Apex-SGI, 2017).

References:

The Source Group, Inc., a division of Apex Companies, LLC (Apex-SGI). 2017. Response Plan and Remedial Technology Evaluation, Former Chemoil Refinery, Signal Hill, California. June.

Table A-11
Summary of Groundwater Analytical Results - Polycyclic Aromatic Hydrocarbons, Northwest and Southwest Parcels
Former ChemOil Refinery
Signal Hill, California

Boring	Sample Date	Depth	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
		ft bgs	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
California MCL[1] / *Notification Level*[2]			**NV**	**NV**	**NV**	**NV**	**0.2**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	*17*	**NV**	**NV**
Final Screening Level Groundwater Commerical/Industrial[3]			**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**NV**	**220**	**NV**	**NV**
NORTHWEST PARCEL																		
AN-02	1/5/2017	38	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	**110**	<40	**1,100**	**170**	<40
AN-03	1/5/2017	40	**4.4**	**3.2**	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	**9.6**	<2.0	**560**	**10**	<2.0
AN-05	1/5/2017	40	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**28**	<10	**580**	**31**	<10
AN-13	1/9/2017	41	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	**12**	<2.0	**260**	**10**	<2.0
	1/9/2017	54	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	**0.72**	<0.20	**11**	**1.0**	<0.20
AN-20	1/18/2017	32	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	**230**	**3.1**	<0.20
	1/18/2017	42	**17**	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	**7.0**	<2.0	**550**	**4.5**	<2.0
	1/18/2017	62	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	**0.20**	<0.20	**4.5**	**0.26**	<0.20
SOUTHWEST PARCEL																		
MW-20	1/18/2017	20-35	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	**2.2**	<0.20	**160**	**1.4**	<0.20
WEST OF GUNDRY AVENUE, OFFSITE																		
AO-01	1/10/2017	34	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	**0.98**	<0.20	**110**	**0.69**	<0.20
	1/10/2017	44	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	**91**	**0.65**	<0.20
	1/10/2017	60	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	**0.48**	<0.20	**3.6**	**0.57**	<0.20

Notes:

Polycyclic aromatic hydrocarbons (PAHs) measured by EPA Method 8270C.
ft bgs = feet below ground surface.
µg/L = microgram per liter.
MCL = Maximum Contaminant Level.
NV = No value published.
<X.XX = Not detected above indicated reporting limit (RL).

Bold values were reported above laboratory detection limits.

▨ **Shaded and bold value exceeds lowest of Table 4-3: Final Screening Levels for Groundwater - Commercial/Industrial Scenario (Apex-SGI, 2017).**

[1] California MCLs shown in bold font. MCLs are enforceable standards.

[2] California notification levels shown in italic font. Notification levels are advisory in nature and not enforceable standards.

[3] Final Screening Level, Groundwater Commercial/Industrial is from Table 4-3: Final Screening Levels for Groundwater - Commercial/Industrial Scenario (Apex-SGI, 2017)

References:

The Source Group, Inc., a division of Apex Companies, LLC (Apex-SGI). 2017. Response Plan and Remedial Technology Evaluation, Former Chemoil Refinery, Signal Hill, California. June.

HISTORICAL GROUNDWATER DATA

EAST PARCEL

Table A-12
Summary of Analytical Results for Volatile Organic Compounds (VOCs) in Groundwater, East Parcel
Former ChemOil Refinery
Signal Hill, California

Sample ID	Consultant	Sample Date	U.S. EPA Method 8015B		U.S. EPA Method 8020B	U.S EPA Method 8260B - VOCs														
			TPHg mg/L	TPHd mg/L	Bis (2-chloroethyl) ether µg/L	Benzene µg/L	tert-Butyl Alcohol µg/L	n-Butylbenzene µg/L	sec-Butylbenzene µg/L	cis-1,2-Dichloroethene µg/L	Ethylbenzene µg/L	Isopropylbenzene µg/L	4-Isopropyltoluene µg/L	Naphthalene µg/L	n-Propylbenzene µg/L	Toluene µg/L	1,2,4-Trimethylbenzene µg/L	1,3,5-Trimethylbenzene µg/L	m,p-Xylene µg/L	o-Xylene µg/L
MW-2	AA&AI	12/9/2012	ND<0.05	**0.48**	ND<10	ND<0.5	ND<10	ND<0.50	ND<0.50	ND<1	ND<0.5	ND<0.50	ND<0.50	ND<1	ND<0.50	ND<0.5	ND<1	ND<1	ND<1.0	ND<0.50
MW-2	AA&AI	12/27/2013	ND<0.05	ND<0.5	ND<10	ND<0.5	ND<10	ND<1	ND<1	ND<1	ND<1	ND<1	--	ND<3	ND<1	ND<0.5	ND<1	ND<1	--	--
MW-2	AA&AI	12/7/2014	ND<0.05	ND<0.5	ND<10	ND<0.5	ND<10	ND<1	ND<1	ND<1	ND<1	ND<1	--	ND<3	ND<1	ND<0.5	ND<1	ND<1	--	--
MW-2	AA&AI	12/10/2015	ND<0.05	ND<0.5	ND<10	ND<0.5	ND<10	ND<1	ND<1	ND<1	ND<1	ND<1	--	ND<3	ND<1	ND<0.5	ND<1	ND<1	--	--
MW-10	AA&AI	12/9/2012	**0.080**	**2.5**	ND<10	ND<0.5	**220**	ND<0.50	ND<0.50	ND<1	ND<0.5	**0.71**	ND<0.50	**1.3**	**0.51**	ND<0.5	ND<1	ND<1	ND<1.0	**0.65**
MW-10	AA&AI	12/27/2013	ND<0.05	ND<0.5	ND<10	ND<0.5	**130**	ND<1	ND<1	ND<1	ND<1	ND<1	--	ND<3	ND<1	ND<0.5	ND<1	ND<1	--	--
MW-10	AA&AI	12/7/2014	ND<0.050	ND<0.5	ND<10	ND<0.5	ND<10	ND<1	ND<1	ND<1	ND<1	ND<1	--	ND<3	ND<1	ND<0.5	ND<1	ND<1	--	--
MW-10	AA&AI	12/10/2015	ND<0.050	**0.911**	ND<10	ND<0.5	ND<10	ND<1	ND<1	ND<1	ND<1	ND<1	--	ND<3	ND<1	ND<0.5	ND<1	ND<1	--	--
MW-10	AA&AI	12/15/2016	**0.079**	**1.03**	ND<9.5	ND<0.50	**15**	ND<1.0	ND<1.0	ND<0.50	ND<0.50	**0.65**	ND<0.50	**1.5**	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<1.0	ND<0.50
B-1	TEC	2001	ND<0.20	--	**1,500**	ND<5.0	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	**2.1**
B-2	TEC	2001	ND<0.20	--	ND<110	ND<5.0	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
B-3	TEC	2001	ND<0.20	--	ND<110	ND<5.0	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
B-4	TEC	2001	ND<0.20	--	**100**	ND<5.0	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	**3.0**
B-5	TEC	2001	ND<0.20	--	ND<110	ND<5.0	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
B-6	TEC	2001	ND<0.20	--	ND<11	ND<5.0	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
B-7	TEC	2001	ND<0.20	--	ND<11	ND<5.0	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
B-8	TEC	2001	ND<0.20	--	ND<11	ND<5.0	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
B-9	TEC	2001	ND<0.20	--	ND<11	ND<5.0	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
E1A	Tetra Tech	6/1/2006	--	--	--	ND<0.5	--	ND<0.5	**1.6**	ND<0.5	ND<0.5	**8.7**	--	**11.6**	**9.6**	ND<0.5	ND<0.5	ND<0.5	ND<1.0	ND<0.5
E1A	Tetra Tech	6/1/2006	--	--	--	ND<0.5	--	ND<0.5	**1.7**	ND<0.5	ND<0.5	**13.3**	--	**64.7**	**13.2**	ND<0.5	ND<0.5	ND<0.5	ND<1.0	ND<0.5
E5	Tetra Tech	6/1/2006	--	--	--	ND<0.5	--	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	--	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<1.0	ND<0.5

Notes:
mg/L = milligram per liter.
µg/L = microgram per liter.
U.S. EPA = United States Environmental Protection Agency.
TPHg = total petroleum hydrocarbons as gasoline.
TPHd - total petroleum hydrocarbons as diesel.
VOCs = volatile organic compounds.
ND = not detected.
ND< = less than the laboratory reporting limit in data from Tetra Tech, 2006 samples or analytical detection limit in data from TEC, 2001.
AA&AI = Ami Amini & Adini, Inc.
TEC = Testa Environmental Corporation.

Data qualifiers from TEC, 2001:
B-1 through B-9 are reported in TEC, 2001.
(a) Sample date is unknown. The date listed is the date reported.
(b) The consultant is unknown. Data collected for borings B-1 through B-9 are assumed to be collected by TEC, 2001, as it is stated in the report text 9 borings were installed as part of their investigation with the same naming convention.
(c) The sample depth is unknown.

References:

AA&AI. 2017. Groundwater Monitoring Report – Fourth Quarter 2016, Former Chemoil Refinery, 2020 Walnut Avenue, Signal Hill, California. January 15.
AA&AI. 2016. Groundwater Monitoring Report – Fourth Quarter 2015, Former Chemoil Refinery, 2020 Walnut Avenue, Signal Hill, California. January 15.
AA&AI. 2015. Groundwater Monitoring Report – Fourth Quarter 2014, Former Chemoil Refinery, 2020 Walnut Avenue, Signal Hill, California. January 15.
AA&AI. 2014. Groundwater Monitoring Report – Fourth Quarter 2013, Former Chemoil Refinery, 2020 Walnut Avenue, Signal Hill, California. January 15.
TEC. 2013. Report on Groundwater Quality Monitoring Program January 2013, Former Chemoil Refinery, Slic No. 453A, Signal Hill, California. January 15.
TEC. 2001. Report on Additional Subsurface Assessment, Former Chemoil Refinery - Eastern Parcel, Signal Hill, California. December 14.
Tetra Tech. 2006. Environmental Due Diligence Site Assessment Results, Former Chemoil Refinery Property, Signal Hill, California. August 8.

Table A-13
Summary of Analytical Results for Metals in Groundwater, East Parcel
Former Chemoil Refinery
Signal Hill, California

Sample ID	Consultant	Data Qualifiers	Sample Date	U.S EPA Method 6010B - Metals																
				Antimony µg/L	Arsenic µg/L	Barium µg/L	Beryllium µg/L	Cadmium µg/L	Chromium µg/L	Cobalt µg/L	Copper µg/L	Lead µg/L	Mercury µg/L	Molybdenum µg/L	Nickel µg/L	Selenium µg/L	Silver µg/L	Thallium µg/L	Vanadium µg/L	Zinc µg/L
MW-2	unknown	(a) (b) (c) (d) (e)	unknown	ND<0.0050	**0.0067**	**0.090**	ND<0.0030	ND<0.0030	**0.030**	ND<0.0030	**0.010**	ND<0.0050	ND<0.0020	ND<0.0050	ND<0.0030	ND<0.0050	ND<0.0030	ND<0.0050	**0.0077**	**0.030**
MW-10	unknown	(a) (b) (c) (d) (e)	unknown	ND<0.0050	**0.26**	**0.060**	ND<0.0030	ND<0.0030	ND<0.0030	ND<0.0030	**0.0072**	ND<0.0050	ND<0.0020	**0.010**	ND<0.0030	ND<0.0050	ND<0.0030	ND<0.0050	ND<0.0030	**0.030**
B-1	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**0.12**	**0.26**	ND<0.0030	ND<0.0030	**0.050**	**0.010**	**0.030**	ND<0.0050	ND<0.0020	**0.080**	**0.020**	ND<0.0050	ND<0.0030	ND<0.0050	**0.070**	**0.10**
B-2	TEC	(a) (b) (c) (d) (e)	2001	**0.0069**	**0.14**	**0.65**	ND<0.0030	ND<0.0030	**0.21**	**0.090**	**0.12**	**0.020**	ND<0.0020	**0.060**	**0.11**	ND<0.0050	ND<0.0030	**0.010**	**0.32**	**0.54**
B-3	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**10.03**	**0.19**	ND<0.0030	ND<0.0030	**0.030**	**0.020**	**0.020**	ND<0.0050	ND<0.0020	**0.030**	**0.020**	ND<0.0050	ND<0.0030	ND<0.0050	**0.070**	**0.10**
B-4	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**0.11**	**0.50**	ND<0.0030	ND<0.0030	**0.060**	**0.020**	**0.030**	ND<0.0050	ND<0.0020	**0.090**	**0.040**	ND<0.0050	ND<0.0030	ND<0.0050	**0.10**	**0.21**
B-5	TEC	(a) (b) (c) (d) (e)	2001	**0.0051**	**0.23**	**2.9**	ND<0.0030	ND<0.0030	**0.35**	**0.27**	**0.30**	**0.11**	ND<0.0020	**0.040**	**0.29**	ND<0.0050	ND<0.0030	**0.020**	**0.50**	**0.72**
B-6	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**0.030**	**0.31**	ND<0.0030	ND<0.0030	**0.030**	**0.050**	**0.040**	ND<0.0050	ND<0.0020	**0.020**	**0.030**	ND<0.0050	ND<0.0030	ND<0.0050	**0.070**	**0.070**
B-7	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**0.10**	**0.69**	ND<0.0030	ND<0.0030	**0.23**	**0.070**	**0.12**	**0.020**	ND<0.0020	**0.060**	**0.11**	ND<0.0050	ND<0.0030	**0.010**	**0.26**	**0.43**
B-8	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**0.040**	**0.33**	ND<0.0030	ND<0.0030	**0.060**	**0.020**	**0.050**	ND<0.0050	ND<0.0020	**0.060**	**0.030**	ND<0.0050	ND<0.0030	ND<0.0050	**0.080**	**0.13**
B-9	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**0.0091**	**215**	ND<0.0030	ND<0.0030	**0.010**	**0.010**	**0.020**	ND<0.0050	ND<0.0020	**0.030**	**0.010**	ND<0.0050	ND<0.0030	ND<0.0050	**0.030**	**0.050**

Notes:
µg/L = micrograms per liter.
U.S. EPA = United States Environmental Protection Agency.
ND = not detected.
ND< = Less than analytical detection limit listed.
TEC = Testa Environmental Corporation.
Data qualifiers from TEC, 2001:
MW-1, MW-10, and B-1 through B-9 are reported in TEC, 2001.
(a) Sample date is unknown. The date listed is the date reported.
(b) The consultant is unknown. Data collected for borings B-1 through B-9 are assumed to be collected by TEC, 2001, as it is stated in the report text 9 borings were installed as part of their investigation with the same naming convention.
(c) The sample depth is unknown.
(d) No analytical method is listed in Table 6-2. The report text lists the analytical method for soil as U.S. EPA Method 6010B; therefore, it is assumed this is the correct listed method.
(e) No units are listed in Table 6-2 or in the report text. The units are assumed to be ug/L.
References:
TEC. 2001. Report on Additional Subsurface Assessment, Former Chemoil Refinery - Eastern Parcel, Signal Hill, California. December 14.

HISTORICAL GROUNDWATER DATA

FOURTH QUARTER 2016 GROUNDWATER MONITORING DATA

Table 1
Current Groundwater Analytical Data
Former ChemOil Refinery
2020 Walnut, Signal Hill, California 90755

Well ID	Date	DO (mg/L)	ORP (mV)	TPHg (µg/L)	TPHd (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl-benzene (µg/L)	Total Xylenes (µg/L)	MTBE (µg/L)	ETBE (µg/L)	DIPE (µg/L)	TAME (µg/L)	TBA (µg/L)	1,2-DCA (µg/L)	cis- 1,2-DCE (µg/L)	1,3,5-TMB (µg/L)	1,2,4-TMB (µg/L)	Naphthalene (µg/L)
MW-1	12/14/16	—	—	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-1A	12/14/16	<1	-34	6,900	9,000	<0.50	<0.50	<0.50	<1.0	5.0	<1.0	<1.0	<1.0	11	<0.50	<0.50	<0.50	<0.50	310
MW-2	12/15/16	—	—	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-3	12/14/16	<1	>-100	<50	<400	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<0.50	<0.50	<0.50	<0.50	<0.50
MW-8	12/15/16	<1	-28.00	2,900	2,800	3.7	<0.50	1.1	<1.0	1.1	<1.0	<1.0	<1.0	120	<0.50	<0.50	<0.50	<0.50	57
MW-9	12/14/16	<1	-58	17,000	57,000	330	<25	140	150	<50	<50	<50	<50	<500	<25	<25	<25	38	310
MW-10	12/14/16	<1	-55.00	79	1,030	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	15	<0.50	<0.50	<0.50	<0.50	1.5
MW-11	12/15/16	—	—	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-12	12/15/16	—	—	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-13	12/14/16	<1	-15.00	250	<400	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<0.50	<0.50	<0.50	<0.50	4.3
MW-14	12/14/16	<1	51	<50	<400	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<0.50	<0.50	<0.50	<0.50	<0.50
MW-15	12/15/16	<1	-24	3,300	6,600	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<0.50	<0.50	<0.50	<0.50	4.2
MW-16	12/14/16	<1	-15	5,100	1,400	<0.50	<0.50	<0.50	<1.0	7.2	<1.0	<1.0	<1.0	<10	<0.50	<0.50	<0.50	<0.50	75
MW-17	12/14/16	<1	35	120	<400	<0.50	<0.50	<0.50	<1.0	29	<1.0	<1.0	<1.0	19	<0.50	<0.50	<0.50	<0.50	<0.50
MW-18	12/14/16	2.00	32.00	<50	<400	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<0.50	<0.50	<0.50	<0.50	<0.50
MW-19	12/15/16	1.00	-36	1,700	4,850	<2.5	<2.5	<2.5	<5.0	<5.0	<5.0	<5.0	<5.0	<50	<2.5	<2.5	<2.5	<2.5	20
BMW-1	12/15/16	—	—	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMW-2	12/15/16	6-8	7	<50	610	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<0.50	<0.50	<0.50	<0.50	<0.50
BMW-3	12/15/16	—	—	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMW-4	12/15/16	—	—	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMW-5	12/15/16	6-8	18	550	<400	<0.50	0.78	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	36	<0.50	<0.50	<0.50	<0.50	3.3
BMW-6	12/15/16	—	—	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMW-7	12/15/16	—	—	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMW-8	12/15/16	6-8	23	870	<400	<0.50	0.65	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<0.50	<0.50	<0.50	<0.50	1.5
BMW-9	12/15/16	—	—	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 1
Current Groundwater Analytical Data

Former ChemOil Refinery
2020 Walnut, Signal Hill, California 90755

Well ID	Date	DO (mg/L)	ORP (mV)	TPHg (µg/L)	TPHd (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl-benzene (µg/L)	Total Xylenes (µg/L)	MTBE (µg/L)	ETBE (µg/L)	DIPE (µg/L)	TAME (µg/L)	TBA (µg/L)	1,2-DCA (µg/L)	cis- 1,2-DCE (µg/L)	1,3,5-TMB (µg/L)	1,2,4-TMB (µg/L)	Naphthalene (µg/L)
BMW-10	12/15/16	—	—	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMW-11	12/15/16	2.00	-12	4,600	1,200	200	<2.5	120	<5.0	<5.0	<5.0	<5.0	<5.0	<50	<2.5	<2.5	4.8	12	120
BMW-12	12/15/16	—	—	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
PQL		NA	NA	100	500	1	1	1	2	2	2	2	2	20	5	2	5	5	5
MDL		NA	NA	50	750	0.5	0.5	0.5	1	1	1	1	1	10	0.5	1	1	1	1

Notes:

MW1, MW2, etc. are monitoring well designations
GC/MS = Gas chromatography/mass spectrometry
DO = Dissolved oxygen
ORP = Oxidation reduction potential
TPHg = Total petroleum hydrocarbons as gasoline (LUFT GC/MS)
TPHd = Tptal petroleum hydrocarbons as diesel (LUFT GC/MS)
MTBE = Methyl tertiary butyl ether (EPA Method 8260B)
ETBE = Ethyl tertiary butyl ether (EPA Method 8260B)
DIPE = Di-isopropyl ether (EPA Method 8260B)
TAME = Tertiary amyl methyl ether (EPA Method 8260B)
TBA = Tertiary butyl alcohol (EPA Method 8260B)
DCA = Dichloroethane (EPA Method 8260B)
DCE = Dichloroethene (EPA Method 8260B)
PCE = Tetrachloroethene (EPA Method 8260B)
TMB = Trimethylbenzene (EPA Method 8260B)
mg/L = Milligrams per liter
mV = Millivolts
µg/L = Micrograms per liter
— = Not measured or not applicable
* = Result obtained from a higher dilution
PQL = Practical quantitation limit
MDL = Method detection limit
J = Estimated value between the MDL and PQL
NS = Not sampled

Other detected contaminant concentrations (µg/L) during this event:
Isopropylbenzene: 89 (MW-1A), 140 (MW-8), 75 (MW-9), 0.65 (MW-10), 8.1 (MW-13), 59 (MW-15), 98 (MW-16), 85 (MW-19), 13 (BMW-5), 3.3 (BMW-8), 64 (BMW-11)
n-Propylbenzene: 49 (MW-1A), 130 (MW-8), 91 (MW-9), 3.7 (MW-13), 3.8 (MW-15), 40 (MW-16), 2.8 (MW-19), 5.0 (BMW-5), 4.2 (BMW-8), 63 (BMW-11)
sec-Butylbenzene: 14 (MW-1A), 23 (MW-8), 1.3 (MW-13), 19 (MW-15), 23 (MW-16), 10 (MW-19), 4.1 (BMW-5), 3.0 (BMW-8), 10 (BMW-11)
n-Butylbenzene: 1.3 (MW-1A), 5.3 (MW-8), 5.4 (BMW-11)
2-Methylnapthalene: 93 (MW-1A), 11 (MW-8), 100 (MW-9), 30 (MW-16), 44 (MW-19), 38 (BMW-11)

APPENDIX B

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC HEALTH PERMITS

ENVIRONMENTAL HEALTH

Drinking Water Program

COUNTY OF LOS ANGELES
Public Health

5050 Commerce Drive, Baldwin Park, CA 91706
Telephone: (626) 430-5420 • Facsimile: (626) 813-3013 • Email: vgallegos@ph.lacounty.gov
http://publichealth.lacounty.gov/eh/ep/dw/dw_main.htm

SR0104311
2105 Walnut Ave Signal Hill 90755 Work Plan Approval

TO BE COMPLETED BY APPLICANT:

WORK SITE ADDRESS	CITY	ZIP	EMAIL ADDRESS FOR WELL PERMIT APPROVAL
2105 Walnut Avenue	Signal Hill	90755	Casey.huff@apexcos.com

NOTICE:

- WORK PLAN APPROVALS ARE VALID FOR 180 DAYS. 30 DAY EXTENSIONS OF WORK PLAN APPROVALS ARE CONSIDERED ON AN INDIVIDUAL (CASE-BY-CASE) BASIS AND MAY BE SUBJECT TO ADDITIONAL PLAN REVIEW FEES (HOURLY RATE AS APPLICABLE).
- WORK PLAN MODIFICATIONS MAY BE REQUIRED IF WELL AND GEOLOGIC CONDITIONS ENCOUNTERED AT THE SITE INSPECTION ARE FOUND TO DIFFER FROM THE SCOPE OF WORK PRESENTED TO THE DEPARTMENT OF PUBLIC HEALTH—DRINKING WATER PROGRAM.
- WORK PLAN APPROVALS ARE LIMITED TO COMPLIANCE WITH THE CALIFORNIA WELL STANDARDS AND THE LOS ANGELES COUNTY CODE AND DOES NOT GRANT ANY RIGHTS TO CONSTRUCT, RENOVATE, OR DECOMMISSION ANY WELL. THE APPLICANT IS RESPONSIBLE FOR SECURING ALL OTHER NECESSARY PERMITS SUCH AS WATER RIGHTS, PROPERTY RIGHTS, COASTAL COMMISSION APPROVALS, USE COVENANTS, ENCROACHMENT PERMISSIONS, UTILITY LINE SETBACKS, CITY/COUNTY PUBLIC WORKS RIGHTS OF WAY, ETC.
- ALL FIELD WORK MUST BE CONDUCTED UNDER THE DIRECT SUPERVISION OF A PROFESSIONAL GEOLOGIST LICENSED IN THE STATE OF CALIFORNIA.
- THIS PERMIT IS NOT COMPLETE UNTIL ALL OF THE FOLLOWING REQUIREMENTS ARE SIGNED BY THE DEPUTY HEALTH OFFICER. WORK SHALL NOT BE INITIATED WITHOUT A WORK PLAN APPROVAL STAMPED BY THE DEPARTMENT OF PUBLIC HEALTH—DRINKING WATER PROGRAM.
- ***ONCE APPROVED NOTIFY VINCENT GALLEGOS AT vgallegos@ph.lacounty.gov PREFERABLY 4 BUSINESS DAYS BEFORE WORK IS SCHEDULED TO BEGIN.***

TO BE COMPLETED BY DEPARTMENT OF PUBLIC HEALTH—DRINKING WATER PROGRAM:

X WORK PLAN APPROVED: 3 direct push boring's DATE: May 15, 2017

ADDITIONAL APPROVAL CONDITIONS:

- Please provide/ verify project dates and time via my email listed above this comment box
- This approval for the 3 borings does not include permission or approval to convert borings or additionally construct such borings to Monitoring / vapor wells. If conversion is field warranted, submit an application $519.00 per well with work plan/ resend work plan that describes well construction that includes State Well Completion Reports.
- Assure that the drilling, sampling and backfill of boring occurs within 72 hours.

.

Vincent Gallegos R.E.H.S.
Drinking Water Program
vgallegos@ph.lacounty.gov

GROUT SEAL INSPECTION)

DATE ACCEPTED: REHS signature

APPENDIX C

CPT LOGS

GREGG DRILLING & TESTING, INC.
GEOTECHNICAL AND ENVIRONMENTAL INVESTIGATION SERVICES

May 19, 2017

The Source Group/APEX
Attn: Kirsten Duey

Subject: CPT Site Investigation
Former Chemoil Refinery
Signal Hill, California
GREGG Project Number: 17-570SH

Dear Ms. Duey:

The following report presents the results of GREGG Drilling & Testing's Cone Penetration Test investigation for the above referenced site. The following testing services were performed:

1	Cone Penetration Tests	(CPTU)	☒
2	Pore Pressure Dissipation Tests	(PPD)	☒
3	Seismic Cone Penetration Tests	(SCPTU)	☐
4	UVOST Laser Induced Fluorescence	(UVOST)	☐
5	Groundwater Sampling	(GWS)	☐
6	Soil Sampling	(SS)	☐
7	Vapor Sampling	(VS)	☐
8	Membrane Interface Probe	(MIP)	☐
9	Vane Shear Testing	(VST)	☐
10	Dilatometer Testing	(DMT)	☐

A list of reference papers providing additional background on the specific tests conducted is provided in the bibliography following the text of the report. If you would like a copy of any of these publications or should you have any questions or comments regarding the contents of this report, please do not hesitate to contact our office at (562) 427-6899.

Sincerely,
GREGG Drilling & Testing, Inc.

PK Robertson

Peter Robertson
Technical Director, Gregg Drilling & Testing, Inc.

Cone Penetration Test Sounding Summary

-Table 1-

CPT Sounding Identification	Date	Termination Depth (feet)	Depth of Groundwater Samples (feet)	Depth of Soil Samples (feet)	Depth of Pore Pressure Dissipation Tests (feet)
AN-22	5/18/17	58	58	-	-
AN-22a	5/18/17	59	-	-	-

Bibliography

Lunne, T., Robertson, P.K. and Powell, J.J.M., "Cone Penetration Testing in Geotechnical Practice" E & FN Spon. ISBN 0 419 23750, 1997

Roberston, P.K., "Soil Classification using the Cone Penetration Test", Canadian Geotechnical Journal, Vol. 27, 1990 pp. 151-158.

Mayne, P.W., "NHI (2002) Manual on Subsurface Investigations: Geotechnical Site Characterization", available through www.ce.gatech.edu/~geosys/Faculty/Mayne/papers/index.html, Section 5.3, pp. 107-112.

Robertson, P.K., R.G. Campanella, D. Gillespie and A. Rice, "Seismic CPT to Measure In-Situ Shear Wave Velocity", Journal of Geotechnical Engineering ASCE, Vol. 112, No. 8, 1986 pp. 791-803.

Robertson, P.K., Sully, J., Woeller, D.J., Lunne, T., Powell, J.J.M., and Gillespie, D.J., "Guidelines for Estimating Consolidation Parameters in Soils from Piezocone Tests", Canadian Geotechnical Journal, Vol. 29, No. 4, August 1992, pp. 539-550.

Robertson, P.K., T. Lunne and J.J.M. Powell, "Geo-Environmental Application of Penetration Testing", Geotechnical Site Characterization, Robertson & Mayne (editors), 1998 Balkema, Rotterdam, ISBN 90 5410 939 4 pp 35-47.

Campanella, R.G. and I. Weemees, "Development and Use of An Electrical Resistivity Cone for Groundwater Contamination Studies", Canadian Geotechnical Journal, Vol. 27 No. 5, 1990 pp. 557-567.

DeGroot, D.J. and A.J. Lutenegger, "Reliability of Soil Gas Sampling and Characterization Techniques", International Site Characterization Conference - Atlanta, 1998.

Woeller, D.J., P.K. Robertson, T.J. Boyd and Dave Thomas, "Detection of Polyaromatic Hydrocarbon Contaminants Using the UVIF-CPT", 53rd Canadian Geotechnical Conference Montreal, QC October pp. 733-739, 2000.

Zemo, D.A., T.A. Delfino, J.D. Gallinatti, V.A. Baker and L.R. Hilpert, "Field Comparison of Analytical Results from Discrete-Depth Groundwater Samplers" BAT EnviroProbe and QED HydroPunch, Sixth national Outdoor Action Conference, Las Vegas, Nevada Proceedings, 1992, pp 299-312.

Copies of ASTM Standards are available through www.astm.org

Cone Penetration Testing Procedure (CPT)

Gregg Drilling carries out all Cone Penetration Tests (CPT) using an integrated electronic cone system, *Figure CPT*.

The cone takes measurements of tip resistance (q_c), sleeve resistance (f_s), and penetration pore water pressure (u_2). Measurements are taken at either 2.5 or 5 cm intervals during penetration to provide a nearly continuous profile. CPT data reduction and basic interpretation is performed in real time facilitating on-site decision making. The above mentioned parameters are stored electronically for further analysis and reference. All CPT soundings are performed in accordance with revised ASTM standards (D 5778-12).

The 5mm thick porous plastic filter element is located directly behind the cone tip in the u_2 location. A new saturated filter element is used on each sounding to measure both penetration pore pressures as well as measurements during a dissipation test (*PPDT*). Prior to each test, the filter element is fully saturated with oil under vacuum pressure to improve accuracy.

When the sounding is completed, the test hole is backfilled according to client specifications. If grouting is used, the procedure generally consists of pushing a hollow tremie pipe with a "knock out" plug to the termination depth of the CPT hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. Disruption or further contamination to the site is therefore minimized.

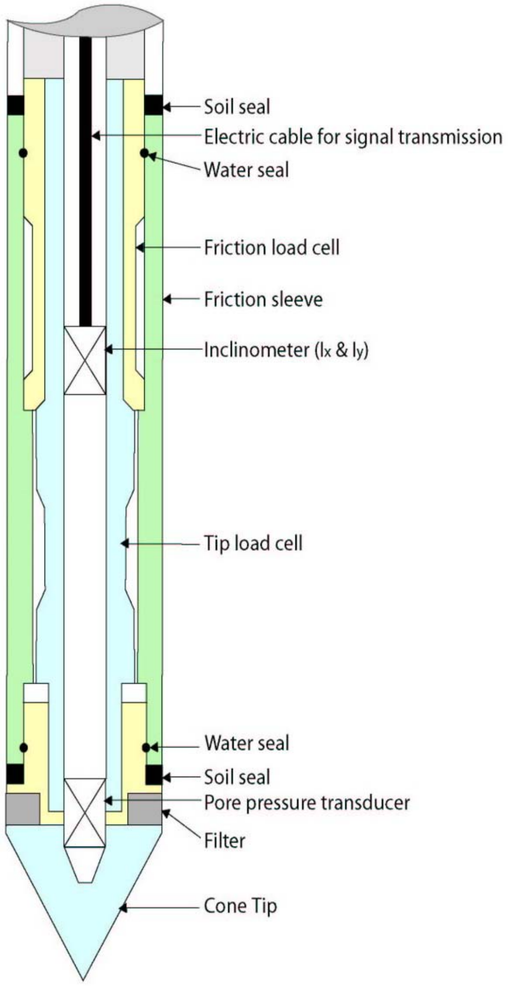


Figure CPT

Gregg $15cm^2$ Standard Cone Specifications

Dimensions	
Cone base area	15 cm^2
Sleeve surface area	225 cm^2
Cone net area ratio	0.80
Specifications	
Cone load cell	
Full scale range	180 kN (20 tons)
Overload capacity	150%
Full scale tip stress	120 MPa (1,200 tsf)
Repeatability	120 kPa (1.2 tsf)
Sleeve load cell	
Full scale range	31 kN (3.5 tons)
Overload capacity	150%
Full scale sleeve stress	1,400 kPa (15 tsf)
Repeatability	1.4 kPa (0.015 tsf)
Pore pressure transducer	
Full scale range	7,000 kPa (1,000 psi)
Overload capacity	150%
Repeatability	7 kPa (1 psi)

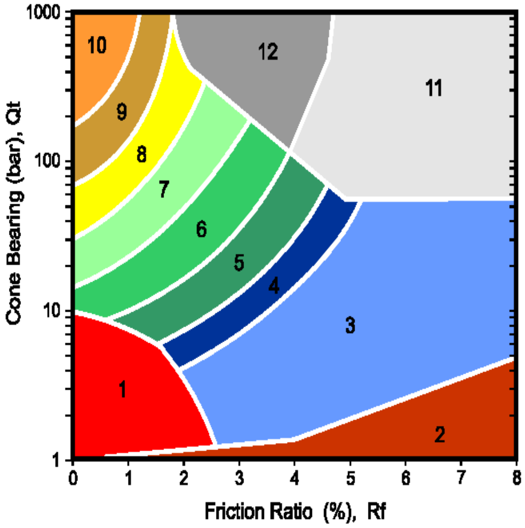
Note: The repeatability during field use will depend somewhat on ground conditions, abrasion, maintenance and zero load stability.

Cone Penetration Test Data & Interpretation

The Cone Penetration Test (CPT) data collected are presented in graphical and electronic form in the report. The plots include interpreted Soil Behavior Type (SBT) based on the charts described by Robertson (1990). Typical plots display SBT based on the non-normalized charts of Robertson et al (1986). For CPT soundings deeper than 30m, we recommend the use of the normalized charts of Robertson (1990) which can be displayed as SBTn, upon request. The report also includes spreadsheet output of computer calculations of basic interpretation in terms of SBT and SBTn and various geotechnical parameters using current published correlations based on the comprehensive review by Lunne, Robertson and Powell (1997), as well as recent updates by Professor Robertson (Guide to Cone Penetration Testing, 2015). The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed. Gregg Drilling & Testing Inc. does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the software and does not assume any liability for use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used in the software. Some interpretation methods require input of the groundwater level to calculate vertical effective stress. An estimate of the in-situ groundwater level has been made based on field observations and/or CPT results, but should be verified by the user.

A summary of locations and depths is available in Table 1. Note that all penetration depths referenced in the data are with respect to the existing ground surface.

Note that it is not always possible to clearly identify a soil type based solely on q_t, f_s, and u_2. In these situations, experience, judgment, and an assessment of the pore pressure dissipation data should be used to infer the correct soil behavior type.



ZONE		SBT
1		🟥 Sensitive, fine grained
2		🟫 Organic materials
3		🟦 Clay
4		🟦 Silty clay to clay
5		🟩 Clayey silt to silty clay
6		🟩 Sandy silt to clayey silt
7		🟨 Silty sand to sandy silt
8		🟨 Sand to silty sand
9		🟫 Sand
10		🟧 Gravely sand to sand
11		⬜ Very stiff fine grained*
12		⬛ Sand to clayey sand*

*over consolidated or cemented

Figure SBT (After Robertson et al., 1986) – Note: Colors may vary slightly compared to plots

Cone Penetration Test (CPT) Interpretation

Gregg uses a proprietary CPT interpretation and plotting software. The software takes the CPT data and performs basic interpretation in terms of soil behavior type (SBT) and various geotechnical parameters using current published empirical correlations based on the comprehensive review by Lunne, Robertson and Powell (1997). The interpretation is presented in tabular format using MS Excel. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed. Gregg does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the software and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used in the software.

The following provides a summary of the methods used for the interpretation. Many of the empirical correlations to estimate geotechnical parameters have constants that have a range of values depending on soil type, geologic origin and other factors. The software uses 'default' values that have been selected to provide, in general, conservatively low estimates of the various geotechnical parameters.

Input:

1 Units for display (Imperial or metric) (atm. pressure, p_a = 0.96 tsf or 0.1 MPa)
2 Depth interval to average results (ft or m). Data are collected at either 0.02 or 0.05m and can be averaged every 1, 3 or 5 intervals.
3 Elevation of ground surface (ft or m)
4 Depth to water table, z_w (ft or m) – input required
5 Net area ratio for cone, a (default to 0.80)
6 Relative Density constant, C_{Dr} (default to 350)
7 Young's modulus number for sands, α (default to 5)
8 Small strain shear modulus number
  a. for sands, S_G (default to 180 for SBT_n 5, 6, 7)
  b. for clays, C_G (default to 50 for SBT_n 1, 2, 3 & 4)
9 Undrained shear strength cone factor for clays, N_{kt} (default to 15)
10 Over Consolidation ratio number, k_{ocr} (default to 0.3)
11 Unit weight of water, (default to $\gamma_w = 62.4\ lb/ft^3$ or $9.81\ kN/m^3$)

Column

1 Depth, z, (m) – CPT data is collected in meters
2 Depth (ft)
3 Cone resistance, q_c (tsf or MPa)
4 Sleeve resistance, f_s (tsf or MPa)
5 Penetration pore pressure, u (psi or MPa), measured behind the cone (i.e. u_2)
6 Other – any additional data
7 Total cone resistance, q_t (tsf or MPa) $q_t = q_c + u\,(1\text{-}a)$

8	Friction Ratio, R_f (%)	$R_f = (f_s/q_t) \times 100\%$
9	Soil Behavior Type (non-normalized), SBT	see note
10	Unit weight, γ (pcf or kN/m^3)	based on SBT, see note
11	Total overburden stress, σ_v (tsf)	$\sigma_{vo} = \sigma\ z$
12	In-situ pore pressure, u_o (tsf)	$u_o = \gamma_w (z - z_w)$
13	Effective overburden stress, σ'_{vo} (tsf)	$\sigma'_{vo} = \sigma_{vo} - u_o$
14	Normalized cone resistance, Q_{t1}	$Q_{t1}= (q_t - \sigma_{vo}) / \sigma'_{vo}$
15	Normalized friction ratio, F_r (%)	$F_r = f_s / (q_t - \sigma_{vo}) \times 100\%$
16	Normalized Pore Pressure ratio, B_q	$B_q = u – u_o / (q_t - \sigma_{vo})$
17	Soil Behavior Type (normalized), SBT_n	see note
18	SBT_n Index, I_c	see note
19	Normalized Cone resistance, Q_{tn} (n varies with I_c)	see note
20	Estimated permeability, k_{SBT} (cm/sec or ft/sec)	see note
21	Equivalent SPT N_{60}, blows/ft	see note
22	Equivalent SPT $(N_1)_{60}$ blows/ft	see note
23	Estimated Relative Density, D_r, (%)	see note
24	Estimated Friction Angle, ϕ', (degrees)	see note
25	Estimated Young's modulus, E_s (tsf)	see note
26	Estimated small strain Shear modulus, Go (tsf)	see note
27	Estimated Undrained shear strength, s_u (tsf)	see note
28	Estimated Undrained strength ratio	s_u/σ_v'
29	Estimated Over Consolidation ratio, OCR	see note

Notes:

1 Soil Behavior Type (non-normalized), SBT (Lunne et al., 1997 and table below)

2 Unit weight, γ either constant at 119 pcf or based on Non-normalized SBT (Lunne et al., 1997 and table below)

3 Soil Behavior Type (Normalized), SBT_n Lunne et al. (1997)

4 SBT_n Index, I_c $I_c = ((3.47 – \log Q_{t1})^2 + (\log F_r + 1.22)^2)^{0.5}$

5 Normalized Cone resistance, Q_{tn} (n varies with Ic)

$Q_{tn} = ((q_t - \sigma_{vo})/pa)\ (pa/(\sigma'_{vo})^n$ and recalculate I_c, then iterate:

When $I_c < 1.64$, $n = 0.5$ (clean sand)
When $I_c > 3.30$, $n = 1.0$ (clays)
When $1.64 < I_c < 3.30$, $n = (I_c – 1.64)0.3 + 0.5$
Iterate until the change in n, $\Delta n < 0.01$

6 Estimated permeability, k_{SBT} based on Normalized SBT_n (Lunne et al., 1997 and table below)

7 Equivalent SPT N_{60}, blows/ft Lunne et al. (1997)

$$\frac{(q_t/p_a)}{N_{60}} = 8.5\left(1-\frac{I_c}{4.6}\right)$$

8 Equivalent SPT $(N_1)_{60}$ blows/ft $(N_1)_{60} = N_{60}\,C_{N,}$

where $C_N = (pa/\sigma'_{vo})^{0.5}$

9 Relative Density, D_r, (%) $D_r^2 = Q_{tn} / C_{Dr}$

Only SBT_n 5, 6, 7 & 8 *Show 'N/A' in zones 1, 2, 3, 4 & 9*

10 Friction Angle, ϕ', (degrees) $$\tan\phi' = \frac{1}{2.68}\left[\log\left(\frac{q_c}{\sigma'_{vo}}\right)+0.29\right]$$

Only SBT_n 5, 6, 7 & 8 *Show'N/A' in zones 1, 2, 3, 4 & 9*

11 Young's modulus, E_s $E_s = \alpha\, q_t$

Only SBT_n 5, 6, 7 & 8 *Show 'N/A' in zones 1, 2, 3, 4 & 9*

12 Small strain shear modulus, Go

a. $G_o = S_G\,(q_t\ \sigma'_{vo}\ pa)^{1/3}$ *For SBT_n 5, 6, 7*

b. $G_o = C_G\,q_t$ *For SBT_n 1, 2, 3& 4*

Show 'N/A' in zones 8 & 9

13 Undrained shear strength, s_u $s_u = (q_t - \sigma_{vo}) / N_{kt}$

Only SBT_n 1, 2, 3, 4 & 9 *Show 'N/A' in zones 5, 6, 7 & 8*

14 Over Consolidation ratio, OCR $OCR = k_{ocr}\,Q_{t1}$

Only SBT_n 1, 2, 3, 4 & 9 *Show 'N/A' in zones 5, 6, 7 & 8*

The following updated and simplified SBT descriptions have been used in the software:

SBT Zones		**SBT_n Zones**	
1	sensitive fine grained	1	sensitive fine grained
2	organic soil	2	organic soil
3	clay	3	clay
4	clay & silty clay	4	clay & silty clay
5	clay & silty clay		
6	sandy silt & clayey silt		

7	silty sand & sandy silt	5	silty sand & sandy silt
8	sand & silty sand	6	sand & silty sand
9	sand		
10	sand	7	sand
11	very dense/stiff soil*	8	very dense/stiff soil*
12	very dense/stiff soil*	9	very dense/stiff soil*

*heavily overconsolidated and/or cemented

Track when soils fall with zones of same description and print that description (i.e. if soils fall only within SBT zones 4 & 5, print ‘clays & silty clays’)

Estimated Permeability (see Lunne et al., 1997)

SBT_n	Permeability (ft/sec)	(m/sec)
1	$3x\ 10^{-8}$	$1x\ 10^{-8}$
2	$3x\ 10^{-7}$	$1x\ 10^{-7}$
3	$1x\ 10^{-9}$	$3x\ 10^{-10}$
4	$3x\ 10^{-8}$	$1x\ 10^{-8}$
5	$3x\ 10^{-6}$	$1x\ 10^{-6}$
6	$3x\ 10^{-4}$	$1x\ 10^{-4}$
7	$3x\ 10^{-2}$	$1x\ 10^{-2}$
8	$3x\ 10^{-6}$	$1x\ 10^{-6}$
9	$1x\ 10^{-8}$	$3x\ 10^{-9}$

Estimated Unit Weight (see Lunne et al., 1997)

SBT	Approximate Unit Weight (lb/ft^3)	(kN/m^3)
1	111.4	17.5
2	79.6	12.5
3	111.4	17.5
4	114.6	18.0
5	114.6	18.0
6	114.6	18.0
7	117.8	18.5
8	120.9	19.0
9	124.1	19.5
10	127.3	20.0
11	130.5	20.5
12	120.9	19.0

Pore Pressure Dissipation Tests (PPDT)

Pore Pressure Dissipation Tests (PPDT's) conducted at various intervals can be used to measure equilibrium water pressure (at the time of the CPT). If conditions are hydrostatic, the equilibrium water pressure can be used to determine the approximate depth of the ground water table. A PPDT is conducted when penetration is halted at specific intervals determined by the field representative. The variation of the penetration pore pressure (*u)* with time is measured behind the tip of the cone and recorded.

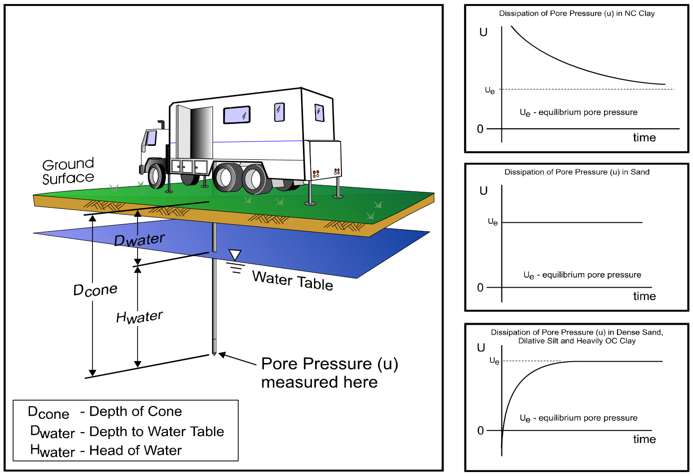
Pore pressure dissipation data can be interpreted to provide estimates of:

- Equilibrium piezometric pressure
- Phreatic Surface
- In situ horizontal coefficient of consolidation (c_h)
- In situ horizontal coefficient of permeability (k_h)

In order to correctly interpret the equilibrium piezometric pressure and/or the phreatic surface, the pore pressure must be monitored until it reaches equilibrium, *Figure PPDT*. This time is commonly referred to as t_{100}, the point at which 100% of the excess pore pressure has dissipated.

A complete reference on pore pressure dissipation tests is presented by Robertson et al. 1992 and Lunne et al. 1997.

A summary of the pore pressure dissipation tests are summarized in Table 1.



Water Table Calculation

$$D_{water} = D_{cone} - H_{water}$$

where $H_{water} = U_e$ (depth units)

Useful Conversion Factors:
1psi = 0.704m = 2.31 feet (water)
1tsf = 0.958 bar = 13.9 psi
1m = 3.28 feet

Figure PPDT

Seismic Cone Penetration Testing (SCPT)

Seismic Cone Penetration Testing (SCPT) can be conducted at various intervals during the Cone Penetration Test. Shear wave velocity (Vs) can then be calculated over a specified interval with depth. A small interval for seismic testing, such as 1-1.5m (3-5ft) allows for a detailed look at the shear wave profile with depth. Conversely, a larger interval such as 3-6m (10-20ft) allows for a more average shear wave velocity to be calculated. Gregg's cones have a horizontally active geophone located 0.2m (0.66ft) behind the tip.

To conduct the seismic shear wave test, the penetration of the cone is stopped and the rods are decoupled from the rig. An automatic hammer is triggered to send a shear wave into the soil. The distance from the source to the cone is calculated knowing the total depth of the cone and the horizontal offset distance between the source and the cone. To calculate an interval velocity, a minimum of two tests must be performed at two different depths. The arrival times between the two wave traces are compared to obtain the difference in time (Δt). The difference in depth is calculated (Δd) and velocity can be determined using the simple equation: $v = \Delta d/\Delta t$

Multiple wave traces can be recorded at the same depth to improve quality of the data.

A complete reference on seismic cone penetration tests is presented by Robertson et al. 1986 and Lunne et al. 1997.

A summary the shear wave velocities, arrival times and wave traces are provided with the report.

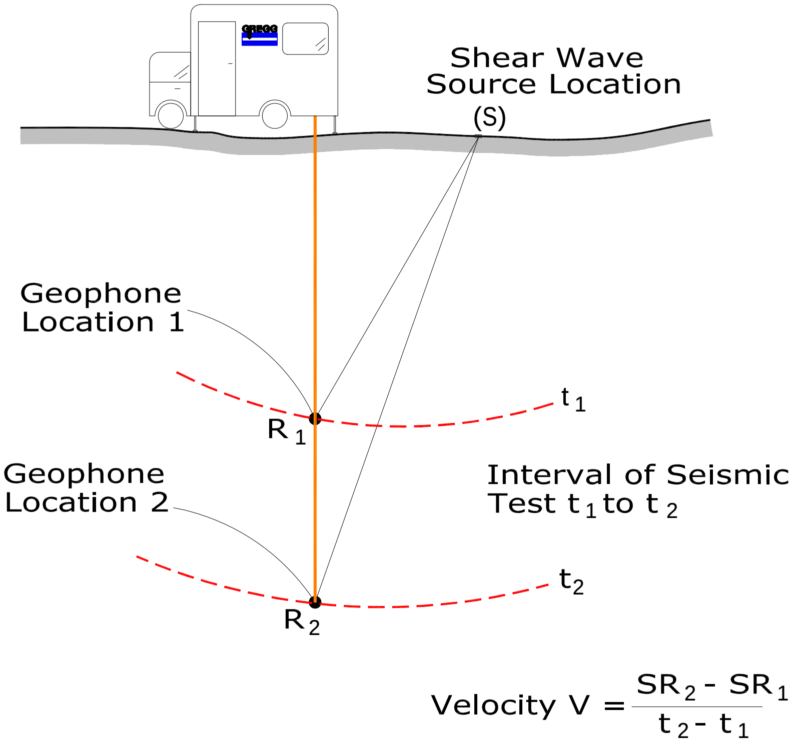


Figure SCPT

Groundwater Sampling

Gregg Drilling & Testing, Inc. conducts groundwater sampling using a sampler as shown in *Figure GWS*. The groundwater sampler has a retrievable stainless steel or disposable PVC screen with steel drop off tip. This allows for samples to be taken at multiple depth intervals within the same sounding location. In areas of slower water recharge, provisions may be made to set temporary PVC well screens during sampling to allow the pushing equipment to advance to the next sample location while the groundwater is allowed to infiltrate.

The groundwater sampler operates by advancing 44.5mm (1¾ inch) hollow push rods with the filter tip in a closed configuration to the base of the desired sampling interval. Once at the desired sample depth, the push rods are retracted; exposing the encased filter screen and allowing groundwater to infiltrate hydrostatically from the formation into the inlet screen. A small diameter bailer (approximately ½ or ¾ inch) is lowered through the push rods into the screen section for sample collection. The number of downhole trips with the bailer and time necessary to complete the sample collection at each depth interval is a function of sampling protocols, volume requirements, and the yield characteristics and storage capacity of the formation. Upon completion of sample collection, the push rods and sampler, with the exception of the PVC screen and steel drop off tip are retrieved to the ground surface, decontaminated and prepared for the next sampling event.

For a detailed reference on direct push groundwater sampling, refer to Zemo et. al., 1992.

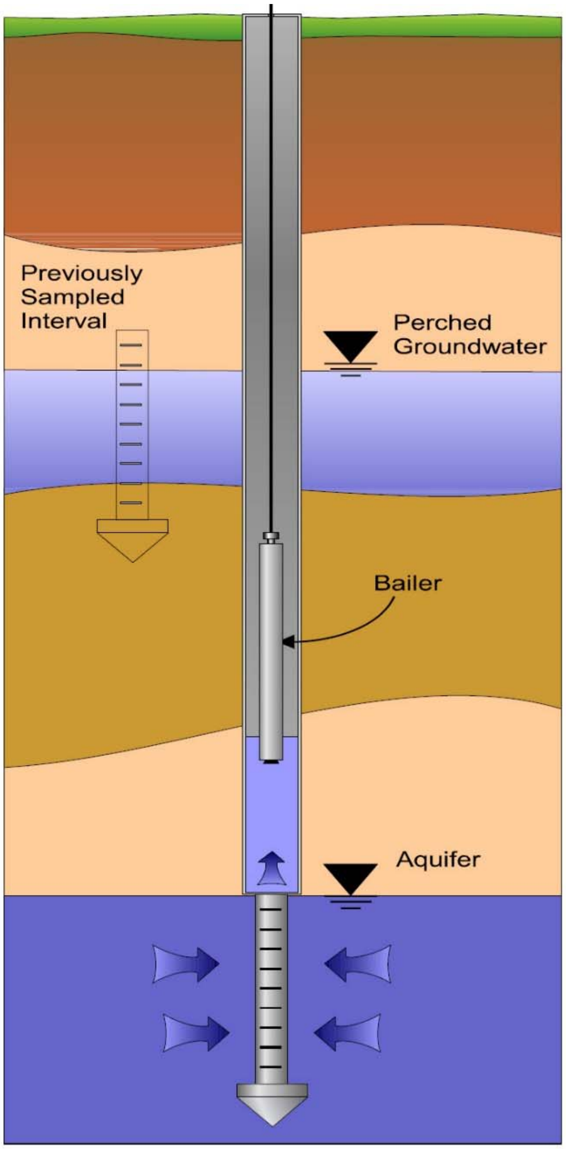


Figure GWS

Soil Sampling

Gregg Drilling & Testing, Inc. uses a piston-type push-in sampler to obtain small soil samples without generating any soil cuttings, *Figure SS*. Two different types of samplers (12 and 18 inch) are used depending on the soil type and density. The soil sampler is initially pushed in a "closed" position to the desired sampling interval using the CPT pushing equipment. Keeping the sampler closed minimizes the potential of cross contamination. The inner tip of the sampler is then retracted leaving a hollow soil sampler with inner 1¼" diameter sample tubes. The hollow sampler is then pushed in a locked "open" position to collect a soil sample. The filled sampler and push rods are then retrieved to the ground surface. Because the soil enters the sampler at a constant rate, the opportunity for 100% recovery is increased. For environmental analysis, the soil sample tube ends are sealed with Teflon and plastic caps. Often, a longer "split tube" can be used for geotechnical sampling.

For a detailed reference on direct push soil sampling, refer to Robertson et al, 1998.

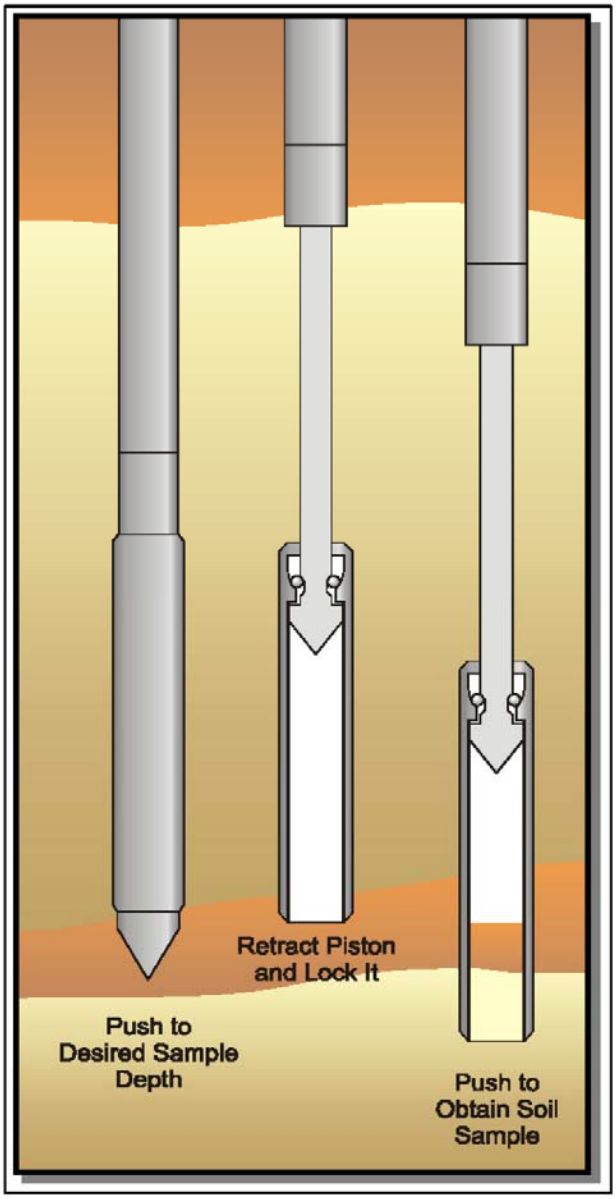


Figure SS

Ultra-Violet Induced Fluorescence (UVOST)

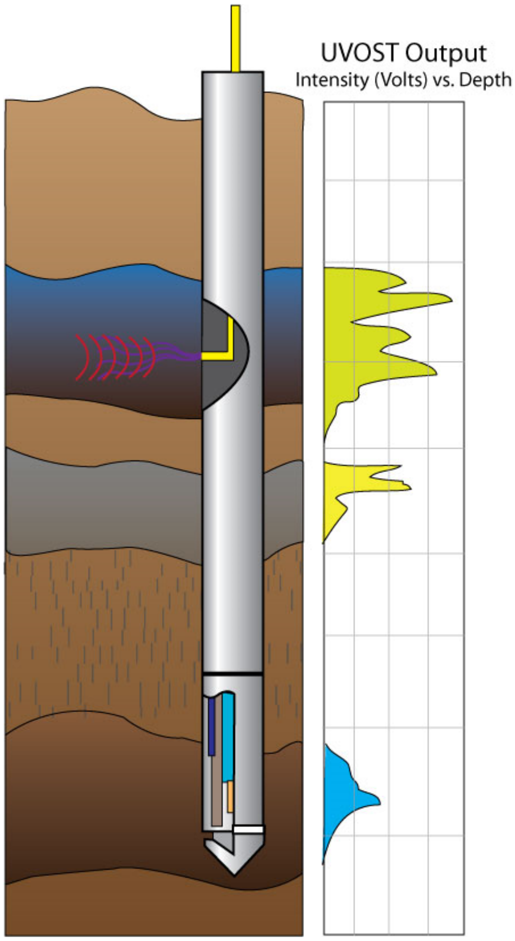
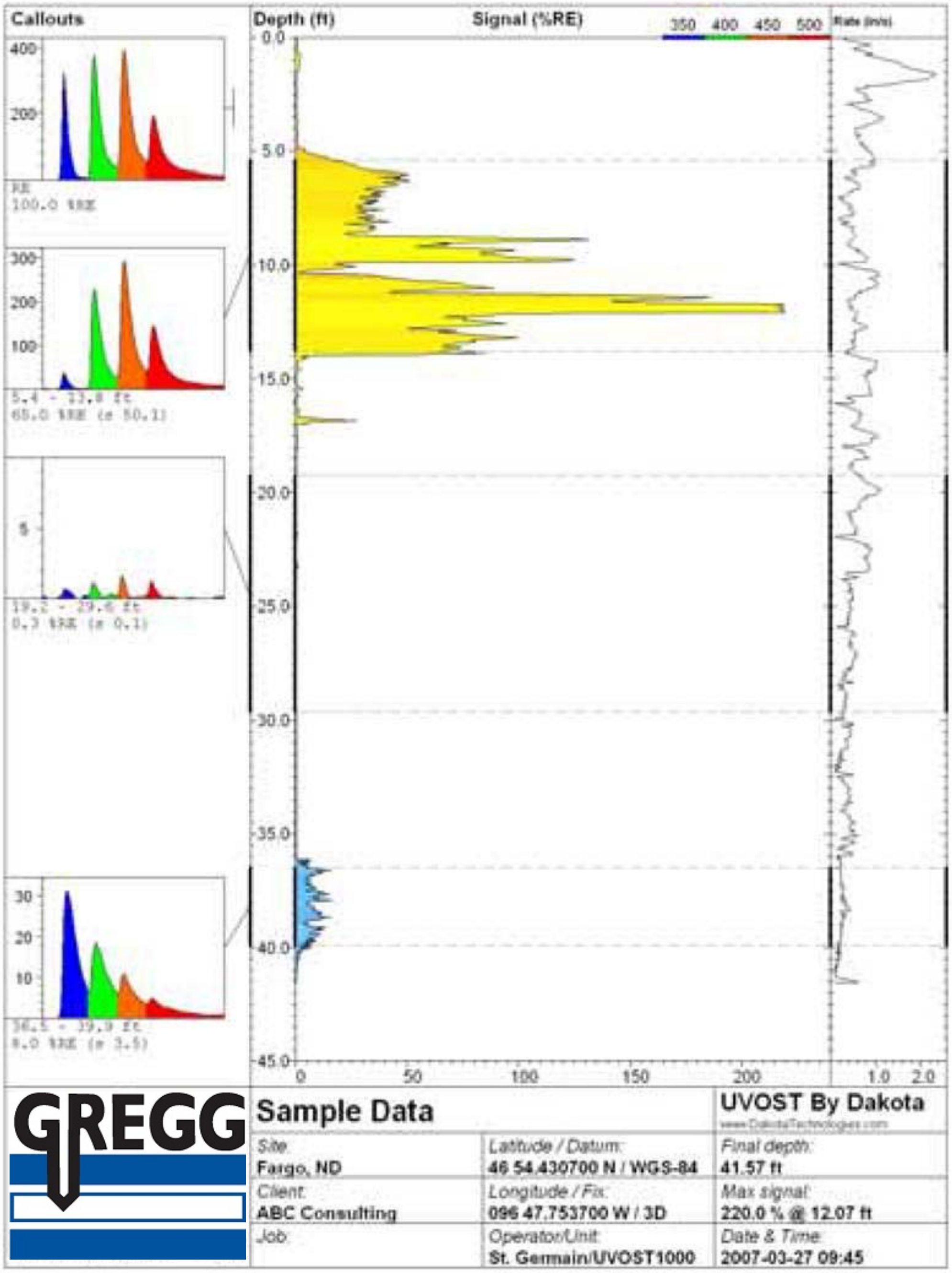


Figure UVOST

Gregg Drilling conducts Laser Induced Fluorescence (LIF) Cone Penetration Tests using a UVOST module that is located behind the standard piezocone, *Figure UVOST*. The laser induced fluorescence cone works on the principle that polycyclic aromatic hydrocarbons (PAH's), mixed with soil and/or groundwater, fluoresce when irradiated by ultra violet light. Therefore, by measuring the intensity of fluorescence, the lateral and vertical extent of hydrocarbon contamination in the ground can be estimated.

The UVOST module uses principles of fluorescence spectrometry by irradiating the soil with ultra violet light produced by a laser and transmitted to the cone through fiber optic cables. The UV light passes through a small window in the side of the cone into the soil. Any hydrocarbon molecules present in the soil absorb the light energy during radiation and immediately re-emit the light at a longer wavelength. This re-emission is termed fluorescence. The UVOST system also measures the emission decay with time at four different wavelengths (350nm, 400nm, 450nm, and 500nm). This allows the software to determine a product "signature" at each data point. This process provides a method to evaluate the type of contaminant. A sample output from the UVOST system is shown in *Figure Output*. In general, the typical detection limit for the UVOST system is <100 ppm and it will operate effectively above and below the saturated zone.

With the capability to push up to 200m (600ft) per day, laser induced fluorescence offers a fast and efficient means for delineating PAH contaminant plumes. Color coded logs offer qualitative information in a quick glance and can be produced in the field for real-time decision making. Coupled with the data provided by the CPT, a complete site assessment can be completed with no samples or cuttings, saving laboratory costs as well as site and environmental impact.



Sample Data

UVOST By Dakota

www.DakotaTechnologies.com

Site:
Fargo, ND

Latitude / Datum:
46 54.430700 N / WGS-84

Final depth:
41.57 ft

Client:
ABC Consulting

Longitude / Fix:
096 47.753700 W / 3D

Max signal:
220.0 % @ 12.07 ft

Job:

Operator/Unit:
St. Germain/UVOST1000

Date & Time:
2007-03-27 09:45

Figure Output

Hydrocarbons detected with UVOST

- Gasoline
- Diesel
- Jet (Kerasene)
- Motor Oil
- Cutting fluids
- Hydraulic fluids
- Crude Oil

Hydrocarbons rarely detected using UVOST

- Extremely weathered gasoline
- Coal tar
- Creosote
- Bunker Oil
- Polychlorinated bi-phenols (PCB's)
- Chlorinated solvent DNAPL
- Dissolved phase (aqueous) PAH's

Potential False Positives (fluorescence observed)

- Sea-shells (weak-medium)
- Paper (medium-strong depending on color)
- Peat/meadow mat (weak)
- Calcite/calcareous sands (weak)
- Tree roots (weak-medium)
- Sewer lines (medium-strong)

Potential False Negatives (do not fluoresce)

- Extremely weathered fuels (especially gasoline)
- Aviation gasoline (weak)
- "Dry" PAHs such as aqueous phase, lamp black, purifier chips
- Creosotes (most)
- Coal tars (most) gasoline (weak)
- Most chlorinated solvents
- Benzene, toluene, zylenes (relatively pure)

DAKOTA TECHNOLOGIES
UVOST LOG REFERENCE

2008-12-12

Main Plot :
Signal (total fluorescence) versus depth where signal is relative to the Reference Emitter (RE). The total area of the waveform is divided by the total area of the Reference Emitter yielding the %RE. This %RE scales with the NAPL fluorescence. The fill color is based on relative contribution of each channel's area to the total waveform area (see callout waveform). The channel-to-color relationship and corresponding wavelengths are given in the upper right corner of the main plot.

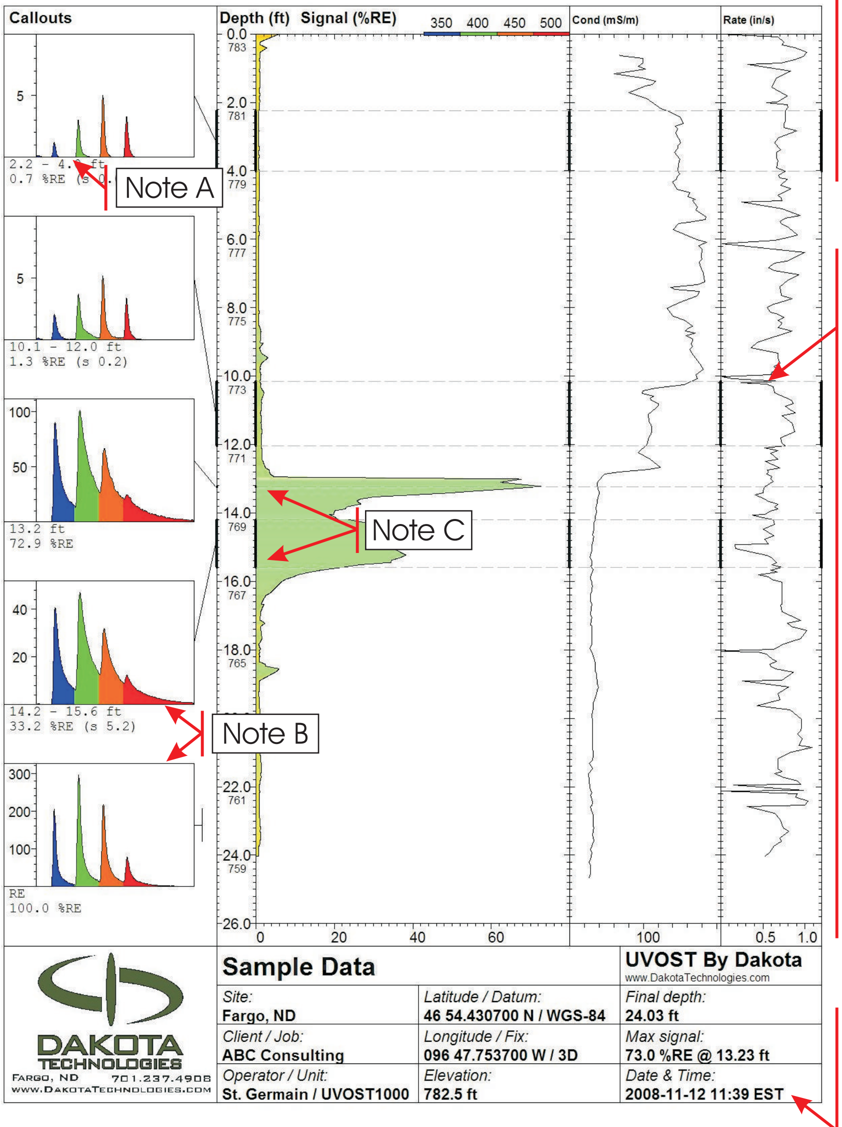
Conductivity Plot :
The Electrical Conductivity (EC) of the soil can be logged simultaneously with the UVOST data. EC often provides insight into the stratigraphy.
Note the drop in EC from 10 - 13 ft, indicating a shift from consolidated to unconsolidated stratigraphy. This correlates with the observed NAPL distribution.

Callouts :
Waveforms from selected depths or depth ranges showing the multi-wavelength waveform for that depth.

The four peaks are due to fluorescence at four wavelengths and referred to as “channels”. Each channel is assigned a color.

Various NAPLs will have a unique waveform "fingerprint" due to the relative amplitude of the four channels and/or broadening of one or more channels.

Basic waveform statistics and any operator notes are given below the callout.



Sample Data

UVOST By Dakota
www.DakotaTechnologies.com

DAKOTA TECHNOLOGIES
Fargo, ND 701.237.4908
www.DakotaTechnologies.com

Site: Fargo, ND	*Latitude / Datum:* 46 54.430700 N / WGS-84	*Final depth:* 24.03 ft
Client / Job: ABC Consulting	*Longitude / Fix:* 096 47.753700 W / 3D	*Max signal:* 73.0 %RE @ 13.23 ft
Operator / Unit: St. Germain / UVOST1000	*Elevation:* 782.5 ft	*Date & Time:* 2008-11-12 11:39 EST

Rate Plot :
The rate of probe advancement. ~ 0.8in (2cm) per second is preferred.

A noticeable decrease in the rate of advancement may be indicative of difficult probing conditions (gravel, angular sands, etc.) such as that seen here at ~5 ft.

Notice that this log was terminated arbitrarily, not due to "refusal", which would have been indicated by a sudden rate drop at final depth.

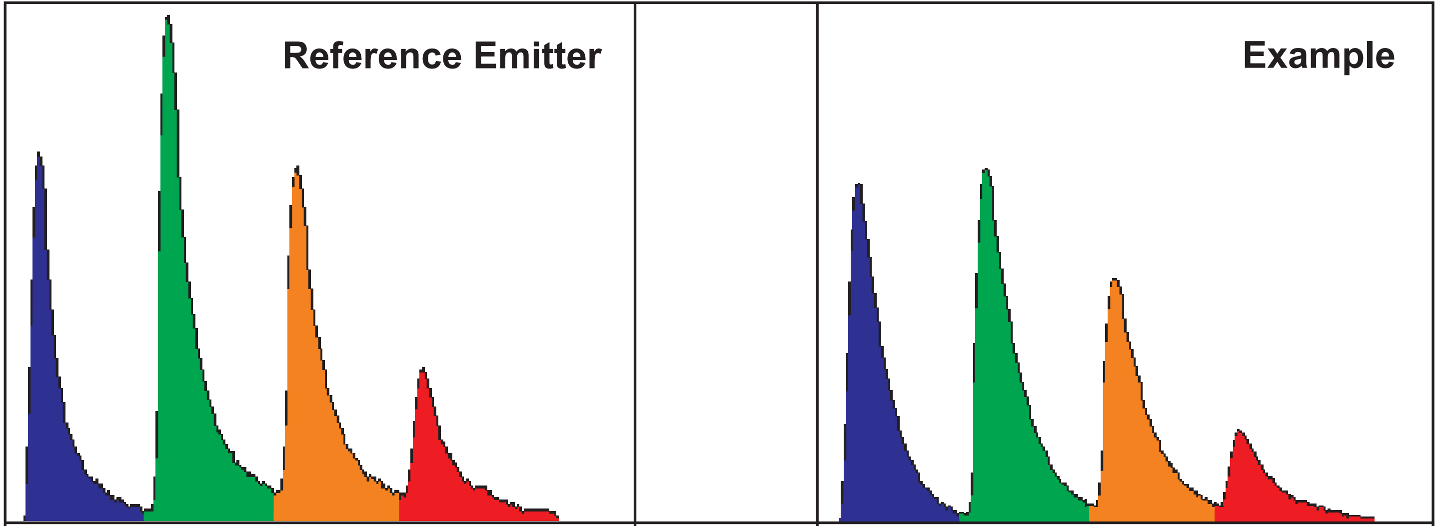
Info Box :
Contains pertinent log info including name and location.

Note A :
Time is along the x axis. No scale is given, but it is a consistent 320ns wide.
The y axis is in mV and directly corresponds to the amount of light striking the photodetector.

Note B :
These two waveforms are clearly different. The first is weathered diesel from the log itself while the second is the Reference Emitter (a blend of NAPLs) always taken before each log for calibration.

Note C :
Callouts can be a single depth (see 3rd callout) or a range (see 4th callout). The range is noted on the depth axis by a bold line. When the callout is a range, the average and standard deviation in %RE is given below the callout.

Waveform Signal Calculation

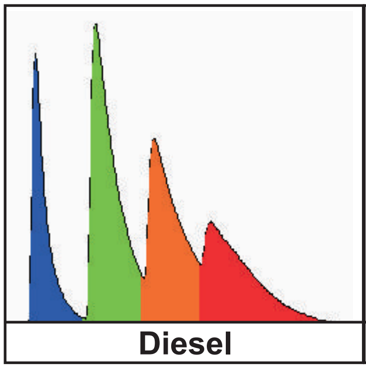


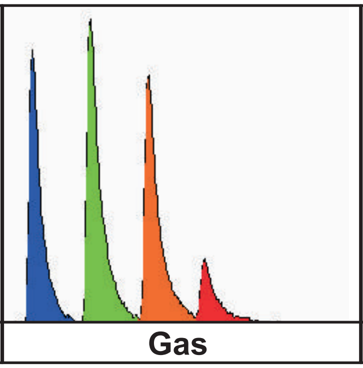
CH1		CH2		CH3		CH4		**Total**	***Channel***	CH1		CH2		CH3		CH4		**Total**
4820	+	8108	+	6249	+	2984	=	**22161**	***Area (pVs)***	4923	+	5743	+	4166	+	1735	=	**16587**
21.7		36.6		28.2		13.5		**100%**	***Percent RE***	22.3		25.9		18.8		7.8		**75%**

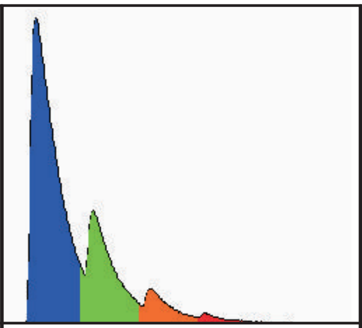
Data Files

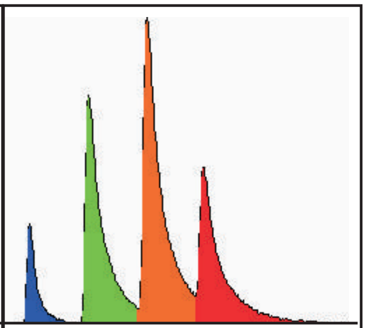
***.lif.raw.bin**	Raw data file. Header is ASCII format and contains information stored when the file was initially written (e.g. date, total depth, max signal, gps, etc., and any information entered by the operator). All raw waveforms are appended to the bottom of the file in a binary format.
***.lif.plt**	Stores the plot scheme history (e.g. callout depths) for associated Raw file. Transfer along with the Raw file in order to recall previous plots.
***.lif.jpg**	A jpg image of the OST log including the main signal vs. depth plot, callouts, information, etc.
***.lif.dat.txt**	Data export of a single Raw file. ASCII tab delimited format. No string header is provided for the columns (to make importing into other programs easier). Each row is a unique depth reading. The columns are: Depth, Total Signal (%RE), Ch1%, Ch2%, Ch3%, Ch4%, Rate, Conductivity Depth, Conductivity Signal, Hammer Rate. Summing channels 1 to 4 yields the Total Signal.
***.lif.sum.txt**	A summary file for a number of Raw files. ASCII tab delimited format. The file contains a string header. The summary includes one row for each Raw file and contains information for each file including: the file name, gps coordinates, max depth, max signal, and depth at which the max signal occured.
***.lif.log.txt**	An activity log generated automatically located in the OST application directory in the 'log' subfolder. Each OST unit the computer operates will generate a separate log file per month. A log file contains much of the header information contained within each separate Raw file, including: date, total depth, max signal, etc.

Common Waveforms (highly dependent on soil, weathering, etc.)


Diesel


Gas

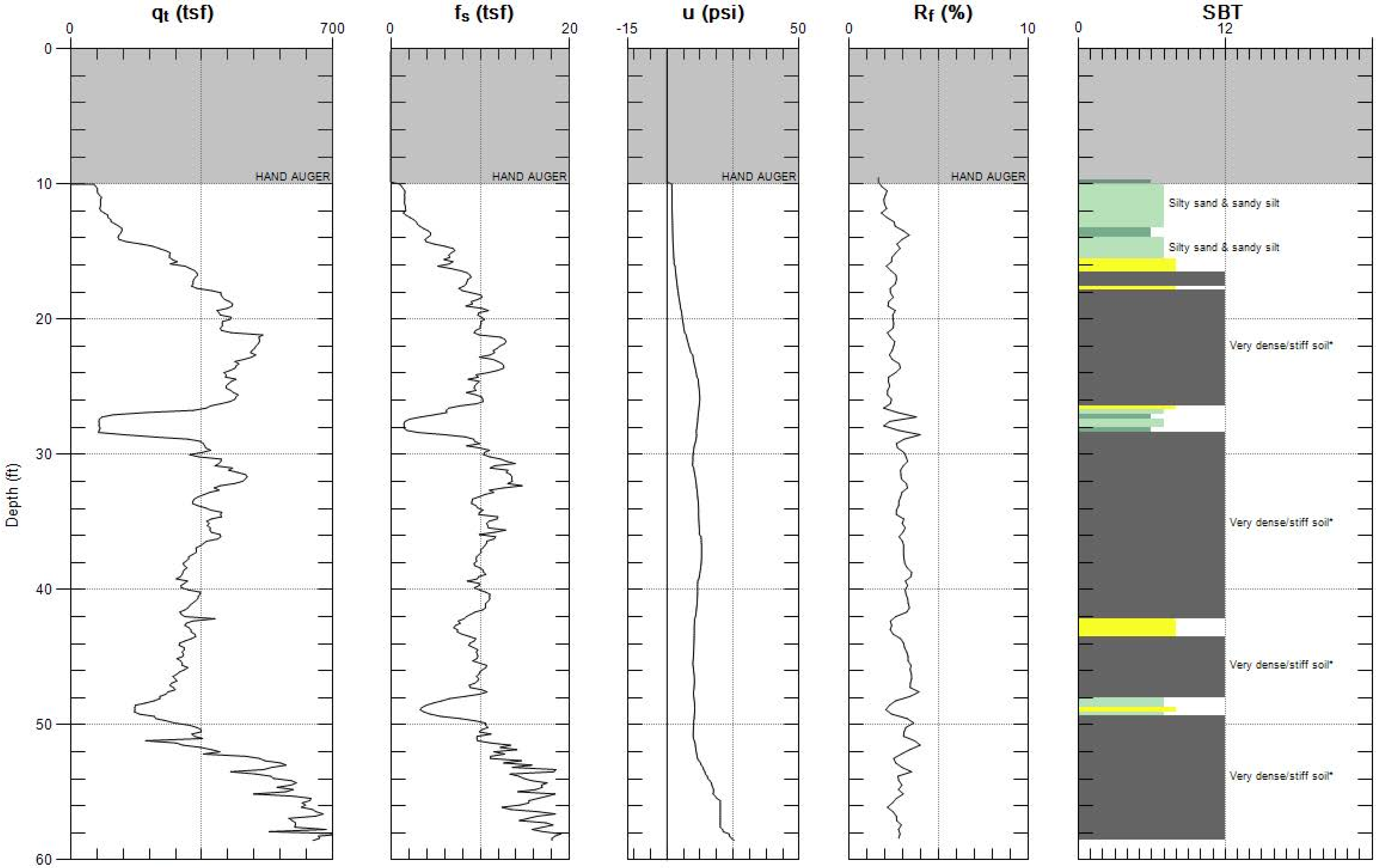

Kerosene


Motor Oil

THE SOURCE GROUP/APEX

Site: FMR. CHEMOIL
Sounding: AN-22A

Engineer: P.GOMEZ
Date: 5/18/17 09:50



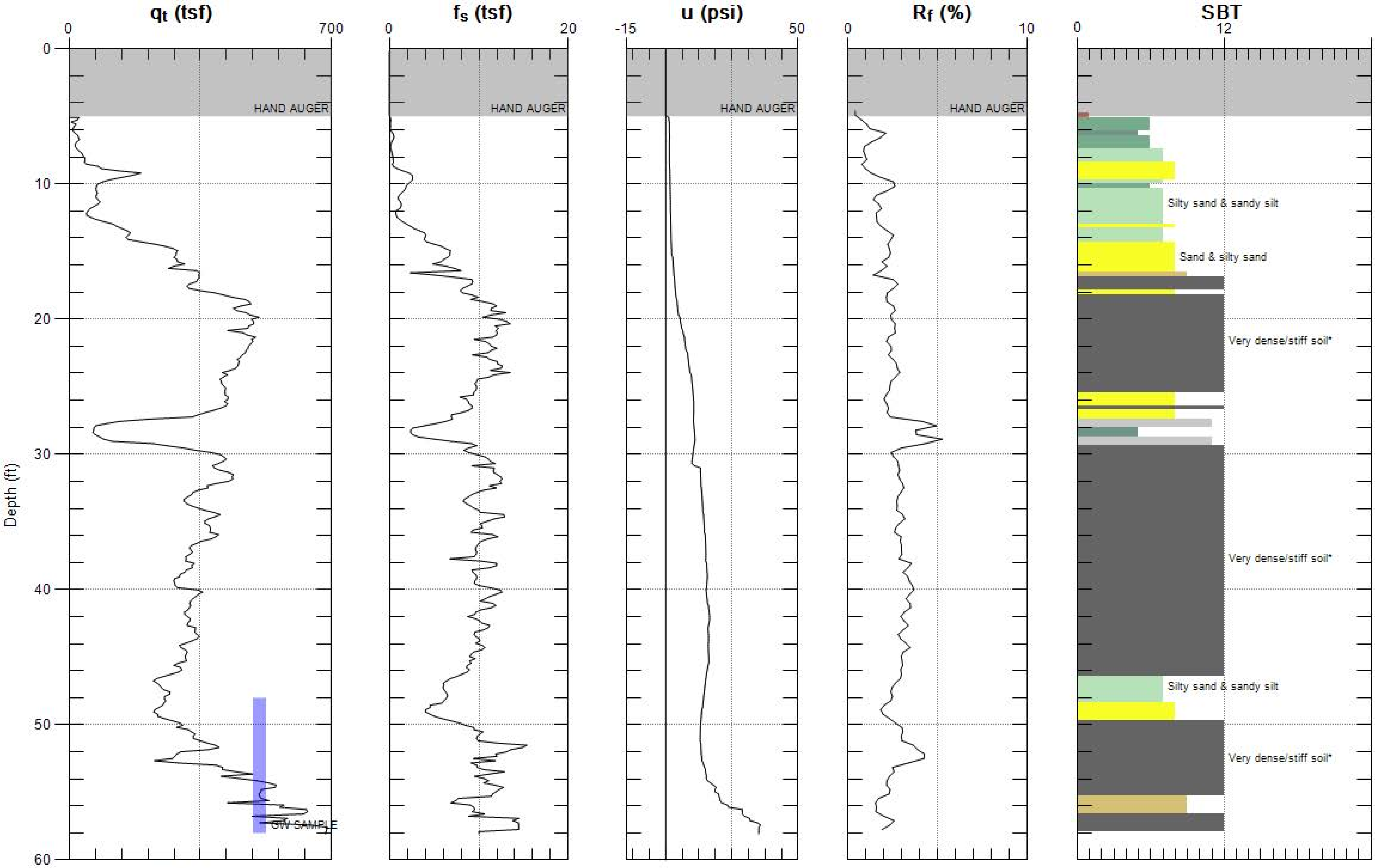
Max. Depth: 58.563 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

THE SOURCE GROUP/APEX

Site: FMR. CHEMOIL
Sounding: AN-22

Engineer: P.GOMEZ
Date: 5/18/17 07:48



Max. Depth: 58.071 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

APPENDIX D

DERIVATION OF SITE SPECIFIC SOIL VAPOR SCREENING LEVELS

APPENDIX D
DERIVATION OF SITE-SPECIFIC SOIL VAPOR SCREENING LEVELS

Former Chemoil Refinery
Site Cleanup Program Number 0453A
Site ID No. 2047W00
Global ID SL 2047W2348

2020 Walnut Avenue
Signal Hill, California

093-CHEMOIL-001

Prepared For:

Signal Hill Enterprises, LLC
1900 South Norfolk Street, Suite 350
San Mateo, California 94403

and

RE | Solutions, LLC
2880 Bryant Street
Denver, Colorado 80211

Prepared By:

SGI environmental APEX

299 West Hillcrest Drive, Suite 220
Thousand Oaks, CA 91360

July 13, 2017

Prepared and Reviewed By:

Prepared By:

ivy inouye

Ivy Inouye
Senior Toxicologist

Reviewed By:

Kirsten L Duey

Kirsten Duey
Project Manager

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 SITE-SPECIFIC SOIL VAPOR SCREENING LEVELS

This section describes the methods used to estimate Site-specific soil vapor screening levels for future onsite resident and commercial/industrial worker receptors for the former Chemoil Refinery located at 2020 Walnut Avenue in Signal Hill, California (Site). The San Francisco Regional Water Quality Control Board (SFRWQCB) Environmental Screening Levels (ESLs), U.S. Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs), and Department of Toxic Substances Control (DTSC) modified screening levels (SLs) for soil vapor are based on default attenuation factors that likely overestimate the attenuation from soil vapor to indoor air for this Site because Site conditions are more reflective of less permeable silts. Therefore, the DTSC modified version of the Johnson and Ettinger (1991; J/E) model (DTSC, 2014) was used to estimate Site-specific screening levels that take into account Site-specific geotechnical data.

1.1 Modeling Vapor Emission from Soil Vapor into Indoor Air

Using the maximum detected VOC concentrations in soil vapor data collected at 5 feet below ground surface (bgs), the fate and transport modeling was performed and a concentration in indoor air for each VOC was estimated. Site conditions were generalized to create a simplified conceptual model to estimate vapor concentration in indoor air. The Site is generally underlain by deposits of unconsolidated, laterally discontinuous sequences of silt and fine to coarse-grained sand. Coarse-grained soils consist of sand (SP) and silty sand (SM); whereas, subordinate fine-grained soils consist of silt (ML and MH) and, to a lesser degree, clay (CL). First encountered groundwater occurs at approximately 30 feet bgs.

1.1.1 Site-Specific Geotechnical Soil Data

The results from physical soil properties analyses were used to determine the appropriate U.S. Department of Agriculture (USDA) soil textural classification, dry bulk density, and porosity for soil at the Site. During the Site investigation conducted in May 2017, soil sample AN-22-5 was collected at 4.75 to 5.25 feet bgs on the Northwest Parcel, for the purposes of physical soil property characterization. The soil sample was analyzed for particle size distribution, dry bulk density, and porosity by PTS Laboratories, Inc. in Santa Fe Springs, California. In addition, the soil vapor sample locations were logged by a geologist. The particle size distribution analysis indicates that Site soils most closely fit with the “silt” USDA soil textural classification. A review of Tetra Tech’s soil physical property data and onsite soil boring logs shows that this classification is consistent with the soils observed at approximately 4 to 6 feet bgs during 2006 Site investigation (Tetra Tech, 2006). The Apex-SGI and Tetra Tech soil boring logs and soil characterization analytical reports are provided in Attachments D-1 and D-2, respectively. The following table summarizes the physical properties for the soil sample collected by Apex-SGI in 2017 and the two soil samples collected by Tetra Tech in 2006:

Soil Sample	**Sample Depth** (ft bgs)	**Sample Date**	**Soil Type Based on Grain Size**	**Soil Bulk Density** (g/cm^3)	**Total Porosity** (cm^3/cm^3)	**Water-Filled Porosity** (cm^3/cm^3)	**Air-Filled Porosity** (cm^3/cm^3)
AN-22-5	4.75-5.25	5-18-17	Silt	1.46	0.465	0.293	0.172
SB1-051606-GT-4’	4	5-16-06	Silt	1.72	0.359	0.222	0.137
SB2-051506-GT-6’	6	5-15-06	Silt	1.66	0.384	0.196	0.188

ft bgs = feet below ground surface
g/cm^3 = grams per cubic centimeter
cm^3/cm^3 = cubic centimeter per cubic centimeter

Based on the physical soil properties analyses results, silt (SI) was selected as the Vadose Zone Soil Type input parameter for the vapor intrusion model. The reported values for dry bulk density and porosity were similar for all three samples collected from 4 to 6 feet bgs; therefore, the reported values for the most recently collected soil sample, AN-22-5, were used as model input parameters in development of Site-specific soil vapor screening levels.

In accordance with DTSC (2014), default values of 24 degrees Celsius for average soil temperature and 15 centimeters (cm) for depth to the bottom of an enclosed space floor for slab-on-grade construction were used as vapor intrusion model input parameters.

The following table summarizes the Site-specific properties input into the DTSC J/E model for vapor migration from soil vapor to indoor air.

Model Variables – Vapor Migration from Soil Vapor to Indoor Air		
Properties	**Symbol**	**Assumed Value**
Depth Below Grade to Bottom of Enclosed Space Floor (default)	L_F	15 centimeters
Soil Vapor Sampling Depth Below Grade (5 feet)	L_S	152 centimeters
Average Soil Temperature (default)	T_s	24°C
Vadose Zone SCS Soil Type (Site-specific)	- -	Silt (SI)
Vadose Zone Soil Dry Bulk Density (Site-specific)	ρ_b	1.46 g/cm^3
Vadose Zone Soil Total Porosity (Site-specific)	θ_T	0.465 cm^3/cm^3
Vadose Zone Soil Water-Filled Porosity (Site-specific)	θ_w	0.172 cm^3/cm^3
Average Vapor Flow Rate into Building (default)	Q_{soil}	5 L/min
Residential Exposure Factors		
Averaging Time for Carcinogens	AT_C	70 years
Averaging Time for Noncarcinogens	AT_{NC}	26 years
Exposure Duration	ED	26 years
Exposure Frequency	EF	350 days/year
Exposure Time	ET	24 hours/day
Air Exchange Rate	ACH	0.5 $hour^{-1}$

Model Variables – Vapor Migration from Soil Vapor to Indoor Air (Continued)		
Properties	**Symbol**	**Assumed Value**
Commercial Exposure Factors		
Averaging Time for Carcinogens	AT_C	70 years
Averaging Time for Noncarcinogens	AT_{NC}	25 years
Exposure Duration	ED	25 years
Exposure Frequency	EF	250 days/year
Exposure Time	ET	8 hours/day
Air Exchange Rate	ACH	1 hour^{-1}

g/cm^3 = gram per cubic centimeter
L/min = liter per minute

The spreadsheets containing the input parameters and results of the DTSC J/E model for subsurface vapor intrusion into buildings for the residential and commercial exposure scenarios are provided in Attachment D-3.

1.1.2 Toxicity Assessment

Toxicity values are combined with exposure factors to estimate adverse noncancer health effects and excess cancer risks. Toxicity values include inhalation reference concentrations (RfCs) and inhalation unit risk factors (IURs). Toxicity values supplied by the DTSC J/E model (DTSC, 2014) were used.

1.1.3 Risk Characterization

The risk characterization process incorporates data from the exposure and toxicity assessments to estimate noncancer adverse health effects and excess cancer risks. To estimate noncancer effects, the chronic daily intake is divided by the RfC. The resulting value is referred to as a hazard quotient (HQ). A HQ less than or equal to 1 indicates that no adverse noncancer health effects are expected to occur (USEPA, 1989). Consistent with USEPA (1989) risk assessment guidelines, carcinogenic effects are typically evaluated by multiplying the IUR by the chronic daily intake averaged over 70 years to estimate lifetime excess cancer risk. The resulting values are referred to as excess cancer risks. These potential excess cancer risks are compared to the CalEPA risk management range of one-in-one-million (1×10^{-6}) to one-in-ten thousand (1×10^{-4}).

Consistent with USEPA (1989; 1991) guidelines, the following general equations were used to estimate excess cancer risks and noncancer adverse health effects (expressed as a HQ):

For carcinogens: $$Risk = \frac{EPC_{indoor\ air} xEFxEDxETxIUR}{AT_c}$$

For noncarcinogens: $$HQ = \frac{EPC_{indoor\ air} xEFxEDxETx\frac{1}{RfC}}{AT_n}$$

Where:
$EPC_{indoor\ air}$ = Exposure point concentration in indoor air ($EPC_{indoor\ air}$; micrograms per cubic meter [μg/m^3]).

EF = Exposure frequency (days/year), see table above.
ED = Exposure duration (years), see table above.
ET = Exposure time (hours/day), see table above.
AT = Averaging time (days).
For noncarcinogenic effects (hours), AT = ED x 365 days/year x 24 hours/day.
For carcinogenic effects, AT (hours) = 70 years x 365 days/year x 24 hours/day.
IUR = Inhalation unit risk for carcinogenic chemicals ($\mu g/m^3)^{-1}$.
RfC = Inhalation reference concentration for noncarcinogenic chemicals ($\mu g/m^3$).

The HQ and excess cancer risk for VOCs in soil vapor were estimated by using the exposure factors presented in the table above and toxicity values supplied by the DTSC J/E model in the equations above. Risk characterization of inhalation of VOCs volatilizing from soil vapor into indoor air for the resident and commercial/industrial worker receptors are presented in Tables D-1 through D-2, respectively.

1.2 Site-Specific Screening Levels

The Site-specific screening levels were estimated for the following hypothetical human receptors:

- Resident Receptor; and
- Commercial/Industrial Worker Receptor.

Using the HQ and excess cancer risk estimates, source EPCs, and USEPA/CalEPA target HI and target excess cancer risk, Site-specific screening levels were estimated using the equations below. Site-specific screening levels based on noncarcinogenic effects used a target HI of one. Site-specific screening levels based on carcinogenic effects used a target excess cancer risk of 1 x 10^{-6}, which represents the lower end (most stringent) of the CalEPA's risk management range and is the point of departure for risk management decisions for all receptors

Site-Specific Screening Level – Noncarcinogenic Effects

$$Site - Specific\ Screening\ Level_{nc} = \frac{HQ_T \times EPC_{i,p}}{HQ_{i,p}}$$

Where:
Site-specific Screening Level$_{nc}$ =Site-specific soil vapor screening level for noncarcinogenic effects for chemical i via pathway p ($\mu g/m^3$);
HQ_T = Target hazard quotient (1), a HQ less than or equal to 1 indicates that no adverse noncancer health effects are expected to occur (USEPA, 1989; unitless);
$EPC_{i,p}$ = Exposure point concentration in soil vapor for source for chemical i via pathway p ($\mu g/m^3$); and
$HQ_{i,p}$ = Hazard quotient for chemical i via pathway p (unitless).

Site-Specific Screening Level – Carcinogenic Effects

$$Site - Specific\ Screening\ Level_c = \frac{CR_T \times EPC_{i,p}}{CR_{i,p}}$$

Where:

$Site\text{-}specific\ Screening\ Level_c$ =Site-specific soil vapor screening level for carcinogenic effects for chemical i via pathway p (µg/m^3);

CR_T = Target excess cancer risk (1 x 10^{-6}), the upper end (most stringent) of CalEPA's risk management range of one-in-ten thousand (1 x 10^{-4}) to one-in-one-million (1 x 10^{-6});

$EPC_{i,p}$ = Exposure point concentration in soil vapor for source for chemical i via pathway p (µg/m^3); and

$CR_{i,p}$ = Excess cancer risk for chemical i via pathway p (unitless).

The Site-specific screening levels for soil vapor for residential and commercial exposure scenarios are presented in Tables D-1 through D-2, respectively.

2.0 REFERENCES

Department of Toxic Substances Control (DTSC). 2014. DTSC Screening-Level Model for Soil Gas Contamination. California Environmental Protection Agency. Last Modified December.

Johnson, P.C. and R.A. Ettinger. 1991. Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings. Environmental Science and Technology. Vol. 25, No. 8, pp. 1445-52.

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U.S. Environmental Protection Agency (USEPA). 1989. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part A. Interim Final. Solid Waste and Emergency Response. December.

USEPA. 1991. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Interim. Office of Emergency and Remedial Response, Washington D.C., Publication 9285.7-01B. December.

TABLES

Table D-1

Residential Site-Specific Screening Levels for the Chemicals of Potential Concern (COPCs) in Soil Vapor (5 feet bgs)

Former ChemOil Refinery
Signal Hill, California

	Soil Vapor - 5 feet bgs		Indoor Air[2]				Risk-Based Screening Level		
Chemical of Potential Concern	**MDC** ($\mu g/m^3$)	**$EPC_{soil\ vapor}$**[1] ($\mu g/m^3$)	**Soil Vapor to Indoor Air Attenuation Factor** (unitless)	**$EPC_{indoor\ air}$** ($\mu g/m^3$)	**Cancer Risk**	**Noncancer Hazard**	**Carcinogenic Effects**[3] ($\mu g/m^3$)	**Noncarcinogenic Effects**[4] ($\mu g/m^3$)	**Lowest Soil Vapor RBSL**[5] ($\mu g/m^3$)
Benzene	271,548	271,548	9.3E-04	2.53E+02	2.6E-03	8.1E+01	1 E+02	3 E+03	1.0E+02
Cyclohexane	2,478,331	2,478,331	8.7E-04	2.15E+03	- -	3.4E-01	- -	7 E+06	7.2E+06
Ethylbenzene	208,432	208,432	7.8E-04	1.63E+02	1.4E-04	1.6E-01	1 E+03	1 E+06	1.4E+03
(6) 4-Ethyltoluene	103,239	103,239	8.5E-04	8.78E+01	- -	2.8E-01	- -	4 E+05	3.7E+05
(7) Heptane	819,714	819,714	8.2E-04	6.69E+02	- -	9.2E-01	- -	9 E+05	8.9E+05
n-Hexane	634,454	634,454	8.2E-04	5.18E+02	- -	7.1E-01	- -	9 E+05	8.9E+05
Methyl tert-Butyl Ether	1,680	1,680	8.3E-04	1.40E+00	1.3E-07	4.5E-04	1 E+04	4 E+06	1.3E+04
Naphthalene	31,452.760	31,453	7.2E-04	2.26E+01	2.7E-04	7.2E+00	1 E+02	4 E+03	1.2E+02
Toluene	22,611	22,611	8.5E-04	1.92E+01	- -	6.1E-02	- -	4 E+05	3.7E+05
1,2,4-Trimethylbenzene	167,149	167,149	7.2E-04	1.20E+02	- -	1.6E+01	- -	1 E+04	1.0E+04
1,3,5-Trimethylbenzene	93,399	93,399	7.1E-04	6.67E+01	- -	1.8E+00	- -	5 E+04	5.1E+04
m,p-Xylenes	955,313	955,313	7.8E-04	7.45E+02	- -	7.1E+00	- -	1 E+05	1.3E+05
o-Xylene	191,063	191,063	7.8E-04	1.50E+02	- -	1.4E+00	- -	1 E+05	1.3E+05
Xylenes	1,146,375	1,146,375	- -	- -	- -	- -	- -	- -	1.3E+05

Notes:
feet bgs = feet below ground surface.
MDC = maximum detected concentration.
EPC = exposure point concentration.
$\mu g/m^3$ = micrograms per cubic meter.
RBSL = risk-based screening level.

[1] Represents the maximum detected concentration.

[2] The EPC in soil vapor ($EPC_{soil\ vapor}$) were coupled with the vapor intrusion model to estimate attenuation factor, EPC in indoor air, cancer risk, and noncancer hazard for each chemical.

[3] Represents the RBSL for carcinogenic effects, based on a target excess cancer risk of one-in-one million (1×10^{-6}).
Soil Vapor $RBSL_i$ = $EPC_{soil\ vapor,i}$ x Target Cancer Risk of 1×10^{-6} / Excess Cancer Risk for compound *i*

[4] Represents the noncancer hazard, based on a target hazard quotient of one (1).
Soil Vapor RBSL*i* = $EPC_{soil\ vapor,i}$ x Target Noncancer Hazard Index of 1 / Hazard Quotient for compound *i*

[5] Represents the lower of the RBSLs based on noncarcinogenic or carcinogenic effects.

[6] In the vapor intrusion model, toluene was used as a surrogate for 4-ethyltoluene.

[7] In the vapor intrusion model, n-hexane was used as a surrogate for heptane.

Table D-2
Commercial/Industrial Site-Specific Screening Levels for the Chemicals of Potential Concern (COPCs) in Soil Vapor (5 feet bgs)

Former ChemOil Refinery
Signal Hill, California

	Soil Vapor - 5 feet bgs		Indoor Air[2]				Risk-Based Screening Level		
Chemical of Potential Concern	**MDC** (μg/m^3)	**EPC$_{soil\ vapor}$[1]** (μg/m^3)	**Soil Vapor to Indoor Air Attenuation Factor** (unitless)	**EPC$_{indoor\ air}$** (μg/m^3)	**Cancer Risk**	**Noncancer Hazard**	**Carcinogenic Effects[3]** (μg/m^3)	**Noncarcinogenic Effects[4]** (μg/m^3)	**Lowest Soil Vapor RBSL[5]** (μg/m^3)
Benzene	271,548	271,548	4.7E-04	1.26E+02	3.0E-04	9.6E+00	9 E+02	3 E+04	9.1E+02
Cyclohexane	2,478,331	2,478,331	4.3E-04	1.07E+03	- -	4.1E-02	- -	6 E+07	6.1E+07
Ethylbenzene	208,432	208,432	3.9E-04	8.14E+01	1.7E-05	1.9E-02	1 E+04	1 E+07	1.3E+04
(6) 4-Ethyltoluene	103,239	103,239	4.3E-04	4.39E+01	- -	3.3E-02	- -	3 E+06	3.1E+06
(7) Heptane	819,714	819,714	4.1E-04	3.35E+02	- -	1.1E-01	- -	8 E+06	7.5E+06
n-Hexane	634,454	634,454	4.1E-04	2.59E+02	- -	8.4E-02	- -	8 E+06	7.5E+06
Methyl tert-Butyl Ether	1,680	1,680	4.2E-04	6.99E-01	1.5E-08	5.3E-05	1 E+05	3 E+07	1.1E+05
Naphthalene	31,452.760	31,453	3.6E-04	1.13E+01	3.1E-05	8.6E-01	1 E+03	4 E+04	1.0E+03
Toluene	22,611	22,611	4.3E-04	9.62E+00	- -	7.3E-03	- -	3 E+06	3.1E+06
1,2,4-Trimethylbenzene	167,149	167,149	3.6E-04	6.00E+01	- -	2.0E+00	- -	9 E+04	8.5E+04
1,3,5-Trimethylbenzene	93,399	93,399	3.6E-04	3.34E+01	- -	2.2E-01	- -	4 E+05	4.3E+05
m,p-Xylenes	955,313	955,313	3.9E-04	3.73E+02	- -	8.5E-01	- -	1 E+06	1.1E+06
o-Xylene	191,063	191,063	3.9E-04	7.49E+01	- -	1.7E-01	- -	1 E+06	1.1E+06
Xylenes	1,146,375	1,146,375	- -	- -	- -	- -	- -	- -	1.1E+06

Notes:

feet bgs = feet below ground surface.
MDC = maximum detected concentration.
EPC = exposure point concentration.
μg/m^3 = micrograms per cubic meter.
RBSL = risk-based screening level.

[1] Represents the maximum detected concentration.

[2] The EPC in soil vapor (EPC$_{soil\ vapor}$) were coupled with the vapor intrusion model to estimate attenuation factor, EPC in indoor air, cancer risk, and noncancer hazard for each chemical.

[3] Represents the RBSL for carcinogenic effects, based on a target excess cancer risk of one-in-one million (1 x 10^{-6}).
Soil Vapor RBSL$_i$ = EPC$_{soil\ vapor,i}$ x Target Cancer Risk of 1 x 10^{-6} / Excess Cancer Risk for compound *i*

[4] Represents the noncancer hazard, based on a target hazard quotient of one (1).
Soil Vapor RBSL*i* = EPC$_{soil\ vapor,i}$ x Target Noncancer Hazard Index of 1 / Hazard Quotient for compound *i*

[5] Represents the lower of the RBSLs based on noncarcinogenic or carcinogenic effects.

[6] In the vapor intrusion model, toluene was used as a surrogate for 4-ethyltoluene.

[7] In the vapor intrusion model, n-hexane was used as a surrogate for heptane.

ATTACHMENT D-1

SOIL BORING LOGS

APEX-SGI SOIL BORING LOG FOR AN-22

The Source Group, Inc.

BORING ID: AN-22

PROJECT NAME AND ADDRESS:	Former Chemoil Refinery, 2020 Walnut Avenue, Signal Hill, CA		
BORING LOCATION (AT SITE):		Project No. 093-Chemoil-001 Task 6	
CONTRACTOR AND EQUIPMENT:	Gregg Drilling/Hand Auger	Logged By: Paola Gomez-Birenbaum	
SAMPLING METHOD:	Hand Auger/Slide Hammer	MONITORING DEVICE:	MiniRae 3000
START DATE/ (TIME):	5/18/17 745	FINISH DATE/ (TIME):	5/18/17 840
FIRST WATER (BGS):		STABILIZED WATER LEVEL:	
SURFACE ELEVATION:		CASING TOP ELEVATION:	
TOTAL BORING DEPTH:	58'	BORING DIAMETER	4" Hand Auger ; 1.5"
SOIL GAS PROBE INSTALLATION DEPTH:		SCREEN INTERVAL(S):	SLOT (IN):
ANNULUS FILL MATERIAL:	bentonite grout	BORING ANGLE:	TREND:

LITHOLOGIC DESCRIPTION
(classification, color, moisture, density, grain size/plasticity, other)

Well Construction

✓ Boring cleared to 5 feet bgs with hand auger

Time: 0800
Depth:
(sample interval): 0-1
PID Result: 0
Blow Counts:
Laboratory Sample ID:

Soil Type: SM ; Group Name: Silty SAND, some Gravel
20 % Gravel; 40 % Sand; 40 % Silt; ___ % Clay; Color: medium brown
Moisture content: ___dry; ✓ slightly moist; ___moist; ___very moist; ___saturated
Grain size: ✓ fine; ✓ medium; ___coarse; Grading: ___poorly; ___well-graded
Plasticity (clays/silts): ✓ non-plastic; ___medium plasticity; ___high plasticity
Odors: ✓ none; ___hydrocarbon; ___other (describe:__________)
Other comments:
med stiff
f-m gravel (subangular)

Time: 0803
Depth:
(sample interval): 1-3
PID Result: 40.5
Blow Counts:
Laboratory Sample ID:

Soil Type: CL ; Group Name: CLAY, trace silt
___ % Gravel; ___ % Sand; 5 % Silt; 95 % Clay; Color: light brown
Moisture content: ___dry; ___slightly moist; ✓ moist; ___very moist; ___saturated
Grain size: ___fine; ___medium; ___coarse; Grading: ___poorly; ___well-graded
Plasticity (clays/silts): ___non-plastic; ✓ medium plasticity; ___high plasticity
Odors: ✓ none; ___hydrocarbon; ___other (describe:__________)
Other comments:
stiff

Time: 0805
Depth:
(sample interval): 3-4.5
PID Result: +15000
Blow Counts:
Laboratory Sample ID:

Soil Type: ML ; Group Name: SILT
___ % Gravel; ___ % Sand; 100 % Silt; ___ % Clay; Color: dk grey brown
Moisture content: ___dry; ___slightly moist; ✓ moist; ___very moist; ___saturated
Grain size: ___fine; ___medium; ___coarse; Grading: ___poorly; ___well-graded
Plasticity (clays/silts): ✓ non-plastic; ___medium plasticity; ___high plasticity
Odors: ___none; ✓ hydrocarbon; ___other (describe:__________)
Other comments:
stiff
strong odor

Time:
Depth:
(sample interval):
PID Result:
Blow Counts:
Laboratory Sample ID:

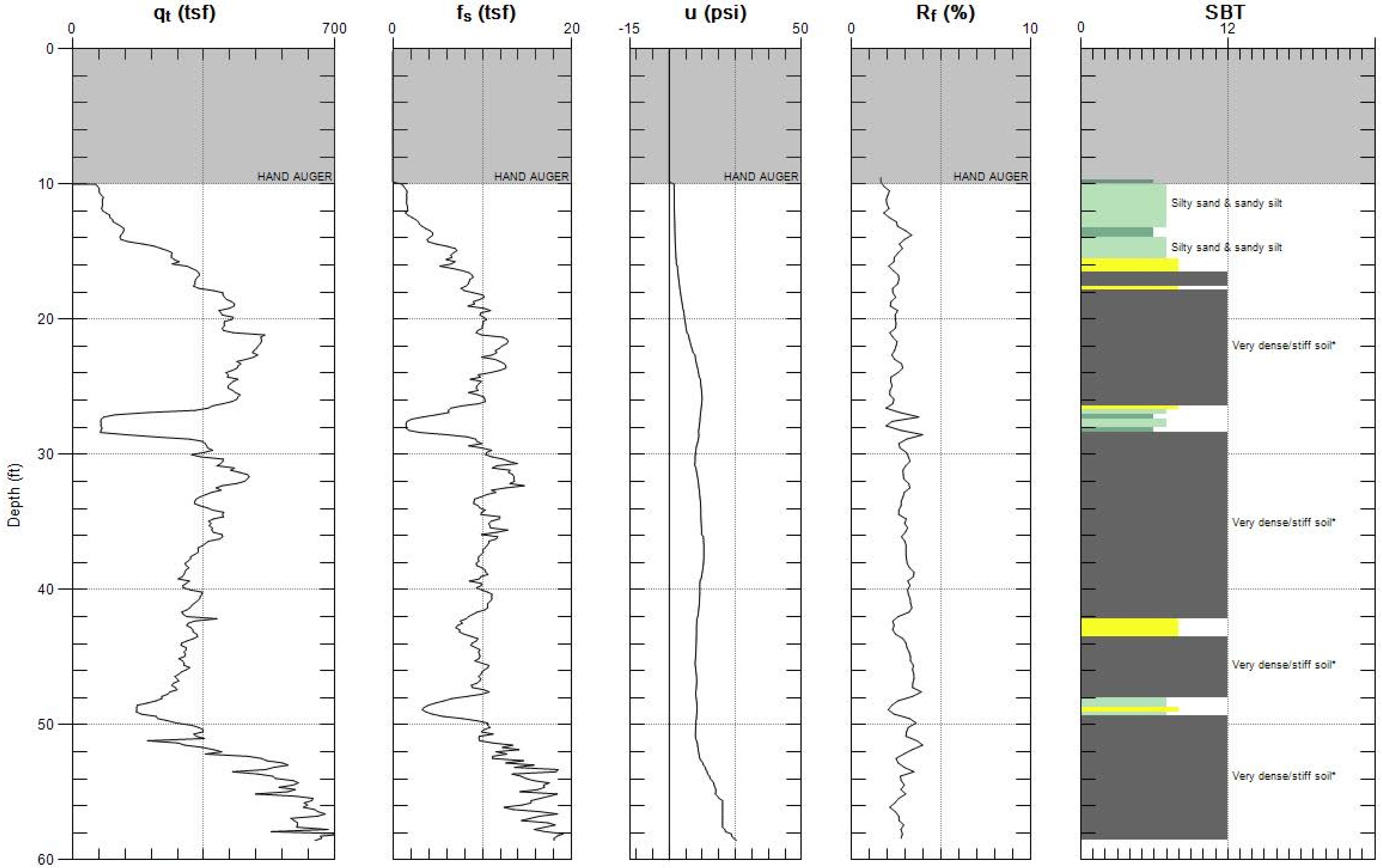
Soil Type:_____; Group Name:__________
___ % Gravel; ___ % Sand; ___ % Silt; ___ % Clay; Color:__________
Moisture content: ___dry; ___slightly moist; ___moist; ___very moist; ___saturated
Grain size: ___fine; ___medium; ___coarse; Grading: ___poorly; ___well-graded
Plasticity (clays/silts): ___non-plastic; ___medium plasticity; ___high plasticity
Odors: ___none; ___hydrocarbon; ___other (describe:__________)
Other comments:

GREGG

THE SOURCE GROUP/APEX

Site: FMR. CHEMOIL
Sounding: AN-22A

Engineer: P.GOMEZ
Date: 5/18/17 09:50



Max. Depth: 58.563 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

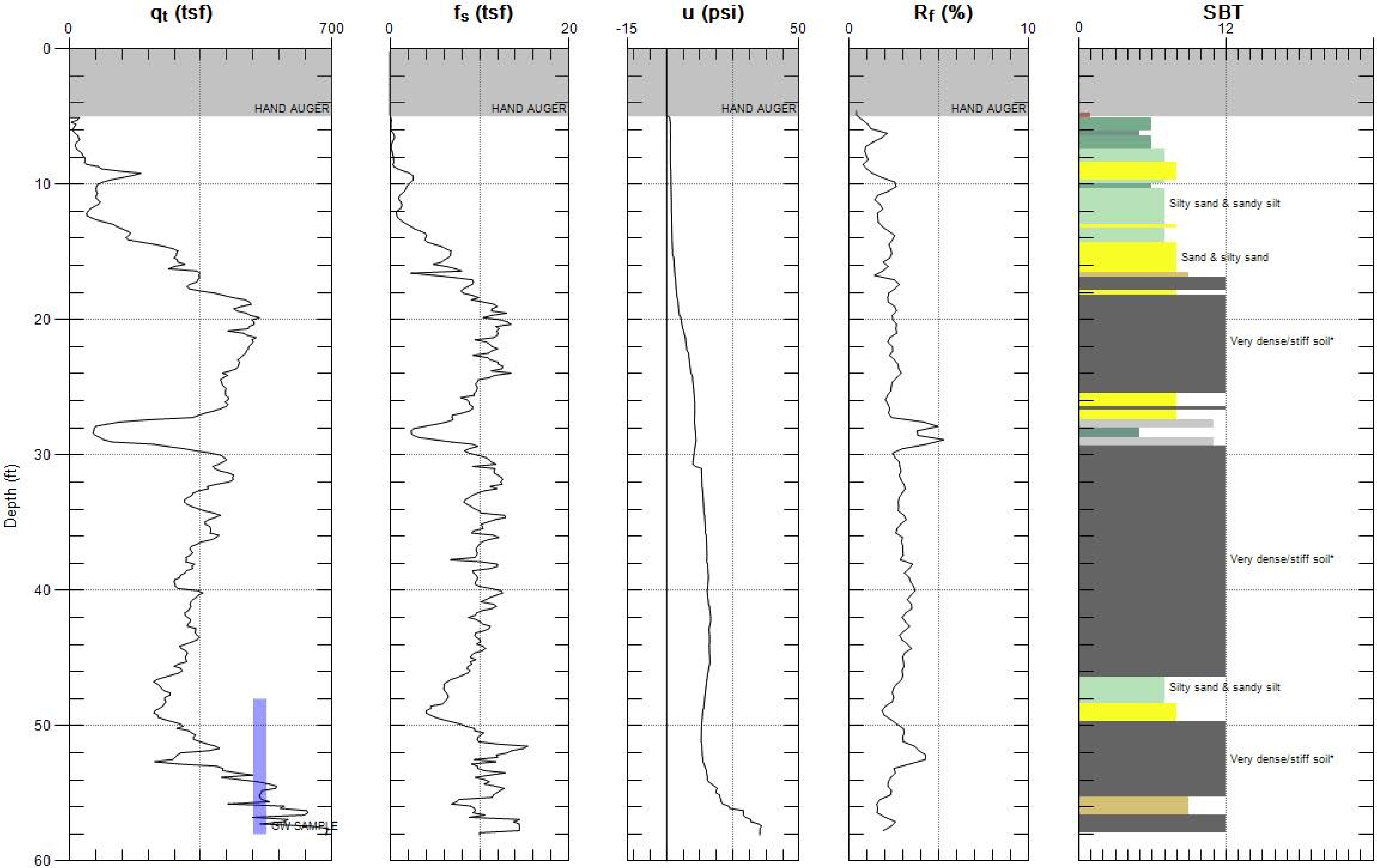
THE SOURCE GROUP/APEX

Site: FMR. CHEMOIL

Sounding: AN-22

Engineer: P.GOMEZ

Date: 5/18/17 07:48



Max. Depth: 58.071 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

TETRA TECH SOIL BORING LOGS FOR SB1 AND SB2

Tetra Tech, Inc.
348 W. Hospitality Ln. Suite 100
San Bernardino, CA 92408
Telephone: (909) 381-1674
Telefax (909) 889-1391

SOIL BORING LOG

BORING/WELL ID: SB1

CLIENT: GEM, Inc.
PROJECT NUMBER: 18116-01
LOCATION: Former Chemoil Refinery

GEOLOGIST: D. Bertolacci
REVIEWED BY:
DATE(S) DRILLED: 05/16/2006
DRILLING COMPANY: Gregg Drilling, Inc.

TOTAL DEPTH: 40'
BOREHOLE DIA.: 1.25"
DRILLING METHOD: CPT/DP
SAMPLING METHOD: Acetate Sleeve

Depth (ft. bgs)	Sample Recovery	Blow Counts	Sample Number	Sampling Time	Soil (ppm) FID/PID	Breathing Zone (ppm) FID/PID	Lithologic Contact (ft. bgs)	GROUP SYMBOL	Color	Moisture	% Gravel	% Sand	% Non-plastic Fines	% Plastic Fines	Grading	Plasticity (Fines)	Angularity (Sand / Gravel)	Grain Size Range (Sand)	Grain Size Range (Gravel)	Max. Grain Size (Gravel)	Comments / Well Construction
									GROUP NAME / GEOLOGIC DESCRIPTION / ADDITIONAL MODIFIERS												
1 2					0.0	0.0		SM	brown 7.5YR4/4	dry	5	65	30	—	P	non	Sr	VF	F	3/8"	no odor
									Silty Sand												
3 4 5	X X		SB1-GT-051606-4 SB1-051606-4'	1100 0945	81.9	0.0	color change ~2.8' bgs	SM/SC	black 10YR2/1	dry to M	—	60	30	30	P	non-low	Sr	VF	—	—	Strong odor, micaceous
									Silty Sand / Clayey Sand												
6 7								SM black br	no recovery @ 5'												
8						0.0		black SM	black 10YR2/1	dry	<5	70	30	<5	P	non-low	Sr	VF		F	3/8"	Strong odor
10	X		SB1-051606-10'	0955		0.0		br SM	As above												
								SP	Gray 10YR5/1	dry to M	—	100	—	—	P	—	Sr	VF-F	—	—	Strong odor
						0.1		SP	As above												
15	X		SB1-051606-15'	1000		0.1		SP	Gray 10YR6/1	dry to M	—	100	—	—	P	-	Sr	VF-F	—	—	Strong odor
									well sorted												
						1.0		SP	As above, increasing grain size, trace plastic fines, (mainly fine, trace to coarse) Gray 10YR7/1												Strong odor
20	X		SB1-051606-20'	1005		1.0		SP	As above												
Notes:								See USCS flow Chart	Use Munsell color chart	Dry Moist Wet	> 1/4 inch	visible - 1/4 in.	visible with hand lens	not visible	W G U P	high med low non	A Sa Sr R	V. Fine Fine Med Coarse	V. Fine Fine Med Coarse	Inches	odor, staining, mineralogy, stucture, cementation, HCl reaction

<5-5%=trace, 10%=few, 15-25%=little, 30-45%=some, 50+%=mostly (cobbles only)
Well Graded - 5 consecutive seive sizes, % decreases with each decreasing particle size
Poorly Graded - one or more particle sizes missing (Gap Graded), or
all particles basically same size (Uniformly Graded)

Tetra Tech, Inc.
348 W. Hospitality Ln. Suite 100
San Bernardino, CA 92408
Telephone: (909) 381-1674
Telefax (909) 889-1391

SOIL BORING LOG

BORING/WELL ID: SB2

CLIENT: GEM, Inc.
PROJECT NUMBER: 18116-01
LOCATION: Former Chemoil Refinery

GEOLOGIST: D. Bertolacci
REVIEWED BY:
DATE(S) DRILLED: 05 / 15 / 2006
DRILLING COMPANY: Gregg Drilling, Inc.

TOTAL DEPTH: 45'
BOREHOLE DIA.: 1.25"
DRILLING METHOD: CPT/DP
SAMPLING METHOD: Acetate Sleeve

Depth (ft. bgs)	Sample Recovery	Blow Counts	Sample Number	Sampling Time	Soil (ppm) FID/PID	Breathing Zone (ppm) FID/PID	Lithologic Contact (ft. bgs)	GROUP SYMBOL	Color	Moisture	% Gravel	% Sand	% Non-plastic Fines	% Plastic Fines	Grading	Plasticity (Fines)	Angularity (Sand / Gravel)	Grain Size Range (Sand)	Grain Size Range (Gravel)	Max. Grain Size (Gravel)	Comments / Well Construction
								ML	black 7.5YR2.5/1	dry	–	30	60	10	P	non-low	Sr	VF	–	–	no odor / staining, micaceous
1									to strong brown 7.5YR 5/6												
2									Sandy Silt												
3								ML	As above												"
4																					
5	X		SS2-051506-5'	14:30	10.2 +	0.0															
	X		SB2-051506-GT 6'					ML	As above												"
								ML	As above												"
									color change, decreasing sand, increasing fines dk grey 2.5Y 4/1												
10	X		SS2-051506-10'	1445		0.0		ML	dk grey 2.5Y4/1	dry	–	10	75	15	P	non/low	Sr	VF	–	–	no odor, some iron oxide staining, very micaceous
								ML	As above												
									no recovery @ 15'												
15	X		SB2-051506-16'	1450		0.0		ML	As above												
								ML	As above												
								SP	Poorly Graded sand, well sorted												no odor, staining
20	X		SS2-051506-20'	1455		0.0			grey 2.5Y5/1	dry	–	100	–	–	P	–	Sr	VF-F	–	–	
Notes:								See USCS flow Chart	Use Munsell color chart	Dry Moist Wet	> 1/4 inch	visible - 1/4 in.	visible with hand lens	not visible	W G U P	high med low non	A Sa Sr R	V. Fine Fine Med Coarse	V. Fine Fine Med Coarse	Inches	odor, staining, mineralogy, stucture, cementation, HCl reaction

<5-5%=trace, 10%=few, 15-25%=little, 30-45%=some, 50+%=mostly (cobbles only)
Well Graded - 5 consecutive sieve sizes, % decreases with each decreasing particle size
Poorly Graded - one or more particle sizes missing (Gap Graded), or
all particles basically same size (Uniformly Grading)

subsurface exploration log 2.2.xls
Rev. 5/12/2006

ATTACHMENT D-2

PHYSICAL SOIL PROPERTIES LABORATORY REPORTS

APEX-SGI PHYSICAL SOIL PROPERTIES LABORATORY REPORT

PTS
Laboratories, Inc.

8100 Secura Way • Santa Fe Springs, CA 90670
Telephone (562) 347-2500 • Fax (562) 907-3610

May 22, 2017

Kirsten Duey
The Source Group, Inc.
3478 Buskirk Avenue, Suite 100
Pleasant Hill, CA 94523

Re: PTS File No: 47257
Physical Properties Data
Former Chemoil Refinery; 093-Chemoil-001 Task 6

Dear Ms. Duey:

Please find enclosed report for Physical Properties analyses conducted upon the sample received from your Former Chemoil Refinery; 093-Chemoil-001 Task 6 project. All analyses were performed by applicable ASTM, EPA, or API methodologies. The sample is currently in storage and will be retained for thirty days past completion of testing at no charge. Please note that the sample will be disposed of at that time. You may contact me regarding storage, disposal, or return of the sample.

PTS Laboratories appreciates the opportunity to be of service. If you have any questions or require additional information, please give me a call at (562) 347-2502.

Sincerely,
PTS Laboratories, Inc.

Michael Mark Brady, P.G.
Laboratory Director

Encl.

Project Name: Former Chemoil Refinery
Project Number: 093-Chemoil-001 Task 6

PTS File No: 47257
Client: The Source Group, Inc.

TEST PROGRAM - 20170518

CORE ID	Depth ft.	Core Recovery ft.	CAL-EPA DTSC Vapor Intrusion					Comments
		Plugs:	Various					
Date Received: 20170518								
AN-22-5	4.75-5.25	0.5	X					
TOTALS:	1 Core	0.5	1					1

Laboratory Test Program Notes

Contaminant identification:

Standard TAT for basic analysis is 10-15 business days.

CAL-EPA DTSC Vapor Intrusion: Bulk & grain density, total porosity, moisture content, volumetric air & moisture, TOC/foc, and grain size distribution.

PTS File No: 47257
Client: The Source Group, Inc.
Report Date: 05/22/17

PHYSICAL PROPERTIES DATA - CAL-EPA DTSC Vapor Intrusion Package

Project Name: Former Chemoil Refinery
Project No: 093-Chemoil-001 Task 6

			METHODS:	**API RP40/ASTM D2216**		**API RP 40**		**API RP 40**		
SAMPLE ID.	DEPTH, ft.	SAMPLE ORIENTATION (1)	ANALYSIS DATE	MOISTURE CONTENT,		DENSITY		POROSITY, (2)		
				% weight	cm^3/cm^3	DRY BULK, g/cm^3	GRAIN, g/cm^3	TOTAL, cm^3/cm^3	AIR-FILLED, cm^3/cm^3	WATER-FILLED, cm^3/cm^3
AN-22-5	4.75-5.25	V	20170518	11.8	0.172	1.46	2.73	0.465	0.293	0.172

(1) Sample Orientation: H = horizontal; V = vertical; R = remold
(2) Total Porosity = all interconnected pore channels; Air Filled = pore channels not occupied by pore fluids.
Vb = Bulk Volume, cc; Pv = Pore Volume, cc; ND = Not Detected

PARTICLE SIZE SUMMARY

(METHODOLOGY: ASTM D422/D4464M)

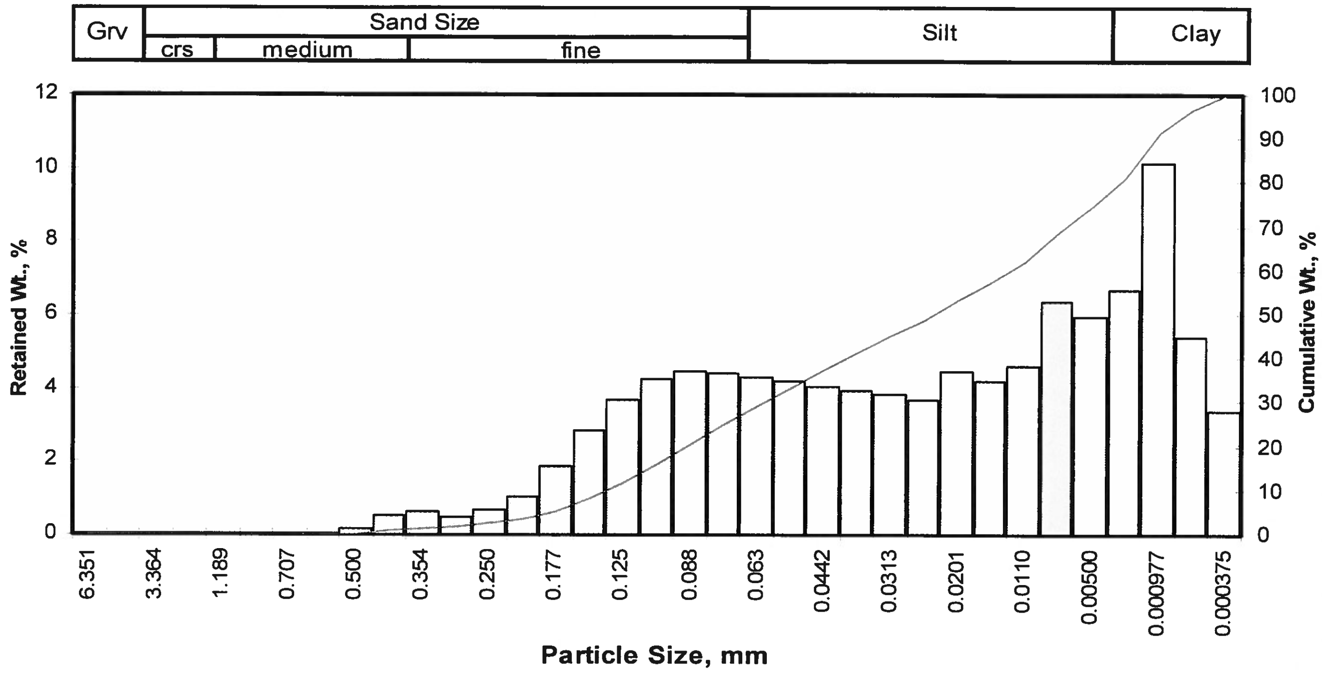
PROJECT NAME: Former Chemoil Refinery
PROJECT NO: 093-Chemoil-001 Task 6

Sample ID	Depth, ft.	Mean Grain Size Description (1)	Median Grain Size mm	Particle Size Distribution, wt. percent						Silt & Clay
					Sand Size					
				Gravel	Coarse	Medium	Fine	Silt	Clay	
AN-22-5	4.75-5.25	Silt	0.024	0.00	0.00	0.66	24.25	49.55	25.55	75.10

(1) Based on Mean from Trask

Particle Size Analysis - ASTM D4464M

Client:	The Source Group, Inc.	**PTS File No:**	47257
Project:	Former Chemoil Refinery	**Sample ID:**	AN-22-5
Project No:	093-Chemoil-001 Task 6	**Depth, ft:**	4.75-5.25



Opening		Phi of	U.S.	Sample Weight,	Increment Weight,	Cumulative Weight,
Inches	Millimeters	Screen	No.	grams	percent	percent
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	0.00	0.00	0.00
0.0331	0.841	0.25	20	0.00	0.00	0.00
0.0278	0.707	0.50	25	0.00	0.00	0.00
0.0234	0.595	0.75	30	0.01	0.01	0.01
0.0197	0.500	1.00	35	0.15	0.15	0.16
0.0166	0.420	1.25	40	0.49	0.49	0.66
0.0139	0.354	1.50	45	0.64	0.64	1.30
0.0117	0.297	1.75	50	0.48	0.48	1.78
0.0098	0.250	2.00	60	0.68	0.68	2.46
0.0083	0.210	2.25	70	1.02	1.02	3.49
0.0070	0.177	2.50	80	1.85	1.86	5.35
0.0059	0.149	2.75	100	2.81	2.82	8.17
0.0049	0.125	3.00	120	3.67	3.68	11.85
0.0041	0.105	3.25	140	4.20	4.22	16.07
0.0035	0.088	3.50	170	4.41	4.43	20.50
0.0029	0.074	3.75	200	4.39	4.41	24.90
0.0025	0.063	4.00	230	4.28	4.30	29.20
0.0021	0.053	4.25	270	4.16	4.18	33.38
0.00174	0.0442	4.50	325	4.03	4.05	37.42
0.00146	0.0372	4.75	400	3.94	3.96	41.38
0.00123	0.0313	5.00	450	3.83	3.85	45.22
0.000986	0.0250	5.32	500	3.67	3.68	48.91
0.000790	0.0201	5.64	635	4.41	4.43	53.34
0.000615	0.0156	6.00		4.18	4.20	57.53
0.000435	0.0110	6.50		4.57	4.59	62.12
0.000308	0.00781	7.00		6.33	6.36	68.48
0.000197	0.00500	7.65		5.95	5.97	74.45
0.000077	0.00195	9.00		6.64	6.67	81.12
0.000038	0.000977	10.00		10.10	10.14	91.26
0.000019	0.000488	11.00		5.36	5.38	96.64
0.000015	0.000375	11.38		3.35	3.36	100.00
TOTALS				**99.60**	**100.00**	**100.00**

Cumulative Weight Percent greater than			
Weight	Phi	Particle Size	
percent	Value	Inches	Millimeters
5	2.45	0.0072	0.183
10	2.87	0.0054	0.136
16	3.25	0.0041	0.105
25	3.76	0.0029	0.074
40	4.66	0.0016	0.039
50	5.40	0.0009	0.024
60	6.27	0.0005	0.013
75	7.76	0.0002	0.005
84	9.28	0.0001	0.002
90	9.88	0.0000	0.001
95	10.70	0.0000	0.001

Measure	Trask	Inman	Folk-Ward
Median, phi	5.40	5.40	5.40
Median, in.	0.0009	0.0009	0.0009
Median, mm	0.024	0.024	0.024
Mean, phi	4.67	6.27	5.98
Mean, in.	0.0015	0.0005	0.0006
Mean, mm	0.039	0.013	0.016
Sorting	4.002	3.019	2.758
Skewness	0.781	0.287	0.286
Kurtosis	0.256	0.365	0.844

Grain Size Description (ASTM-USCS Scale)	Silt (based on Mean from Trask)

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	0.66
Fine Sand	200	24.25
Silt	>0.005 mm	49.55
Clay	<0.005 mm	25.55
	Total	**100**

ORGANIC CARBON DATA - TOC (foc)

(Methodology: Walkley-Black)

Project Name: Former Chemoil Refinery
Project No: 093-Chemoil-001 Task 6

SAMPLE ID.	DEPTH, ft.	ANALYSIS DATE	ANALYSIS TIME	SAMPLE MATRIX	TOTAL ORGANIC CARBON, mg/kg	FRACTION ORGANIC CARBON, g/g
AN-22-5	4.75-5.25	20170520	1005	SOIL	2760	2.76E-03
Blank	N/A	20170520	1005	BLANK	ND	ND
SRM D093-542	N/A	20170520	1005	SRM	5930	5.93E-03
				Reporting Limit:	100	1.00E-04

QC DATA

SRM ID/Lot No.	REC (%)	Control Limits	Certified Concentration mg/kg	QC Performance Acceptance Limits, mg/kg	
				Lower	Upper
SRM D093-542	106	75-125	5590	4193	6988

ND = Not Detected

PTS Laboratories, Inc.

CHAIN OF CUSTODY RECORD

PAGE 1 OF 1

COMPANY
The Source Group

ADDRESS / CITY / ZIP CODE
3478 Buskirk Ave, Suite 100, Pleasant Hill, CA 94523

PROJECT MANAGER
Kirsten Duey

PROJECT NAME
Former Chemoil Refinery

PHONE NUMBER
925-951-6376

PROJECT NUMBER
093-Chemoil-001 Task 6

FAX NUMBER

SITE LOCATION
2020 Walnut Avenue, Signal Hill, CA

SAMPLER SIGNATURE

PO#

TURNAROUND TIME
24 HOURS ☐ 5 DAYS ☐
48 HOURS ☐ NORMAL ☐
72 HOURS ☒
OTHER: ____

SAMPLE INTEGRITY (CHECK):
INTACT ____ ON ICE 65°F

PTS QUOTE NO.

PTS FILE:
47257

ANALYSIS REQUEST

SAMPLE ID NUMBER	DATE	TIME	DEPTH, FT	NUMBER OF SAMPLES	SOIL PROPERTIES PACKAGE	HYDRAULIC CONDUCTIVITY PACKAGE	PORE FLUID SATURATIONS PACKAGE	TCEQ/TNRCC PROPERTIES PACKAGE	CAPILLARITY PACKAGE	FLUID PROPERTIES PACKAGE	PHOTOLOG: CORE PHOTOGRAPHY	MOISTURE CONTENT, ASTM D2216	POROSITY: TOTAL, API RP40	POROSITY: EFFECTIVE, ASTM D425M	SPECIFIC GRAVITY, ASTM D854	BULK DENSITY (DRY), API RP40 or ASTM D2937	AIR PERMEABILITY, API RP40	HYDRAULIC CONDUCTIVITY, EPA9100, API RP40, D5084	GRAIN SIZE DISTRIBUTION, ASTM D422/4464M	TOC: WALKLEY-BLACK	ATTERBERG LIMITS, ASTM D4318	Vapor Instrusion Package (Cal DTSC)				COMMENTS
AN-22-5	5/18/17	814	4.75-5.25	1																		X				Size: 2"x6"

1. RELINQUISHED BY	2. RECEIVED BY	3. RELINQUISHED BY	4. RECEIVED BY
COMPANY TSGI	COMPANY PTS LABS	COMPANY	COMPANY
DATE 05-18-17 TIME 1215	DATE 05-18-17 TIME 12:15	DATE TIME	DATE TIME

PTS Laboratories, Inc. • 8100 Secura Way • Santa Fe Springs, CA 90670 • Phone (562) 347-2500 • Fax (562) 907-3610

TETRA TECH PHYSICAL SOIL PROPERTIES LABORATORY REPORTS

TABLE
Summary of Soil Analytical Results for Total Organic Carbon (SW-846)
Former Chemoil Refinr. Walnut Avenue 21st Street Signall Hill, CA 90755

Total Organic Carbon (SW-846). Method: (9060)

Sample ID	Units	SB1-051606-GT-4'
Sample Date		5/16/2006
Laboratory Job Number		37420
Carbon, Total Organic (TOC)	mg/Kg	**16,000**

1) "ND<X" INDICATES CONSTITUENT(S) NOT DETECTED AT OR ABOVE METHOD DETECTION LIMIT.
2) "J" INDICATES ANALYTE WAS DETECTED. HOWEVER, ANALYTE CONCENTRATION IS AN ESTIMATED VALUE WHICH IS BETWEEN THE METHOD DETECTION LIMIT (MDL) AND THE PRACTICAL QUANTITATION LIMIT(PQL).
3) "D" INDICATES THE SAMPLE WAS DILUTED TO BRING THE ANALYTE CONCENTRATION WITHIN CALIBRATION RANGE.

File: SO_9060.xls

TABLE
Summary of Soil Analytical Results for Physical Properties
Former Chemoil Refinr. Walnut Avenue 21st Street Signall Hill, CA 90755

Physical Properties. Method: API-RP40

Sample ID	Units	SB1-051606-GT-4'
Sample Date		5/16/2006
Laboratory Job Number		37420
Bulk Density	g/cc	**1.72**

1) "ND<X" INDICATES CONSTITUENT(S) NOT DETECTED AT OR ABOVE METHOD DETECTION LIMIT.
2) "J" INDICATES ANALYTE WAS DETECTED. HOWEVER, ANALYTE CONCENTRATION IS AN ESTIMATED VALUE WHICH IS BETWEEN THE METHOD DETECTION LIMIT (MDL) AND THE PRACTICAL QUANTITATION LIMIT(PQL).
3) "D" INDICATES THE SAMPLE WAS DILUTED TO BRING THE ANALYTE CONCENTRATION WITHIN CALIBRATION RANGE.

File: SO_APIRP40.xls

TABLE
Summary of Soil Analytical Results for Physical Properties
Former Chemoil Refinr. Walnut Avenue 21st Street Signall Hill, CA 90755

Physical Properties. Method: API-RP40

Sample ID	Units	SB1-051606-GT-4'
Sample Date		5/16/2006
Laboratory Job Number		37420
Porosity, Total	% Vb	35.9

1) "ND<X" INDICATES CONSTITUENT(S) NOT DETECTED AT OR ABOVE METHOD DETECTION LIMIT.
2) "J" INDICATES ANALYTE WAS DETECTED. HOWEVER, ANALYTE CONCENTRATION IS AN ESTIMATED VALUE WHICH IS BETWEEN THE METHOD DETECTION LIMIT (MDL) AND THE PRACTICAL QUANTITATION LIMIT(PQL).
3) "D" INDICATES THE SAMPLE WAS DILUTED TO BRING THE ANALYTE CONCENTRATION WITHIN CALIBRATION RANGE.

File: SO_APIRP40_1.xls

TABLE
Summary of Soil Analytical Results for Moisture Content
Former Chemoil Refinr. Walnut Avenue 21st Street Signall Hill, CA 90755

Moisture Content. Method: ASTM-D2216

Sample ID	Units	SB1-051606-GT-4'
Sample Date		5/16/2006
Laboratory Job Number		37420
Moisture Content	% wt	12.9

1) "ND<X" INDICATES CONSTITUENT(S) NOT DETECTED AT OR ABOVE METHOD DETECTION LIMIT.
2) "J" INDICATES ANALYTE WAS DETECTED. HOWEVER, ANALYTE CONCENTRATION IS AN ESTIMATED VALUE WHICH IS BETWEEN THE METHOD DETECTION LIMIT (MDL) AND THE PRACTICAL QUANTITATION LIMIT(PQL).
3) "D" INDICATES THE SAMPLE WAS DILUTED TO BRING THE ANALYTE CONCENTRATION WITHIN CALIBRATION RANGE.

File: SO_ASTMD2216.xls

American Environmental Testing Laboratory Inc.
2834 & 2908 North Naomi Street, Burbank, CA 91504 • DOHS NO: 1541, LACSD NO: 10181
Tel: (888) 288-AETL • (818) 845-8200 • Fax: (818) 845-8840 • www.aetlab.com

ANALYTICAL RESULTS

Ordered By

Tetra Tech, Inc.
348 West Hospitality Lane
Suite 300
San Bernardino, CA 92408-3242

Telephone: (909)381-1674
Attn: Ben Weink

Site

Former Chemoil Refinr.
Walnut Avenue & 21st Street
Signall Hill, CA 90755

Page 93
Project ID: 18116-01
Project Name: Former Chemoil Refinr.

AETL Job Number	Submitted	Client
37420	05/16/2006	T/TSB2

Analytes			Porosity, Total	Bulk Density	Moisture Content	Carbon, Total Organic (TOC)
Methods of Analyses			API-RP40	API-RP40	ASTM-D2216	(9060)
Date Prepared			05/31/2006	05/31/2006	05/17/2006	05/26/2006
Date Analyzed			05/31/2006	05/31/2006	05/18/2006	05/26/2006
Matrix			Soil	Soil	Soil	Soil
QC Batch Number						052606
Units			% Vb	g/cc	% wt	mg/Kg
Method Detection Limit			0.1	0.01	0.1	25
Practical Quantitation Limit			0.1	0.01	0.1	50
Dilution Factor			1	1	1	1
Lab ID	**Sample ID**	**Sampled**	**Results**	**Results**	**Results**	**Results**
37420.13	SB1-051606-GT-4'	05/16/2006	35.9	1.72	12.9	16,000
N/A	Method Blank	05/16/2006	ND	ND	NA	ND

ANALYTICAL RESULTS

Ordered By

Tetra Tech, Inc.
348 West Hospitality Lane
Suite 300
San Bernardino, CA 92408-3242

Site

Former Chemoil Refinr.
Walnut Avenue & 21st Street
Signall Hill, CA 90755

Telephone: (909)381-1674
Attn: Ben Weink

Page: 101
Project ID: 18116-01
Project Name: Former Chemoil Refinr.

AETL Job Number	Submitted	Client
37420	05/16/2006	T/TSB2

Method: (9060), Total Organic Carbon (SW-846)

QUALITY CONTROL REPORT

QC Batch No: 052606 Sample Spiked: 052606 QC Prepared: 05/26/2006 QC Analyzed: 05/26/2006 Units: mg/Kg

Analytes	Sample Result	MS Concen	MS Recov	MS % REC	MS DUP Concen	MS DUP Recov	MS DUP % REC	RPD %	MS/MSD % Limit	MS RPD % Limit
Carbon, Total Organic (TOC)	0.0	100.00	104.00	104	100.00	97.00	97	7.0	52-130	<12

QC Batch No: 052606 Sample Spiked: 052606 QC Prepared: 05/26/2006 QC Analyzed: 05/26/2006 Units: mg/Kg

Analytes	LCS Concen	LCS Recov	LCS % REC	LCS/LCSD % Limit						
Carbon, Total Organic (TOC)	100.00	92.00	92	80-120						

PHYSICAL PROPERTIES DATA

PROJECT NAME: N/A
PROJECT NO: 37420

METHODOLOGY: **API RP40**

SAMPLE ID.	DEPTH, ft.	SAMPLE ORIENT. (1)	BULK DENSITY (g/cc)	TOTAL POROSITY, % Vb (2)
37420.13A	4	V	1.72	35.9

(1) Sample Orientation: H = horizontal; V = vertical (2) Total Porosity = no pore fluids in place; all interconnected pore channels; Air Filled = pore channels not occupied by pore fluids Vb = Bulk Volume, cc

PTS Laboratories, Inc.

AETL

PTS File No: 36342

PARTICLE SIZE SUMMARY

(METHODOLOGY: ASTM D422/D4464M)

PROJECT NAME: N/A
PROJECT NO: 37420

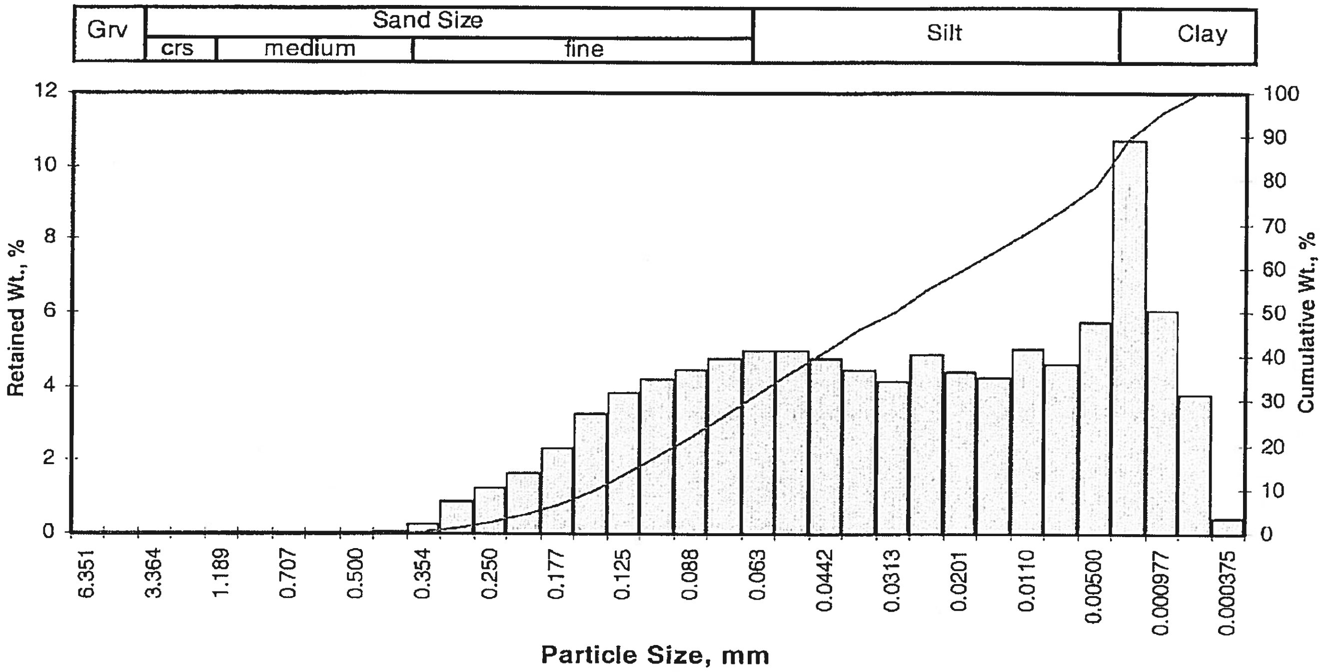
Sample ID	Depth, ft.	Mean Grain Size Description (1)	Median Grain Size mm	Particle Size Distribution, wt. percent						Silt & Clay
					Sand Size					
				Gravel	Coarse	Medium	Fine	Silt	Clay	
37420.13A	4	Silt	0.031	0.00	0.00	0.05	26.83	52.20	20.92	73.12

(1) Based on Mean from Trask

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	AETL	**PTS File No:**	36342
Project:	N/A	**Sample ID:**	37420.13A
Project No:	37420	**Depth, ft:**	4



Opening		Phi of Screen	U.S. No.	Sample Weight, grams	Increment Weight, percent	Cumulative Weight, percent
Inches	Millimeters					
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	0.00	0.00	0.00
0.0331	0.841	0.25	20	0.00	0.00	0.00
0.0278	0.707	0.50	25	0.00	0.00	0.00
0.0234	0.595	0.75	30	0.00	0.00	0.00
0.0197	0.500	1.00	35	0.00	0.00	0.00
0.0166	0.420	1.25	40	0.05	0.05	0.05
0.0139	0.354	1.50	45	0.25	0.25	0.30
0.0117	0.297	1.75	50	0.90	0.90	1.20
0.0098	0.250	2.00	60	1.22	1.22	2.42
0.0083	0.210	2.25	70	1.68	1.68	4.10
0.0070	0.177	2.50	80	2.35	2.35	6.45
0.0059	0.149	2.75	100	3.24	3.24	9.69
0.0049	0.125	3.00	120	3.82	3.82	13.51
0.0041	0.105	3.25	140	4.17	4.17	17.68
0.0035	0.088	3.50	170	4.44	4.44	22.12
0.0029	0.074	3.75	200	4.76	4.76	26.88
0.0025	0.063	4.00	230	4.96	4.96	31.84
0.0021	0.053	4.25	270	4.96	4.96	36.80
0.00174	0.0442	4.50	325	4.76	4.76	41.56
0.00146	0.0372	4.75	400	4.46	4.46	46.02
0.00123	0.0313	5.00	450	4.15	4.15	50.17
0.000986	0.0250	5.32	500	4.88	4.88	55.06
0.000790	0.0201	5.64	635	4.39	4.39	59.45
0.000615	0.0156	6.00		4.25	4.25	63.70
0.000435	0.0110	6.50		5.02	5.02	68.72
0.000308	0.00781	7.00		4.61	4.61	73.33
0.000197	0.00500	7.65		5.75	5.75	79.08
0.000077	0.00195	9.00		10.70	10.70	89.78
0.000038	0.000977	10.00		6.06	6.06	95.84
0.000019	0.000488	11.00		3.75	3.75	99.59
0.000015	0.000375	11.38		0.41	0.41	100.00
TOTALS				100.00	100.00	100.00

Cumulative Weight Percent greater than			
Weight percent	Phi Value	Particle Size	
		Inches	Millimeters
5	2.35	0.0077	0.197
10	2.77	0.0058	0.147
16	3.15	0.0044	0.113
25	3.65	0.0031	0.080
40	4.42	0.0018	0.047
50	4.99	0.0012	0.031
60	5.69	0.0008	0.019
75	7.19	0.0003	0.007
84	8.27	0.0001	0.003
90	9.04	0.0001	0.002
95	9.86	0.0000	0.001

Measure	Trask	Inman	Folk-Ward
Median, phi	4.99	4.99	4.99
Median, in.	0.0012	0.0012	0.0012
Median, mm	0.031	0.031	0.031
Mean, phi	4.53	5.71	5.47
Mean, in.	0.0017	0.0008	0.0009
Mean, mm	0.043	0.019	0.023
Sorting	3.406	2.560	2.419
Skewness	0.742	0.281	0.289
Kurtosis	0.251	0.468	0.871

Grain Size Description (ASTM-USCS Scale)	Silt (based on Mean from Trask)

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	0.05
Fine Sand	200	26.83
Silt	>0.005 mm	52.20
Clay	<0.005 mm	20.92
	Total	100

DATE **PTS FILE#** 36342 **CHAIN OF CUSTODY RECORD** **PAGE** 1 **OF** 1

COMPANY AETL

ADDRESS 2834 North Naomi st
Burbank, CA, 91504

PROJECT MANAGER Jim Lin

PROJECT NAME

PHONE NUMBER (818) 845-8200

PROJECT NUMBER 37420

FAX NUMBER (818) 845-8840

SITE LOCATION

SAMPLER SIGNATURE

PO#

SPECIAL HANDLING

24 HOURS 5 DAYS
72 HOURS [✓ NORMAL]
OTHER

SAMPLE CONDITIONS

RECEIVED ON ICE YES/NO
SEALED YES/NO
OTHER YES/NO

COMMENTS

P.O. # 10323

ANALYSIS REQUEST

SAMPLE ID NUMBER	DATE	TIME	DEPTH, FT	PHYSICAL PROPERTIES PACKAGE, API RP40	MOISTURE CONTENT, ASTM D2216	POROSITY, API RP40	GRAIN DENSITY, API RP40	BULK DENSITY, API RP40	AIR PERMEABILITY, API RP40	SPECIFIC RETENTION/YIELD ASTM D425	CAPILLARY PRESSURE, ASTM D425M	SOIL pH, EPA 9045	GRAIN SIZE: DRY; 400 MESH	GRAIN SIZE: SIEVE & LASER	GRAIN SIZE: LASER; 1 MICRON	HYDRAULIC CONDUCTIVITY, EPA 9100, API RP40	TOC: WALKLEY-BLACK	HYDRAULIC CONDUCTIVITY PACKAGE	ATTERBERG LIMITS, ASTM D4318	TNRCC PROPERTIES PACKAGE					NUMBER OF SAMPLES
✓ 37420.13A	5/16-06	1100	4'			X		X							X										

1. RELINQUISHED BY	2. RECEIVED BY	3. RELINQUISHED BY	4. RECEIVED BY
COMPANY AETL	COMPANY PTS laboratories	COMPANY	COMPANY
DATE 5/18/06 TIME	DATE 5-18-06 TIME 1523	DATE TIME	DATE TIME

PTS GeoLabs, Inc. • 8100 Secura Way • Santa Fe Springs, CA 90670 • Phone (562) 907-3607 • Fax (562) 907-3610
PTS GeoLabs, Inc. • 4342 W. 12th St. • Houston, TX 77055 • Phone (713) 680-2291 • Fax (713) 680-0763

Advanced Technology Laboratories

3275 Walnut Avenue
Signal Hill CA 90807
(562) 989-4045 Phone
(562) 989-4040 Fax

Fax Transmittal Sheet

To: Jim

From: Rachelle

RE: Results for 084490

Message:

Enclosed are the results for your project 37420. Thank you very much for your business and we are looking forward to being of service to you.

Advanced Technology Laboratories

Date: *31-May-06*

CLIENT:	American Environmental Testing Laborator	**Client Sample ID:**	37420.13C
Lab Order:	084490	**Tag Number:**	
Project:	37420	**Collection Date:**	5/17/2006 11:00:00 AM
Lab ID:	084490-001A	**Matrix:**	SOIL

Analyses	**Result**	**PQL**	**Qual**	**Units**	**DF**	**Date Analyzed**
TOTAL ORGANIC CARBON						
				EPA 415.1(M)		
RunID: TOC2_060526A	QC Batch: R63818			PrepDate:		Analyst: JT
Total Organic Carbon	16000	30		mg/Kg	1	5/26/2006

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	ND	Not Detected at the Reporting Limit
S	Spike/Surrogate outside of limits due to matrix interference		Results are wet unless otherwise specified
DO	Surrogate Diluted Out		

Advanced Technology Laboratories

Date: *31-May-06*

CLIENT: American Environmental Testing Laborator
Work Order: 084490
Project: 37420

ANALYTICAL QC SUMMARY REPORT

TestCode: 415.1_S

Sample ID: MB-R63818 SampType: MBLK TestCode: 415.1_S Units: mg/Kg Prep Date: RunNo: 63818
Client ID: PBS Batch ID: R63818 TestNo: EPA 415.1(M) Analysis Date: 5/26/2006 SeqNo: 943878

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Total Organic Carbon	ND	30									

Sample ID: LCSR63818 SampType: LCS TestCode: 415.1_S Units: mg/Kg Prep Date: RunNo: 63818
Client ID: LCSS Batch ID: R63818 TestNo: EPA 415.1(M) Analysis Date: 5/26/2006 SeqNo: 943879

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Total Organic Carbon	921.000	30	1000	0	92.1	80	120				

Sample ID: 084654-002AMS SampType: MS TestCode: 415.1_S Units: mg/Kg Prep Date: RunNo: 63818
Client ID: ZZZZZZ Batch ID: R63818 TestNo: EPA 415.1(M) Analysis Date: 5/26/2006 SeqNo: 943983

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Total Organic Carbon	2490.000	30	1000	1446	104	52	130				

Sample ID: 084654-005AMSD SampType: MSD TestCode: 415.1_S Units: mg/Kg Prep Date: RunNo: 63818
Client ID: ZZZZZZ Batch ID: R63818 TestNo: EPA 415.1(M) Analysis Date: 5/26/2006 SeqNo: 943984

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Total Organic Carbon	2411.000	30	1000	1446	96.5	52	130	2490	3.22	12	

Qualifiers:

E	Value above quantitation range	H	Holding times for preparation or analysis exceeded	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike/Surrogate outside of limits due to matrix interferenc	DO	Surrogate Diluted Out
	Calculations are based on raw values				

CHAIN OF CUSTODY RECORD

Pg 1 of 1

Advanced Technology Laboratories
3275 Walnut Avenue
Signal Hill, CA 90755
(562) 989-4045 • Fax (562) 989-4040

FOR LABORATORY USE ONLY:

P.O.#: 10322

Logged By:

Date: 5/18/06

Method of Transport
- Client ☑
- ATL ☐
- CA OverN ☐
- FEDEX ☐
- Other:

Sample Condition Upon Receipt
1. CHILLED Y ☑ N ☐
2. HEADSPACE (VOA) Y ☐ N ☐
3. CONTAINER INTACT Y ☑ N ☐
4. SEALED Y ☐ N ☑
5. # OF SPLS MATCH COC Y ☑ N ☐
6. PRESERVED Y ☐ N ☑

Client: AETL
Attn: Jim Lin
Address: 2834 North Naomi st.
City: Burbank State: CA Zip Code: 91504
TEL: (818) 845-8200
FAX: (818) 845-8840

Project Name:
Project #: 37420
Sampler: (Printed Name) (Signature)

Relinquished by: (Signature and Printed Name) Date: 05/18/06 Time: 1215 Received by: (Signature and Printed Name) Date: 5/18/06 Time: 1215
Relinquished by: (Signature and Printed Name) Date: Time: Received by: (Signature and Printed Name) Date: Time:
Relinquished by: (Signature and Printed Name) Date: Time: Received by: (Signature and Printed Name) Date: Time:

I hereby authorize ATL to perform the work indicated below:
Project Mgr /Submitter:
Print Name
Date 5-17-06
Signature

Send Report To:
Attn: Jim Lin
Co:
Address
City State Zip

Bill To:
Attn: Nilloo chaudhry
Co:
Address
City State Zip

Special Instructions/Comments:

Sample/Records - Archival & Disposal
Unless otherwise requested by client, all samples will be disposed 45 days after receipt and records will be disposed 1 year after submittal of final report.
Storage Fees (applies when storage is requested):
- Sample : $2.00 / sample / mo (after 45 days)
- Records: $1.00 / ATL workorder / mo (after 1 year)

Circle or Add Analysis(es) Requested

ITEM	LAB USE ONLY: Batch #: Lab No.	Sample Description Sample I.D. / Location	Date	Time	8081A (Pesticides)	8082 (PCB)	8260B (Volatiles)	8270C (BNA)	6010B (Total Metal)	8015B (GRO) / 8020 (BTEX)	8015B (DRO)	8021 (BTEX)	TITLE 22 / CAM 17 (6010/7000)	TOC 415.1					SOIL	WATER	GROUND WATER	WASTEWATER			TAT	Container(s) #	Container(s) Type	PRESERVATION	REMARKS
1	084490-001	37420.13C	5/17.06	1100										X					X						E	1	J G	—	

SPECIFY APPROPRIATE MATRIX

QA/QC
- RTNE ☐
- CT ☐
- SWRCB ☐
- Logcode
- OTHER

- TAT starts 8 a.m. following day if samples received after 3 p.m.

TAT: A= Overnight ≤ 24 hr B= Emergency Next workday C= Critical 2 Workdays D= Urgent 3 Workdays E= Routine 7 Workdays

Container Types: T=Tube V=VOA L=Liter P=Pint [✓ J=Jar] B=Tedlar [✓ G=Glass] P=Plastic M=Metal

Preservatives:
H=Hcl N=HNO_3 S=H_2SO_4 C=4°C
Z=Zn(AC)$_2$ O=NaOH T=$Na_2S_2O_3$

DISTRIBUTION: White with report, Yellow to folder, Pink to submitter

American Environmental Testing Laboratory Inc.
2834 & 2908 North Naomi Street, Burbank, CA 91504 • DOHS NO: 1541, LACSD NO: 10181
Tel: (888) 288-AETL • (818) 845-8200 • Fax: (818) 845-8840 • www.aetlab.com

Data Qualifiers and Descriptors

Data Qualifier:

*:	In the QC section, sample results have been taken directly from the ICP reading. No preparation factor has been applied.
B:	Analyte was present in the Method Blank.
D:	Result is from a diluted analysis.
E:	Result is beyond calibration limits and is estimated.
H:	Analysis was performed over the allowed holding time due to circumstances which were beyond laboratory control.
J:	Analyte was detected . However, the analyte concentration is an estimated value, which is between the Method Detection Limit (MDL) and the Practical Quantitation Limit (PQL).
M:	Matrix spike recovery is outside control limits due to matrix interference. Laboratory Control Sample recovery was acceptable.
S6:	Surrogate recovery is outside control limits due to matrix interference.
S8:	The analysis of the sample required a dilution such that the surrogate concentration was diluted below the method acceptance criteria.
X:	Results represent LCS and LCSD data.

Definition:

%Limi:	Percent acceptable limits.
%REC:	Percent recovery.
Con.L:	Acceptable Control Limits
Conce:	Added concentration to the sample.
LCS:	Laboratory Control Sample
MDL:	Method Detection Limit is a statistically derived number which is specific for each instrument, each method, and each compound. It indicates a distinctively detectable quantity with 99% probability.
MS:	Matrix Spike
MS DU:	Matrix Spike Duplicate

Data Qualifiers and Descriptors

ND:	Analyte was not detected in the sample at or above MDL.
PQL:	Practical Quantitation Limit or ML (Minimum Level as per RWQCB) is the minimum concentration that can be quantified with more than 99% confidence. Taking into account all aspects of the entire analytical instrumentation and practice.
Recov:	Recovered concentration in the sample.
RPD:	Relative Percent Difference

TETRA TECH, INC.
348 W. Hospitality Lane, Suite 300
San Bernardino, California 92408
Telephone: (909) 381-1674
FAX: (909) 889-1391

SHIP TO: AETL

~~#37420~~

CHAIN OF COUSTODY RECORD

DATE 5/16/06 PAGE 3 OF 4

CLIENT: GEM
PROJECT NAME: Former ChemOil
PROJECT MANAGER: Ben Weink.
TC #: 18116-01
SAMPLERS (Signatures) Tuong Phu Ngo

TURN-AROUND TIME: Standard

OBSERVATIONS/COMMENTS
Geotechnical Testing:
Grain size
Porosity
Bulk density
Moisture Content
Total organic Carbon

LINE ITEM	SAMPLE NO.	DATE	TIME	Geotechnical Testing	VOCs 8260+OXYS													FILTERED/UNFILTERED	MATRIX TYPE	CONTAINER TYPE	NUMBER OF CONTAINERS	PRESERVATIVE	OBSERVATIONS/COMMENTS
1.	~~SB1-051606-GT-32'~~	5/16/06	~~10:40~~	X															~~S~~	~~P~~	~~1~~		~~37420.13~~AG
2.	SB1-051606-GT-4'	↓	11:00	X															S	D	1		37420.13
3.	Trip Blanks	↓	14:25		X														W	G	2		37420.14
4.																							
5.																							
6.																							
7.																							
8.																							
9.																							
10.																							

FILTERING:
☐ FILTERED ☐ UNFILTERED

MATRIX TYPE:
S - Soil
M - Sediment
W - Water

CONTAINER TYPE:
G - Glass Bottle/Jar
SS - Stainless Steel Sleeve
SB - Brass Sleeve
P - Plastic Bottle/Jar

PRESERVATIVES: (Water Only)
HCL
NR (None required)
NaOH
H_2SO_4

RELINQUISHED BY Tuong Phu Ngo	SIGNATURE Tuong Phu Ngo	TETRA TECH, INC.	DATE 5/16/06	TIME 1540
RECEIVED BY Argisht	SIGNATURE	COMPANY AETL	DATE 5/16-06	TIME 1540
RELINQUISHED BY Argisht	SIGNATURE	COMPANY AETL	DATE 5/16-06	TIME 1700
RECEIVED BY Argisht	SIGNATURE	COMPANY AETL	DATE 5/16-06	TIME 1700

TOTAL NUMBER OF CONTAINERS ON THIS CHAIN OF CUSTODY: 3
METHOD OF SHIPMENT/SHIPMENT NO Courier
Special Shipping/Handling/Storage Requirements

DISTRIBUTION: White and Pink = Tetra Tech, Inc. Canary = Laboratory

G COCRgen car

TABLE
Summary of Soil Analytical Results for Total Organic Carbon (SW-846)
Former Chemoil Refinr. Walnut Avenue 21st Street Signal Hill, CA 90755

Total Organic Carbon (SW-846). Method: (9060)

Sample ID	Units	SB2-051506-GT-24'	SB2-051506-GT-31'	SB2-051506-GT-6'
Sample Date		5/15/2006	5/15/2006	5/15/2006
Laboratory Job Number		37405	37405	37405
Carbon, Total Organic (TOC)	mg/Kg	**160**	**9,900**	**17,000**

1) "ND<X" INDICATES CONSTITUENT(S) NOT DETECTED AT OR ABOVE METHOD DETECTION LIMIT.
2) "J" INDICATES ANALYTE WAS DETECTED. HOWEVER, ANALYTE CONCENTRATION IS AN ESTIMATED VALUE WHICH IS BETWEEN THE METHOD DETECTION LIMIT (MDL) AND THE PRACTICAL QUANTITATION LIMIT(PQL).
3) "D" INDICATES THE SAMPLE WAS DILUTED TO BRING THE ANALYTE CONCENTRATION WITHIN CALIBRATION RANGE.

File: SO_9060.xls

TABLE
Summary of Soil Analytical Results for Physical Properties
Former Chemoil Refinr. Walnut Avenue 21st Street Signal Hill, CA 90755

Physical Properties. Method: API-RP40

Sample ID	Units	SB2-051506-GT-24'	SB2-051506-GT-31'	SB2-051506-GT-6'
Sample Date		5/15/2006	5/15/2006	5/15/2006
Laboratory Job Number		37405	37405	37405
Bulk Density	g/cc	**1.50**	**1.69**	**1.66**

1) "ND<X" INDICATES CONSTITUENT(S) NOT DETECTED AT OR ABOVE METHOD DETECTION LIMIT.
2) "J" INDICATES ANALYTE WAS DETECTED. HOWEVER, ANALYTE CONCENTRATION IS AN ESTIMATED VALUE WHICH IS BETWEEN THE METHOD DETECTION LIMIT (MDL) AND THE PRACTICAL QUANTITATION LIMIT(PQL).
3) "D" INDICATES THE SAMPLE WAS DILUTED TO BRING THE ANALYTE CONCENTRATION WITHIN CALIBRATION RANGE.

File: SO_APIRP40.xls

TABLE
Summary of Soil Analytical Results for Physical Properties
Former Chemoil Refinr. Walnut Avenue 21st Street Signal Hill, CA 90755

Physical Properties. Method: API-RP40

Sample ID	Units	SB2-051506-GT-24'	SB2-051506-GT-31'	SB2-051506-GT-6'
Sample Date		5/15/2006	5/15/2006	5/15/2006
Laboratory Job Number		37405	37405	37405
Porosity, Total	% Vb	**44.5**	**37.3**	**38.4**

1) "ND<X" INDICATES CONSTITUENT(S) NOT DETECTED AT OR ABOVE METHOD DETECTION LIMIT.
2) "J" INDICATES ANALYTE WAS DETECTED. HOWEVER, ANALYTE CONCENTRATION IS AN ESTIMATED VALUE WHICH IS BETWEEN THE METHOD DETECTION LIMIT (MDL) AND THE PRACTICAL QUANTITATION LIMIT(PQL).
3) "D" INDICATES THE SAMPLE WAS DILUTED TO BRING THE ANALYTE CONCENTRATION WITHIN CALIBRATION RANGE.

File: SO_APIRP40_1.xls

TABLE

Summary of Soil Analytical Results for Moisture Content

Former Chemoil Refinr. Walnut Avenue 21st Street Signal Hill, CA 90755

Moisture Content. Method: ASTM-D2216

Sample ID	Units	SB2-051506-GT-24'	SB2-051506-GT-31'	SB2-051506-GT-6'
Sample Date		5/15/2006	5/15/2006	5/15/2006
Laboratory Job Number		37405	37405	37405
Moisture Content	% wt	**4.89**	**10.8**	**11.8**

1) "ND<X" INDICATES CONSTITUENT(S) NOT DETECTED AT OR ABOVE METHOD DETECTION LIMIT.
2) "J" INDICATES ANALYTE WAS DETECTED. HOWEVER, ANALYTE CONCENTRATION IS AN ESTIMATED VALUE WHICH IS BETWEEN THE METHOD DETECTION LIMIT (MDL) AND THE PRACTICAL QUANTITATION LIMIT(PQL).
3) "D" INDICATES THE SAMPLE WAS DILUTED TO BRING THE ANALYTE CONCENTRATION WITHIN CALIBRATION RANGE.

File: SO_ASTMD2216.xls

ANALYTICAL RESULTS

Ordered By

Tetra Tech, Inc.
348 West Hospitality Lane
Suite 300
San Bernardino, CA 92408-3242

Telephone: (909)381-1674
Attn: Ben Weink

Site

Former Chemoil Refinr.
Walnut Avenue & 21st Street
Signal Hill, CA 90755

Page 52
Project ID: 18116-01
Project Name: Former Chemoil Refinr.

AETL Job Number	Submitted	Client
37405	05/15/2006	T/TSB2

Analytes			Porosity, Total	Bulk Density	Moisture Content	Carbon, Total Organic (TOC)
Methods of Analyses			API-RP40	API-RP40	ASTM-D2216	(9060)
Date Prepared			05/31/2006	05/31/2006	05/16/2006	05/17/2006
Date Analyzed			05/31/2006	05/31/2006	05/17/2006	05/17/2006
Matrix			Soil	Soil	Soil	Soil
QC Batch Number						051706
Units			% Vb	g/cc	% wt	mg/Kg
Method Detection Limit			0.1	0.01	0.1	25
Practical Quantitation Limit			0.1	0.01	0.1	50
Dilution Factor			1	1	1	1
Lab ID	Sample ID	Sampled	Results	Results	Results	Results
37405.17	SB2-051506-GT-6'	05/15/2006	38.4	1.66	11.8	17,000
37405.18	SB2-051506-GT-24'	05/15/2006	44.5	1.50	4.89	160
37405.19	SB2-051506-GT-31'	05/15/2006	37.3	1.69	10.8	9,900
N/A	Method Blank	05/15/2006	ND	ND	ND	ND

ANALYTICAL RESULTS

Ordered By

Tetra Tech, Inc.
348 West Hospitality Lane
Suite 300
San Bernardino, CA 92408-3242

Telephone: (909)381-1674
Attn: Ben Weink

Site

Former Chemoil Refinr.
Walnut Avenue & 21st Street
Signal Hill, CA 90755

Page: 64
Project ID: 18116-01
Project Name: Former Chemoil Refinr.

AETL Job Number	Submitted	Client
37405	05/15/2006	T/TSB2

Method: (9060), Total Organic Carbon (SW-846)

QUALITY CONTROL REPORT

QC Batch No: 051706 Sample Spiked: 051706 QC Prepared: 05/17/2006 QC Analyzed: 05/17/2006 Units: mg/Kg

Analytes	Sample Result	MS Concen	MS Recov	MS % REC	MS DUP Concen	MS DUP Recov	MS DUP % REC	RPD %	MS/MSD % Limit	MS RPD % Limit
Carbon, Total Organic (TOC)	0.0	100.00	79.00	79	100.00	90.00	90	13.0	52-130	<12

QC Batch No: 051706 Sample Spiked: 051706 QC Prepared: 05/17/2006 QC Analyzed: 05/17/2006 Units: mg/Kg

Analytes	LCS Concen	LCS Recov	LCS % REC	LCS/LCSD % Limit						
Carbon, Total Organic (TOC)	100.00	97.00	97	80-120						

PHYSICAL PROPERTIES DATA

PROJECT NAME: N/A
PROJECT NO: 37405

METHODOLOGY: **API RP40**

SAMPLE ID.	DEPTH, ft.	SAMPLE ORIENT. (1)	BULK DENSITY (g/cc)	TOTAL POROSITY, % Vb (2)
37405.17A	6	V	1.66	38.4
37405.18A	24	V	1.50	44.5
37405.19A	31	V	1.69	37.3

(1) Sample Orientation: H = horizontal; V = vertical (2) Total Porosity = no pore fluids in place; all interconnected pore channels; Air Filled = pore channels not occupied by pore fluids Vb = Bulk Volume, cc

AETL
PTS File No: 36338

PARTICLE SIZE SUMMARY

(METHODOLOGY: ASTM D422/D4464M)

PROJECT NAME: N/A
PROJECT NO: 37405

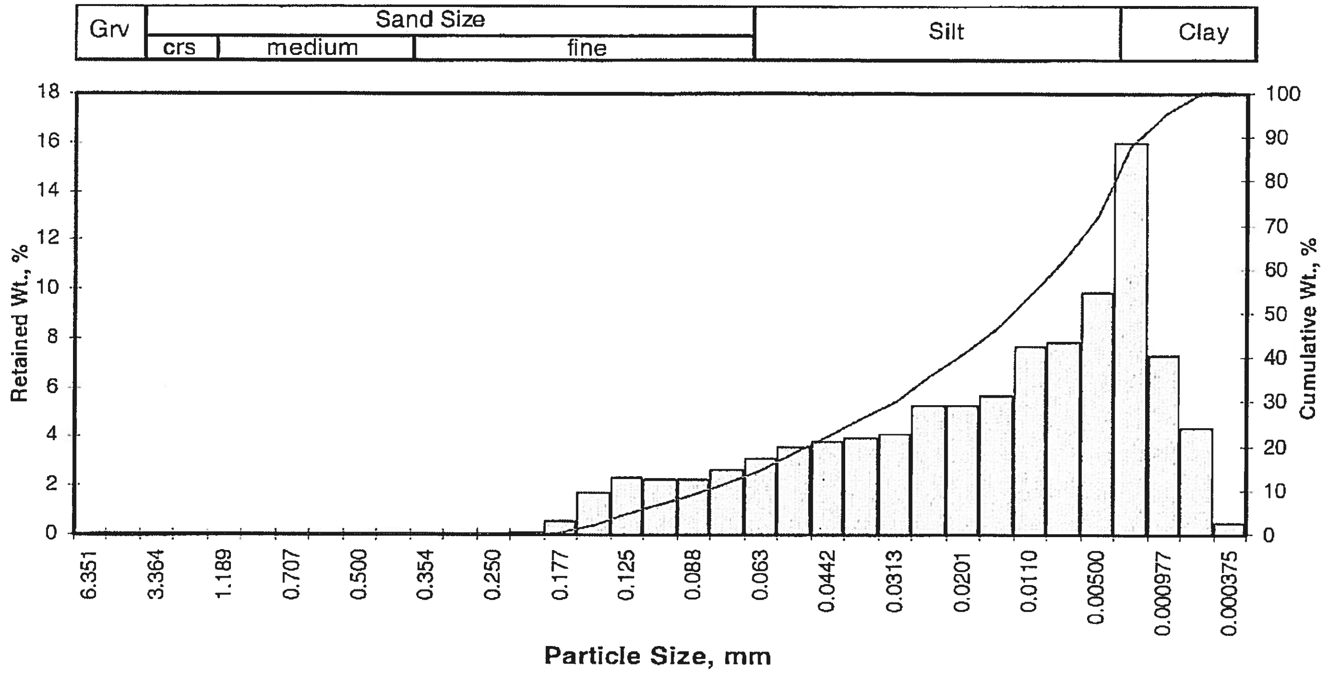
Sample ID	Depth, ft.	Mean Grain Size Description (1)	Median Grain Size mm	Particle Size Distribution, wt. percent						Silt & Clay
					Sand Size					
				Gravel	Coarse	Medium	Fine	Silt	Clay	
37405-17A	6	Silt	0.013	0.00	0.00	0.00	11.72	60.13	28.15	88.28
37405-18A	24	Fine sand	0.221	0.00	0.00	29.48	37.02	25.02	8.49	33.51
37405-19A	31	Fine sand	0.053	0.00	0.00	13.77	29.26	44.26	12.70	56.97

(1) Based on Mean from Trask

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	AETL	**PTS File No:**	36338
Project:	N/A	**Sample ID:**	37405-17A
Project No:	37405	**Depth, ft:**	6



Opening		Phi of Screen	U.S. No.	Sample Weight, grams	Increment Weight, percent	Cumulative Weight, percent
Inches	Millimeters					
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	0.00	0.00	0.00
0.0331	0.841	0.25	20	0.00	0.00	0.00
0.0278	0.707	0.50	25	0.00	0.00	0.00
0.0234	0.595	0.75	30	0.00	0.00	0.00
0.0197	0.500	1.00	35	0.00	0.00	0.00
0.0166	0.420	1.25	40	0.00	0.00	0.00
0.0139	0.354	1.50	45	0.00	0.00	0.00
0.0117	0.297	1.75	50	0.00	0.00	0.00
0.0098	0.250	2.00	60	0.00	0.00	0.00
0.0083	0.210	2.25	70	0.06	0.06	0.06
0.0070	0.177	2.50	80	0.57	0.57	0.63
0.0059	0.149	2.75	100	1.71	1.71	2.34
0.0049	0.125	3.00	120	2.29	2.29	4.63
0.0041	0.105	3.25	140	2.25	2.25	6.88
0.0035	0.088	3.50	170	2.24	2.24	9.12
0.0029	0.074	3.75	200	2.60	2.60	11.72
0.0025	0.063	4.00	230	3.12	3.12	14.84
0.0021	0.053	4.25	270	3.55	3.55	18.39
0.00174	0.0442	4.50	325	3.82	3.82	22.20
0.00146	0.0372	4.75	400	3.99	3.99	26.19
0.00123	0.0313	5.00	450	4.09	4.09	30.28
0.000986	0.0250	5.32	500	5.30	5.30	35.58
0.000790	0.0201	5.64	635	5.28	5.28	40.86
0.000615	0.0156	6.00		5.66	5.66	46.52
0.000435	0.0110	6.50		7.69	7.69	54.21
0.000308	0.00781	7.00		7.80	7.80	62.01
0.000197	0.00500	7.65		9.84	9.84	71.85
0.000077	0.00195	9.00		16.00	16.00	87.84
0.000038	0.000977	10.00		7.30	7.30	95.14
0.000019	0.000488	11.00		4.38	4.38	99.52
0.000015	0.000375	11.38		0.48	0.48	100.00
TOTALS				100.00	100.00	100.00

Cumulative Weight Percent greater than			
Weight percent	Phi Value	Particle Size	
		Inches	Millimeters
5	3.04	0.0048	0.121
10	3.58	0.0033	0.083
16	4.08	0.0023	0.059
25	4.68	0.0015	0.039
40	5.59	0.0008	0.021
50	6.23	0.0005	0.013
60	6.87	0.0003	0.009
75	7.91	0.0002	0.004
84	8.67	0.0001	0.002
90	9.30	0.0001	0.002
95	9.98	0.0000	0.001

Measure	Trask	Inman	Folk-Ward
Median, phi	6.23	6.23	6.23
Median, in.	0.0005	0.0005	0.0005
Median, mm	0.013	0.013	0.013
Mean, phi	5.53	6.38	6.33
Mean, in.	0.0009	0.0005	0.0005
Mean, mm	0.022	0.012	0.012
Sorting	3.071	2.296	2.200
Skewness	0.954	0.066	0.074
Kurtosis	0.214	0.511	0.879

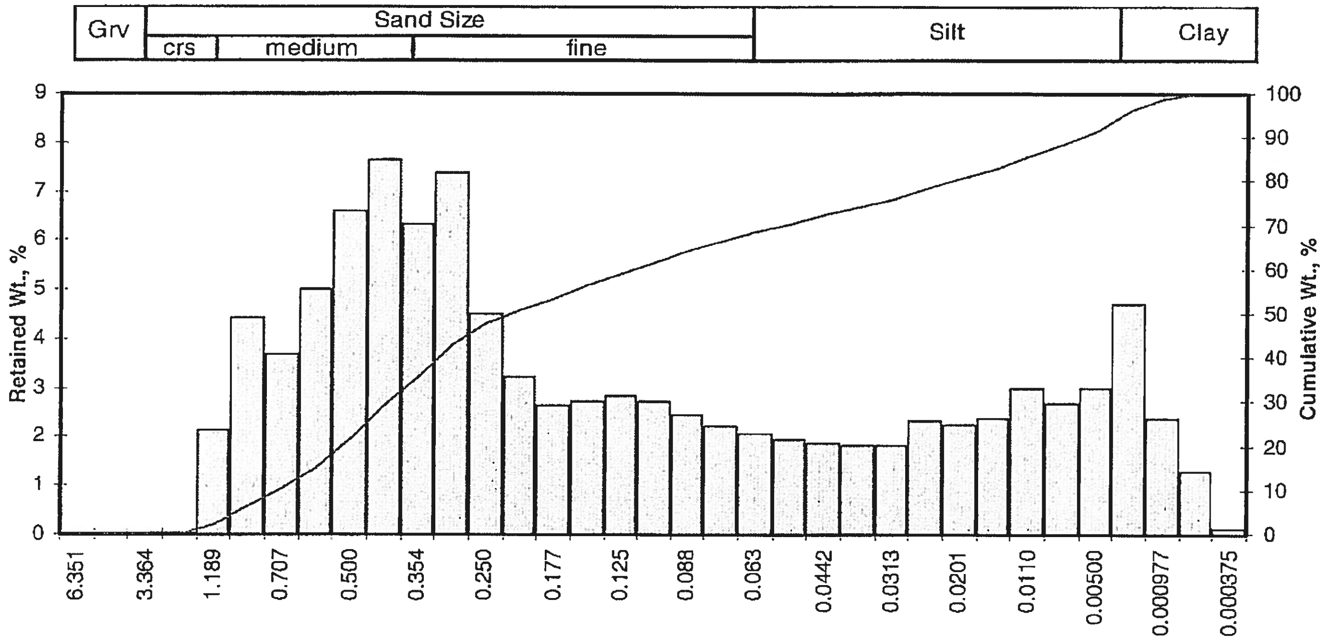
Grain Size Description (ASTM-USCS Scale)	Silt (based on Mean from Trask)

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	0.00
Fine Sand	200	11.72
Silt	>0.005 mm	60.13
Clay	<0.005 mm	28.15
	Total	100

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	AETL	**PTS File No:**	36338
Project:	N/A	**Sample ID:**	37405-18A
Project No:	37405	**Depth, ft:**	24



Particle Size, mm

Opening		Phi of	U.S.	Sample Weight,	Increment Weight,	Cumulative Weight,
Inches	Millimeters	Screen	No.	grams	percent	percent
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	2.13	2.13	2.13
0.0331	0.841	0.25	20	4.44	4.44	6.57
0.0278	0.707	0.50	25	3.70	3.70	10.27
0.0234	0.595	0.75	30	4.99	4.99	15.26
0.0197	0.500	1.00	35	6.59	6.59	21.85
0.0166	0.420	1.25	40	7.63	7.63	29.48
0.0139	0.354	1.50	45	6.32	6.32	35.80
0.0117	0.297	1.75	50	7.37	7.37	43.17
0.0098	0.250	2.00	60	4.51	4.51	47.68
0.0083	0.210	2.25	70	3.23	3.23	50.90
0.0070	0.177	2.50	80	2.65	2.65	53.55
0.0059	0.149	2.75	100	2.72	2.72	56.27
0.0049	0.125	3.00	120	2.82	2.82	59.09
0.0041	0.105	3.25	140	2.73	2.73	61.82
0.0035	0.088	3.50	170	2.46	2.46	64.28
0.0029	0.074	3.75	200	2.21	2.21	66.49
0.0025	0.063	4.00	230	2.04	2.04	68.53
0.0021	0.053	4.25	270	1.93	1.93	70.46
0.00174	0.0442	4.50	325	1.86	1.86	72.32
0.00146	0.0372	4.75	400	1.82	1.82	74.14
0.00123	0.0313	5.00	450	1.81	1.81	75.95
0.000986	0.0250	5.32	500	2.31	2.31	78.26
0.000790	0.0201	5.64	635	2.26	2.26	80.52
0.000615	0.0156	6.00		2.36	2.36	82.88
0.000435	0.0110	6.50		2.97	2.97	85.85
0.000308	0.00781	7.00		2.66	2.66	88.51
0.000197	0.00500	7.65		3.00	3.00	91.51
0.000077	0.00195	9.00		4.71	4.71	96.22
0.000038	0.000977	10.00		2.37	2.37	98.59
0.000019	0.000488	11.00		1.28	1.28	99.87
0.000015	0.000375	11.38		0.13	0.13	100.00
TOTALS				100.00	100.00	100.00

Cumulative Weight Percent greater than			
Weight	Phi	Particle Size	
percent	Value	Inches	Millimeters
5	0.07	0.0374	0.950
10	0.48	0.0282	0.716
16	0.78	0.0230	0.583
25	1.10	0.0183	0.465
40	1.64	0.0126	0.320
50	2.18	0.0087	0.221
60	3.08	0.0046	0.118
75	4.87	0.0013	0.034
84	6.19	0.0005	0.014
90	7.32	0.0002	0.006
95	8.65	0.0001	0.002

Measure	Trask	Inman	Folk-Ward
Median, phi	2.18	2.18	2.18
Median, in.	0.0087	0.0087	0.0087
Median, mm	0.221	0.221	0.221
Mean, phi	2.00	3.48	3.05
Mean, in.	0.0098	0.0035	0.0048
Mean, mm	0.250	0.089	0.121
Sorting	3.687	2.705	2.652
Skewness	0.572	0.482	0.495
Kurtosis	0.304	0.585	0.933

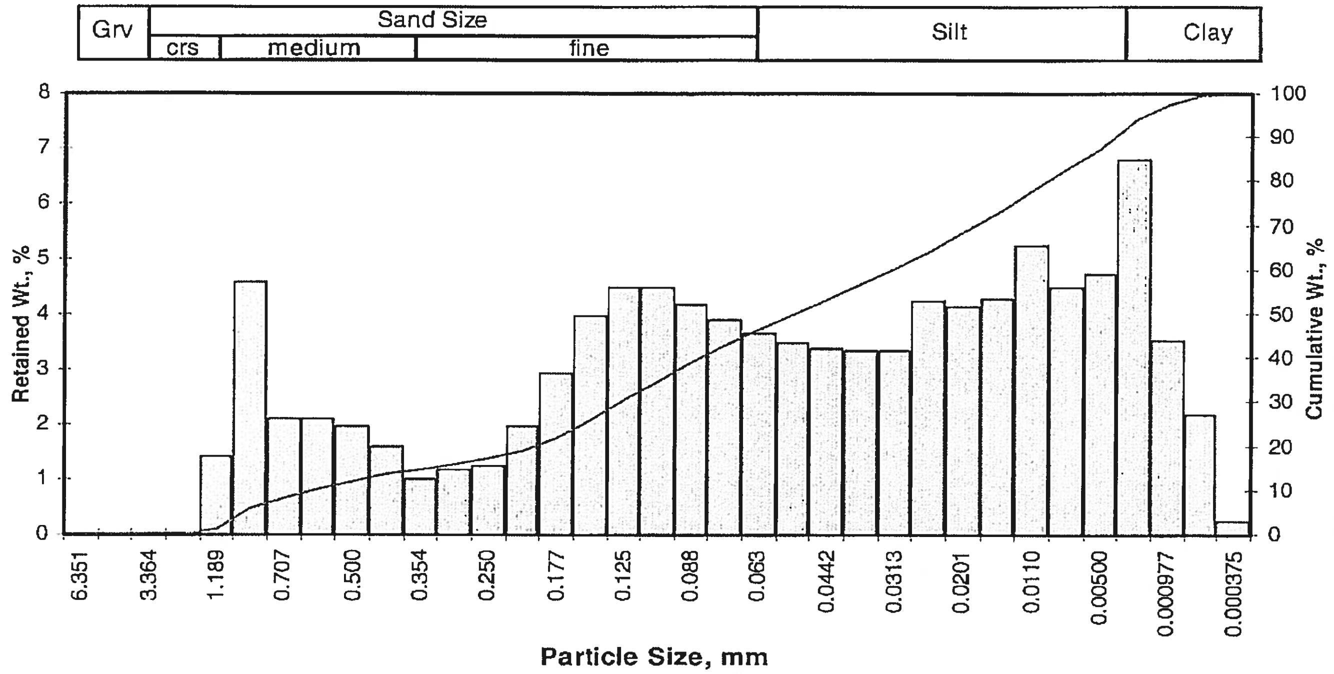
Grain Size Description (ASTM-USCS Scale)	Fine sand (based on Mean from Trask)

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	29.48
Fine Sand	200	37.02
Silt	>0.005 mm	25.02
Clay	<0.005 mm	8.49
	Total	100

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	AETL	**PTS File No:**	36338
Project:	N/A	**Sample ID:**	37405-19A
Project No:	37405	**Depth, ft:**	31



Opening		Phi of Screen	U.S. No.	Sample Weight, grams	Increment Weight, percent	Cumulative Weight, percent
Inches	Millimeters					
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	1.41	1.41	1.41
0.0331	0.841	0.25	20	4.57	4.57	5.98
0.0278	0.707	0.50	25	2.11	2.11	8.09
0.0234	0.595	0.75	30	2.10	2.10	10.19
0.0197	0.500	1.00	35	1.98	1.98	12.17
0.0166	0.420	1.25	40	1.60	1.60	13.77
0.0139	0.354	1.50	45	0.99	0.99	14.76
0.0117	0.297	1.75	50	1.16	1.16	15.92
0.0098	0.250	2.00	60	1.24	1.24	17.16
0.0083	0.210	2.25	70	1.95	1.95	19.11
0.0070	0.177	2.50	80	2.92	2.92	22.03
0.0059	0.149	2.75	100	3.98	3.98	26.01
0.0049	0.125	3.00	120	4.49	4.49	30.50
0.0041	0.105	3.25	140	4.48	4.48	34.98
0.0035	0.088	3.50	170	4.17	4.17	39.15
0.0029	0.074	3.75	200	3.88	3.88	43.03
0.0025	0.063	4.00	230	3.64	3.64	46.67
0.0021	0.053	4.25	270	3.47	3.47	50.15
0.00174	0.0442	4.50	325	3.37	3.37	53.52
0.00146	0.0372	4.75	400	3.33	3.33	56.85
0.00123	0.0313	5.00	450	3.33	3.33	60.18
0.000986	0.0250	5.32	500	4.24	4.24	64.42
0.000790	0.0201	5.64	635	4.14	4.14	68.56
0.000615	0.0156	6.00		4.28	4.28	72.84
0.000435	0.0110	6.50		5.25	5.25	78.09
0.000308	0.00781	7.00		4.48	4.48	82.57
0.000197	0.00500	7.65		4.73	4.73	87.30
0.000077	0.00195	9.00		6.78	6.78	94.08
0.000038	0.000977	10.00		3.51	3.51	97.59
0.000019	0.000488	11.00		2.18	2.18	99.77
0.000015	0.000375	11.38		0.23	0.23	100.00
TOTALS				100.00	100.00	100.00

Cumulative Weight Percent greater than			
Weight percent	Phi Value	Particle Size	
		Inches	Millimeters
5	0.14	0.0357	0.906
10	0.73	0.0238	0.604
16	1.77	0.0116	0.294
25	2.69	0.0061	0.155
40	3.55	0.0034	0.085
50	4.24	0.0021	0.053
60	4.99	0.0012	0.032
75	6.21	0.0005	0.014
84	7.20	0.0003	0.007
90	8.18	0.0001	0.003
95	9.26	0.0001	0.002

Measure	Trask	Inman	Folk-Ward
Median, phi	4.24	4.24	4.24
Median, in.	0.0021	0.0021	0.0021
Median, mm	0.053	0.053	0.053
Mean, phi	3.57	4.48	4.40
Mean, in.	0.0033	0.0018	0.0019
Mean, mm	0.084	0.045	0.047
Sorting	3.386	2.715	2.739
Skewness	0.867	0.089	0.095
Kurtosis	0.118	0.680	1.062
Grain Size Description (ASTM-USCS Scale)	Fine sand (based on Mean from Trask)		

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	13.77
Fine Sand	200	29.26
Silt	>0.005 mm	44.26
Clay	<0.005 mm	12.70
	Total	100

Phone: (562) 907-3607

Fax: (562) 907-3610

DATE **PTS FILE#** 36338 **CHAIN OF CUSTODY RECORD** **PAGE** 1 **OF** 1

COMPANY AETL

ADDRESS

PROJECT MANAGER JIM LIN

PROJECT NAME

PHONE NUMBER (818)845-8200

PROJECT NUMBER 37405

FAX NUMBER (818)845-8840

SITE LOCATION

SAMPLER SIGNATURE

PO# 10311

SPECIAL HANDLING

24 HOURS
72 HOURS
[✓ 5 DAYS NORMAL]
OTHER

SAMPLE CONDITIONS

RECEIVED ON ICE YES/NO
SEALED YES/NO
OTHER YES/NO

ANALYSIS REQUEST

	SAMPLE ID NUMBER	DATE	TIME	DEPTH, FT	PHYSICAL PROPERTIES PACKAGE, API RP40	MOISTURE CONTENT, ASTM D2216	POROSITY, API RP40	GRAIN DENSITY, API RP40	BULK DENSITY, API RP40	AIR PERMEABILITY, API RP40	SPECIFIC RETENTION/YIELD ASTM D425	CAPILLARY PRESSURE, ASTM D425M	SOIL pH, EPA 9045	GRAIN SIZE: DRY; 400 MESH	GRAIN SIZE: SIEVE & LASER	GRAIN SIZE: LASER; 1 MICRON	HYDRAULIC CONDUCTIVITY, EPA 9100, API RP40	TOC: WALKLEY-BLACK	HYDRAULIC CONDUCTIVITY PACKAGE	ATTERBERG LIMITS, ASTM D4318	TNRCC PROPERTIES PACKAGE					NUMBER OF SAMPLES	COMMENTS
✓	37405.17A	05/15/06		6ft			X		X							X										1	
✓	37405.18A	↓		24ft			X		X							X										1	
✓	37405.19A	↓		31ft			X		X							X										1	

1. RELINQUISHED BY	2. RECEIVED BY	3. RELINQUISHED BY	4. RECEIVED BY
COMPANY AETL	COMPANY PTS	COMPANY	COMPANY
DATE 05/17/06 TIME 1004	DATE 5/17/06 TIME 10:04	DATE TIME	DATE TIME

PTS GeoLabs, Inc. • 8100 Secura Way • Santa Fe Springs, CA 90670 • Phone (562) 907-3607 • Fax (562) 907-3610
PTS GeoLabs, Inc. • 4342 W. 12th St. • Houston, TX 77055 • Phone (713) 680-2291 • Fax (713) 680-0763

Advanced Technology
Laboratories

3275 Walnut Avenue
Signal Hill CA 90807
(562) 989-4045 Phone
(562) 989-4040 Fax

Fax Transmittal Sheet

To: Jim

From: Rachelle

RE: Results for 084452

Message:

Enclosed are the results for your project 37405. Thank you very much for your business and we are looking forward to being of service to you.

Advanced Technology Laboratories **Date:** *22-May-06*

CLIENT: American Environmental Testing Laborator
Project: 37405
Lab Order: 084452

Lab ID: 084452-001
Client Sample ID: 37405.17A
Collection Date: 5/15/2006
Matrix: SOIL

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
TOTAL ORGANIC CARBON						
			EPA 415.1(M)			
RunID: TOC2_060517C	QC Batch: R63349			PrepDate:		Analyst: JT
Total Organic Carbon	17000	30		mg/Kg	1	5/17/2006

Lab ID: 084452-002
Client Sample ID: 37405.18A
Collection Date: 5/15/2006
Matrix: SOIL

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
TOTAL ORGANIC CARBON						
			EPA 415.1(M)			
RunID: TOC2_060517C	QC Batch: R63349			PrepDate:		Analyst: JT
Total Organic Carbon	160	30		mg/Kg	1	5/17/2006

Lab ID: 084452-003
Client Sample ID: 37405.19A
Collection Date: 5/15/2006
Matrix: SOIL

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
TOTAL ORGANIC CARBON						
			EPA 415.1(M)			
RunID: TOC2_060517C	QC Batch: R63349			PrepDate:		Analyst: JT
Total Organic Carbon	9900	30		mg/Kg	1	5/17/2006

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	ND	Not Detected at the Reporting Limit
S	Spike/Surrogate outside of limits due to matrix interference		Results are wet unless otherwise specified
DO	Surrogate Diluted Out		

Advanced Technology Laboratories
3275 Walnut Avenue Signal Hill, CA 90755 Tel: 562 989-4045 Fax: 562 989-4040

Advanced Technology Laboratories

Date: *22-May-06*

CLIENT: American Environmental Testing Laborator
Work Order: 084452
Project: 37405

ANALYTICAL QC SUMMARY REPORT

TestCode: 415.1_S

Sample ID: MB-R63349 SampType: MBLK TestCode: 415.1_S Units: mg/Kg Prep Date: RunNo: 63349
Client ID: PBS Batch ID: R63349 TestNo: EPA 415.1(M) Analysis Date: 5/17/2006 SeqNo: 938696

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Total Organic Carbon	ND	30									

Sample ID: LCSR63349 SampType: LCS TestCode: 415.1_S Units: mg/Kg Prep Date: RunNo: 63349
Client ID: LCSS Batch ID: R63349 TestNo: EPA 415.1(M) Analysis Date: 5/17/2006 SeqNo: 938697

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Total Organic Carbon	966.40	30	1000	0	96.6	80	120				

Sample ID: 084354-104AMS SampType: MS TestCode: 415.1_S Units: mg/Kg Prep Date: RunNo: 63349
Client ID: ZZZZZZ Batch ID: R63349 TestNo: EPA 415.1(M) Analysis Date: 5/17/2006 SeqNo: 938700

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Total Organic Carbon	1986.00	30	1000	1200	78.6	52	130				

Sample ID: 084354-104AMSD SampType: MSD TestCode: 415.1_S Units: mg/Kg Prep Date: RunNo: 63349
Client ID: ZZZZZZ Batch ID: R63349 TestNo: EPA 415.1(M) Analysis Date: 5/17/2006 SeqNo: 938701

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Total Organic Carbon	2096.00	30	1000	1200	89.6	52	130	1986	5.39	12	

Qualifiers:						
	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded	ND	Not Detected at the Reporting Limit
	R	RPD outside accepted recovery limits	S	Spike/Surrogate outside of limits due to matrix interferenc	DO	Surrogate Diluted Out

CHAIN OF CUSTODY RECORD

Pg 1 of 1

Advanced Technology Laboratories
3275 Walnut Avenue
Signal Hill, CA 90755
(562) 989-4045 • Fax (562) 989-4040

FOR LABORATORY USE ONLY:

P.O.#: 10310

Logged By: Date: 05/16/06

Method of Transport
Client ☑
ATL ☐
CA OverN ☐
FEDEX ☐
Other:

Sample Condition Upon Receipt
1. CHILLED Y ☑ N ☐
2. HEADSPACE (VOA) Y ☐ N ☐
3. CONTAINER INTACT Y ☑ N ☐
4. SEALED Y ☐ N ☑
5. # OF SPLS MATCH COC Y ☑ N ☐
6. PRESERVED Y ☐ N ☑

Client:
Attn: AETL
Address:
City State Zip Code
TEL: (818) 845-8200
FAX: (818) 845-8840

Project Name:
Project #: 37405
Sampler: (Printed Name) (Signature)

Relinquished by: (Signature and Printed Name) Date: 5/16-06 Time: 1525 Received by: (Signature and Printed Name) Date: 5/16/06 Time: 3:27
Relinquished by: (Signature and Printed Name) Date: Time: Received by: (Signature and Printed Name) Date: Time:
Relinquished by: (Signature and Printed Name) Date: Time: Received by: (Signature and Printed Name) Date: Time:

I hereby authorize ATL to perform the work indicated below:
Project Mgr /Submitter:
Print Name 5-16-06 Date
Signature

Send Report To:
Attn: JIM LIN
Co:
Address
City State Zip

Bill To:
Attn: N. CHOWDHRY
Co:
Address
City State Zip

Special Instructions/Comments:

Sample/Records - Archival & Disposal
Unless otherwise requested by client, all samples will be disposed 45 days after receipt and records will be disposed 1 year after submittal of final report.
Storage Fees (applies when storage is requested):
- Sample : $2.00 / sample / mo (after 45 days)
- Records : $1.00 / ATL workorder / mo (after 1 year)

QA/QC
RTNE ☐
CT ☐
SWRCB ☐
Logcode
OTHER

ITEM	LAB USE ONLY: Batch #: Lab No.	Sample I.D. / Location	Date	Time	8081A (Pesticides)	8082 (PCB)	8260B (Volatiles)	8270C (SNA)	6010B (Total Metal)	8015B (GRO) / 8020 (BTEX)	8015B (DRO)	8021 (BTEX)	TITLE 22 / CAM 17 (6010/7000)	TOC (415.1)				SOIL	WATER	GROUND WATER	WASTEWATER			TAT	Container(s) #	Container(s) Type	PRESERVATION	REMARKS
	064452-001	37405.17A	05/15/06											X				X						E	1	T P	C	
	-002	37405.18A	↓											X				X						↓	↓	↓ ↓	↓	
↓	-003	37405.19A												X				X										

- TAT starts 8 a.m. following day if samples received after 3 p.m.

TAT: A= Overnight ≤ 24 hr B= Emergency Next workday C= Critical 2 Workdays D= Urgent 3 Workdays [✓ E= Routine 7 Workdays]

Container Types: [✓ T=Tube] V=VOA L=Liter P=Pint J=Jar B=Tedlar G=Glass [✓ P=Plastic] M=Metal

Preservatives: H=Hcl N=HNO₃ S=H₂SO₄ [✓ C=4°C] Z=Zn(AC)

American Environmental Testing Laboratory Inc.
2834 & 2908 North Naomi Street, Burbank, CA 91504 • DOHS NO: 1541, LACSD NO: 10181
Tel: (888) 288-AETL • (818) 845-8200 • Fax: (818) 845-8840 • www.aetlab.com

Data Qualifiers and Descriptors

Data Qualifier:

*:	In the QC section, sample results have been taken directly from the ICP reading. No preparation factor has been applied.
B:	Analyte was present in the Method Blank.
D:	Result is from a diluted analysis.
E:	Result is beyond calibration limits and is estimated.
H:	Analysis was performed over the allowed holding time due to circumstances which were beyond laboratory control.
J:	Analyte was detected . However, the analyte concentration is an estimated value, which is between the Method Detection Limit (MDL) and the Practical Quantitation Limit (PQL).
M:	Matrix spike recovery is outside control limits due to matrix interference. Laboratory Control Sample recovery was acceptable.
S6:	Surrogate recovery is outside control limits due to matrix interference.
S8:	The analysis of the sample required a dilution such that the surrogate concentration was diluted below the method acceptance criteria.
X:	Results represent LCS and LCSD data.

Definition:

%Limi:	Percent acceptable limits.
%REC:	Percent recovery.
Con.L:	Acceptable Control Limits
Conce:	Added concentration to the sample.
LCS:	Laboratory Control Sample
MDL:	Method Detection Limit is a statistically derived number which is specific for each instrument, each method, and each compound. It indicates a distinctively detectable quantity with 99% probability.
MS:	Matrix Spike
MS DU:	Matrix Spike Duplicate

Data Qualifiers and Descriptors

ND:	Analyte was not detected in the sample at or above MDL.
PQL:	Practical Quantitation Limit or ML (Minimum Level as per RWQCB) is the minimum concentration that can be quantified with more than 99% confidence. Taking into account all aspects of the entire analytical instrumentation and practice.
Recov:	Recovered concentration in the sample.
RPD:	Relative Percent Difference

TETRA TECH, INC.
348 W. Hospitality Lane, Suite 300
San Bernardino, California 92408
Telephone: (909) 381-1674
FAX: (909) 889-1391

SHIP TO: AETL

~~#~~ 37405

CHAIN OF CUSTODY RECORD

DATE 5/15/06 PAGE 3 OF 3

CLIENT: GEM

PROJECT NAME: Former Chemoil

PROJECT MANAGER: Ben Weink.

TC #:

SAMPLERS (Signatures) Tuong Phu Ngo

TURN-AROUND TIME: Standard

OBSERVATIONS/COMMENTS: Geotechnical Testing: Grain size, Bulk density, Moisture Content, Total Organic Carbon

PARAMETERS

LINE ITEM	SAMPLE NO.	DATE	TIME	Geotechnical / Testing														FILTERED/UNFILTERED	MATRIX TYPE	CONTAINER TYPE	NUMBER OF CONTAINERS	PRESERVATIVE	OBSERVATIONS/COMMENTS
1.	SB2-051506-GT-6'	5/15/06	13:45	X															S	BS	1		37405.17
2.	SB2-051506-GT-24'	↓	13:47	X															S	↓	1		37405.18
3.	SB2-051506-GT-31'	↓	13:49	X															S	↓	1		37405.19
4.																							
5.																							
6.																							
7.																							
8.																							
9.																							
10.																							

FILTERING:
☐ FILTERED ☐ UNFILTERED

MATRIX TYPE:
S - Soil
M - Sediment
W - Water

CONTAINER TYPE:
G - Glass Bottle/Jar
SS - Stainless Steel Sleeve
SB - Brass Sleeve
P - Plastic Bottle/Jar

PRESERVATIVES: (Water Only)
HCL
NR (None required)
NaOH
H_2SO_4

RELINQUISHED BY	SIGNATURE		DATE	TIME
Tuong Phu Ngo	Tuong Phu Ngo	TETRA TECH, INC.	5/15/06	16:00
RECEIVED BY	**SIGNATURE**	**COMPANY**	**DATE**	**TIME**
		AETL	5/15/06	1600
RELINQUISHED BY	**SIGNATURE**	**COMPANY**	**DATE**	**TIME**
		AETL	5/15/06	1730
RECEIVED BY	**SIGNATURE**	**COMPANY**	**DATE**	**TIME**
Argisht		AETL	5/15/06	1730

TOTAL NUMBER OF CONTAINERS ON THIS CHAIN OF CUSTODY: 3

METHOD OF SHIPMENT/SHIPMENT NO: couier.

Special Shipping/Handling/Storage Requirements:

DISTRIBUTION: White and Pink = Tetra Tech, Inc. Canary = Laboratory

G:COCRgen.cdr

ATTACHMENT D-3

OUTPUT OF JOHNSON AND ETTINGER MODEL FOR SUBSURFACE VAPOR INTRUSION INTO BUILDINGS FROM SOIL VAPOR

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Reset to Defaults

Soil Gas Concentration Data

	ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
1	71432	2.72E+05			**Benzene**
2	110827	2.48E+06			**Cyclohexane**
3	100414	2.08E+05			**Ethylbenzene**
4	108883	1.03E+05			**4-Ethyltoluene**
5	110543	8.20E+05			**Heptane**
6	110543	6.34E+05			**Hexane**
7	1634044	1.68E+03			**MTBE (methyl-tert-butyl ether)**
8	91203	3.15E+04			**Naphthalene**
9	108883	2.26E+04			**Toluene**
10	95636	1.67E+05			**1,2,4-Trimethylbenzene**
11	108678	9.34E+04			**1,3,5-Trimethylbenzene**
12	108383	9.55E+05			**m-Xylene**
13	95476	1.91E+05			**o-Xylene**

Scenario: Residential

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
2.72E+05	**9.3E-04**	**2.5E+02**	**2.6E-03**	**8.1E+01**
2.48E+06	**8.7E-04**	**2.1E+03**	**NA**	**3.4E-01**
2.08E+05	**7.8E-04**	**1.6E+02**	**1.4E-04**	**1.6E-01**
1.03E+05	**8.5E-04**	**8.8E+01**	**NA**	**2.8E-01**
8.20E+05	**8.2E-04**	**6.7E+02**	**NA**	**9.2E-01**
6.34E+05	**8.2E-04**	**5.2E+02**	**NA**	**7.1E-01**
1.68E+03	**8.3E-04**	**1.4E+00**	**1.3E-07**	**4.5E-04**
3.15E+04	**7.2E-04**	**2.3E+01**	**2.7E-04**	**7.2E+00**
2.26E+04	**8.5E-04**	**1.9E+01**	**NA**	**6.1E-02**
1.67E+05	**7.2E-04**	**1.2E+02**	**NA**	**1.6E+01**
9.34E+04	**7.1E-04**	**6.7E+01**	**NA**	**1.8E+00**
9.55E+05	**7.8E-04**	**7.5E+02**	**NA**	**7.1E+00**
1.91E+05	**7.8E-04**	**1.5E+02**	**NA**	**1.4E+00**
			3.E-03	**1.2E+02**

MESSAGE: See VLOOKUP table comments on chemical properties and/or toxicity criteria for this chemical.

Enter soil gas concentration above.

MORE ↓

ENTER Depth below grade #N/A of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas #N/A depth below grade, L_s (cm)	ENTER #N/A soil temperature, T_S (°C)	ENTER Vadose zone #N/A soil type (used to estimate soil vapor permeability)	#N/A OR	ENTER User-defined #N/A soil vapor permeability, k_v (cm^2)
15	152	24	SI		

MORE ↓

ENTER Vandose zone SCS soil type Lookup Soil Parameters	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SI	1.46	0.465	0.172	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24 (NEW)	0.5 (NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Reset to Defaults

Soil Gas Concentration Data

	ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
1	71432	2.72E+05			**Benzene**
2	110827	2.48E+06			**Cyclohexane**
3	100414	2.08E+05			**Ethylbenzene**
4	108883	1.03E+05			**4-Ethyltoluene**
5	110543	8.20E+05			**Heptane**
6	110543	6.34E+05			**Hexane**
7	1634044	1.68E+03			**MTBE (methyl-tert-butyl ether)**
8	91203	3.15E+04			**Naphthalene**
9	108883	2.26E+04			**Toluene**
10	95636	1.67E+05			**1,2,4-Trimethylbenzene**
11	108678	9.34E+04			**1,3,5-Trimethylbenzene**
12	108383	9.55E+05			**m-Xylene**
13	95476	1.91E+05			**o-Xylene**

MESSAGE: See VLOOKUP table comments on chemical properties and/or toxicity criteria for this chemical.

Scenario: Commercial

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
2.72E+05	**4.7E-04**	**1.3E+02**	**3.0E-04**	**9.6E+00**
2.48E+06	**4.3E-04**	**1.1E+03**	**NA**	**4.1E-02**
2.08E+05	**3.9E-04**	**8.1E+01**	**1.7E-05**	**1.9E-02**
1.03E+05	**4.3E-04**	**4.4E+01**	**NA**	**3.3E-02**
8.20E+05	**4.1E-04**	**3.3E+02**	**NA**	**1.1E-01**
6.34E+05	**4.1E-04**	**2.6E+02**	**NA**	**8.4E-02**
1.68E+03	**4.2E-04**	**7.0E-01**	**1.5E-08**	**5.3E-05**
3.15E+04	**3.6E-04**	**1.1E+01**	**3.1E-05**	**8.6E-01**
2.26E+04	**4.3E-04**	**9.6E+00**	**NA**	**7.3E-03**
1.67E+05	**3.6E-04**	**6.0E+01**	**NA**	**2.0E+00**
9.34E+04	**3.6E-04**	**3.3E+01**	**NA**	**2.2E-01**
9.55E+05	**3.9E-04**	**3.7E+02**	**NA**	**8.5E-01**
1.91E+05	**3.9E-04**	**7.5E+01**	**NA**	**1.7E-01**
			3.E-04	**1.4E+01**

Enter soil gas concentration above.

MORE ↓

ENTER Depth below grade #N/A of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas #N/A depth below grade, L_s (cm)	ENTER #N/A soil temperature, T_S (°C)	ENTER Vadose zone #N/A soil type (used to estimate soil vapor permeability)	#N/A OR	ENTER User-defined #N/A soil vapor permeability, k_v (cm^2)
15	152	24	SI		

MORE ↓

ENTER Vandose zone SCS soil type Lookup Soil Parameters	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)		ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SI	1.46	0.465	0.172		5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

APPENDIX E

HUMAN HEALTH RISK ASSESSMENT FOR EAST PARCEL

(Appendix E located in separate binder)

APPENDIX E

HUMAN HEALTH RISK ASSESSMENT FOR EAST PARCEL

Former Chemoil Refinery
Site Cleanup Program Number 0453A
Site ID No. 2047W00
Global ID SL 2047W2348

2020 Walnut Avenue
Signal Hill, California

093-CHEMOIL-001

Prepared For:

Signal Hill Enterprises, LLC
1900 South Norfolk Street, Suite 350
San Mateo, California 94403

and

RE | Solutions, LLC
2880 Bryant Street
Denver, Colorado 80211

Prepared By:

SGI environmental
APEX

299 West Hillcrest Drive, Suite 220
Thousand Oaks, CA 91360

July 13, 2017

Prepared and Reviewed By:

Casey Huff
Staff Geologist

ivy inouye

Ivy Inouye
Senior Toxicologist

Kirsten L Duey

Kirsten Duey
Project Manager

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EXECUTIVE SUMMARY

A Human Health Risk Assessment (HHRA) was conducted for the East Parcel of the former Chemoil Refinery located at 2020 Walnut Avenue in Signal Hill, California (Site). Currently, the East Parcel is vacant and all aboveground storage tanks (ASTs) and support structures have been removed. The Site is owned by Signal Hill Enterprises, LLC (SHE) and negotiation is underway between SHE and RE | Solutions, LLC (RES) to transfer property ownership for redevelopment purposes. Future development plans include construction of new buildings for light industrial and commercial use. The East Parcel will be covered by future building footprints or concrete/asphalt paving. Future remedies for the East Parcel will include engineering controls to mitigate stormwater runoff into offsite areas.

The purpose of this HHRA is to quantify potential exposures to Site-related chemicals in the East Parcel, in order to identify the need for, and the possible extent of, remedial action activities to adequately protect human health or request no further action if human health risks are below risk management thresholds. The HHRA was based on previous Site investigations, which are documented in the *Report on Additional Subsurface Assessment* (TEC, 2001), *Environmental Due Diligence Site Assessment Results Report* (Tetra Tech, 2006), and *Site Investigation and Site Conceptual Model Report* (Apex-SGI, 2017). The methods used to conduct this risk assessment are consistent with U.S. Environmental Protection Agency (USEPA, 1989 and 1991) and California Environmental Protection Agency (CalEPA) Department of Toxic Substances Control (DTSC, 1992 and 2015) guidance. For the evaluation of potential indoor air impacts, DTSC (2011b) vapor intrusion guidance was used.

Based on previous Site investigations, the following chemical compounds were evaluated in this HHRA:

- Metals;
- Total petroleum hydrocarbons (TPH), including oxygenates and carbon ranges;
- Volatile organic compounds (VOCs); and
- Polycyclic aromatic hydrocarbons (PAHs).

Based on current and likely potential future uses at the East Parcel, the following hypothetical human receptors were evaluated in this HHRA:

- Hypothetical Onsite Construction/Utility Trench Worker Receptor; and
- Hypothetical Onsite Commercial/Industrial Worker Receptor.

However, it should be noted that although hypothetical construction/utility trench worker receptors are included in this HHRA, any hypothetical construction worker receptor will be performing activities consistent with a Site Management Plan (SMP) and a Site Health and Safety Plan (HASP). The SMP, HASP, and best management practices (BMPs) will protect construction worker receptors from exposure to Site-related contaminants.

All hypothetical human receptors were evaluated under a conservative reasonable maximum exposure (RME) scenario only. RME scenarios are conducted to account for potential impacts to the most (chemically) sensitive individuals within a hypothetical population. As a result, estimated health impacts presented in this report may exaggerate the actual adverse noncancer health effects and excess cancer risks.

USEPA guidance on risk and exposure levels considered protective of human health is presented to provide context for interpretation of the estimates of excess cancer risk and noncancer hazards presented in this HHRA. Hazard indices are compared to the USEPA and CalEPA recommended target HI of one (USEPA, 1989). Excess cancer risks are compared to CalEPA's risk management range of 1 x 10^{-6} to 1 x 10^{-4}. The CalEPA threshold value of one-in-one million (1 x 10^{-6}) represents the lower end (most stringent) of the CalEPA's risk management range and is the point of departure for risk management decisions for all receptors. An excess cancer risk of one-in-one hundred thousand (1 x 10^{-5}) is generally acceptable for occupational exposures.

The analysis of uncertainties associated with the HHRA indicates that adverse noncancer health effects and excess cancer risk estimates overestimate actual impacts to human health. The inherent conservativeness of this risk assessment is a direct result of using conservative and upper-bound input values to yield maximum, health-conservative estimates. The following sections summarize the results of the HHRA.

Arsenic

The 95-percent upper confidence limit of the mean concentration (95UCL) for arsenic in soil from 0 to 10 feet below ground surface (bgs) is 12 milligrams per kilogram (mg/kg), which is equal to the Southern California regional background arsenic concentration of 12 mg/kg. Arsenic was detected at a concentration above background in only 7 of the 27 soil samples. At these 7 locations, arsenic concentrations at 1 foot bgs were below 12 mg/kg. The arsenic concentrations above 12 mg/kg were at 5 and 10 feet bgs, indicating likely background concentrations. Generally, direct contact with soil will occur in the top foot of soil, except under construction exposure scenarios. Since arsenic concentrations above background are only detected at depth (i.e., greater than 5 feet bgs), arsenic in soil is likely background and not related to previous Site use and does not pose a risk above background to potential onsite receptors.

Lead

The maximum detected concentration of lead in soil does not exceed the Office of Environmental Health Hazard Assessment (OEHHA) commercial/industrial California Human Health Screening Level (CHHSL) of 320 mg/kg (OEHHA, 2009).

Other COPCs

For the remaining chemicals of potential concern (COPCs) in soil and soil vapor, the estimated hazard indices (HIs) and excess cancer risks for the potential human receptors are summarized in the following table:

Hypothetical Receptors			
Onsite Construction/Utility Trench Worker		Onsite Commercial/ Industrial Worker	
Hazard Index	**Cancer Risk**	**Hazard Index**	**Cancer Risk**
2	3 x 10^{-7}	0.3	7 x 10^{-6}

The following bullets summarize the soil and soil vapor COPCs contributing to HI and excess cancer risk estimates for each receptor.

Hypothetical Onsite Construction/Utility Trench Worker

- Although the total HI exceeds one, the individual HIs for each COPC in soil do not exceed one. Cobalt, nickel, thallium, and vanadium in soil are the primary contributors to the elevated HI. However, the primary critical effects of cobalt, nickel, thallium, and vanadium toxicity do not include the same target organ or system. Since individual HI estimates do not exceed one and the highest individual HIs are not associated with a primary critical effect on the same target organ or system, the COPCs do not pose adverse noncancer effects to the hypothetical onsite construction/utility worker receptor.
- The total excess cancer risk is less than the most stringent end of CalEPA's risk management range of 1 x 10^{-6} to 1 x 10^{-4} and is less than 1 x 10^{-5}, which is generally acceptable for occupational exposures. Therefore, COPCs do not pose a risk to the hypothetical onsite construction/utility trench worker receptor.

Hypothetical Onsite Commercial/Industrial Worker

- The total HI does not exceed one; therefore, the COPCs do not pose adverse noncancer effects to the hypothetical onsite commercial/industrial worker receptor.
- The total excess cancer risk is within CalEPA's risk management range and is less than 1 x 10^{-5}, which is generally acceptable for occupational exposures. Therefore, COPCs do not pose a risk to the hypothetical onsite commercial/industrial worker receptor.

Based on the exposure pathways evaluated and the conservative upper-bound assumptions used in this HHRA, potential exposure to Site-related COPCs do not pose an unacceptable human health risk to hypothetical onsite construction/utility trench worker and onsite commercial/industrial worker receptors.

Administrative and institutional controls will be implemented prior to development of the East Parcel, as required in the California Land Reuse and Revitalization Act Agreement (CLRRA) prepared for the Site. Expected controls include a land use covenant (LUC) and Site Management Plan (SMP). The LUC will prohibit use of underlying groundwater and prohibit unrestricted or sensitive land uses.

Based on results of the HHRA, combined with the administrative and institutional controls planned for the Site, remedial actions are not warranted at the East Parcel prior to development of the Site for industrial/commercial purposes.

1.0 INTRODUCTION

The Source Group, Inc. a division of Apex Companies, LLC (Apex-SGI) has prepared this Human Health Risk Assessment (HHRA) for the East Parcel on behalf of Signal Hill Enterprises, LLC (SHE) and RE | Solutions, LLC (RES). The East Parcel is one of three parcels that was occupied by the former Chemoil Refinery located at 2020 Walnut Avenue in Signal Hill, California (Site, Figure E1-1). The Site is currently owned by SHE and negotiation is underway between SHE and RES to transfer property ownership for redevelopment of all three parcels for light industrial and commercial purposes. This HHRA was prepared as an appendix to the Response Plan.

The purpose of this HHRA is to quantify potential exposures to Site-related chemicals in the East Parcel, in order to identify the need for, and the possible extent of, remedial action activities to adequately protect human health or request no further action if human health risks are below risk management thresholds. This HHRA focuses on the East Parcel of the Site. The remainder of the Site (Northwest and Southwest Parcels), including groundwater, will be remediated in accordance with the Response Plan upon approval from the Los Angeles Regional Water Quality Control Board (LARWQCB).

This HHRA uses specific equations and exposure factors to estimate doses for potentially exposed receptors via various exposure routes. The methods used to conduct this risk assessment are consistent with U.S. Environmental Protection Agency (USEPA, 1989 and 1991) and California Environmental Protection Agency (CalEPA) Department of Toxic Substances Control (DTSC, 1992 and 2015) guidance. For the evaluation of potential indoor air impacts, DTSC (2011b) guidance was used.

The general outline of this report is as follows:

- **Section 2 Site Description and Background:** A brief description of the Site and Site history.
- **Section 3 Data Evaluation:** A summary of data used in the HHRA to characterize the East Parcel and to identify Site-related chemicals of potential concern (COPCs).
- **Section 4 Exposure Assessment:** An assessment of potentially exposed hypothetical receptors and the most likely ways they might be exposed to chemicals at the Site, based on current and likely future Site uses. The conceptual site model (CSM) illustrates the chemical sources, chemical release and transport mechanisms, and exposure routes for human receptors.
- **Section 5 Toxicity Assessment:** A summary of information available to evaluate the toxicity of COPCs, which are used to characterize risk.
- **Section 6 Risk Characterization:** An incorporation of the results of the exposure assessment and toxicity assessment to estimate adverse noncancer health effects and excess cancer risks for potential human receptors.

- **Section 7 Uncertainty Analysis:** A presentation of potential sources of uncertainty and the degree of uncertainty associated with elements of the HHRA. These uncertainties are considered when evaluating the HHRA results for making risk management decisions for the Site.
- **Section 8 Human Health Risk Assessment Results**: A summary of the results of the HHRA for each potential human receptor.
- **Section 9 Conclusions.**

A list of references cited in this report and limitations are presented in Sections 10 and 11, respectively.

2.0 SITE DESCRIPTION AND BACKGROUND

2.1 Site Description

The property known as the former Chemoil Refinery is located at 2020 Walnut Avenue in Signal Hill, California (Figure E1-1). The Site was developed as an oil refinery in 1922. The MacMillan-Ring Free Oil Company owned and operated the facility from 1922 until 1988. Chemoil Corporation purchased the refinery in August 1988 and operated it until February 1994. From early 1994 to early 1997, the refinery was shut down with occasional operation of its waste water system. Operation of the waste water system was discontinued and all of the above-ground structures were dismantled in early 1997. It has been reported that known below-ground structures, including piping, sumps, footings, and foundations, were also removed at that time (S. Testa, verbal communication, October 2016). Since December 2013, the property owner of title has been Signal Hill Enterprises, LLC.

The Site is approximately 8.2 acres, located north of the intersection of East 20th Street, East Wesley Drive, Walnut Avenue, and Alamitos Avenue. The Site is divided into an East Parcel, situated immediately east of Walnut Avenue and Northwest and Southwest Parcels, situated immediately west of Walnut Avenue. The East Parcel encompasses approximately 2.4 acres and the West Parcels encompass approximately 5.8 acres. The West Parcels are subdivided into the Northwest and Southwest Parcels by East 21st Street. The division of the Site into the East Parcel, the Northwest Parcel, and the Southwest Parcel is shown on Figure E2-1.

2.2 Site Background

A detailed discussion of the Site background, history, previous investigations, ongoing remediation, and regional and local geology and hydrogeology is provided in Section 2 of the Response Plan. The Site background provided in the following sections generally focuses on the East Parcel of the Site.

2.2.1 Refinery History

The refinery and supporting structures were dismantled between 1997 and 1998. The East Parcel is somewhat a rectangular-shaped parcel except for its southern perimeter and was formerly occupied by six aboveground storage tanks (ASTs) as well as support structures (warehouse, offices, laboratory, and maintenance facilities). Currently the East Parcel is vacant, and does not contain any ASTs or known underground storage tanks (USTs).

2.2.2 Surrounding Community/Properties

Land use in the vicinity of the East Parcel includes commercial, office, and light industrial development to the north, light industrial development to the west, east, and south, and a former railroad corridor to the south, with residential properties located south and west of the former railway corridor.

2.2.3 Regional and Local Geology

The Site is located within the Los Angeles Coastal Plain (California Department of Water Resources [CDWR], 1961) of the Peninsular Ranges geomorphic province of southern California (Norris and Webb, 1990). The geologic structure beneath the Coastal Plain is referred to as the Los Angeles Basin and consists of undifferentiated, pre-Pleistocene bedrock overlain by approximately 2,200 feet of layered, semi-consolidated and unconsolidated water-bearing terrestrial and marine sediments.

The Site is generally underlain by deposits of unconsolidated, laterally discontinuous sequences of silt and fine to coarse-grained sand. Coarse-grained soils consist of sand (SP) and silty sand (SM); whereas, subordinate fine-grained soils consist of silt (ML and MH) and, to a lesser degree, clay (CL). In the East Parcel, soil consists primarily of coarse-grained sand and silty sand.

2.2.4 Regional and Local Hydrogeology

The Site is located within the West Coast Basin. Based on lateral distribution and varying hydrogeologic characteristics, five major aquifers have been identified in the geologic formations underlying the West Coast Basin (CDWR, 1961). The aquifers consist of (from oldest to youngest) the Silverado and Lynwood Aquifers of the San Pedro Formation, the Gage Aquifer of the Lakewood Formation, and the Gaspur and Semi-perched Aquifers of the recent Holocene-age Alluvium. In general, the older/deeper Silverado and Lynwood Aquifers are currently designated as drinking water sources and the younger/shallow aquifers (Gage, Gaspur, and Semi-perched) are not currently used for drinking water purposes due to low yield and/or generally poor quality. Shallow groundwater beneath the Site is encountered in the semi-perched Aquifer in the southern portion of the West Coast Basin. Groundwater quality within the Site vicinity is generally poor due to seawater intrusion and elevated salinity.

Depth to water in the East Parcel is approximately 30 feet below ground surface (bgs; wells MW-2 and MW-10). As of the December 2016 (Fourth Quarter) monitoring event, groundwater occurred at elevation of 1.82 feet relative to mean sea level (MSL) in well MW-10. Well MW-2 was most recently gauged in December 2015 (Fourth Quarter) monitoring event, with an observed groundwater elevation of 1.5 feet relative to MSL. The hydraulic gradient calculated based on Site-wide Fourth Quarter 2016 groundwater gauging data was 0.0013 foot/foot (Ami Adini & Associates, Inc. [AA&AI], 2017). Groundwater flow beneath the Site, including the East Parcel, is generally toward the south.

2.3 Surface Water

The nearest surface water body to the Site is the Los Angeles River, which is located 1.9 miles west of the Site. The section of the Los Angeles River west of the Site is contained in a north-south trending concrete lined flood control channel. The Los Angeles River accepts treated industrial discharge and stormwater runoff from the greater Los Angeles area.

3.0 DATA EVALUATION

Soil and underlying groundwater in the East Parcel are impacted by historic petroleum releases. Primary constituents of interest (COIs) for the Site include total petroleum hydrocarbons (TPH), volatile organic compounds (VOCs; primarily aromatic constituents), and fuel oxygenates (including methyl tert-butyl ether [MtBE] and tertiary-butyl alcohol [TBA]. During previous Site investigations, samples were analyzed for one or more of the following classes of chemical compounds:

- Metals;
- TPH (including oxygenates and carbon ranges);
- VOCs; and
- Polycyclic aromatic hydrocarbons (PAHs).

For each media, only those chemicals detected in at least one sample were included in this HHRA.

The data used in this HHRA were based on the information for the East Parcel, as provided in the following Site investigation reports:

- *Report on Additional Subsurface Assessment* (Testa Environmental Corporation [TEC], 2001);

  TEC (2001) provided a summary of soil and groundwater assessments conducted in the East Parcel and summarized data from three different Site investigations as follows:

  - **Engineering Enterprises, Inc. (EEI) 1988 soil and groundwater investigation.** A copy of the report or its associated documents were not available for review by Apex-SGI. EEI data used for this HHRA were only available as presented in the *Report on Additional Subsurface Assessment* (TEC, 2001);
  - **The Source Group, Inc. (SGI) 1999 soil investigation.** A final site investigation report was not prepared by SGI and analytical laboratory reports or other associated documents were not available for review by Apex-SGI. SGI data used for this HHRA were only available as presented in the *Report on Additional Subsurface Assessment* (TEC, 2001); and
  - **TEC 2001 soil and groundwater investigation.** Results from this investigation are included in the *Report on Additional Subsurface Assessment* (TEC, 2001). Apex-SGI reviewed the tables, maps, and text from this report. The associated appendices for this report were not available for review by Apex-SGI.

  In the TEC (2001) report, there were errors and/or inconsistencies with the data reported, including mislabeled units, missing sampling dates, and missing analytical methods. Any assumptions or data qualifiers regarding information presented in the TEC (2001) report were provided in the notes at the bottom of the data summary tables in Attachment E-1.

- *Environmental Due Diligence Site Assessment Results* Report (Tetra Tech, 2006); and
- *Site Investigation and Site Conceptual Model Report* (Apex-SGI, 2017).
- Groundwater data for the two monitoring wells located in the East Parcel, wells MW-2 and MW-10, were provided in groundwater monitoring reports from December 2012 to December 2016 (AA&AI, 2017; AA&AI, 2016; AA&AI, 2015; AA&AI, 2014; TEC, 2013).

For the purposes of this HHRA, Apex-SGI compiled the data reported by TEC (2001), Tetra Tech (2006), and Apex-SGI (2017) into tables, which are provided in Attachment E-1. Summaries of the soil, groundwater, and soil vapor data are provided in the following sections.

3.1 Soil

Soil data collected to date indicate that COIs are present in soil throughout the vadose zone in a relatively small portion of the northern part of the East Parcel. Based on a screening evaluation presented in the *Site Investigation and Site Conceptual Model Report* (Apex-SGI, 2017), TPH in the gasoline, diesel, and oil range as well as VOCs, including ethylbenzene, toluene, and xylenes, have been identified as COPCs in vadose zone soil at the Site.

During previous Site investigation activities, soil samples were collected from various depths ranging from 1 foot bgs to 40 feet bgs at the East Parcel. Future development at the East Parcel could involve mixing and redistribution of subsurface soils as deep as 10 feet bgs to the surface, as a result of construction activities (i.e., trenching for utilities). Based on groundwater gauging data from monitoring wells located in the East Parcel, wells MW-2 and MW-10, first encountered groundwater lies at approximately 30 feet bgs. Considering depth to groundwater and anticipated land use scenarios, all soil data collected from the surface to 10 feet bgs will be included in the HHRA. Although data for deeper soil (i.e., greater than 10 feet bgs) were not used in the HHRA, the analytical results for deeper soil are included in Attachment E-1.

Dependent on the chemical, up to 33 soil samples were collected from soil at 0 to 10 feet bgs. The soil data used in this HHRA are provided in Attachment E-1. For VOCs and PAHs, soil samples were analyzed for the full suite of analytes using the specified laboratory method but only the analytes that were detected above the detection limit (analytical method detection limit or the practical quantitation limit) were included in Attachment E-1. A summary of the soil data is provided in Table E3-1. The soil sample locations are shown on Figure E3-1.

The soil samples were analyzed for TPH mixtures representing various carbon ranges. Based on an evaluation of the available TPH data (Table E-1B), the TPH data were separated into the following three TPH carbon ranges for this HHRA:

- TPH C4-C12;
- TPH C13-C22; and
- TPH C23-C44.

If individual carbon data were available, the laboratory analytical carbon data within the specific TPH carbon ranges above were summed to represent a total TPH value for each carbon range. The TPH data were not fractionated into aliphatic and aromatic compounds; therefore, a 50-percent (%) aliphatic to 50% aromatic ratio was assumed. Consistent with DTSC (2015) guidance, the evaluation of petroleum hydrocarbons in this HHRA includes its components most likely to reflect risk (i.e., benzene, toluene, ethylbenzene, xylenes [BTEX], and naphthalene).

3.2 Groundwater

Groundwater data collected to date indicate that TPH as gasoline (TPHg), TPH in the C13 to C22 carbon range (similar carbon range to TPH as diesel [TPHd]), and a few VOCs, including naphthalene, are generally the COPCs detected in the highest concentration in groundwater at the Site, which is consistent with its historical use as a petroleum refinery.

Groundwater data is comprised of grab groundwater samples and groundwater monitoring data from wells MW-2 and MW-10. Groundwater samples from the East Parcel are sampled primarily from first encountered water at approximately 30 feet bgs. One grab groundwater sample was collected at 40 feet bgs by Tetra Tech (2006). On the East Parcel, groundwater data indicate non-detect to low concentrations of metals and VOCs. Based on the most recent groundwater monitoring events in December 2016 for well MW-10 and December 2015 for well MW-2, only five COPCs, including TPHg, TPHd, naphthalene, isopropylbenzene, and tert-butyl alcohol were detected in well MW-10 and no COPCs were detected in well MW-2 (AA&AI, 2017; AA&AI, 2016). The concentrations of COPCs detected in groundwater did not exceed applicable screening levels. The grab groundwater and monitoring well locations are shown on Figure E3-1.

Due to approximate depth to first encountered groundwater of 30 feet bgs, hypothetical receptors at the East Parcel are not expected to have direct contact with groundwater. Since only a single soil vapor sample was collected from the East Parcel, potential vapor intrusion exposure pathways from contaminants in the subsurface (soil, soil vapor, and groundwater) will be evaluated using groundwater data. The groundwater data used in this HHRA are provided in Attachment E-1. A summary of the groundwater data is provided in Table E3-2.

3.3 Soil Vapor

Soil vapor data was collected from a single point, E1, at a depth of 15 feet bgs in the northern portion of the East Parcel during the 2006 investigation by Tetra Tech. This soil vapor sample was analyzed for VOCs. Only ethylbenzene was detected at a concentration above laboratory reporting limits. Due to limited soil vapor data (i.e., one soil vapor point) and to the age of the data (i.e., more than 10 years old) in the East Parcel, the vapor intrusion exposure pathway was evaluated using groundwater data from the East Parcel. The soil vapor sample location is shown on Figure E3-1. The soil vapor data are provided in Attachment E-1. A summary of the soil vapor data is provided in Table E3-3.

3.4 Statistical Evaluation of Data

Data were statistically analyzed and the following parameters were estimated separately for each chemical detected in soil, groundwater, and soil vapor:

- Number of samples analyzed;
- Number of samples in which chemicals were detected;
- Frequency of detection;
- Arithmetic mean (average);
- Standard deviation;
- Minimum detected concentration; and
- Maximum detected concentration.

Not all samples were analyzed for all chemicals; therefore, the total number of samples may vary by chemical.

4.0 EXPOSURE ASSESSMENT

This section describes the methods used to estimate exposures for potential human receptors in the East Parcel of the Site. The exposure assessment provides a scientifically defensible basis for the selection of potentially exposed hypothetical receptors and the most likely ways they might be exposed to chemicals at the Site. To develop a conceptual understanding of the Site, information regarding potential chemical source, chemical release and transport mechanisms, locations of potentially exposed human receptors, and potential exposure routes were assessed. This information is outlined schematically in a conceptual site model (CSM) shown on Figure E4-1. The CSM associates source of chemicals with potentially exposed human receptors and associated complete exposure pathways. In this way, the CSM assists in quantifying potential impacts to human health.

As defined by USEPA (1989), all of the following four components are necessary for a chemical exposure pathway to be considered complete and for chemical exposure to occur:

- A chemical source and a mechanism of chemical release to the environment;
- An environmental transport medium (e.g., soil) for the released chemical;
- A point of contact between the contaminated medium and the receptor (i.e., the exposure point); and
- An exposure route (e.g., dermal contact with chemically-impacted soils) at the exposure point.

The following sections describe these components and provide a basis for the CSM.

4.1 Potential Source Evaluation

The sources of potential contamination at a site are related to exposure setting (site characteristics and past and current site operations) and land and groundwater uses at the site and surrounding area. Environmental impacts beneath the East Parcel are a result of the Site's prior use as an oil refinery from 1922 until 1997. Former operations on the East Parcel included ASTs and support structures including a warehouse, laboratory, and maintenance facilities. Currently the East Parcel is vacant, and does not contain any ASTs or known USTs.

The primary sources for potential contamination at the East Parcel are related to former Site operations as a refinery and subsequent releases to onsite soil. Following a release to soil, secondary sources may include fugitive dust, soil vapor, ambient air, and groundwater.

4.2 Exposure Setting and Land Use

The Site is approximately 8.2-acres in size, with the East Parcel encompassing approximately 2.4 acres. Land use in the vicinity of the Site includes commercial, office, and light industrial development to the north, light industrial development to the west, east and south of the Site, and a former railroad corridor to the south, with residential properties located south and west of the former railway corridor. There are five schools located within ¼-mile of the Site. Signal Hill Elementary School is located upgradient and north of the Site. Alvarado Elementary School and Jessie Elwin Nelson Academy Middle School are located crossgradient and east of the Site. Mary Butler Middle School and Renaissance High School for the Arts are located downgradient and south of the Site. There are two day care centers located within a ½-mile of the Site, Central Child Development Center to the west and LBCC Children Development Center to the south. No known hospitals are located within a ½-mile of the Site. There are no known active public water supply wells located within a mile radius of the Site. Groundwater quality within the Site vicinity is generally poor due to seawater intrusion and elevated salinity. Los Angeles County Department of Public Works (LADPW) maintains a well located approximately 850 feet south of the Site (LADPW Well 420); however, based on personal communication with the LADPW, this well is used only for groundwater monitoring purposes. The nearest surface water body to the Site is the Los Angeles River, which is located 1.9 miles west of the Site.

Currently the Site, including the East Parcel, is vacant, and all former refinery and supporting structures have been removed. In the future, as shown on Figure E3-1, the East Parcel will be redeveloped with four onsite buildings for light industrial and commercial land use. Administrative and institutional controls will be implemented prior to development of the East Parcel, as required in the California Land Reuse and Revitalization Act Agreement (CLRRA) prepared for the Site. Expected controls include a land use covenant (LUC) and Site Management Plan (SMP). The LUC will prohibit use of underlying groundwater and prohibit unrestricted or sensitive land uses.

4.3 Chemical Release Mechanisms and Identification of Transport Media

In this section, chemical properties of the COPCs and the physical characteristics of the East Parcel were reviewed to identify the factors that might allow the release of a chemical to the environment, and transport to or through soil, soil vapor, and groundwater.

Future planned redevelopment of the East Parcel will include commercial building(s) and concrete/asphalt paving across the East Parcel, which will limit direct contact with soil for potential onsite receptors. Although direct contact with soil is likely an incomplete exposure pathway for future onsite receptors, it was conservatively included as a potential exposure pathway. Further release of chemicals can potentially occur through volatilization, wind and/or mechanical erosion (i.e., during construction), migration of chemicals into the groundwater, lateral migration of chemicals in groundwater, or migration of chemicals via stormwater runoff. These types of releases may result in chemical vapor or dust (with sorbed chemicals) emissions in air, or the movement of chemicals downward into groundwater with infiltrating rain water (i.e., leaching from soil) or stormwater runoff into surface water and sediment. These potential release mechanisms are discussed in more detail below.

4.3.1 Volatilization of Chemical Vapors

Some of the chemicals detected in the East Parcel are VOCs. These chemicals typically have a low organic-carbon partition coefficient (K_{oc}), a low molecular weight, and a high Henry's Law constant, indicating that these chemicals may volatilize. Therefore, volatilization of VOCs was considered a potential release mechanism for COPCs.

4.3.2 Emission of Fugitive Dust

Some of the chemicals detected in the East Parcel adsorb readily to dust particles (e.g., metals in soil). Chemicals adsorbed to soil particles can be blown into the air by wind and/or mechanical erosion. This is referred to as fugitive dust. Therefore, emission of fugitive dust was considered a significant release mechanism for COPCs.

4.3.3 Leaching

The evaluation of chemical concentrations in soil for groundwater protection (soil leaching) is designed to address the potential leaching of chemicals from vadose zone soils and their subsequent impact on groundwater. The potential for chemicals to leach from soil depends on the physical and chemical properties of the chemicals, soil type, pH (for metals), and other site-specific conditions. For example, chemicals with high water solubilities tend to leach more readily than chemicals with lower solubilities. In addition, a chemical's K_{oc} is important for assessing the degree of chemical sorption to soil particles; chemicals with a high sorption potential do not tend to leach as readily (i.e., metals). Site-specific conditions are also important for assessing whether leaching may occur, such as soil type (leaching occurs more readily in sandy soils than in clayey or silty soils), amount of rainfall, gradient, etc.

In addition, other competing migration pathways can affect the tendency of a chemical to leach. Because metals and PAHs are expected to sorb strongly to soil particles, and because VOCs are expected to volatilize, leaching is not expected to occur at the Site to any significant extent. Furthermore, over 90-percent of the East Parcel will be capped with buildings and an asphalt parking lot, which will further minimize the potential leaching to groundwater. Leaching potential of COPCs from vadose zone soil into groundwater may be a potential chemical release mechanism but not a significant release mechanism for COPCs.

This potentially complete but insignificant exposure pathway was not included in the HHRA but a screening evaluation of soil exposure point concentrations (EPC_{soil}) and Site-specific soil screening levels (SLs) for protection of groundwater is provided in Attachment E-2. Metals were not included in this screening evaluation because leaching of metals is variable based on metal speciation and physical chemical conditions of the soil. Metals are expected to sorb strongly to soil particles, limiting their leachability. Based on the screening evaluation for TPH, VOCs, and PAHs, the soil EPCs for TPH C5-C12, naphthalene, and chrysene exceeded the soil SLs for protection of groundwater. All other TPH (C13-C22 and C23-C44), VOCs, and PAHs were not detected above the laboratory reporting limit or were detected below the soil SLs for protection of groundwater. Although the soil EPC for TPH C5-C12 of 1,700 mg/kg exceeded the soil SL of 1,000 mg/kg, this TPH carbon range is generally evaluated by its components most likely to reflect risk; such as, benzene, toluene, ethylbenzene, and total xylenes (BTEX) and naphthalene. The soil EPCs for BTEX did not exceed their individual soil SLs for protection of groundwater. Soil EPCs for naphthalene and chrysene slightly exceeded the soil SLs for protection of groundwater but these compounds are not expected to leach to any significant extent because of other competing migration pathways. In the future, the presence of a cap (i.e., buildings and pavement) across the East Parcel will effectively limit any leaching to groundwater.

4.3.4 Lateral Migration of Groundwater into Offsite Areas

The surrounding offsite area includes industrial and residential land use. Groundwater flow at the Site is generally to the south with a low horizontal hydraulic gradient. Due to the approximate depth to first encountered groundwater of 30 feet bgs in the East Parcel, hypothetical receptors in offsite areas are not expected to have direct contact with groundwater. However, any Site-related VOCs in groundwater may migrate offsite and potentially impact indoor air via vapor intrusion. The nearest offsite groundwater data were collected from grab groundwater sample GW-28 (sampled in 2012) and groundwater monitoring well MW-14 (most recently sampled in December 2016), which indicated no VOCs were detected above the laboratory reporting limit. Therefore, offsite migration of groundwater from the East Parcel was not considered a significant release mechanism for COPCs.

4.3.5 Stormwater Runoff

Stormwater runoff from areas of contaminated soil has the potential to transport contaminants bound to soil particles. There are no known surface water bodies within a ½-mile of the Site. Future redevelopment plans include commercial building(s) and concrete/asphalt paving across the East Parcel, and will include engineering controls related to stormwater runoff from the East Parcel. The potential chemical release via stormwater runoff is not identified as a significant chemical release mechanism.

4.4 Potential Human Receptors

The third component necessary for an exposure pathway to be complete is identification of potential receptors at the East Parcel. The following hypothetical human receptors were identified based on proposed activities that could possibly result in direct or indirect contact with Site-related chemicals, and anticipated land use.

- Future Onsite Construction/Utility Trench Worker Receptor; and
- Future Onsite Commercial/Industrial Worker Receptor.

4.5 Potential Exposure Points

The other portion of the third component necessary for an exposure pathway to be complete is a point of contact between the contaminated medium and the receptor (i.e., the exposure point). For the purposes of this CSM, it is assumed that access to the East Parcel is unrestricted and that onsite receptors may be exposed directly to contaminated soil and indirectly to soil vapor and groundwater. During redevelopment of the East Parcel, onsite construction/utility trench worker receptors may be directly exposed to soil. For soil, the exposure point is assumed to be the area within the Site boundaries. Future planned redevelopment of the East Parcel will include four buildings and concrete/asphalt paving across the East Parcel, which will limit direct contact with soil for potential onsite receptors.

Any hypothetical onsite construction worker receptor will be performing activities consistent with a Site Management Plan (SMP) and a site-specific Health and Safety Plan (HASP). The HASP will require the use of proper personal protective equipment (PPE) and the best management practices (BMPs) will require dewatering to preclude any direct contact with groundwater for workers at the Site. Construction activities and utility trenching is not expected to exceed a depth of 10 feet bgs. With depth to groundwater at approximately 30 feet bgs in the East Parcel, direct contact with groundwater for onsite workers was not considered further.

Volatile compounds can be released from the subsurface into outdoor and indoor air resulting in an indirect exposure to contaminants in soil, soil vapor, and groundwater. Inhalation of VOCs in outdoor air is generally negligible due to dispersion in ambient air. For the volatilization pathway into indoor air, exposure to subsurface contamination is best characterized through the collection of soil vapor or groundwater samples. For onsite receptors, the exposure point for vapor intrusion into indoor air is assumed to be the soil vapor or groundwater beneath areas with proposed onsite commercial buildings. Due to limited soil vapor data (i.e., one soil vapor point) and to the age of the soil vapor data (i.e., more than 10 years old) in the East Parcel, the vapor intrusion exposure pathway was evaluated using groundwater data from the East Parcel.

Groundwater quality within the Site vicinity is generally poor due to seawater intrusion and elevated salinity. Shallow groundwater is not currently used and is not likely to be developed for beneficial use. Risk management measures can be implemented to ensure that groundwater is not used. Therefore, domestic use of groundwater was not considered a complete exposure point.

4.6 Exposure Pathways Considered Potentially Complete and Significant

The fourth and final component, a complete exposure pathway (i.e., route of exposure) is discussed in combination with the third component (i.e., presence of receptors at an exposure point) to define those exposure pathways considered to be complete and significant. The following sections summarize those pathways considered complete and significant for each receptor. This information is summarized schematically on Figure E4-1.

4.6.1 Hypothetical Future Onsite Construction/Utility Trench Worker Receptor

The hypothetical onsite construction/utility trench worker receptor is included in this HHRA in the event any construction or redevelopment occurs at the East Parcel. This receptor is expected to be a short-term outdoor worker (i.e., 2 weeks to 7 years [USEPA, 1989]) that spends 250 days per year performing construction projects at the East Parcel. The exposure duration for this receptor is one year. This receptor spends the workday outdoors performing construction-related tasks. This receptor is expected to encounter both surface and subsurface soils down to a depth of 10 feet bgs and has a very high soil ingestion rate of 330 milligrams per day (mg/day). Inhalation of chemical vapors while indoors was not considered a complete and significant exposure pathway because this receptor is not expected to be working inside buildings. The exposure pathways assumed to be complete and significant for the hypothetical onsite construction/utility trench worker receptor are:

- Incidental ingestion of soil;
- Dermal contact with soil; and
- Inhalation of dust in outdoor air.

4.6.2 Hypothetical Future Onsite Commercial/Industrial Worker Receptor

The hypothetical onsite commercial/industrial worker receptor is included in this HHRA based on expected future land use. This receptor is a long-term receptor (i.e., greater than 7 years [USEPA, 1989]). This receptor is a full-time employee that is assumed to spend 250 days per year at work for 25 years. This receptor spends the workday (8 hours per day) conducting activities indoors and outdoors. Although inhalation of vapors in outdoor air may be complete, outdoor air concentrations are typically lower than indoor air concentrations due to dispersion; such relatively minor exposures are subsumed by the assumption that all exposure is from indoor air. The East Parcel is expected to be capped by buildings and concrete/asphalt paving, which would significantly limit any direct contact with soil. The exposure pathways assumed to be complete and significant for the hypothetical onsite commercial/industrial worker receptor are:

- Incidental ingestion of soil;
- Dermal contact with soil;
- Inhalation of dust in outdoor air; and
- Inhalation of vapors in indoor air.

4.7 Selection of Chemicals of Potential Concern

Typically, only the most toxic, persistent, and prevalent site-related chemicals detected at a site are fully evaluated in a risk assessment. In this way, the assessment can focus solely on those chemicals that are expected to account for the majority of the estimated health impacts at the Site. These selected chemicals are known as COPCs. In order to provide a conservative and more complete characterization of potential risks associated with exposures at the East Parcel, all detected inorganic and organic chemicals were retained as COPCs in this HHRA.

4.8 Average and Reasonable Maximum Exposures

Two types of exposure scenarios can be evaluated in a risk assessment: an average exposure scenario (central tendency exposure [CTE]) and an upper-bound exposure scenario (reasonable maximum exposure [RME]). The CTE scenario represents a more typical exposure and is based on average intake assumptions. The RME scenario represents the maximum exposure that is reasonably expected to occur (USEPA, 1989). The range of exposure estimates between the average and upper-bound exposure scenarios provides a measure of the uncertainty inherent in these estimates. Where the upper-bound estimate of exposure may be above the range of possible exposures, the average estimate may be lower than exposures for a subset of a population. Therefore, USEPA guidance (1989) recommends evaluating a RME scenario, which is considered a conservative upper-bound exposure scenario. USEPA guidance (1989) recommends selecting intake assumptions for each exposure pathway so that the cumulative effect of all intake assumptions results in an estimate of the reasonable maximum exposure for that pathway. The RME scenarios evaluated in this HHRA estimate the exposures a receptor might receive using mostly conservative upper-bound intake assumptions (e.g., 90th or 95th percentile for nearly all intake assumptions) and upper-bound estimates of chemical concentrations. Under the RME scenario, USEPA (1989) recommends the use of the arithmetic average concentration for the exposure point concentration because long-term contact with the maximum concentration is not reasonable. Due to the uncertainties associated with estimating the average concentration, USEPA (1989) recommends using the lesser of the maximum detected concentration and 95-percent upper confidence limit of the mean concentration (95UCL) for the soil exposure point concentration (EPC). However, for exposure pathways associated with inhalation of vapors in indoor air, the maximum detected concentration was selected as the groundwater EPC (based on the assumption that a building may be located over maximum concentrations). Conservatively, only an RME scenario was evaluated in this HHRA.

4.9 Intake Assumptions Used to Estimate Exposure

The purpose of establishing exposure scenarios for a site is to allow quantification of potential exposures that may occur either currently or in the future. To quantify exposures, it is necessary to derive a chemical dose to which a receptor might be exposed. Such doses are estimates of the amount of a chemical that might be taken up into the body. The estimated doses are developed on the basis of the specific exposure scenarios, and are used along with chemical toxicity information (Section 5), in the risk characterization stage of the risk assessment (Section 6), to estimate possible adverse noncancer health effects and excess cancer risks associated with the COPCs.

Chemical doses were estimated based on a number of intake assumptions, also referred to as exposure factors, including EPCs, exposure frequencies, exposure durations, body weights, and other parameters. Some intake assumptions are common to all pathways, whereas others are chemical-specific or receptor-specific. Assumptions made for these exposure parameters may not be representative of any actual exposure situation because actual individual activity patterns and physiological response of individuals may vary considerably. However, the intake assumptions used in this risk assessment are intended to overestimate actual exposure and risk. All intake assumptions used to evaluate possible exposures for the hypothetical onsite construction/utility trench worker and onsite commercial/industrial worker receptors identified previously in Section 4.4 are presented in Tables E4-1 and E4-2.

In nearly all cases, the intake assumptions listed in Tables E4-1 and E4-2 represent default RME values recommended by DTSC (2014a) and USEPA (2009). As recommended by USEPA (2009), if the inhalation exposure scenario is less than 24 hours per day, then the exposure time parameter should be used. For all the hypothetical receptors, the exposure time was assumed to be an 8-hour work day.

Some default intake assumptions are chemical-specific or receptor-specific, as discussed in the following sections.

4.9.1 Dermal Absorption Factor for Soil Contact

The amount of chemical that passes through the skin from a soil matrix is determined by the dermal absorption factor (ABS). The higher the ABS, the greater percentage of a given amount of chemical is expected to pass through the skin. As summarized on Table E4-3, the chemical-specific ABS values recommended by DTSC (2015 and 2014a) and USEPA (2016) were used in this risk assessment.

4.9.2 Particulate Emission Factor

The particulate emission factor (PEF) is used to evaluate the inhalation of soil as fugitive dust exposure pathway. DTSC (2014a) recommended PEF of 1.36 x 10^9 cubic meters per kilogram (m^3/kg) was used for the hypothetical onsite commercial/industrial worker exposure scenario. Due to greater dust emissions assumed under a construction worker exposure scenario, a PEF of 1.00 x 10^6 m^3/kg (DTSC, 2014a) was used for the hypothetical onsite construction/utility trench worker exposure scenarios. A PEF was used for all COPCs detected in soil.

4.10 Estimating Exposure Point Concentrations

The EPC represents the amount of a chemical to which a hypothetical receptor is assumed exposed. The EPC is a conservative estimate of the average chemical concentration in an environmental medium. For exposure pathways involving direct contact with soil, the EPCs are the measured soil concentrations. For indirect exposure pathways (i.e., inhalation), measured concentrations of volatile chemicals in groundwater were used as starting concentrations that were coupled with a mathematical model to estimate COPC concentrations in indoor air. The model is described in Attachment E-3. The methods used to estimate EPCs are summarized in the following sections.

4.10.1 Exposure Point Concentrations in Soil

Soil EPCs were used for evaluating the direct contact with soil exposure pathway. It is unlikely that a potential receptor will spend the entire exposure duration (one year for onsite construction/utility trench worker receptor and 25 years for onsite commercial/industrial worker receptor) residing over maximum detected concentrations in soil. Therefore, in this HHRA, it is relevant and appropriate to statistically evaluate the soil data on an area-wide basis. Consistent with USEPA (1989) procedures, when evaluating an RME scenario the lesser of the maximum detected concentration and the 95UCL was selected as the appropriate soil EPC. A USEPA software package, ProUCL Version 5.1.00, was used to estimate the upper confidence limit of the mean concentration (UCL; [typically the 95UCL, but sometimes the 97.5UCL or 99UCL, depending on the data set]). ProUCL and USEPA

(2015) guidance make recommendations for estimating UCLs and were developed as tools to support risk assessment. Due to limitations of certain datasets (i.e., limited number of samples or low detection frequency), ProUCL was not used to estimate a UCL. For those analytes with adequate datasets, the ProUCL output spreadsheets are presented in Attachment E-4. The soil EPCs (EPC_{soil}) used in this HHRA are summarized in Table E4-4.

4.10.2 Exposure Point Concentrations in Groundwater

The only complete exposure pathway associated with groundwater is inhalation of vapors in indoor air. Based on the assumption that a building may be located over maximum concentrations, the maximum detected concentration was selected as the groundwater EPC to be used in mathematical fate and transport models to estimate COPC concentrations in indoor air (Section 4.10.3). For onsite indoor exposures, the groundwater EPCs (EPC_{gw}) used in this HHRA are summarized in Table E4-5.

4.10.3 Exposure Point Concentrations in Air

For indirect exposure pathways (i.e., inhalation), measured concentrations in groundwater were used as starting concentrations that were coupled with mathematical models to estimate COPC concentrations in indoor air. Outdoor air EPCs resulting from inhalation of dust are not specifically presented, since the dose equations for direct contact with soil incorporate PEFs relating source concentrations in soil to those in fugitive dust (Section 4.11.1). Fate and transport modeling was used to estimate indoor air EPCs for volatile COPCs detected in groundwater. The fate and transport modeling involves incorporating Site-specific data and chemical-specific data into analytical models that simulate vapor migration of VOCs.

The Johnson and Ettinger (1991) model, recommended and provided by the DTSC (2014b), was used to estimate vapor emissions from groundwater into indoor air. This model estimates vapor concentrations in indoor air directly from concentrations in groundwater, accounting for advection and diffusion in the vadose zone and the effects of building foundation and mixing in the building interior. For onsite indoor exposures, model derived soil vapor EPCs ($EPC_{soil\ vapor}$) and indoor air EPCs ($EPC_{indoor\ air}$) from groundwater are summarized in Table E4-5. The conceptual approach to estimating indoor air concentrations, the equations and calculations used, and the modeling results are described in Attachment E-3.

4.11 Estimating Chronic and Subchronic Daily Intakes

Based on the exposure duration assumed under each potential human receptor, different types of chemical doses were estimated. For long-term exposures (referred to as chronic; exposures greater than seven years in duration), a chronic daily intake (CDI) was estimated. For shorter periods of time (between 30 days and seven years), a subchronic daily intake (SDI) was estimated. Therefore, SDIs were estimated for the hypothetical construction/utility trench worker receptor (exposure duration of one year). CDIs were estimated for the hypothetical commercial/industrial worker receptor (exposure duration of 25 years). This section presents the mathematical equations used to estimate CDIs and SDIs.

Chronic or subchronic daily intake (CDI/SDI; i.e., dose) is defined as the amount of chemical absorbed by the body over a given period of time. For noncarcinogenic effects, the CDI/SDI is averaged over the period of exposure (i.e., receptor-specific exposure duration). For carcinogenic effects, the CDI/SDI was averaged over a lifetime (i.e., 70 years).

The exposure pathway-specific equations used in this HHRA are presented in the following sections.

4.11.1 Direct Exposure to Soil

Direct exposure to soil includes the following three exposure pathways: incidental ingestion of soil, dermal contact with soil, and inhalation of fugitive dust from soil. The individual CDIs and SDIs for each of these exposure pathways are summarized below.

4.11.1.1 Incidental Ingestion of Soil

The CDI/SDI for incidental ingestion of soil was estimated using the following equation:

$$CDI / SDI = \frac{EPC_{soil} \times EF \times ED \times \left(\dfrac{IRs}{10^{6}\ mg/kg} \right)}{BW \times AT}$$

Where:

CDI = Chronic daily intake (milligram per kilogram body weight per day [mg/kg-day]);
SDI = Subchronic daily intake (mg/kg-day);
EPC_{soil} = EPC in soil (milligram per kilogram [mg/kg]);
EF = Exposure frequency (days/year);
ED = Exposure duration (years);
IRs = Soil ingestion rate (mg/day);
BW = Body weight (kilogram [kg]); and
AT = Averaging time (days).

4.11.1.2 Dermal Contact with Soil

The CDI/SDI for dermal contact with soil was estimated using the following equation:

$$CDI / SDI = \frac{EPC_{soil} \times EF \times ED \times \left(\dfrac{SA \times AF \times ABS}{10^{6}\ mg / kg} \right)}{BW \times AT}$$

Where:

CDI = Chronic daily intake (mg/kg-day);
SDI = Subchronic daily intake (mg/kg-day);
EPC_{soil} = EPC in soil (mg/kg);
EF = Exposure frequency (days/year);
ED = Exposure duration (years);
SA = Skin surface area (square centimeters [cm^2]);

AF = Soil adherence factor (milligrams per square centimeter [mg/cm^2-day]);
ABS = Dermal absorption factor (unitless);
BW = Body weight (kg); and
AT = Averaging time (days).

4.11.1.3 Inhalation of Outdoor Dust from Soil

The CDI/SDI for inhalation of dust was estimated using the following equation:

$$CDI / SDI = \frac{EPC_{soil} \times EF \times ED \times ET \times \frac{1 day}{24 hour} \times \left(\frac{1}{PEF} \right)}{AT}$$

Where:

CDI = Chronic daily intake (milligram per cubic meter [mg/m^3]);
SDI = Subchronic daily intake (mg/m^3);
EPC_{soil} = EPC in soil (mg/kg);
EF = Exposure frequency (days/year);
ED = Exposure duration (years);
ET = Exposure time (hours/day);
PEF = Particulate Emission Factor (for non-volatile compounds; m^3/kg); and
AT = Averaging time (days).

The CDIs and SDIs for each of these pathways described above are combined to evaluate multipathway direct exposures to soil. These exposure pathways were evaluated for the hypothetical onsite construction/utility trench worker and onsite commercial/industrial worker receptors.

4.11.2 Inhalation of Chemical Vapors Volatilizing from Groundwater into Indoor Air

The CDI for inhalation of chemical vapors volatilizing from soil vapor is estimated using the following equation:

$$CDI = \frac{EPC_{indoor\ air} \times EF \times ED \times ET \times \frac{1 day}{24 hour}}{AT}$$

Where:

CDI = Chronic daily intake ($\mu g/m^3$);
$EPC_{indoor\ air}$= EPC in indoor air from soil vapor ($\mu g/m^3$);
EF = Exposure frequency (days/year);
ED = Exposure duration (years);
ET = Exposure time (hours/day); and
AT = Averaging time (days).

The inhalation of vapors migrating from soil vapor into indoor air exposure pathway was evaluated for the hypothetical onsite commercial/industrial worker receptor.

5.0 TOXICITY ASSESSMENT

This section summarizes the methods used to evaluate the toxicity of COPCs. Toxicity values include oral reference doses (RfDs), inhalation reference concentrations (RfCs), oral slope factors (SFs), and inhalation unit risk factors (IURs), which are combined with exposure factors to estimate adverse noncancer health effects and excess cancer risks.

5.1 Oral Reference Doses and Inhalation Reference Concentrations

Noncancer health effects are evaluated using an oral RfD, which is expressed in units of milligrams per kilogram body weight per day (mg/kg-day) and an inhalation RfC, which is expressed in units of micrograms per cubic meter (µg/m^3). An RfD/RfC represents an agency-developed, estimated daily exposure level (dose) to which humans may be exposed without expectation of adverse health effects. USEPA assumes the existence of a threshold concentration for noncancer effects, below which toxic effects are not expected to occur (USEPA, 1989).

The following sources were used in this HHRA to identify appropriate RfDs and RfCs:

- CalEPA Office of Environmental Health Hazard Assessment's (OEHHA, 2017) toxicity values available from the on-line toxicity criteria database.
- DTSC (2016) toxicity values used for DTSC-modified screening levels. The DTSC HERO published toxicity values in the HERO HHRA Note Number 3.
- Integrated Risk Information System (IRIS; USEPA, 2017), an on-line database that contains USEPA-approved RfDs and RfCs.
- USEPA toxicity values used for USEPA Regional Screening Levels (RSLs; USEPA, 2016). Toxicity values were obtained from USEPA, CalEPA OEHHA, and Agency for Toxic Substances and Disease Registry (ATSDR) sources. The RSLs include provisional peer reviewed toxicity values (PPRTV) derived by USEPA's Superfund Health Risk Technical Support Center for the USEPA Superfund Program.
- Agency for Toxic Substances and Disease Registry (ATSDR, 2015) minimal risk levels (MRLs). For some chemicals, ATSDR presents chronic oral and inhalation MRLs, which are used as chronic RfDs and RfCs.
- USEPA Health Effects Assessment Summary Tables (HEAST; USEPA, 1997). HEAST provides a listing of provisional RfDs and RfCs that have undergone agency review, but that have not achieved agency-wide consensus. Unlike the sources listed above, HEAST is no longer updated.

For most chemicals, in the absence of a specific value for subchronic exposure, the chronic toxicity value was adopted as the subchronic toxicity value. For a few chemicals, the chronic toxicity value was modified using the subchronic to chronic uncertainty factor as provided by the USEPA IRIS online database. Unless noted otherwise, a unique subchronic toxicity value was only used for those chemicals with toxicity values sourced from USEPA IRIS and with published uncertainty factors applied for the use of a subchronic study for chronic toxicity value derivation. Chronic and subchronic RfDs/RfCs used in this assessment are presented in Table E5-1.

RfDs/RfCs are often based on animal toxicity studies, for which data are then extrapolated to a chemical concentration considered "safe" for humans. The threshold of observed effects in test animals is divided by uncertainty factors (UFs) and possibly modifying factors (MFs). Separate UFs, each of which may be up to 10, are used to account for each of the following:

- Protection of sensitive individuals within the receptor population;
- Extrapolation of toxicity data from animals to humans;
- Extrapolation of subchronic toxicity data to chronic exposure durations; and
- Extrapolation from a lowest-observed adverse effect level (LOAEL) to a no-observed adverse effect level (NOAEL) to assess toxicity.

A MF of one to 10 (generally no higher than 3) is typically used to account for other considerations such as the perceived adequacy of the scientific data. The UFs and the MFs for a given chemical are then multiplied together to provide a total UF, which is then used to derive a chronic RfD/RfC (cRfD/cRfC). In order to derive an RfD/RfC protective of the most sensitive members of the human population, the UF may range from one to 10,000. The higher the total UF, the more uncertainty and the more conservative is the resultant cRfD/cRfC.

The cRfD/cRfC is the USEPA-established dose used to evaluate health effects associated with long-term (chronic) exposures of at least seven years (USEPA, 1989). These cRfD/cRfC values were used in this assessment to evaluate potential impacts to the hypothetical commercial/industrial worker receptor at the East Parcel. The subchronic RfD/RfC (sRfD/sRfC) is the dose used to evaluate health effects associated with exposures less than seven years (USEPA, 1989). These sRfD/sRfC values were used in this assessment to evaluate potential impacts to the hypothetical construction/utility trench worker receptor.

Oral and inhalation route-specific toxicity values (oral RfD and inhalation RfC) have been developed to evaluate adverse noncancer health effects. However, USEPA and CalEPA have not developed toxicity values to specifically evaluate possible impacts from dermal (skin) exposure. As recommended by USEPA (2004), to characterize risk from the dermal exposure pathway, the oral toxicity value should be adjusted to represent an absorbed dose rather than an administered dose. The USEPA recommended gastrointestinal absorption (GIABS) values are available in Exhibit 4-1 of the Risk Assessment Guidance for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment (USEPA, 2004). Organic chemicals are generally well absorbed across the gastrointestinal tract; therefore, USEPA (2004) recommends assuming 100% absorption. For inorganics, USEPA (2004) presents a wide range of absorption values for most inorganics. In the absence of an appropriate GIABS value, an assumption of 100% absorption was used. As recommended by USEPA (2004), oral RfDs multiplied by GIABS values were used to estimate possible noncancer health effects from dermal exposure. Chemical-specific GIABS values are presented in Table E5-2.

5.2 Oral Slope Factors and Inhalation Unit Risk Factors

USEPA has developed oral SFs and IURs for chemicals that are known or potential human carcinogens. USEPA (1989) defines an SF/IUR as a plausible upper-bound estimate of the probability of a carcinogenic response in human populations per unit intake of a chemical (averaged over an expected lifetime of 70 years). SFs/IURs are used to estimate excess cancer risks are expressed in units of risk per dose in mg/kg-day $(mg/kg\text{-}day)^{-1}$ for oral SF and $(\mu g/m^3)^{-1}$ for IUR.

The following sources were used in this HHRA to identify appropriate SFs and IURs:

- OEHHA (2017) toxicity values available from the on-line toxicity criteria database.
- DTSC (2016) toxicity values used for DTSC-modified screening levels. The DTSC HERO published toxicity values in the HERO HHRA Note Number 3.
- Integrated Risk Information System (IRIS; USEPA, 2017), an on-line database that contains USEPA-approved SFs and IURs.
- USEPA toxicity values used for USEPA RSLs (USEPA, 2016). Toxicity values were obtained from USEPA, CalEPA OEHHA, and ATSDR sources. The RSLs include PPRTV derived by USEPA's Superfund Health Risk Technical Support Center for the USEPA Superfund Program.

The SFs and IURs used in the HHRA are presented in Table E5-3.

Most SFs/IURs are based on a continuous exposure, linear non-threshold extrapolation model (generally the linearized multistage model) which is predicated on the assumption that any level of exposure to a carcinogen will result in some degree of carcinogenic risk, however minute (i.e., no threshold is assumed to exist). The extrapolation model derives a mathematical relationship between the generally high chemical doses and resulting effects measured in laboratory animals or epidemiological (human) studies, and applies that relationship to extrapolate effects for the generally lower doses that occur in the environment. This low-dose extrapolation is generally regarded as a very conservative (extremely health protective) approach. The resulting SF/IUR typically represents at least the upper 95th percentile of the measured dose-response relationship.

Oral and inhalation route-specific toxicity values (SF and IUR) have been developed to evaluate excess cancer risk. However, USEPA and CalEPA have not developed toxicity values to specifically evaluate possible impacts from dermal (skin) exposure. Similar to reference doses, oral slope factors were adjusted to represent an absorbed dose rather than an administered dose. As recommended by USEPA (2004), oral SFs were divided by GIABS values to estimate possible noncancer health effects from dermal exposure. Chemical-specific GIABS values are presented in Table E5-2.

5.3 Total Petroleum Hydrocarbons (TPH)

TPH carbon ranges C4-C12, C13-C22, and C23-C44 were included this HHRA. For each TPH carbon range, 50% of the TPH concentration was assumed to represent the aliphatic compounds and the other 50% was assumed to represent the aromatic compounds. DTSC's Preliminary

Endangerment Assessment Guidance Manual (DTSC, 2013) provides the toxicity values recommended to evaluate aliphatic and aromatic components of TPH. The TPH toxicity values used in the HHRA are presented in Tables E5-1 and E5-3.

5.4 Lead

Neither USEPA nor CalEPA publishes toxicity values for lead, which is classified as a "probable human carcinogen" by USEPA (2017). In the absence of toxicity values, noncarcinogenic risks for lead are evaluated by predicting blood lead concentrations using toxicokinetic modeling.

In 2011, the DTSC methodology for evaluating the potential adverse health effects associated with exposure to lead was revised. OEHHA toxicity evaluation of lead replaced the 10 micrograms per deciliter (µg/dL) threshold blood concentration previously used with a source-specific "benchmark change" of 1 µg/dL increase above ambient conditions. For industrial worker exposure scenarios, DTSC (2011c) recommends a modified version of USEPA's June 21, 2009 Adult Lead Model (ALM). This evaluation is discussed in Section 6.2.

5.5 Chemicals without Toxicity Values

If chemical-specific toxicity values were not available from the sources listed in Sections 5.1 and 5.2, the chemical was reviewed to assess whether an appropriate surrogate chemical could be identified to characterize toxicity. In this HHRA, there were two COPCs without published toxicity values. The following table summarizes the COPCs and their identified surrogates, based primarily on structural similarities.

COPC	Surrogate
Tertiary Butyl alcohol	sec-Butyl alcohol
Phenanthrene	Anthracene

The toxicity values for each identified surrogate were used to evaluate the compounds without published toxicity values.

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6.0 RISK CHARACTERIZATION

This section summarizes the approach used to estimate human noncancer adverse health effects and excess cancer risks from assumed exposure to COPCs in soil and groundwater. The risk characterization process incorporates data from the exposure and toxicity assessments. The exposure assessment information necessary to estimate noncancer adverse health effects and excess cancer risks includes the estimated chemical intakes, exposure modeling assumptions, and the exposure pathways assumed to contribute to the majority of exposure for each hypothetical receptor over a given time period (USEPA, 1989).

6.1 Arsenic

It is appropriate to evaluate arsenic concentrations in comparison to acceptable background concentrations. A Southern California regional background arsenic concentration of 12 mg/kg has been suggested as a useful risk management screening value by representatives of DTSC (Chernoff, D. et al.). With the exception of arsenic, this HHRA conservatively includes all detected metals as COPCs.

6.2 Lead

According to the DTSC website, the methodology for evaluating the potential adverse health effects associated with exposure to lead has been revised based on OEHHAs new toxicity evaluation of lead which replaced the 10 µg/dL threshold blood concentration previously used with a source-specific “benchmark change” of 1 µg/dL. For industrial worker exposure scenarios, DTSC (2011a) recommends a modified version of USEPA's June 21, 2009 ALM (DTSC, 2011c). The model calculates the concentration in exterior soil and interior dust that will result in a 90th percentile estimate of blood lead of 1 µg/dL among fetuses of adult pregnant workers. Based on this model, the revised commercial/industrial California Human Health Screening Level (CHHSL) for lead is 320 mg/kg (OEHHA, 2009).

6.3 Estimated Adverse Noncancer Health Effects

Noncarcinogenic effects are typically evaluated by comparing an exposure level over a specified time period, with an RfD/RfC based on a similar time period. To estimate noncancer effects, the intake is divided by the RfD/RfC. The resulting value is referred to as a hazard quotient (HQ).

The hazard index (HI) for each receptor from exposure to multiple chemicals was estimated by summing the HQs for each chemical for a given exposure pathway using the following equation:

$$HI_p = \sum_{i=1}^{n} HQ_{i,p}$$

Where:

HI_p = Hazard index for the receptor's exposure to *n* chemicals via pathway *p* (unitless);
n = Number of chemicals (i.e., all relevant COPCs); and
$HQ_{i,p}$ = Hazard quotient for chemical *i* for pathway *p* (unitless).

A HI less than or equal to one indicates that no adverse noncancer health effects are expected to occur (USEPA, 1989).

6.4 Estimated Lifetime Excess Cancer Risk

SFs/IURs were used to estimate the potential excess cancer risk associated with exposure to individual COPCs. Consistent with USEPA (1989) risk assessment guidelines, the SF/IUR was multiplied by the chronic daily intake averaged over 70 years to estimate lifetime excess cancer risk. The resulting values are referred to as excess cancer risks. These potential excess cancer risks are compared to CalEPA's risk management range of 1 x 10^{-6} to 1 x 10^{-4}. The CalEPA threshold value of one-in-one million (1 x 10^{-6}) represents the lower end (most stringent) of the CalEPA's risk management range and is the point of departure for risk management decisions for all receptors. An excess cancer risk of one-in-one hundred thousand (1 x 10^{-5}) is generally acceptable for occupational exposures.

The excess cancer risk for each receptor from exposure to multiple chemicals was estimated by summing the excess cancer risks for each chemical for a given exposure pathway using the following equation:

$$CR_p = \sum_{i=1}^{n} CR_{i,p}$$

Where:

CR_p = Excess cancer risk for the receptor's exposure to *n* chemicals via pathway *p* (unitless);
n = Number of chemicals (i.e., all relevant COPCs); and
$CR_{i,p}$ = Excess cancer risk for chemical *i* via pathway *p.*

The results of this risk characterization process for potential human receptors identified in Section 4.4 are summarized in Table E6-1. The risk characterization equations and tables for each potential receptor and exposure pathway are presented in Attachment E-5. The results are summarized in Section 8.0, following a discussion of uncertainties (Section 7.0) that may influence the results of the risk assessment.

7.0 UNCERTAINTY ANALYSIS

Quantifying uncertainty is an essential element of the risk assessment process. According to the USEPA Guidance on Risk Characterization for Risk Managers and Risk Assessors, point estimates of risk "do not fully convey the range of information considered and used in developing the assessment" (USEPA, 1992). This section presents the major sources of uncertainty and characterizes the degree of uncertainty associated with the HHRA.

Risk assessments are not intended to estimate actual risks to a receptor associated with exposure to chemicals in the environment. In fact, estimating actual risks is impossible because of the variability in the potentially exposed populations. In actuality, the risk assessment estimates the probability that an adverse health effect will occur in a receptor. The additive effect of using conservative assumptions in the risk assessment guards against underestimation of risks.

Risk estimates are calculated by combining site data, assumptions about individual receptor's exposures to impacted media, and toxicity data. The uncertainties in this HHRA are driven by variability in the following:

- The chemical monitoring data used to identify COPCs;
- The fate and transport models with which concentrations at receptor locations were estimated;
- The receptor intake parameters; and
- The accuracy of toxicity values used to characterize exposure, HIs, and excess cancer risks.

Additionally, uncertainties are introduced in the risk assessment when exposures to several substances across multiple pathways are summed.

Uncertainties are inherent in each of the following components of the risk assessment process:

- Data Collection and Evaluation;
- Selection of COPCs;
- Exposure Assessment;
- Toxicity Assessment; and
- Risk Characterization.

Key uncertainties associated with these components are described below.

7.1 Data Collection and Evaluation

The techniques used for data sampling and analysis, and the methods used for identifying chemicals for evaluation in this assessment, may result in a number of uncertainties. These uncertainties are itemized below in the form of assumptions.

- It was assumed that the nature and extent of chemical impacts on and near the Site have been adequately characterized. If this assumption is not valid, then potential health impacts may be over- or underestimated.

- It was assumed that the upper 10 feet of soil may be disturbed in the future during redevelopment. If this assumption is not valid, then potential health impacts may be slightly over- or underestimated.
- It was assumed that the data were accurate. Systematic or random errors in the chemical analyses may yield erroneous data. These types of errors may result in an over- or underestimation of risk.

As noted, each of these assumptions may result in an over- or underestimation of risk. However, the use of maximum detected and 95UCL concentrations as a conservative estimate of average site concentrations can compensate for potential deficiencies in sample size, systematic or random errors, or detection limits in the chemical analyses.

7.2 Selection of Chemicals of Potential Concern

With the exception of arsenic, all detected chemicals were evaluated as COPCs, including naturally occurring constituents. This may result in an overestimation of Site-related noncancer hazards and excess cancer risks for any metals detected below background concentrations or chemicals with a low frequency of detection (i.e., less than 5-percent).

7.3 Exposure Assessment

A number of uncertainties are associated with the exposure assessment, including identification of complete exposure pathways, assumptions used to estimate chemical intakes, estimation of EPCs, and fate and transport modeling. Key uncertainties associated with these components of the risk assessment are summarized below.

7.3.1 Exposure Pathways

The exposure pathways evaluated in this assessment are expected to represent the primary pathways of exposure, based on the results of the chemical analyses and the expected fate and transport of the COPCs in the environment. Minor or secondary pathways may also exist, but often cannot be identified or evaluated using the available data. The contribution of secondary pathways to the overall risk from the Site is not likely to be significant, but it does introduce a minor level of uncertainty to this risk assessment process. However, use of upper-bound intake assumptions, combined with conservative estimates of the mean concentrations, likely compensate for any underestimation of risk from exclusion of minor exposure pathways.

7.3.2 Chemical Intake

For estimating chemical intake, there are uncertainties associated with standard exposure assumptions, such as body weight, length of assumed exposure, life expectancy, population characteristics, and lifestyle. In reality, activity patterns and the physiological response of individuals may vary considerably. Therefore, assumptions made for these exposure parameters may not be representative of any actual exposure situation, but are intended to overestimate exposure and risk.

7.3.3 Exposure Point Concentrations

It is unlikely that a potential receptor will spend the entire exposure duration (one year for construction/utility trench worker receptor, 25 years for commercial/industrial worker receptor) at locations of maximum detected concentrations in soil and groundwater. In this HHRA, the soil data were statistically evaluated on a Parcel-wide basis. Consistent with USEPA (1989) procedures, the lesser of the maximum detected concentration and the recommended UCL was selected to develop soil EPCs. Based on the assumption that a building may be located over maximum concentrations, it is assumed that hypothetical commercial/industrial worker receptor resides over maximum detected concentrations in groundwater. Therefore, the maximum detected concentration was selected as the groundwater EPC. Using a single upperbound concentration to represent an entire area will likely result in an overestimate of exposures, particularly when some of these upperbound concentrations are above 95UCLs (e.g., 99UCL).

7.3.4 Fate and Transport Models

In the absence of direct measurements, mathematical models were used to estimate concentrations of contaminants in indoor air. EPCs for indoor air were derived from a complex model, and some of the associated uncertainties for the indoor air model include estimation of organic carbon content, characteristics of building foundations, and air exchange within a building. Although models cannot predict true EPCs at different times and locations or in different media, they tend to yield conservative EPC values.

The vapor intrusion model used for this risk assessment has been accepted by regulatory agencies and tends to overestimate the EPCs. Some examples of the inherent conservatism built into the model include:

- The model does not account for chemical losses such as biodegradation and vapor-phase adsorption;
- The model assumes a nondepleting, constant source, which results in an unlimited supply of contaminated vapor and an overestimation of vapor emissions to ambient air; and
- The model assumes vapor transport occurs under a single (vertical) dimension and ignores the potential for vapor migration in multiple directions away from the source area.

A more detailed discussion of uncertainties associated with the fate and transport models is presented in Attachment E-3.

7.4 Toxicity Assessment

Primary uncertainties associated with the toxicity assessment are related to the derivation of toxicity values for COPCs. Published RfDs and SFs established by OEHHA, DTSC, USEPA, and ATSDR were used to estimate potential adverse noncancer health effects and excess cancer risks from exposure to COPCs. The toxicity values are derived by applying conservative (health protective) assumptions and are intended to protect all potentially exposed individuals within a population.

Toxicity information for many chemicals is often limited. Consequently, there are varying degrees of uncertainty with the calculated toxicity values. Sources of uncertainty associated with toxicity values include:

- Using dose-response information from effects observed at high doses to predict the adverse effects that may occur following exposure to the low levels expected from human contact with the agent in the environment;
- Using dose-response information from short-term exposures to predict the effects of long-term exposures, and vice-versa;
- Using dose-response information from animal studies to predict effects in humans; and
- Using dose-response information from homogeneous animal populations or a small subset of human populations to predict the effects likely to be observed in the general population consisting of individuals with a wide range of sensitivities.

To compensate for these uncertainties, USEPA applies modifying and uncertainty factors in developing noncancer-based toxicity values and applies low-dose extrapolation in developing cancer-based toxicity values. Use of the USEPA toxicity values is intended to result in an overestimation of HIs and excess cancer risks.

7.4.1 Surrogates

Toxicity values were not available for some COPCs (Section 5.5). Based on structural similarities, an appropriate surrogate compound was identified to characterize toxicity. The toxicity values for each identified surrogate were used to evaluate the COPCs without published toxicity values, which may over- or underestimate risks.

7.4.2 Route-to-Route Extrapolation

Toxicity values for both the oral and inhalation routes of exposure were not available for certain COPCs. Noncancer adverse health effects and excess cancer risks can be assessed only when relevant toxicity values are available for the COPCs. For some compounds, DTSC (2016) recommends route-to-route extrapolation between the oral and inhalation exposure pathways where no toxicity value is available for the inhalation route of exposure but an oral toxicity value is available. Without route–specific toxicity values, the use of route-to-route extrapolation may over- or underestimate risks.

7.4.3 Dermal Exposure

The use of oral toxicity values to assess the dermal pathway introduces additional uncertainty into the results; risks may be over- or underestimated as a result. Adjusting the oral toxicity values by using the GIABS factor to estimate dermal toxicity values could underestimate risk, the magnitude of which being inversely proportional to the true oral absorption of the chemical in question.

7.5 Risk Characterization

Standard USEPA methods were used for the risk characterization step. Using USEPA methods, risks from exposure to multiple noncarcinogens and carcinogens were added to estimate the HI and total excess cancer risk, respectively. This approach assumes that the risks from COPCs that have different target organs are additive. That assumption contributes to the uncertainty in the risk assessment and may underestimate or overestimate risks, depending on whether synergistic or antagonistic interactions occur among COPCs at the site. Information about such interactions is generally not available, so possible interactions were not evaluated in this HHRA.

7.6 Summary of Risk Assessment Uncertainties

The analysis of uncertainties associated with the HHRA indicates that noncancer adverse health effects as well as excess cancer risk estimates will overestimate actual impacts to human health. Although many factors can contribute to the potential for over- or underestimating risk, a mixture of conservative and upper-bound input values were identified to estimate potential exposures. Compounding conservative and upper-bound input values in the risk assessment process is intended to yield health-protective and conservative estimates. A summary of uncertainties is presented in the following table.

Item	Potential to Overestimate Risk	Potential to Underestimate Risk	Comments
A single representative concentration for COPCs was used for the Site.	Moderate	Low	Using a single upperbound concentration to represent an entire site will likely result in an overestimate of exposures for the majority of the site.
Minor or secondary exposure pathways may exist but often cannot be identified or evaluated using the available data.	None	Low	Secondary pathways are unlikely to contribute significantly to the overall risk.
COPCs in soil and groundwater were considered at steady-state concentrations throughout the duration of the exposure.	Moderate	Low	Conservative intake assumptions are used, likely resulting in an overestimate of risks. No mass reduction over time is assumed.
EPCs in indoor air were modeled using a variety of conservative assumptions. These conservative assumptions included assuming porous soil types, shallow depths to affected soil, low building air exchange rates, and high amounts of foundation cracking.	High	Low	Assumptions used to address uncertainty are conservative and multiplicative.

Item	Potential to Overestimate Risk	Potential to Underestimate Risk	Comments
Default input parameters recommended by the regulatory agencies were used to estimate exposures. The input parameters may not represent actual receptor intakes.	Moderate-High	Low	Chronic daily intake likely does not accurately reflect actual exposure for most receptors.
Toxicity values were developed primarily from data on animals, for various exposure durations.	Moderate-High	Low	High uncertainty factors and modifying factors addressing various uncertainties compound conservatism.
Chemicals that have been assigned toxicity values were used as surrogates for chemicals without toxicity values.	Low	Low	Surrogate compounds are identified based on similar chemical structure. Surrogates allow for the evaluation of COPCs without published toxicity values.
In characterizing excess cancer risks, SFs derived from animal data were given the same weight-of-evidence as SFs derived from human data.	Moderate-High	Low	To compensate for these uncertainties, USEPA applies low-dose extrapolation when publishing a human toxicity value.
HQs from exposure to multiple noncarcinogens were added to estimate the HI. Similarly, excess cancer risks from exposure to carcinogens were added to estimate the total excess cancer risk. This approach assumes that the risks from COPCs that have different target organs are additive.	Moderate	Low	Compounding conservative and upper-bound input values in the risk assessment process is intended to yield maximum, health-conservative HI and excess cancer risk estimates.

Notes:

The potential for under- or overestimation of risk (low, moderate, high) associated with each uncertainty item is based on the professional judgment of the risk assessor.

8.0 HUMAN HEALTH RISK ASSESSMENT RESULTS

This section summarizes the results of the HHRA conducted for the East Parcel at the Former Chemoil Refinery site. Arsenic, even at low concentrations or background concentrations, can result in elevated estimated risks. Section 8.1 discusses the regional background arsenic screening level in comparison with Site-related arsenic concentrations. Lead was evaluated by comparing the lead concentrations with the commercial/industrial CHHSL of 320 mg/kg. The results of the lead evaluation are discussed in Section 8.2. Section 8.3 discusses the HHRA results for the remaining COPCs.

USEPA guidance on risk and exposure levels considered protective of human health is presented to provide context for interpretation of the HI and excess cancer risk estimates presented in this HHRA. Hazard indices are compared to the USEPA and CalEPA recommended target HI of one (USEPA, 1989). Excess cancer risks are compared to the CalEPA's risk management range of one-in-one-million (1×10^{-6}) to one-in-ten thousand (1×10^{-4}). The CalEPA threshold value of 1×10^{-6} represents the lower end (most stringent) of the CalEPA's risk management range and is the point of departure for risk management decisions for all receptors. An excess cancer risk of one-in-one hundred thousand (1×10^{-5}) is generally acceptable for occupational exposures. The USEPA target excess cancer risks represent the incremental probability of an individual developing cancer over a lifetime as a result of chemical exposure. This probability is considered an excess cancer risk because the incidence of cancer from all sources other than chemicals associated with a site (i.e., background) are substantial.

8.1 Arsenic

At many sites in California, arsenic is naturally occurring and detected at concentrations greater than a risk-based screening level. Therefore, it is appropriate to compare the maximum detected arsenic concentration with the appropriate ambient arsenic concentration. A Southern California regional background arsenic concentration of 12 mg/kg has been suggested as a useful risk management screening number by representatives of the DTSC (Chernoff, D. et.al.). Arsenic was detected at the East Parcel with a frequency of 100%, with concentrations in soil from 0 to 10 feet bgs ranging from 4.0 mg/kg to 18 mg/kg. The 95-percent upper confidence limit of the mean concentration (95UCL) for arsenic in soil is 12 mg/kg. Arsenic was detected at a concentration above 12 mg/kg in 7 of the 27 soil samples. These 7 soil samples were collected at 5 and 10 feet bgs. At these 7 locations at 1 foot bgs, arsenic concentrations were below 12 mg/kg. Generally direct contact with soil will occur in the top foot of soil, except under construction exposure scenarios. Since arsenic concentrations above background are only detected at depth (i.e., greater than 5 feet bgs), arsenic in soil is likely background. Therefore, arsenic in soil at the East Parcel does not pose a risk above background to potential onsite receptors.

8.2 Lead

For industrial worker exposure scenarios, DTSC (2011a) recommends a modified version of USEPA's June 21, 2009 ALM (DTSC, 2011c). The model calculates the concentration in exterior soil and interior dust that will result in a 90th percentile estimate of blood lead among fetuses of adult workers of 1 µg/dL. Based on this model, the commercial/industrial CHHSL is 320 mg/kg (OEHHA, 2009). Lead was detected at the East Parcel with a frequency of 96%, with concentrations in soil from 0 to 10 feet bgs ranging from 0.5 mg/kg to 100 mg/kg. The maximum detected lead concentration of 100 mg/kg is well below the commercial/industrial CHHSL of 320 mg/kg.

8.3 Other COPCs

The HHRA results for the all remaining COPCs are discussed in the following sections by hypothetical receptor.

8.3.1 Hypothetical Onsite Construction/Utility Trench Worker Receptor

The HI estimate exceeds the USEPA and CalEPA target level of one. The excess cancer risk estimate is below CalEPA's risk management range of 1 x 10^{-6} to 1 x 10^{-4}.

Exposure Pathway	Hazard Index (HI)	Excess Cancer Risk (CR)	Comments
Direct Contact with COPCs in Soil (0 to 10 feet bgs)	2	3 x 10^{-7}	HI exceeds USEPA/CalEPA target level. Individual HIs for all COPCs do not exceed 1. Cobalt HI = 0.4 (Target: Thyroid) Nickel HI = 0.3 (Target: Development) Thallium HI = 0.4 (Target: Skin) Vanadium HI = 0.2 (Target: Kidney) CR is less than CalEPA's risk management range.
TOTAL	**2**	**3 x 10^{-7}**	

No COPCs in soil have an individual HI exceeding the acceptable USEPA/CalEPA target level of one. Cobalt, nickel, thallium, and vanadium in soil are the primary contributors to the elevated HI. The individual HI estimates for direct contact with cobalt, nickel, thallium, and vanadium in soil account for 83% of the total HI. As shown in the table above, the primary critical effects of cobalt, nickel, thallium, and vanadium toxicity do not include the same target organ or system. Since individual HI estimates do not exceed one and the highest individual HIs are not associated with a primary critical effect on the same target organ or system, the COPCs do not pose adverse noncancer effects to the hypothetical onsite construction/utility worker receptor.

The total excess cancer risk of 3 x 10^{-7} is less than the most stringent end of CalEPA's risk management range of 1 x 10^{-6} to 1 x 10^{-4} and is less than 1 x 10^{-5}, which is generally acceptable for occupational exposures. Therefore, COPCs do not pose an excess cancer risk to the hypothetical onsite construction/utility trench worker receptor.

Individual, pathway-specific risk characterization results for this receptor, showing estimated HIs and excess cancer risks are presented in Table E-5A of Attachment E-5.

8.3.2 Hypothetical Onsite Commercial/Industrial Worker Receptor

The HI estimate does not exceed the USEPA and CalEPA target level of one and the excess cancer risk estimate is within CalEPA's risk management range of 1×10^{-6} to 1×10^{-4}.

Exposure Pathway	Hazard Index (HI)	Excess Cancer Risk (CR)	Comments
Direct Contact with COPCs in Soil (0 to 15 feet bgs)	0.3	2×10^{-8}	HI does not exceed USEPA/CalEPA target level. CR is less than CalEPA's risk management range.
Inhalation of COPCs Volatilizing from Groundwater into Indoor Air	0.009	7×10^{-6}	HI does not exceed USEPA/CalEPA target level. CR is within CalEPA's risk management range.
TOTAL	**0.3**	**7×10^{-6}**	

For direct contact with COPCs in soil, the COPCs do not pose adverse noncancer effects to the hypothetical onsite commercial/industrial worker receptor.

For inhalation of COPCs volatilizing from groundwater into indoor air, the total excess cancer risk of 7×10^{-6} is within CalEPA's risk management range and is less than 1×10^{-5}, which is generally acceptable for occupational exposures. Therefore, COPCs do not pose a risk to the hypothetical onsite commercial/industrial worker receptor.

Individual, pathway-specific risk characterization results for this receptor, showing estimated HIs and excess cancer risks are presented in Tables E-5B and E-5C of Attachment E-5.

9.0 CONCLUSIONS

Based on the results of the HHRA, estimated human health risks are below risk management thresholds for commercial/industrial land use. Remedial actions are not warranted at the East Parcel prior to redevelopment of the East Parcel for light industrial/commercial purposes.

Administrative and institutional controls will be implemented prior to development of the East Parcel, as required in the California Land Reuse and Revitalization Act Agreement (CLRRA) prepared for the Site. Expected controls include a land use covenant (LUC) and Site Management Plan (SMP). The LUC will prohibit use of underlying groundwater and prohibit unrestricted or sensitive land uses.

10.0 REFERENCES

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11.0 LIMITATIONS

This document has been prepared for the exclusive use of SHE, RES, and their representatives as it pertains to the affected property as described above. Any interpretation of the data represents our professional opinions, and is based in part on information supplied by the client. These opinions and information are based on currently available data and are arrived at in accordance with currently accepted hydrogeologic and engineering practices at this time and location.

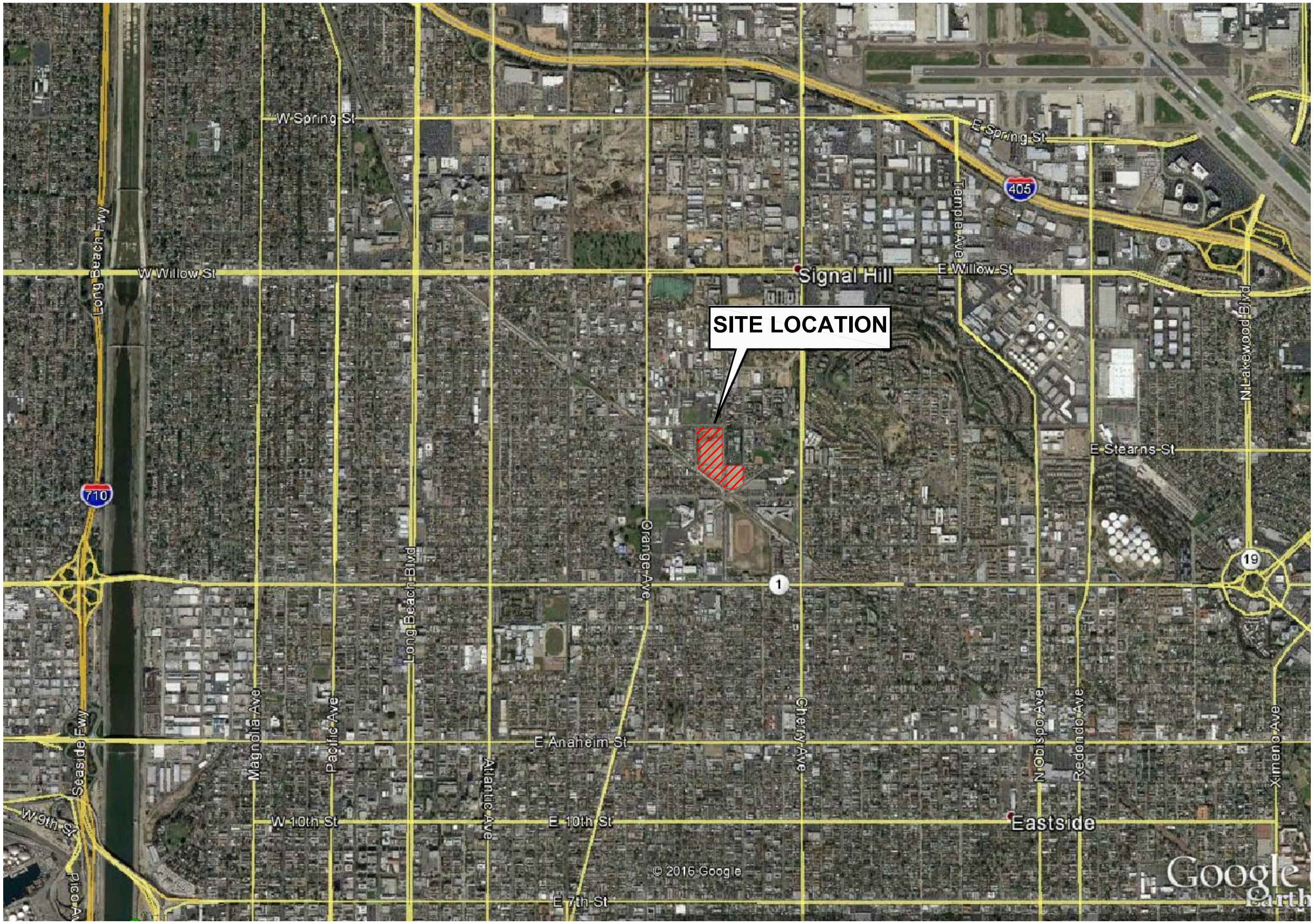
The data presented in this transmittal are intended only for the purpose, site location, and project indicated. This report is not a definitive study of contamination at the site and should not be interpreted as such. The data reported are limited by the scope of the work as defined by the request of the client, the time, availability of access to the site, and information passed to Apex-SGI.

There are no representations or guarantees that the sampling points are representative of the entire site. Data collected in response to this work may reflect the conditions at specific locations at a specific point in time and does not reflect subsurface variations that may exist between sampling points. These variations cannot be anticipated nor can they be entirely accounted for even with exhaustive additional testing. No other interpretations, warranties, guarantees, expressed or implied, are included or intended in the contents of this transmittal.

As required, all proposed work will be performed under the direct supervision of a Professional Geologist or Registered Civil Engineer as defined in the Registered Geologist Act of the California Code of Regulations.

FIGURES

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\App\App E\Figures\Fig.E1-1-Site Location Map.dwg, 6/12/2017 11:51:12 AM



SGI environmental | APEX

299 WEST HILLCREST DR. SUITE 220
THOUSAND OAKS, CA 91360

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

SITE LOCATION MAP

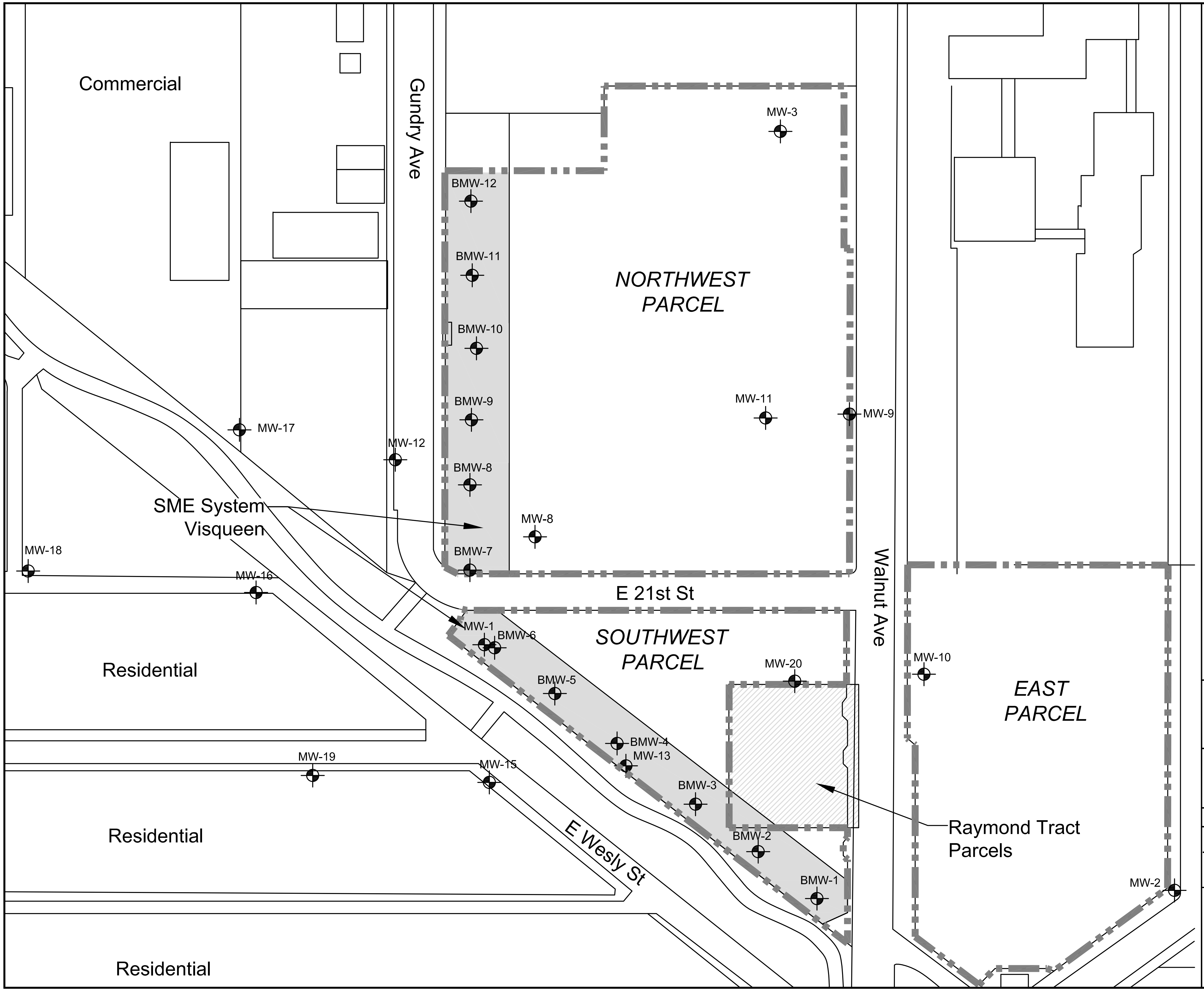
PROJECT NO.	DATE	DR.BY:	APP. BY:
093-CHEMOIL-001	05/30/17	ZA	KD

0 2500 5000
HORIZONTAL SCALE IN FEET

N

FIGURE E1-1

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\App\App E\Fig.E1-2-Site Map.dwg, 6/12/2017 11:57:14 AM



LEGEND

Site Boundary

MW-16 Groundwater Monitoring Well Locations

SME Subsurface Metabolic Enhancement

SITE MAP

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

PROJECT NO.	DATE	DRAWN BY:	APP. BY:
01-CHEMOIL-001	02/08/17	ZA	KD

0 100 200
HORIZONTAL SCALE IN FEET

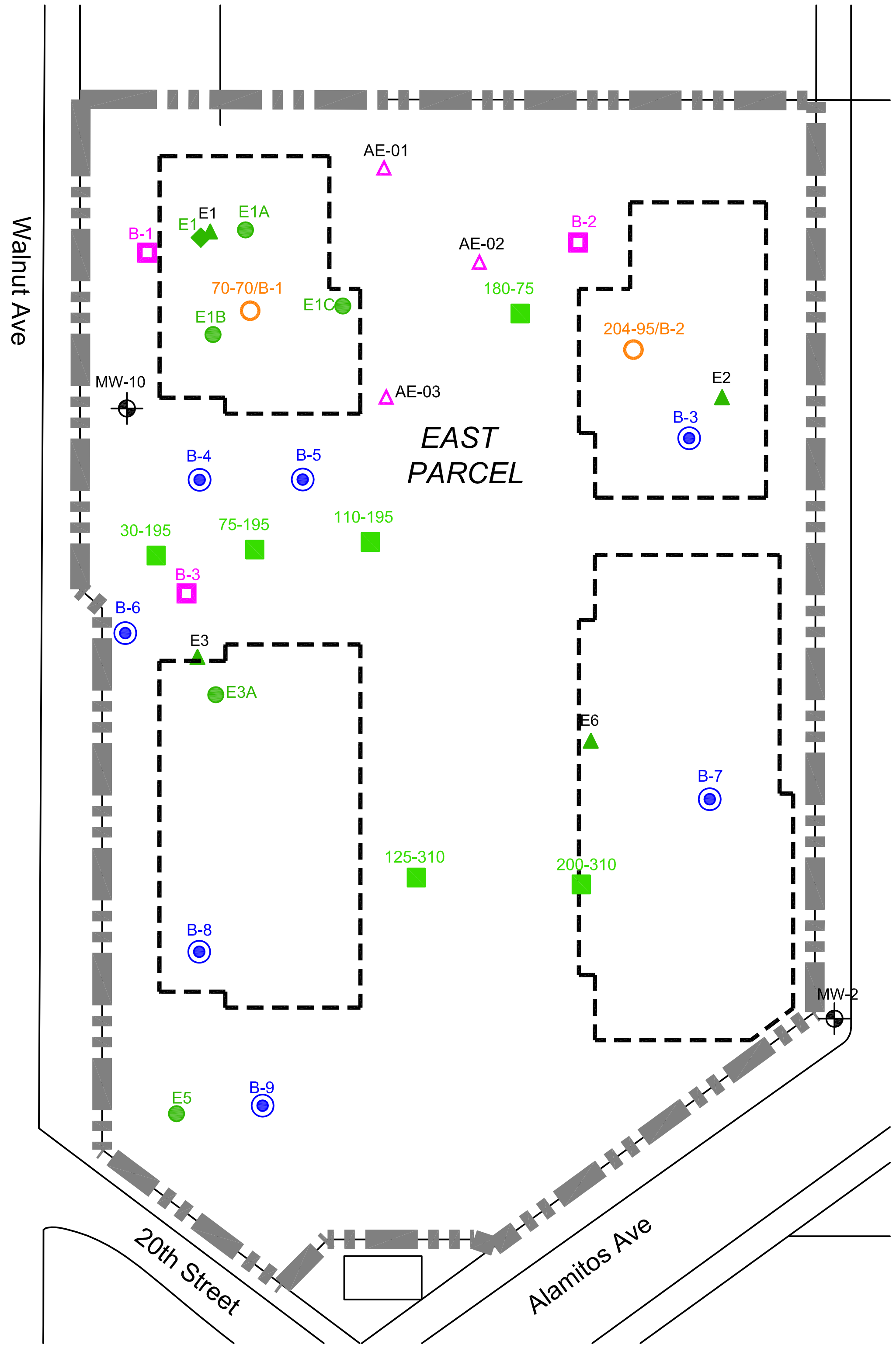
SGI environmental APEX

3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

N

FIGURE
E2-1

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\App\App E\Figures\Fig.E3-1-Site Plan East Parcel.dwg, 6/12/2017 12:02:07 PM



LEGEND

MW-10 ⌖	Groundwater Monitoring Well Locations
E1 ▲	2006 ROST™ Boring Location (Tetratech, 2006)
AE-03 △	2016 UVOST™ Boring Location
E1B ●	Soil and Grab Groundwater Sample Locations (Tetratech, 2006)
E1 ◆	Soil Vapor Point (Tetratech, 2006)
UVOST	Ultra-Violet Optical Screening Tool
ROST	Rapid Optical Screening Tool
B-7 ◉	TEC Push-Drive Soil Boring (TEC, 2001)
B-3 ▣	Former EEI (1988) Soil Boring (TEC, 2001)
200-30 ■	Former TSG (1999) Soil Boring (TEC, 2001)
11 ○	Combined TSG/TEC Boring Location (TEC, 2001)
⬚	Proposed Building Location

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299 WEST HILLCREST DR. SUITE 220
THOUSAND OAKS, CA 91360

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

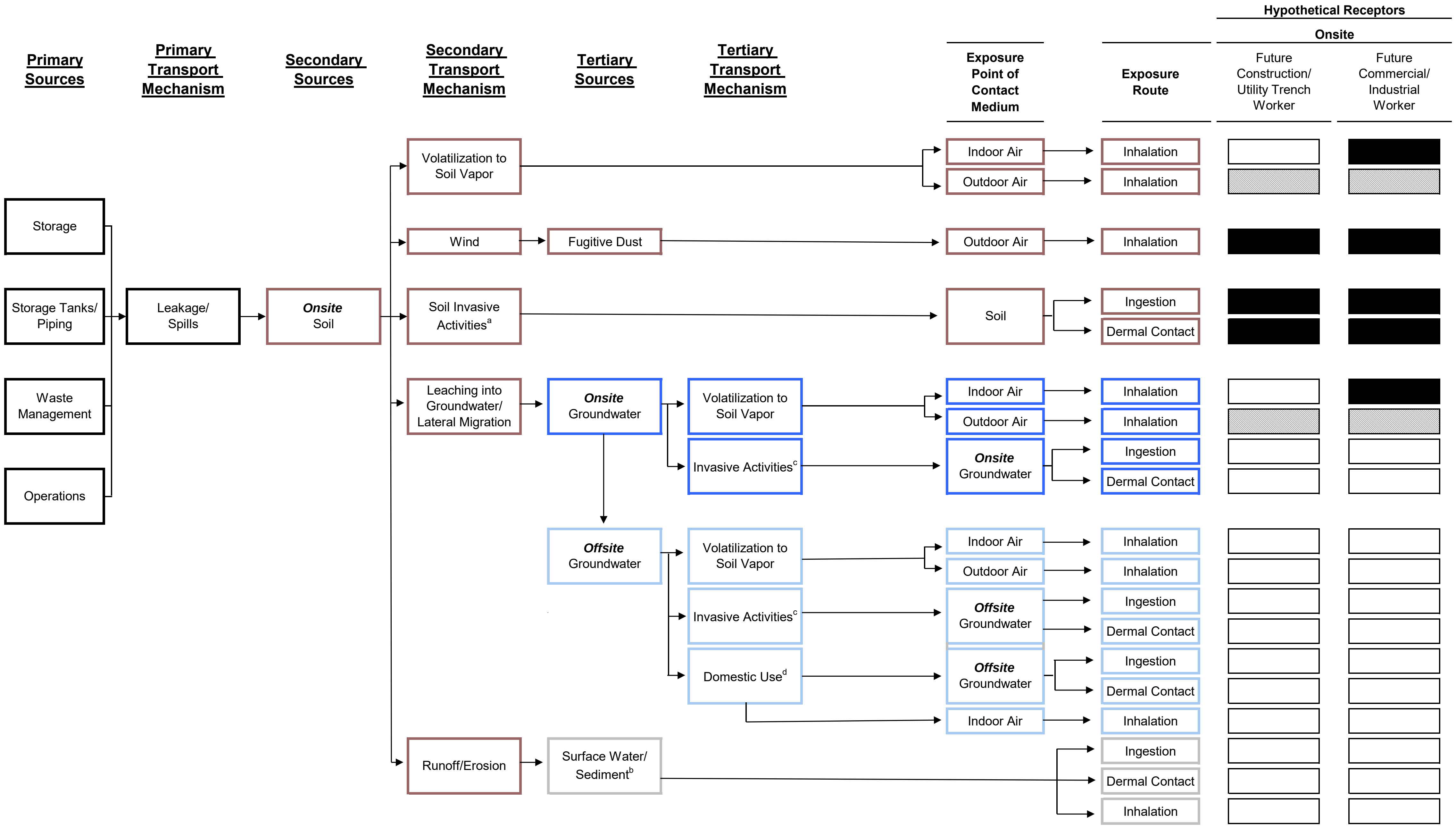
SITE PLAN
EAST PARCEL

N

PROJECT NO.	DATE	DR.BY:	APP. BY:
093-CHEMOIL-001	05/03/17	ZA	KD

0 60 100
HORIZONTAL SCALE IN FEET

FIGURE E3-1



☐ CSM components related to soil.

☐ CSM components related to onsite groundwater.

☐ CSM components related to offsite groundwater.

☐ CSM components related to surface water.

■ Receptor likely to be exposed via this route, so pathway is considered potentially complete.

▨ Receptor may be exposed via this route, so pathway is considered potentially complete; however, pathway is considered minor.

☐ Pathway is incomplete, no further evaluation required.

[a] Soil invasive activities may extend to 10 feet below ground surface (bgs) and include construction and development for commercial/industrial land use.

[b] No surface water bodies were identified within a one-half mile radius of the site.

[c] Surface invasive activities are not expected to extend beyond 10 feet bgs during construction and development. Due to Site topography, depth to water in existing monitoring wells on East Parcel is approximately 30 feet bgs.

[d] Groundwater quality within the Site vicinity is generally poor due to seawater intrusion and elevated salinity. Shallow groundwater is not currently used and is not likely to be developed for beneficial use. Risk management measures can be implemented to ensure that groundwater is not used. The nearest public water supply well is located downgradient approximately 850 feet south of the Site (Los Angeles County Department of Public Works Well 420), however is used for groundwater monitoring purposes only.

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CALIFORNIA

EAST PARCEL
HUMAN HEALTH
CONCEPTUAL SITE MODEL

PROJECT NO.	DATE	DRAWN BY	APP. BY
093-CHEMOIL-001	05/19/17	II	KD

SGI environmental APEX
299 WEST HILLCREST DRIVE, SUITE 220
THOUSAND OAKS, CA 91360

FIGURE
E4-1

TABLES

Table E3-1
Statistical Summary of Soil (0 to 10 feet bgs) Analytical Data - East Area

Former ChemOil Refinery
Signal Hill, California

Chemical	Number of Samples	Number of Detections	Frequency of Detection	Arithmetic Mean of Detected (mg/kg)	Standard Deviation of Detected (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	95 Percent Upper Confidence Limit of the Arithmetic Mean (95UCL) (mg/kg)	Lesser of the Maximum Detected Concentration and the 95UCL (mg/kg)
Metals									
Antimony	27	26	96%	0.58	0.21	0.36	1.0	0.64	0.64
Arsenic	27	27	100%	10	4.7	4.0	18	12	12
Barium	27	27	100%	103	87	30	450	125	125
Beryllium	27	0	0%	ND	ND	ND	ND	NE	ND
Cadmium	27	0	0%	ND	ND	ND	ND	NE	ND
Chromium	27	27	100%	18	8.3	7.5	40	20	20
Cobalt	27	27	100%	8.1	3.3	3.5	14	9.2	9.2
Copper	27	27	100%	17	10	3.0	48	20	20
Lead	27	26	96%	6.9	19	0.50	100	22	22
Mercury	26	3	12%	1.1	1.7	0.11	3.0	0.44	0.44
Molybdenum	27	23	85%	0.43	0.1	0.26	0.50	0.44	0.44
Nickel	27	27	100%	15	12	4.5	64	18	18
Selenium	27	0	0%	ND	ND	ND	ND	NE	ND
Silver	27	0	0%	ND	ND	ND	ND	NE	ND
Thallium	27	26	96%	0.89	0.46	0.33	2.0	1.3	1.3
Vanadium	27	27	100%	35	21	15	120	43	43
Zinc	27	27	100%	44	33	22	200	56	56
TPH									
C5-C12	29	4	14%	235	399	7.4	830	216	216
C13-C22	29	8	28%	1,246	2,280	9.2	6,540	1,553	1,553
C23-C44	29	16	55%	650	1,320	5.3	3,880	1,561	1,561
VOCs									
Benzene	33	1	3%	NE	NE	0.057	0.057	NE	0.057
n-Butylbenzene	5	0	0%	ND	ND	ND	ND	NE	ND
sec-Butylbenzene	5	0	0%	ND	ND	ND	ND	NE	ND
tert-Butylbenzene	5	0	0%	ND	ND	ND	ND	NE	ND
Ethylbenzene	33	6	18%	0.23	0.35	0.0088	0.82	0.18	0.18
Isopropylbenzene	5	0	0%	ND	ND	ND	ND	NE	ND
Naphthalene	5	1	20%	NE	NE	0.0050	0.0050	NE	0.0050
Toluene	33	2	6%	0.15	0.20	0.0068	0.29	0.087	0.087
Total Xylenes	33	5	15%	0.73	1.5	0.014	3.4	0.82	0.82
PAHs									
Acenaphthene	1	1	100%	NE	NE	0.22	0.22	NE	0.22
Acenaphthylene	1	1	100%	NE	NE	ND	ND	NE	ND
Anthracene	1	1	100%	NE	NE	ND	ND	NE	ND
Benz(a)anthracene	1	1	100%	NE	NE	ND	ND	NE	ND
Benzo(a)pyrene	1	1	100%	NE	NE	ND	ND	NE	ND
Benzo(b)fluoranthene	1	1	100%	NE	NE	ND	ND	NE	ND
Benzo(k)fluoranthene	1	1	100%	NE	NE	ND	ND	NE	ND
Benzo(g,h,i)perylene	1	1	100%	NE	NE	ND	ND	NE	ND
Chrysene	1	1	100%	NE	NE	1.6	1.6	NE	1.6
Dibenz(a,h)anthracene	1	1	100%	NE	NE	ND	ND	NE	ND
Fluoranthene	1	1	100%	NE	NE	0.036	0.036	NE	0.036
Fluorene	1	1	100%	NE	NE	0.39	0.39	NE	0.39
Indeno(1,2,3-c,d)pyrene	1	1	100%	NE	NE	ND	ND	NE	ND
Naphthalene	1	1	100%	NE	NE	1.2	1.2	NE	1.2
Phenanthrene	1	1	100%	NE	NE	2.0	2.0	NE	2.0
Pyrene	1	1	100%	NE	NE	2.0	2.0	NE	2.0

Notes:
feet bgs = feet below ground surface.
mg/kg = milligrams per kilogram.
TPH = total petroleum hydrocarbons.
VOC = volatile organic compounds.
PAH = polycyclic aromatic hydrocarbons.
ND = Not detected.
NE = Not estimated due to limitations in database (i.e., not detected in more than one sample).

Table E3-2
Statistical Summary of Groundwater Analytical Data - East Area
Former ChemOil Refinery
Signal Hill, California

Chemical	Number of Samples	Number of Detections	Frequency of Detection	Arithmetic Mean of Detected (µg/L)	Standard Deviation of Detected (µg/L)	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)
Metals							
Antimony	11	2	18%	0.0060	0.0013	0.0051	0.0069
Arsenic	11	11	100%	1.0	3.0	0.0067	10
Barium	11	11	100%	20	65	0.060	215
Beryllium	11	0	0%	ND	ND	ND	ND
Cadmium	11	0	0%	ND	ND	ND	ND
Chromium	11	10	91%	0.11	0.12	0.010	0.35
Cobalt	11	9	82%	0.062	0.083	0.010	0.27
Copper	11	11	100%	0.068	0.087	0.0072	0.30
Lead	11	3	27%	0.050	0.052	0.020	0.11
Mercury	11	0	0%	ND	ND	ND	ND
Molybdenum	11	10	91%	0.048	0.026	0.010	0.090
Nickel	11	9	82%	0.073	0.090	0.010	0.29
Selenium	11	0	0%	ND	ND	ND	ND
Silver	11	0	0%	ND	ND	ND	ND
Thallium	11	3	27%	0.013	0.0058	0.010	0.020
Vanadium	11	10	91%	0.15	0.16	0.0077	0.50
Zinc	11	11	100%	0.22	0.24	0.030	0.72
VOCs							
Bis (2-chloroethyl) ether	18	2	11%	800	990	100	1,500
tert-Butyl Alcohol	9	3	33%	122	103	15	220
sec-Butylbenzene	21	2	10%	1.7	0.071	1.6	1.7
Isopropylbenzene	21	4	19%	5.8	6.2	0.65	13
Naphthalene	21	4	19%	20	30	1.3	65
n-Propylbenzene	21	3	14%	7.8	6.5	0.51	13
o-Xylene	15	3	20%	1.9	1.2	0.65	3.0

Notes:
feet bgs = feet below ground surface.
µg/L = micrograms per liter.
VOC = volatile organic compounds.
ND = Not detected.
NE = Not estimated due to limitations in database (i.e., not detected in more than one sample).

Table E3-3
Statistical Summary of Soil Vapor (5 feet bgs) Analytical Data - East Area
Former ChemOil Refinery
Signal Hill, California

Chemical	Number of Samples	Number of Detections	Frequency of Detection	Arithmetic Mean of Detected ($\mu g/m^3$)	Standard Deviation of Detected ($\mu g/m^3$)	Minimum Detected Concentration ($\mu g/m^3$)	Maximum Detected Concentration ($\mu g/m^3$)
VOCs							
Benzene	1	0	0%	ND	ND	ND	ND
Ethylbenzene	1	1	100%	NE	NE	10,800	10,800
Methyl tert-Butyl Ether	1	0	0%	ND	ND	ND	ND
Toluene	1	0	0%	ND	ND	ND	ND
1,2,4-Trimethylbenzene	1	0	0%	ND	ND	ND	ND
1,3,5-Trimethylbenzene	1	0	0%	ND	ND	ND	ND
o-Xylene	1	0	0%	ND	ND	ND	ND
m,p-Xylenes	1	0	0%	ND	ND	ND	ND

Notes:

feet bgs = feet below ground surface.

$\mu g/m^3$ = micrograms per liter.

VOC = volatile organic compounds.

ND = Not detected.

NE = Not estimated due to limitations in database (i.e., not detected in more than one sample).

Table E4-1

Exposure Intake Assumptions for Hypothetical Onsite Construction/Utility Trench Worker Receptor

Former ChemOil Refinery
Signal Hill, California

Parameter	Acronym	Value	Unit	Source
Averaging Time - Carcinogens[1]	ATc	25,550	days	DTSC, 2014
Averaging Time - Noncarcinogens	ATn	365	days	DTSC, 2014
Lifetime	LT	70	years	DTSC, 2014
Exposure Frequency	EF	250	days/year	DTSC, 2014
Exposure Duration	ED	1	year	DTSC, 2014
Exposure Time	ET	8	hours/day	USEPA, 2009
Body Weight	BW	80	kg	DTSC, 2014
Soil Ingestion Rate	IRs	330	mg/day	DTSC, 2014
Skin Surface Area	SA	6,032	cm^2	DTSC, 2014
Soil Adherence Factor	AF	0.8	mg/cm^2-day	DTSC, 2014
Dermal Absorption Factor	ABS	Chemical-Specific	unitless	Table E4-3
Particulate Emission Factor	PEF	1.00E+06	m^3/kg	DTSC, 2014

Notes:

kg = kilograms.
mg/day = milligrams per day.
cm^2 = square centimeters.
[1] Based on a 70 year lifetime.
mg/cm^2-day = milligrams per square centimeter per day.
m^3/kg = cubic meters per kilogram.

References:

DTSC. 2014. Human Health Risk Assessment Note Number 1, Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities. September 30.

USEPA. 2009. Supplemental Guidance for Inhalation Risk Assessment, or Part F of Volume I of Risk Assessment Guidance for Superfund, Human Health Evaluation Manual. Office of Solid Waste and Emergency Response. EPA-540-R-070-002. January.

Table E4-2
Exposure Intake Assumptions for Hypothetical Onsite Commercial/Industrial Worker Receptor
Former ChemOil Refinery
Signal Hill, California

Parameter	Acronym	Value	Unit	Source
Averaging Time (carcinogens)[1]	ATc	25,550	days	DTSC, 2014
Averaging Time (noncarcinogens)	ATn	9,125	days	DTSC, 2014
Lifetime	LF	70	years	DTSC, 2014
Exposure Frequency	EF	250	day/year	DTSC, 2014
Exposure Duration	ED	25	years	DTSC, 2014
Exposure Time	ET	8	hours/day	USEPA, 2009
Body Weight	BW	80	kg	DTSC, 2014
Soil Ingestion Rate	IRs	100	mg/day	DTSC, 2014
Skin Surface Area	SA	6,032	cm^2	DTSC, 2014
Soil Adherence Factor	AF	0.2	mg/cm^2-day	DTSC, 2014
Dermal Absorption Factor	ABS	Chemical-Specific	unitless	Table E4-3
Particulate Emission Factor	PEF	1.36E+09	m^3/kg	DTSC, 2014

Notes:

kg = kilograms.

mg/day = milligrams per day.

cm^2 = square centimeters.

[1] Based on a 70 year lifetime.

mg/cm^2-day = milligrams per square centimeter per day.

m^3/kg = cubic meters per kilogram.

References:

DTSC. 2014. Human Health Risk Assessment Note Number 1, Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities. September 30.

USEPA. 2009. Supplemental Guidance for Inhalation Risk Assessment, or Part F of Volume I of Risk Assessment Guidance for Superfund, Human Health Evaluation Manual. Office of Solid Waste and Emergency Response. EPA-540-R-070-002. January.

Table E4-3
Chemical-Specific Dermal Absorption Factors (ABS)
Former ChemOil Refinery
Signal Hill, California

Chemical of Potential Concern	ABS (unitless)	Source
Metals		
Antimony	0.01	DTSC, 2015
Arsenic	0.03	DTSC, 2015
Barium	0.01	DTSC, 2015
Chromium	0.01	DTSC, 2015
Cobalt	0.01	DTSC, 2015
Copper	0.01	DTSC, 2015
Lead	0.01	DTSC, 2015
Mercury	0.01	DTSC, 2015
Molybdenum	0.01	DTSC, 2015
Nickel	0.01	DTSC, 2015
Thallium	0.01	DTSC, 2015
Vanadium	0.01	DTSC, 2015
Zinc	0.01	DTSC, 2015
Total Petroleum Hydrocarbons (TPH)		
TPH (C4-C12) Aliphatic	0	USEPA, 2016
TPH (C4-C12) Aromatic	0	USEPA, 2016
TPH (C13-C22) Aliphatic	0	USEPA, 2016
TPH (C13-C22) Aromatic	0	USEPA, 2016
TPH (C23-C44) Aliphatic	0	USEPA, 2016
TPH (C23-C44) Aromatic	0.10	USEPA, 2016
Volatile Organic Compounds (VOCs)		
Benzene	0	DTSC, 2014
Ethylbenzene	0	DTSC, 2014
Naphthalene	0	DTSC, 2014
Toluene	0	DTSC, 2014
Total Xylenes	0	DTSC, 2014
Polycyclic Aromatic Hydrocarbons (PAHs)		
Acenaphthene	0.15	DTSC, 2015
Chrysene	0.15	DTSC, 2015
Fluoranthene	0.15	DTSC, 2015
Fluorene	0.15	DTSC, 2015
Phenanthrene	0.15	DTSC, 2015
Pyrene	0.15	DTSC, 2015

References:

DTSC. 2014. Human Health Risk Assessment Note Number 1, Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities. September 30.

DTSC. 2015. Preliminary Endangerment Assessment Guidance Manual. October.

USEPA. 2016. Regional Screening Levels for Chemical Contaminants at Superfund Sites. USEPA Region 3, Region 6, and Region 9. May.

Table E4-4
Exposure Point Concentrations for the Chemicals of Potential Concern (COPCs) in Soil (0 to 10 feet bgs)
Former ChemOil Refinery
Signal Hill, California

Chemical of Potential Concern	Soil		
	MDC (mg/kg)	95UCL[1] (mg/kg)	EPC_{soil}[2] (mg/kg)
Metals			
Antimony	1.0	0.64	0.64
Arsenic	18	12	12
Barium	450	125	125
Chromium	40	20	20
Cobalt	14	9.2	9.2
Copper	48	20	20
Lead	100	22	22
Mercury	3.0	0.44	0.44
Molybdenum	0.50	0.44	0.44
Nickel	64	18	18
Thallium	2.0	1.3	1.3
Vanadium	120	43	43
Zinc	200	56	56
TPH[4]			
C5-C12	830	216	216
TPH (C4-C12) Aliphatic	415	108	108
TPH (C4-C12) Aromatic	415	108	108
C13-C22	6,540	1,553	1,553
TPH (C13-C22) Aliphatic	3,270	777	777
TPH (C13-C22) Aromatic	3,270	777	777
C23-C44	3,880	1,561	1,561
TPH (C23-C44) Aliphatic	1,940	781	781
TPH (C23-C44) Aromatic	1,940	781	781
VOCs			
Benzene	0.057	NE	0.057
Ethylbenzene	0.82	0.18	0.18
Naphthalene	0.0050	NE	0.0050
Toluene	0.29	0.087	0.087
Total Xylenes	3.4	0.82	0.82
PAHs			
Acenaphthene	0.22	NE	0.22
Chrysene	1.6	NE	1.6
Fluoranthene	0.036	NE	0.036
Fluorene	0.39	NE	0.39
Naphthalene	1.2	NE	1.2
Phenanthrene	2.0	NE	2.0
Pyrene	2.0	NE	2.0

Notes:
MDC = maximum detected concentration.
95UCL = 95-percent upper confidence limit of the mean.
EPC = exposure point concentration.
mg/kg = milligrams per kilogram.
TPH = total petroleum hydrocarbons.
VOC = volatile organic compounds.
PAH = polycyclic aromatic hydrocarbons.
NE = not estimated (see Note 3).
ND = Not detected.

[1] A summary of the methods used to identify an appropriate 95UCL is provided in Attachment E-4.
[2] Represents the lesser of the maximum detected concentration and the 95UCL.
[3] Due to limitations of chemical dataset, ProUCL was unable to estimate a 95UCL.
[4] In the absence of fractionated TPH data, the TPH data were assumed to be 50 percent aliphatic and 50 percent aromatic.

Table E4-5
Exposure Point Concentrations for the Chemicals of Potential Concern (COPCs) in Groundwater and Indoor Air at Future Buildings

Former ChemOil Refinery
Signal Hill, California

	Groundwater - 30 feet bgs		Vapor Intrusion to Indoor Air[2]		
Chemical of Potential Concern	**MDC** (µg/L)	**EPC_{gw}[1]** (µg/L)	**$EPC_{soil\ vapor}$** (µg/m^3)	**Soil Vapor to Indoor Air Attenuation Factor** (unitless)	**$EPC_{indoor\ air}$** (µg/m^3)
Volatile Organic Compounds (VOCs)					
Bis (2-chloroethyl) ether	1,500	1,500	969	1.2E-04	1.18E-01
tert-Butyl Alcohol	220	220	- -	- -	- -
sec-Butylbenzene	1.7	1.7	670	8.9E-05	5.97E-02
Isopropylbenzene	13	13	5,713	1.0E-04	5.75E-01
Naphthalene	65	65	1,091	1.0E-04	1.13E-01
n-Propylbenzene	13	13	5,253	1.0E-04	5.28E-01
o-Xylene	3.0	3.0	601	1.1E-04	6.85E-02

Notes:
feet bgs = feet below ground surface.
MDC = maximum detected concentration.
EPC = exposure point concentration.
µg/L = micrograms per liter.
µg/m^3 = micrograms per cubic meter.
- - = Not available. Chemical properties were not included in vapor intrusion model.

[1] Represents the maximum detected concentration.
[2] EPCs in groundwater (EPC_{gw}) were coupled with the vapor intrusion model to estimate EPCs in soil vapor, attenuation factors, and EPCs in indoor air (Attachment E-3).

Table E5-1
Toxicity Values - Reference Doses/Reference Concentrations[1]
Former ChemOil Refinery
Signal Hill, California

	Oral Reference Dose (RfDo)[2]					Inhalation Reference Concentration (RfCi)				
Chemical of Potential Concern	**Chronic (cRfDo)**	**Target Organ(s)/ System(s)**	**Source**	**Subchronic (sRfDo)**	**Source[3]**	**Chronic (cRfCi)**	**Target Organ(s)/ System(s)**	**Source**	**Subchronic (sRfCi)**	**Source[3]**
	(mg/kg-day)			(mg/kg-day)		(μg/m^3)			(μg/m^3)	
Metals										
Antimony	4.00E-04	Blood	USEPA, 2017	4.00E-04	c	- -	- -	- -	- -	- -
Arsenic	3.50E-06	Reproductive-Development, Cardiovascular, Nervous, Lung, Skin	DTSC, 2016	3.50E-06	c	1.50E-02	Reproductive-Development, Cardiovascular, Nervous, Lung, Skin	DTSC, 2016	1.50E-02	c
Barium	2.00E-01	Kidney	USEPA, 2017	2.00E-01	c	5.00E-01	Reproductive	USEPA, 1997	5.00E+00	USEPA, 1997
Chromium	1.50E+00	None	USEPA, 2017	1.50E+00	c	- -	- -	- -	- -	- -
Cobalt	3.00E-04	Thyroid	USEPA, 2016	3.00E-04	c	6.00E-03	Respiratory	USEPA, 2016	6.00E-03	c
Copper	4.00E-02	Gastrointestinal	USEPA, 1997	4.00E-02	c	- -	- -	- -	- -	- -
Lead	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Mercury	1.60E-04	Nervous, Kidney, Development	DTSC, 2016	1.60E-04	c	3.00E-02	Nervous, Kidney, Development	DTSC, 2016	3.00E-02	c
Molybdenum	5.00E-03	Kidney	USEPA, 2017	5.00E-03	c	- -	- -	- -	- -	- -
Nickel	1.10E-02	Development	DTSC, 2016	1.10E-02	c	1.40E-02	Respiratory, Blood	DTSC, 2016	1.40E-02	c
Thallium	1.00E-05	Skin (hair follicle atrophy)	USEPA, 2016	1.00E-05	c	- -	- -	- -	- -	- -
Vanadium	5.00E-03	Kidney	USEPA, 2016	5.00E-03	c	1.00E-01	Respiratory	ATSDR, 2015	- -	- -
Zinc	3.00E-01	Blood, Immune	USEPA, 2017	3.00E-01	c	- -	- -	- -	- -	- -
TPH										
TPH (C4-C12) Aliphatic	4.00E-02	- -	DTSC, 2013	4.00E-02	c	7.00E+02	- -	DTSC, 2013	7.00E+02	c
[4] TPH (C4-C12) Aromatic	- -	- -	DTSC, 2013	- -	- -	- -	- -	DTSC, 2013	- -	- -
TPH (C13-C22) Aliphatic	1.00E-01	- -	DTSC, 2013	1.00E-01	c	3.00E+02	- -	DTSC, 2013	3.00E+02	c
TPH (C13-C22) Aromatic	3.00E-02	- -	DTSC, 2013	3.00E-02	c	5.00E+01	- -	DTSC, 2013	5.00E+01	c
[5] TPH (C23-C44) Aliphatic	2.00E+00	- -	DTSC, 2013	2.00E+00	c	- -	- -	DTSC, 2013	- -	- -
[5] TPH (C23-C44) Aromatic	4.00E-02	- -	DTSC, 2013	4.00E-02	c	- -	- -	DTSC, 2013	- -	- -
VOCs										
Benzene	4.00E-03	Immune	USEPA, 2017	1.20E-02	s	3.00E+00	Development, Nervous, Blood	DTSC, 2016	3.00E+00	c
Bis (2-chloroethyl) ether	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
[6] tert-Butyl Alcohol	1.00E-01	- -	USEPA, 2016	1.00E-01	c	- -	- -	- -	- -	- -
sec-Butylbenzene	1.00E-01	Kidney	USEPA, 2016	1.00E-01	c	4.00E+02	RTR	DTSC, 2016	4.00E+02	c
Ethylbenzene	1.00E-01	Liver, Kidney	USEPA, 2017	1.00E+00	s	1.00E+03	Development	USEPA, 2017	1.00E+03	c
Isopropylbenzene	1.00E-01	Kidney	USEPA, 2017	3.00E-01	s	4.00E+02	Endocrine, Kidney	USEPA, 2017	4.00E+03	s
Naphthalene	2.00E-02	Development	USEPA, 2017	2.00E-01	s	3.00E+00	Nervous, Respiratory	USEPA, 2017	3.00E+00	c
n-Propylbenzene	1.00E-01	- -	USEPA, 2016	1.00E-01	c	1.00E+03	- -	USEPA, 2016	1.00E+03	c
Toluene	8.00E-02	Kidney	USEPA, 2017	8.00E-01	s	3.00E+02	Nervous, Respiratory, Development	DTSC, 2016	3.00E+02	c
o-Xylene	2.00E-01	Development	USEPA, 2017	2.00E-01	c	1.00E+02	Nervous	USEPA, 2017	3.00E+02	s
Total Xylenes	2.00E-01	Development	USEPA, 2017	2.00E-01	c	1.00E+02	Nervous	USEPA, 2017	3.00E+02	s

Table E5-1
Toxicity Values - Reference Doses/Reference Concentrations[1]
Former ChemOil Refinery
Signal Hill, California

Chemical of Potential Concern	Oral Reference Dose (RfDo)[2]					Inhalation Reference Concentration (RfCi)				
	Chronic (cRfDo)	Target Organ(s)/ System(s)	Source	Subchronic (sRfDo)	Source[3]	Chronic (cRfCi)	Target Organ(s)/ System(s)	Source	Subchronic (sRfCi)	Source[3]
	(mg/kg-day)			(mg/kg-day)		(µg/m^3)			(µg/m^3)	
PAHs										
Acenaphthene	6.00E-02	Liver	USEPA, 2017	6.00E-01	s	2.40E+02	RTR	DTSC, 2016	2.40E+02	c
Chrysene	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Fluoranthene	4.00E-02	Liver, Blood	USEPA, 2017	4.00E-02	c	1.40E+02	RTR	- -	1.40E+02	c
Fluorene	4.00E-02	Blood	USEPA, 2017	4.00E-01	s	1.60E+02	RTR	DTSC, 2016	1.60E+02	c
[7] Phenanthrene	3.00E-01	None	USEPA, 2017	3.00E-01	c	1.20E+03	RTR	DTSC, 2016	1.20E+03	c
Pyrene	3.00E-02	Kidney	USEPA, 2017	3.00E-01	s	1.20E+02	RTR	DTSC, 2016	1.20E+02	c

Notes:

mg/kg-day = milligrams per kilogram body weight per day.

µg/m^3 = micrograms per cubic meter.

RTR = route to route extrapolation.

TPH = total petroleum hydrocarbons.

VOC = volatile organic compounds.

PAH = polycyclic aromatic hydrocarbons.

"- -" = value was not available from the sources listed above or not applicable for this exposure route.

c = In the absence of specific values for subchronic exposure, the chronic toxicity value was adopted as the subchronic toxicity value.

s = In the absence of specific values for subchronic exposure, the chronic toxicity value was modified using the subchronic to chronic uncertainty factor used in developing the chronic value.

[1] Toxicity values were obtained from the following sources of information: OEHHA, 2017; DTSC, 2016; USEPA, 2017, 2016; DTSC, 2013; ATSDR, 2015; USEPA, 1997.

[2] In the absence of dermal toxicity values the oral reference doses were multiplied by the gastrointestinal absorption (GIABS) factor and used to evaluate dermal exposure.

[3] For most chemicals, in the absence of a specific value for subchronic exposure, the chronic toxicity value was adopted as the subchronic toxicity value. For a few chemicals, the chronic toxicity value was modified using the subchronic to chronic uncertainty factor as provided by the USEPA IRIS online database. Unless noted otherwise, a unique subchronic toxicity value was only used for those chemicals with toxicity values sourced from USEPA IRIS and with published uncertainty factors applied for the use of a subchronic study for chronic toxicity value derivation.

[4] The aromatic fraction of this hydrocarbon range is evaluated by its more toxic components (i.e., benzene, toluene, ethylbenzene, and xylenes [BTEX]; DTSC, 2013).

[5] Inhalation exposure not evaluated due to low volatility of COPCs in this hydrocarbon range (DTSC, 2013).

[6] In the absence of toxicity values for tertiary-butyl alcohol, values for sec-butyl alcohol were used.

[7] In the absence of toxicity values for phenanthrene, values for anthracene were used.

References:

ATSDR. 2015. Minimal Risk Levels (MRLs). September.

DTSC. 2013. Preliminary Endangerment Assessment Guidance Manual. October.

DTSC. 2016. Human Health Risk Assessment Note Number 3: DTSC-modified Screening Levels. June.

OEHHA. 2017. Toxicity Criteria Database. On-line computer database. Last accessed May.

USEPA. 1997. Health Effects Assessment Summary Tables (HEAST) FY 1997 Update. Office of Solid Waste and Emergency Response. July.

USEPA. 2016. Regional Screening Levels for Chemical Contaminants at Superfund Sites. USEPA Region 3, Region 6, and Region 9. May.

USEPA. 2017. Integrated Risk Information System (IRIS). On-line computer database. Last accessed May.

Table E5-2
Chemical-Specific Gastrointestinal Absorption Factors (GIABS)
Former ChemOil Refinery
Signal Hill, California

Chemical of Potential Concern	GIABS (unitless)	Source
Metals		
Antimony	0.15	USEPA, 2004
Arsenic	1	USEPA, 2004
Barium	0.07	USEPA, 2004
Chromium	0.013	USEPA, 2004
Cobalt	1	USEPA, 2004
Copper	1	USEPA, 2004
Lead	1	USEPA, 2004
Mercury	1	USEPA, 2004
Molybdenum	1	USEPA, 2004
Nickel	0.04	USEPA, 2004
Thallium	1	USEPA, 2004
Vanadium	0.026	USEPA, 2004
Zinc	1	USEPA, 2004
Total Petroleum Hydrocarbons (TPH)		
TPH (C4-C12) Aliphatic	1	USEPA, 2004
TPH (C4-C12) Aromatic	1	USEPA, 2004
TPH (C13-C22) Aliphatic	1	USEPA, 2004
TPH (C13-C22) Aromatic	1	USEPA, 2004
TPH (C23-C44) Aliphatic	1	USEPA, 2004
TPH (C23-C44) Aromatic	1	USEPA, 2004
Volatile Organic Compounds (VOCs)		
Benzene	1	USEPA, 2004
Bis (2-chloroethyl) ether	1	USEPA, 2004
[1] tert-Butyl Alcohol	1	USEPA, 2004
sec-Butylbenzene	1	USEPA, 2004
Ethylbenzene	1	USEPA, 2004
Isopropylbenzene	1	USEPA, 2004
Naphthalene	1	USEPA, 2004
n-Propylbenzene	1	USEPA, 2004
Toluene	1	USEPA, 2004
o-Xylene	1	USEPA, 2004
Total Xylenes	1	USEPA, 2004
Polycyclic Aromatic Hydrocarbons (PAHs)		
Acenaphthene	1	USEPA, 2004
Chrysene	1	USEPA, 2004
Fluoranthene	1	USEPA, 2004
Fluorene	1	USEPA, 2004
[2] Phenanthrene	1	USEPA, 2004
Pyrene	1	USEPA, 2004

Notes:

[1] In the absence of a GIABS value for tertiary-butyl alcohol, the value for sec-butyl alcohol were used.

[2] In the absence of a GIABS value for phenanthrene, the value for anthracene were used.

Reference:

USEPA. 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. Office of Superfund Remediation and Technology Innovation. July.

Table E5-3
Toxicity Values - Slope Factors/Inhalation Unit Risk Factors [1]
Former ChemOil Refinery
Signal Hill, California

Chemical of Potential Concern	Oral Slope Factor (SFo)[2] (mg/kg-day)$^{-1}$		Inhalation Unit Risk Factor (IUR) ($\mu g/m^3$)$^{-1}$	
	Value	Source	Value	Source
Metals				
Antimony	- -	- -	- -	- -
Arsenic	9.50E+00	DTSC, 2016	3.30E-03	DTSC, 2016
Barium	- -	- -	- -	- -
Chromium	- -	- -	- -	- -
Cobalt	- -	- -	9.00E-03	USEPA, 2016
Copper	- -	- -	- -	- -
Lead	- -	- -	- -	- -
Mercury	- -	- -	- -	- -
Molybdenum	- -	- -	- -	- -
Nickel	- -	- -	2.60E-04	OEHHA, 2017
Thallium	- -	- -	- -	- -
Vanadium	- -	- -	- -	- -
Zinc	- -	- -	- -	- -
Total Petroleum Hydrocarbons (TPH)				
TPH (C4-C12) Aliphatic	- -	DTSC, 2013	- -	DTSC, 2013
[3] TPH (C4-C12) Aromatic	- -	DTSC, 2013	- -	DTSC, 2013
TPH (C13-C22) Aliphatic	- -	DTSC, 2013	- -	DTSC, 2013
TPH (C13-C22) Aromatic	- -	DTSC, 2013	- -	DTSC, 2013
[4] TPH (C23-C44) Aliphatic	- -	DTSC, 2013	- -	DTSC, 2013
[4] TPH (C23-C44) Aromatic	- -	DTSC, 2013	- -	DTSC, 2013
Volatile Organic Compounds (VOCs)				
Benzene	1.00E-01	DTSC, 2016	2.90E-05	DTSC, 2016
Bis (2-chloroethyl) ether	2.50E+00	OEHHA, 2017	7.10E-04	OEHHA, 2017
[5] tert-Butyl Alcohol	- -	- -	- -	- -
sec-Butylbenzene	- -	- -	- -	- -
Ethylbenzene	1.10E-02	OEHHA, 2017	2.50E-06	OEHHA, 2017
Isopropylbenzene	- -	- -	- -	- -
Naphthalene	1.20E-01	OEHHA, 2017	3.40E-05	OEHHA, 2017
n-Propylbenzene	- -	- -	- -	- -
Toluene	- -	- -	- -	- -
o-Xylene	- -	- -	- -	- -
Total Xylenes	- -	- -	- -	- -
Polycyclic Aromatic Hydrocarbons (PAHs)				
Acenaphthene	- -	- -	- -	- -
Chrysene	7.30E-03	USEPA, 2016	1.10E-05	OEHHA, 2017
Fluoranthene	- -	- -	- -	- -
Fluorene	- -	- -	- -	- -
[6] Phenanthrene	- -	- -	- -	- -
Pyrene	- -	- -	- -	- -

Table E5-3
Toxicity Values - Slope Factors/Inhalation Unit Risk Factors [1]
Former ChemOil Refinery
Signal Hill, California

Notes:

mg/kg-day = milligrams per kilogram body weight per day.

µg/m^3 = micrograms per cubic meter.

"- -" = value was not available from the sources listed above or not applicable for this exposure route.

[1] Toxicity values were obtained from the following sources of information: OEHHA, 2017; DTSC, 2016; USEPA, 2017, 2016; DTSC, 2013.

[2] In the absence of dermal toxicity values the oral slope factors were divided by the gastrointestinal absorption (GIABS) factor and used to evaluate dermal exposure.

[3] The aromatic fraction of this hydrocarbon range is evaluated by its more toxic components (i.e., benzene, toluene, ethylbenzene, and xylenes [BTEX]; DTSC, 2013).

[4] Inhalation exposure not evaluated due to low volatility of COPCs in this hydrocarbon range (DTSC, 2013).

[5] In the absence of toxicity values for tertiary-butyl alcohol, values for sec-butyl alcohol were used.

[6] In the absence of toxicity values for phenanthrene, values for anthracene were used.

References:

DTSC. 2013. Preliminary Endangerment Assessment Guidance Manual. October.

DTSC. 2016. Human Health Risk Assessment Note Number 3: DTSC-modified Screening Levels. October.

OEHHA. 2017. Toxicity Criteria Database. On-line computer database. Last accessed May.

USEPA. 2016. Regional Screening Levels for Chemical Contaminants at Superfund Sites. USEPA Region 3, Region 6, and Region 9. June (Revised).

USEPA. 2017. Integrated Risk Information System (IRIS). On-line computer database. Last accessed May.

Table E6-1
Summary of Noncancer Hazard Indices and Excess Cancer Risks
Former ChemOil Refinery
Signal Hill, California

Exposure Pathway	**Hazard Index (HI)**	**Excess Cancer Risk (CR)**	**Comments**
Hypothetical Onsite Construction/Utility Worker Receptor - Future Construction/Development Scenario			
Direct Exposure to COPCs in Soil (0 to 10 feet bgs)	2	3 E-07	The total HI exceeds the USEPA/CalEPA target level of one. Individual HI estimates for each COPC do not exceed the USEPA/CalEPA target level of one. The individual HI estimates for cobalt, nickel, thallium, and vanadium in soil account for 83% of the total HI. However, their individual HIs do not exceed one and are not associated with an effect on the same primary critical target organ or system. Therefore, the COPCs do not pose adverse noncancer effects to the hypothetical onsite construction/utility worker receptor. The CR is within CalEPA's risk management range and is less than 1 x 10^{-5}, which is generally acceptable for occupational exposures. Therefore, COPCs do not pose a risk to the hypothetical onsite construction/utility worker receptor.
Total	**2**	**3 E-07**	
Hypothetical Onsite Commercial/Industrial Worker Receptor - Future Building Scenario			
Direct Exposure to COPCs in Soil	0.3	2 E-08	The HI does not exceed USEPA/CalEPA target level of one. Therefore, the COPCs do not pose adverse noncancer effects to the hypothetical onsite commercial/industrial worker receptor. The CR is below the most stingent end of CalEPA's risk management range of 1 x 10^{-6} to 1 x 10^{-4} and is less than 1 x 10^{-5}, which is generally acceptable for occupational exposures. Therefore, COPCs do not pose a risk to the hypothetical onsite commercial/industrial worker receptor.
Inhalation of COPCs Volatilizing from Groundwater into Indoor Air	0.009	7 E-06	The HI does not exceed USEPA/CalEPA target level of one. Therefore, the COPCs do not pose adverse noncancer effects to the hypothetical onsite commercial/industrial worker receptor. The CR is within CalEPA's risk management range and is less than 1 x 10^{-5}, which is generally acceptable for occupational exposures. Therefore, COPCs do not pose a risk to the hypothetical onsite commercial/industrial worker receptor.
Total	**0.3**	**7 E-06**	

Notes:

HI = hazard index.
CR = cancer risk.
feet bgs = feet below ground surface
COPC = chemical of potential concern
USEPA = U.S. Environmental Protection Agency
CalEPA = California Environmental Protection Agency

ATTACHMENT E-1

SUMMARY OF SOIL, GROUNDWATER, AND SOIL VAPOR DATA

SOIL

Table E-1A
Summary of Analytical Results for Metals in Soil, East Parcel
Former ChemOil Refinery
Signal Hill, California

Sample ID	Consultant	Data Qualifiers	Sample Date	Sample Depth	U.S. EPA Method 6010B - Metals																
				feet bgs	**Antimony** mg/kg	**Arsenic** mg/kg	**Barium** mg/kg	**Beryllium** mg/kg	**Cadmium** mg/kg	**Chromium** mg/kg	**Cobalt** mg/kg	**Copper** mg/kg	**Lead** mg/kg	**Mercury** mg/kg	**Molybdenum** mg/kg	**Nickel** mg/kg	**Selenium** mg/kg	**Silver** mg/kg	**Thallium** mg/kg	**Vanadium** mg/kg	**Zinc** mg/kg
B-1-1	TEC	(a) (b) (c) (d)	2001	1	**0.50**	**4.5**	**50**	ND<0.15	ND<0.15	**10**	**4.0**	**8.0**	**2.0**	ND<0.10	ND<0.25	**5.0**	ND<0.25	ND<0.15	**0.42**	**17**	**23**
B-1-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**13**	**92**	ND<0.15	ND<0.15	**20**	**11**	**21**	**4.0**	ND<0.10	**0.36**	**17**	ND<0.25	ND<0.15	**0.50**	**46**	**46**
B-1-10	TEC	(a) (b) (c) (d)	2001	10	**0.50**	**12**	**86**	ND<0.15	ND<0.15	**20**	**10**	**19**	ND<0.25	**3.0**	ND<0.25	**17**	ND<0.25	ND<0.15	**0.50**	**38**	**41**
B-2-1	TEC	(a) (b) (c) (d)	2001	1	**1.0**	**9.5**	**120**	ND<0.15	ND<0.15	**40**	**7.0**	**48**	**100**	**--**	**0.50**	**64**	ND<0.25	ND<0.15	**0.50**	**120**	**200**
B-2-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**10**	**450**	ND<0.15	ND<0.15	**18**	**10**	**15**	**3.0**	**0.11**	ND<0.25	**18**	ND<0.25	ND<0.15	**1.0**	**31**	**38**
B-2-10	TEC	(a) (b) (c) (d)	2001	10	**0.50**	**8.0**	**56**	ND<0.15	ND<0.15	**8.5**	**4.5**	**9.0**	**1.5**	ND<0.10	ND<0.25	**7.5**	ND<0.25	ND<0.15	**0.33**	**20**	**27**
B-3-1	TEC	(a) (b) (c) (d)	2001	1	**0.39**	**5.0**	**58**	ND<0.15	ND<0.15	**9.5**	**4.5**	**8.0**	1.5	ND<0.10	**0.33**	**6.0**	ND<0.25	ND<0.15	**0.50**	**18**	**22**
B-3-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**12**	**100**	ND<0.15	ND<0.15	**19**	**10**	**16**	**3.0**	ND<0.10	**0.41**	**14**	ND<0.25	ND<0.15	**1.0**	**41**	**41**
B-3-10	TEC	(a) (b) (c) (d)	2001	10	**1.0**	**16**	**150**	ND<0.15	ND<0.15	**25**	**12**	**26**	**4.5**	ND<0.10	**0.50**	**20**	ND<0.25	ND<0.15	**1.5**	**48**	**48**
B-4-1	TEC	(a) (b) (c) (d)	2001	1	**0.50**	**10**	**76**	ND<0.15	ND<0.15	**18**	**8.0**	**16**	**3.0**	ND<0.10	**0.36**	**12**	ND<0.25	ND<0.15	**1.0**	**36**	**41**
B-4-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**18**	**90**	ND<0.15	ND<0.15	**28**	**13**	**31**	**4.5**	ND<0.10	**0.50**	**22**	ND<0.25	ND<0.15	**2.0**	**53**	**56**
B-4-10	TEC	(a) (b) (c) (d)	2001	10	ND<0.25	**4.5**	**44**	ND<0.15	ND<0.15	**8.0**	**4.0**	**7.5**	**1.0**	ND<0.10	**0.26**	**6.5**	ND<0.25	ND<0.15	ND<0.25	**16**	**23**
B-5-1	TEC	(a) (b) (c) (d)	2001	1	**0.50**	**4.5**	**54**	ND<0.15	ND<0.15	**10**	**4.5**	**7.0**	**2.0**	ND<0.10	**0.42**	**6.0**	ND<0.25	ND<0.15	**1.0**	**17**	**24**
B-5-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**9.0**	**73**	ND<0.15	ND<0.15	**15**	**8.0**	**12**	**2.5**	ND<0.10	**0.50**	**12**	ND<0.25	ND<0.15	**1.0**	**30**	**38**
B-5-10	TEC	(a) (b) (c) (d)	2001	10	**0.50**	**18**	**140**	ND<0.15	ND<0.15	**32**	**13**	**31**	**5.5**	**0.12**	**0.50**	**23**	ND<0.25	ND<0.15	**1.5**	**52**	**57**
B-6-1	TEC	(a) (b) (c) (d)	2001	1	**0.36**	**4.0**	**30**	ND<0.15	ND<0.15	**7.5**	**3.5**	**3.0**	**0.50**	ND<0.10	**0.35**	**5.5**	ND<0.25	ND<0.15	**0.50**	**15**	**22**
B-6-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**10**	**68**	ND<0.15	ND<0.15	**16**	**8.0**	**14**	**3.0**	ND<0.10	**0.42**	**12**	ND<0.25	ND<0.15	**1.0**	**32**	**45**
B-6-10	TEC	(a) (b) (c) (d)	2001	10	**0.50**	**17**	**310**	ND<0.15	ND<0.15	**25**	**12**	**26**	**5.0**	ND<0.10	**0.50**	**20**	ND<0.25	ND<0.15	**1.0**	**48**	**48**
B-7-1	TEC	(a) (b) (c) (d)	2001	1	**0.45**	**5.0**	**56**	ND<0.15	ND<0.15	**9.0**	**4.5**	**7.5**	**3.0**	ND<0.10	**0.35**	**5.5**	ND<0.25	ND<0.15	**0.50**	**16**	**23**
B-7-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**9.0**	**88**	ND<0.15	ND<0.15	**16**	**6.5**	**12**	**3.0**	ND<0.10	**0.49**	**10**	ND<0.25	ND<0.15	**0.50**	**27**	**38**
B-7-10	TEC	(a) (b) (c) (d)	2001	10	**1.0**	**18**	**98**	ND<0.15	ND<0.15	**26**	**14**	**31**	**6.0**	ND<0.10	**0.50**	**22**	ND<0.25	ND<0.15	**1.5**	**52**	**54**
B-8-1	TEC	(a) (b) (c) (d)	2001	1	**0.50**	**4.5**	**47**	ND<0.15	ND<0.15	**9.5**	**4.5**	**6.5**	**1.5**	ND<0.10	**0.49**	**4.5**	ND<0.25	ND<0.15	**0.50**	**17**	**22**
B-8-5	TEC	(a) (b) (c) (d)	2001	5	**0.50**	**12**	**73**	ND<0.15	ND<0.15	**22**	**10**	**17**	**3.5**	ND<0.10	**0.42**	**15**	ND<0.25	ND<0.15	**1.5**	**40**	**50**
B-8-10	TEC	(a) (b) (c) (d)	2001	10	**1.0**	**16**	**76**	ND<0.15	ND<0.15	**25**	**12**	**28**	**4.5**	ND<0.10	**0.50**	**20**	ND<0.25	ND<0.15	**1.5**	**48**	**50**
B-9-1	TEC	(a) (b) (c) (d)	2001	1	**0.50**	**7.0**	**72**	ND<0.15	ND<0.15	**12**	**6.0**	**12**	**5.5**	ND<0.10	**0.47**	**8.0**	ND<0.25	ND<0.15	**0.50**	**22**	**39**
B-9-5	TEC	(a) (b) (c) (d)	2001	5	**1.0**	**9.0**	**84**	ND<0.15	ND<0.15	**16**	**7.5**	**12**	**3.0**	ND<0.10	**0.46**	**11**	ND<0.25	ND<0.15	**0.50**	**29**	**40**
B-9-10	TEC	(a) (b) (c) (d)	2001	10	**0.50**	**7.0**	**140**	ND<0.15	ND<0.15	**10**	**7.0**	**12**	**3.0**	ND<0.10	**0.37**	**10**	ND<0.25	ND<0.15	**1.0**	**19**	**26**
Number of Samples					**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**26**	**27**	**27**	**27**	**27**	**27**	**27**	**27**
Number of Detections					**26**	**27**	**27**	**0**	**0**	**27**	**27**	**27**	**26**	**3**	**23**	**27**	**0**	**0**	**26**	**27**	**27**
Frequency of Detection					**96%**	**100%**	**100%**	**0%**	**0%**	**100%**	**100%**	**100%**	**96%**	**12%**	**85%**	**100%**	**0%**	**0%**	**96%**	**100%**	**100%**
Mean					**0.58**	**10.09**	**103.00**	**ND**	**ND**	**17.59**	**8.11**	**16.87**	**6.90**	**1.08**	**0.43**	**14.57**	**ND**	**ND**	**0.89**	**35.11**	**43.78**
Standard Deviation					**0.21**	**4.67**	**87.43**	**ND**	**ND**	**8.29**	**3.29**	**10.39**	**19.04**	**1.67**	**0.07**	**11.56**	**ND**	**ND**	**0.46**	**21.49**	**33.29**
Minimum Detected Concentration					**0.36**	**4**	**30**	**ND**	**ND**	**7.5**	**3.5**	**3**	**0.5**	**0.11**	**0.26**	**4.5**	**ND**	**ND**	**0.33**	**15**	**22**
Maximum Detected Concentration					**1.0**	**18.0**	**450.0**	**ND**	**ND**	**40.0**	**14.0**	**48.0**	**100.0**	**3.0**	**0.5**	**64.0**	**ND**	**ND**	**2.0**	**120.0**	**200.0**

Table E-1A
Summary of Analytical Results for Metals in Soil, East Parcel

Former ChemOil Refinery
Signal Hill, California

Sample ID	Consultant	Data Qualifiers	Sample Date	Sample Depth	U.S. EPA Method 6010B - Metals																
					Antimony mg/kg	**Arsenic** mg/kg	**Barium** mg/kg	**Beryllium** mg/kg	**Cadmium** mg/kg	**Chromium** mg/kg	**Cobalt** mg/kg	**Copper** mg/kg	**Lead** mg/kg	**Mercury** mg/kg	**Molybdenum** mg/kg	**Nickel** mg/kg	**Selenium** mg/kg	**Silver** mg/kg	**Thallium** mg/kg	**Vanadium** mg/kg	**Zinc** mg/kg
B-1-15	TEC	(a) (b) (c) (d)	2001	15	**0.41**	**5.0**	**54**	ND<0.15	ND<0.15	**5.5**	**3.6**	**6.0**	**1.0**	ND<0.10	ND<0.25	**5.0**	ND<0.25	ND<0.15	ND<0.25	**12**	**18**
B-1-20	TEC	(a) (b) (c) (d)	2001	20	ND<0.25	**3.0**	**15**	ND<0.15	ND<0.15	**5.0**	**1.5**	**1.5**	**0.50**	ND<0.10	ND<0.25	**2.5**	ND<0.25	ND<0.15	ND<0.25	**9.5**	**10**
B-1-25	TEC	(a) (b) (c) (d)	2001	25	ND<0.25	**5.0**	**22**	ND<0.15	ND<0.15	**7.0**	**3.5**	**3.0**	**0.50**	ND<0.10	**0.50**	**4.5**	ND<0.25	**5.0**	**0.50**	**15**	**18**
B-1-30	TEC	(a) (b) (c) (d)	2001	30	ND<0.25	**5.0**	**24**	ND<0.15	ND<0.15	**8.0**	**3.0**	**3.5**	**0.50**	ND<0.10	**0.37**	**4.5**	ND<0.25	ND<0.15	**0.48**	**16**	**18**
B-1-35	TEC	(a) (b) (c) (d)	2001	35	**0.42**	**10**	**26**	ND<0.15	ND<0.15	**7.0**	**3.5**	**6.5**	**1.0**	ND<0.10	**0.50**	**5.0**	ND<0.25	ND<0.15	**0.45**	**20**	**22**
B-2-15	TEC	(a) (b) (c) (d)	2001	15	**0.50**	**9.5**	**63**	ND<0.15	ND<0.15	**16**	**8.0**	**12**	**2.0**	ND<0.10	**0.50**	**12**	ND<0.25	**0.50**	**1.0**	**32**	**36**
B-2-20	TEC	(a) (b) (c) (d)	2001	20	**0.38**	**6.0**	**50**	ND<0.15	ND<0.15	**10**	**6.0**	**10**	**1.5**	ND<0.10	**0.44**	**8.0**	ND<0.25	ND<0.15	**0.50**	**24**	**29**
B-2-25	TEC	(a) (b) (c) (d)	2001	25	ND<0.25	**2.5**	**24**	ND<0.15	ND<0.15	**6.5**	**3.0**	**5.5**	**1.0**	ND<0.10	**0.29**	**4.5**	ND<0.25	ND<0.15	**0.25**	**12**	**16**
B-2-30	TEC	(a) (b) (c) (d)	2001	30	**0.47**	**8.0**	**35**	ND<0.15	ND<0.15	**9.0**	**4.5**	**4.5**	**1.0**	ND<0.10	**0.30**	**5.5**	ND<0.25	ND<0.15	**0.50**	**18**	**25**
B-2-35	TEC	(a) (b) (c) (d)	2001	35	**0.32**	**5.5**	**28**	ND<0.15	ND<0.15	**8.0**	**4.5**	**4.0**	**0.50**	ND<0.10	**0.34**	**5.0**	ND<0.25	ND<0.15	**0.45**	**18**	**26**
B-2-40	TEC	(a) (b) (c) (d)	2001	40	**0.50**	**5.5**	**32**	ND<0.15	ND<0.15	**9.0**	**5.5**	**5.0**	**0.50**	ND<0.10	**0.31**	**6.0**	ND<0.25	ND<0.15	**0.50**	**20**	**30**
B-3-15	TEC	(a) (b) (c) (d)	2001	15	**0.39**	**3.5**	**38**	ND<0.15	ND<0.15	**6.5**	**3.5**	**6.0**	**1.0**	ND<0.10	**0.27**	**5.5**	ND<0.25	ND<0.15	**0.36**	**14**	**16**
B-3-20	TEC	(a) (b) (c) (d)	2001	20	**0.43**	**5.5**	**50**	ND<0.15	ND<0.15	**10**	**5.5**	**10**	**1.5**	ND<0.10	ND<0.25	**8.0**	ND<0.25	ND<0.15	**0.50**	**22**	**26**
B-3-25	TEC	(a) (b) (c) (d)	2001	25	**0.26**	**5.0**	**29**	ND<0.15	ND<0.15	**9.5**	**4.5**	**3.5**	**1.0**	ND<0.10	**0.50**	**6.0**	ND<0.25	ND<0.15	**0.50**	**16**	**25**
B-3-33	TEC	(a) (b) (c) (d)	2001	33	**0.42**	**8.0**	**34**	ND<0.15	ND<0.15	**8.0**	**5.0**	**5.0**	**0.50**	ND<0.10	ND<0.25	**5.5**	ND<0.25	ND<0.15	**0.50**	**19**	**28**
B-4-15	TEC	(a) (b) (c) (d)	2001	15	**0.42**	**4.5**	**43**	ND<0.15	ND<0.15	**9.0**	**4.5**	**7.0**	**3.0**	ND<0.10	**0.46**	**5.0**	ND<0.25	ND<0.15	**0.50**	**18**	**21**
B-4-20	TEC	(a) (b) (c) (d)	2001	20	**0.34**	**3.5**	**33**	ND<0.15	ND<0.15	**6.0**	**2.5**	**5.5**	**1.0**	ND<0.10	**0.29**	**4.0**	ND<0.25	ND<0.15	ND<0.25	**13**	**14**
B-4-25	TEC	(a) (b) (c) (d)	2001	25	**0.38**	**4.0**	**36**	ND<0.15	ND<0.15	**7.0**	**3.5**	**3.0**	**2.0**	ND<0.10	ND<0.25	**5.0**	ND<0.25	ND<0.15	**0.50**	**14**	**20**
B-5-15	TEC	(a) (b) (c) (d)	2001	15	**0.45**	**6.0**	**82**	ND<0.15	ND<0.15	**10**	**6.0**	**11**	**1.5**	ND<0.10	ND<0.25	**8.5**	ND<0.25	ND<0.15	**0.50**	**21**	**29**
B-5-20	TEC	(a) (b) (c) (d)	2001	20	ND<0.25	**3.0**	**20**	ND<0.15	ND<0.15	**5.0**	**2.0**	**4.0**	**1.0**	ND<0.10	**0.30**	**3.5**	ND<0.25	ND<0.15	**0.28**	**10**	**12**
B-5-25	TEC	(a) (b) (c) (d)	2001	25	**0.40**	**4.0**	**29**	ND<0.15	ND<0.15	**6.5**	**3.5**	**3.0**	**0.50**	ND<0.10	**0.38**	**4.5**	ND<0.25	ND<0.15	**0.41**	**14**	**20**
B-6-15	TEC	(a) (b) (c) (d)	2001	15	**0.31**	**6.0**	**40**	ND<0.15	ND<0.15	**8.5**	**5.0**	**12**	**8.0**	ND<0.10	**0.26**	**8.0**	ND<0.25	ND<0.15	**0.49**	**18**	**28**
B-6-20	TEC	(a) (b) (c) (d)	2001	20	**0.25**	**5.0**	**27**	ND<0.15	ND<0.15	**5.5**	**3.0**	**5.0**	**1.0**	ND<0.10	ND<0.25	**3.5**	ND<0.25	ND<0.15	**0.34**	**12**	**14**
B-6-25	TEC	(a) (b) (c) (d)	2001	25	ND<0.25	**3.0**	**23**	ND<0.15	ND<0.15	**7.0**	**2.0**	**3.5**	**1.5**	ND<0.10	**0.25**	**2.5**	ND<0.25	ND<0.15	ND<0.25	**9.5**	**12**
B-7-15	TEC	(a) (b) (c) (d)	2001	15	**0.46**	**7.5**	**61**	ND<0.15	ND<0.15	**11**	**6.5**	**15**	**2.5**	**0.12**	**0.40**	**10**	ND<0.25	ND<0.15	**0.50**	**24**	**32**
B-7-20	TEC	(a) (b) (c) (d)	2001	20	**0.50**	**6.5**	**62**	ND<0.15	ND<0.15	**12**	**6.5**	**13**	**3.0**	ND<0.10	**0.26**	**9.5**	ND<0.25	ND<0.15	**0.50**	**24**	**31**
B-7-25	TEC	(a) (b) (c) (d)	2001	25	**0.36**	**4.5**	**34**	ND<0.15	ND<0.15	**8.0**	**4.0**	**3.0**	**1.0**	ND<0.10	**0.30**	**55**	ND<0.25	ND<0.15	**0.47**	**15**	**20**
B-8-15	TEC	(a) (b) (c) (d)	2001	15	**0.50**	**7.5**	**62**	ND<0.15	ND<0.15	**12**	**7.5**	**14**	**2.0**	ND<0.10	ND<0.25	**11**	ND<0.25	ND<0.15	**1.0**	**26**	**37**
B-8-20	TEC	(a) (b) (c) (d)	2001	20	**0.50**	**4.5**	**29**	ND<0.15	ND<0.15	**5.0**	**2.5**	**4.0**	**1.0**	ND<0.10	ND<0.25	**3.5**	ND<0.25	ND<0.15	ND<0.25	**12**	**13**
B-8-25	TEC	(a) (b) (c) (d)	2001	25	**1.0**	**12**	**100**	ND<0.15	ND<0.15	**25**	**14**	**24**	**5.0**	ND<0.10	**0.37**	**20**	ND<0.25	ND<0.15	**1.5**	**32**	**62**
B-9-15	TEC	(a) (b) (c) (d)	2001	15	**0.50**	**7.0**	**66**	ND<0.15	ND<0.15	**10**	**6.0**	**10**	**2.0**	ND<0.10	**0.38**	**8.5**	ND<0.25	ND<0.15	**0.50**	**22**	**26**
B-9-20	TEC	(a) (b) (c) (d)	2001	20	**0.50**	**4.5**	**26**	ND<0.15	ND<0.15	**5.5**	**2.5**	**5.0**	**1.5**	**0.12**	ND<0.25	**3.5**	ND<0.25	ND<0.15	**0.31**	**12**	**14**
Number of Samples					**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**
Number of Detections					**26**	**32**	**32**	**0**	**0**	**32**	**32**	**32**	**32**	**2**	**22**	**32**	**0**	**2**	**27**	**32**	**32**
Frequency of Detection					**81%**	**100%**	**100%**	**0%**	**0%**	**100%**	**100%**	**100%**	**100%**	**6%**	**69%**	**100%**	**0%**	**6%**	**84%**	**100%**	**100%**
Mean					**0.44**	**5.63**	**40.53**	**ND**	**ND**	**8.69**	**4.58**	**7.13**	**1.61**	**0.12**	**0.36**	**7.91**	**ND**	**2.75**	**0.53**	**17.63**	**23.38**
Standard Deviation					**0.14**	**2.18**	**19.53**	**ND**	**ND**	**3.86**	**2.37**	**4.81**	**1.51**	**0.00**	**0.09**	**9.27**	**ND**	**3.18**	**0.25**	**5.95**	**10.15**
Minimum Detected Concentration					**0.25**	**2.5**	**15**	**ND**	**ND**	**5**	**1.5**	**1.5**	**0.5**	**0.12**	**0.25**	**2.5**	**ND**	**0.5**	**0.25**	**9.5**	**10**
Maximum Detected Concentration					**1.0**	**12.0**	**100.0**	**ND**	**ND**	**25.0**	**14.0**	**24.0**	**8.0**	**0.1**	**0.5**	**55.0**	**ND**	**5.0**	**1.5**	**32.0**	**62.0**

Table E-1A
Summary of Analytical Results for Metals in Soil, East Parcel
Former ChemOil Refinery
Signal Hill, California

Notes:
mg/kg = milligram per kilogram.
bgs = below ground surface.
U.S. EPA = United States Environmental Protection Agency.
ND = not detected.
ND< = less than analytical detection limit listed.
TEC = Testa Environmental Corporation
-- = sample not analyzed for compound.

Data qualifiers from TEC, 2001:
(a) Sample date is unknown. The date listed is the date reported.
(b) Table 5-2 in TEC, 2001 does not indicate the whether this is soil or groundwater data. The units listed on the table indicate this is groundwater data (milligrams per liter), but the report text indicates this table is soil data. The table is inferred to be soil data based on the report text and the units are assumed to be milligrams per kilogram.
(c) The consultant is inferred from the report text and figures.
(d) No analytical method is listed on Table 5-2 in TEC, 2001. The report text lists the analytical method for soil as U.S. EPA Method 6010B; therefore, it is assumed this is the correct listed method.

References:
TEC. 2001. Report on Additional Subsurface Assessment, Former Chemoil Refinery - Eastern Parcel, Signal Hill, California. December 14.

Table E-1B
Summary of Analytical Results for Total Petroleum Hydrocarbons (TPH) in Soil, East Parcel
Former ChemOil Refinery
Signal Hill, California

Sample ID	Consultant	Data Qualifiers	Sample Date	Sample Depth	TPHg	TPHd	U. S. EPA Method 8015 - TPH																	Total TPH[1]		
							C06-C08	C08-C10	C10-C12	C12-C14	C14-C16	C16-C18	C18-C20	C20-C22	C22-C24	C24-C26	C26-C28	C28-C32	C32-C34	C34-C38	C38-C40	C40-C44	Total	C5-C12 (Note 2)	C13-C22 (Note 3)	C23-C44 (Note 4)
				feet bgs	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
B-1	EEI	(a) (b) (c)	1988	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-1	EEI	(a) (b) (c) (d)	1988	10	--	ND<10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-2	EEI	(a) (b) (c)	1988	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-2	EEI	(a) (b) (c)	1988	10	--	11,000 *	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-3	EEI	(a) (b) (c)	1988	2	2,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-3	EEI	(a) (b) (c)	1988	10	--	1,100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-3	EEI	(a) (b) (c)	1988	10	--	410 *	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
110-95-1	TSG	(a) (b) (c) (d) (e)	1999	1	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	13	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	13	ND<1	ND<1	6.5
110-95-5	TSG	(a) (b) (c) (d) (e)	1999	5	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	8.8	ND<1	ND<1	ND<1	2.6	ND<1	11	ND<1	ND<1	11.4
110-95-10	TSG	(a) (b) (c) (d) (e)	1999	10	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
125-310-1	TSG	(a) (b) (c) (d) (e)	1999	1	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	11	14	27	24	24	25	7.4	11	ND<1	ND<1	143	ND<1	25	104.9
125-310-5	TSG	(a) (b) (c) (d) (e)	1999	5	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	15	ND<1	ND<1	1.9	ND<1	ND<1	ND<1	ND<1	17	ND<1	ND<1	9.4
125-310-10	TSG	(a) (b) (c) (d) (e)	1999	10	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
180-75-1	TSG	(a) (b) (c) (d) (e)	1999	1	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
180-75-5	TSG	(a) (b) (c) (d) (e)	1999	5	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
180-75-10	TSG	(a) (b) (c) (d) (e)	1999	10	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
200-310-1	TSG	(a) (b) (c) (d) (e)	1999	1	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	15	ND<1	ND<1	1.9	ND<1	ND<1	ND<1	ND<1	17	ND<1	ND<1	9.4
200-310-5	TSG	(a) (b) (c) (d) (e)	1999	5	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
200-310-10	TSG	(a) (b) (c) (d) (e)	1999	10	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
204-95-1	TSG	(a) (b) (c) (d) (e)	1999	1	ND<1	--	ND<20	ND<20	ND<20	ND<20	ND<20	ND<20	ND<20	42	91	180	240	450	270	220	430	200	2,123	ND<20	42	2,036
204-95-5	TSG	(a) (b) (c) (d) (e)	1999	5	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	14	ND<1	ND<1	ND<1	3.0	4.8	22	ND<1	ND<1	21.8
204-95-10	TSG	(a) (b) (c) (d) (e)	1999	10	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	28	ND<1	ND<1	ND<1	4.0	2.1	34	ND<1	ND<1	34.1
30-195-1	TSG	(a) (b) (c) (d) (e) (g)	1999	1	24	--	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10	ND<10
30-195-5	TSG	(a) (b) (c) (d) (e) (g)	1999	5	30	--	ND<1	6.3	3.0	ND<1	ND<1	3.5	3.9	1.8	1.2	ND<1	7.1	ND<1	1.1	ND<1	ND<1	ND<1	28	9.3	9.2	8.8
30-195-10	TSG	(a) (b) (c) (d) (e) (g)	1999	10	8.8	--	ND<1	6.1	1.3	ND<1	ND<1	5.3	6.9	2.8	2.9	1.7	2.1	ND<1	ND<1	ND<1	ND<1	ND<1	29	7.4	15.0	5.3
70-70-1	TSG	(a) (b) (c) (d) (e)	1999	1	10	--	ND<20	ND<20	ND<20	ND<20	510	820	650	320	220	260	590	960	550	470	700	240	6,290	ND<20	2,300	3,880
70-70-5	TSG	(a) (b) (c) (d) (e)	1999	5	7.2	--	ND<10	ND<10	ND<10	50	310	270	170	59	76	53	56	110	85	52	74	22	1,387	ND<10	834	490
70-70-10	TSG	(a) (b) (c) (d) (e)	1999	10	370	--	ND<10	230	310	580	2,300	2,300	1,300	350	290	470	570	890	470	400	550	170	11,180	830	6,540	3,665
75-195-1	TSG	(a) (b) (c) (d) (e)	1999	1	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	10	ND<1	ND<1	7	ND<1	ND<1	ND<1	ND<1	17	ND<1	ND<1	12
75-195-5	TSG	(a) (b) (c) (d) (e)	1999	5	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	10	ND<1	7.7	ND<1	ND<1	ND<1	2.0	1.1	21	ND<1	ND<1	15.8
75-195-10	TSG	(a) (b) (c) (d) (e)	1999	10	ND<1	--	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1	ND<1
B-6-1	TEC	(a) (b) (c)	2001	1	--	45	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-6-10	TEC	(a) (b) (c)	2001	10	--	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-8-1	TEC	(a) (b) (c)	2001	1	--	46	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-9-1	TEC	(a) (b) (c)	2001	1	--	220	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E1B	Tetra Tech		06/01/06	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48
E1C	Tetra Tech		06/01/06	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	94	201	92
E3A	Tetra Tech		06/01/06	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48
E5	Tetra Tech		06/01/06	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48
E5	Tetra Tech		06/01/06	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48
Number of Samples																								29	29	29
Number of Detections																								4	8	16
Frequency of Detection																								14%	28%	55%
Mean																								235	1,246	650
Standard Deviation																								399	2,280	1,320
Minimum Detected Concentration																								7.4	9.2	5.3
Maximum Detected Concentration																								830	6,540	3,880
70-70-15	TSG	(a) (b) (c) (d) (e)	1999	15	370	--	66	980	2,200	3,300	2,900	2,400	1,700	860	1,200	910	720	740	120	350	88	78	18,612	4896	9,510	3,606
70-70-20	TSG	(a) (b) (c) (d) (e)	1999	20	760	--	ND<5	1,800	3,300	8,100	4,300	3,400	2,700	1,400	1,800	1,100	1,300	960	210	480	93	120	31,063	9150	15,850	5,163
70-70-25	TSG	(a) (b) (c) (d) (e)	1999	25	ND<1	--	ND<1	1.2	4.7	11	10	9.1	12	11	16	11	12	8.6	3.7	5.4	2.5	ND<1	118	11.4	47.6	51.2
B-2-40	TEC	(a) (b) (c) (d)	2001	40	--	ND<10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-9-15	TEC	(a) (b) (c)	2001	15	--	27	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-9-20	TEC	(a) (b) (c)	2001	20	--	17	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E1B	Tetra Tech		06/01/06	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48
E1B	Tetra Tech		06/01/06	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.72	7.59 J	5.04 J
E1C	Tetra Tech		06/01/06	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,829	2,540	2,162
E1C	Tetra Tech		06/01/06	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,999	13,030	8,238
E5	Tetra Tech		06/01/06	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48
E5	Tetra Tech		06/01/06	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND<4.5	ND<25	ND<48
Number of Samples																								9	9	9
Number of Detections																								6	6	6
Frequency of Detection																								67%	67%	67%
Mean																								3,482	6,831	3,204
Standard Deviation																								3,558	6,898	3,181
Minimum Detected Concentration																								5.7	7.6	5.0
Maximum Detected Concentration																								9,150	15,850	8,238

Table E-1B
Summary of Analytical Results for Total Petroleum Hydrocarbons (TPH) in Soil, East Parcel
Former ChemOil Refinery
Signal Hill, California

Notes:
mg/kg = milligrams per kilogram.
bgs = below ground surface.
U.S. EPA = United States Environmental Protection Agency.
TPH = Total Petroleum Hydrocarbons.
TPHg = total petroleum hydrocarbons as gasoline.
TPHd = total petroleum hydrocarbons as diesel.
ND = not detected.
ND< = less than the laboratory reporting limit in data from Tetra Tech, 2006 samples or analytical detection limit in data from Testa, 2001.
* = Carbon range C8-C30
Consultant listed is the consultant that collected the data. Data from EEI, TSG, and TEC are recorded from TEC, 2001 report.
EEI = Engineering Enterprises, Inc.
TSG = The Source Group, Inc.
TEC = Testa Environmental Corporation
-- = sample not analyzed for compound.
- = Data not presented herein. Refer to Tetra Tech, 2006.
[1] For use in the risk assessment, laboratory analytical results for carbon data within the specific TPH carbon ranges were summed to represent a total TPH value for each carbon range.
[2] TPH (C5-C12) was calculated based on summing detected results from C6-C8, C8-C10, and C10-C12.
[3] TPH (C13-C22) was calculated based on summing detected results of one half C12-C14 and the results between C14 and C22.
[4] TPH (C23-C44) was calculated based on summing the results of one half C22-C24 and the results between C24 and C44.

Data qualifiers from TEC, 2001:
(a) Sample date is unknown. The date listed is the date reported.
(b) Table 5-3 in TEC, 2001 does not indicate the whether this is soil or groundwater data. The table is inferred to be soil data based on the report text.
(c) Table 5-3 in TEC, 2001 does not indicate what units these data are presented in. Units are inferred from the report text.
(d) <1 was not defined in this table. All <1 symbols were assumed to indicate "not detected above the analytical detection limit".
(e)The sum totals of TPH presented in TEC, 2001 did not sum up and were recalculated for this report.
(f) The carbon ranges for TPHg and TPHd were not defined except where indicated.
(g) TSG boring 130-195 is not shown on any figure in TEC, 2001. It is assumed to be boring 130-95 on all figures in TEC, 2001.

References:
TEC. 2001. Report on Additional Subsurface Assessment, Former Chemoil Refinery - Eastern Parcel, Signal Hill, California. December 14.
Tetra Tech. 2006. Environmental Due Diligence Site Assessment Results, Former Chemoil Refinery Property, Signal Hill, California. August 8.

Table E-1C
Summary of Analytical Results for Volatile Organic Compounds (VOCs) in Soil, East Parcel
Former ChemOil Refiney
Signal Hill, California

Sample ID	Consultant	Data Qualifiers	Sample Date	Sample Depth feet bgs	U.S. EPA Method 8260B - VOCs								
					Benzene mg/kg	n-Butylbenzene mg/kg	sec-Butylbenzene mg/kg	tert-Butylbenzene mg/kg	Ethylbenzene mg/kg	Isopropylbenzene mg/kg	Naphthalene mg/kg	Toluene mg/kg	Total Xylenes mg/kg
B-1	EEI	(a) (b) (c)	1988	2	--	--	--	--	--	--	--	--	--
B-1	EEI	(a) (b) (c)	1988	10	--	--	--	--	--	--	--	--	--
B-2	EEI	(a) (b) (c)	1988	2	--	--	--	--	--	--	--	--	--
B-2	EEI	(a) (b) (c)	1988	10	--	--	--	--	--	--	--	--	--
B-3	EEI	(a) (b) (c)	1988	2	--	--	--	--	--	--	--	--	--
B-3	EEI	(a) (b) (c)	1988	10	--	--	--	--	--	--	--	--	--
B-3	EEI	(a) (b) (c)	1988	10	--	--	--	--	--	--	--	--	--
110-95-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
110-95-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
110-95-10	TSG	(a) (b) (c)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
125-310-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
125-310-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
125-310-10	TSG	(a) (b) (c)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
180-75-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
180-75-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
180-75-10	TSG	(a) (b) (c)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
200-310-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
200-310-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
200-310-10	TSG	(a) (b) (c)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
204-95-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
204-95-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
204-95-10	TSG	(a) (b) (c)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
30-195-1	TSG	(a) (b) (c) (e)	1999	1	ND<0.005	--	--	--	**0.017**	--	--	ND<0.005	**0.014**
30-195-5	TSG	(a) (b) (c) (e)	1999	5	ND<0.005	--	--	--	**0.52**	--	--	**0.0068**	**0.13**
30-195-10	TSG	(a) (b) (c) (e)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
70-70-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	**0.024**	--	--	ND<0.005	**0.045**
70-70-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	**0.013**	--	--	ND<0.005	**0.058**
70-70-10	TSG	(a) (b) (c)	1999	10	**0.057**	--	--	--	**0.82**	--	--	**0.29**	**3.4**
75-195-1	TSG	(a) (b) (c)	1999	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
75-195-5	TSG	(a) (b) (c)	1999	5	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
75-195-10	TSG	(a) (b) (c)	1999	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
B-6-1	TEC	(a) (b) (c)	2001	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
B-6-10	TEC	(a) (b) (c)	2001	10	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
B-8-1	TEC	(a) (b) (c)	2001	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
B-9-1	TEC	(a) (b) (c)	2001	1	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
E1B	Tetra Tech		06/01/06	5	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
E1C	Tetra Tech		06/01/06	5	ND<0.002	ND<0.005	ND<0.005	ND<0.005	**0.0088 J**	ND<0.005	**0.0050 J**	ND<0.002	ND<0.002
E3A	Tetra Tech		06/01/06	10	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
E5	Tetra Tech		06/01/06	5	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
E5	Tetra Tech		06/01/06	10	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
Number of Samples					**33**	**5**	**5**	**5**	**33**	**5**	**5**	**33**	**33**
Number of Detections					**1**	**0**	**0**	**0**	**6**	**0**	**1**	**2**	**5**
Frequency of Detection					**3%**	**0%**	**0%**	**0%**	**18%**	**0%**	**20%**	**6%**	**15%**
Mean					**NE**	**ND**	**ND**	**ND**	**0**	**ND**	**NE**	**0**	**1**
Standard Deviation					**NE**	**ND**	**ND**	**ND**	**0**	**ND**	**NE**	**0**	**1**
Minimum Detected Concentration					**0.057**	**ND**	**ND**	**ND**	**0.0088**	**ND**	**0.005**	**0.0068**	**0.014**
Maximum Detected Concentration					**0.057**	**ND**	**ND**	**ND**	**0.82**	**ND**	**0.005**	**0.29**	**3.4**

Table E-1C
Summary of Analytical Results for Volatile Organic Compounds (VOCs) in Soil, East Parcel
Former ChemOil Refiney
Signal Hill, California

Sample ID	Consultant	Data Qualifiers	Sample Date	Sample Depth (feet bgs)	U.S. EPA Method 8260B - VOCs								
					Benzene mg/kg	n-Butylbenzene mg/kg	sec-Butylbenzene mg/kg	tert-Butylbenzene mg/kg	Ethylbenzene mg/kg	Isopropylbenzene mg/kg	Naphthalene mg/kg	Toluene mg/kg	Total Xylenes mg/kg
70-70-15	TSG	(a) (b) (c)	1999	15	ND<0.005	--	--	--	**0.33**	--	--	**0.33**	**4.2**
70-70-20	TSG	(a) (b) (c)	1999	20	ND<0.005	--	--	--	**0.25**	--	--	**0.80**	**8.1**
70-70-25	TSG	(a) (b) (c)	1999	25	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
B-2-40	TEC	(a) (b) (c) (d)	2001	40	ND<0.005	**5.1**	**10**	--	ND<0.005	--	--	ND<0.005	**7.2**
B-9-15	TEC	(a) (b) (c)	2001	15	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
B-9-20	TEC	(a) (b) (c)	2001	20	ND<0.005	--	--	--	ND<0.005	--	--	ND<0.005	ND<0.01
E1B	Tetra Tech		06/01/06	15	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
E1B	Tetra Tech		06/01/06	25	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
E1C	Tetra Tech		06/01/06	15	ND<0.012	**1.100**	**3.100**	**0.175**	ND<0.012	**2.600**	**4.320**	**0.114**	ND<0.012
E1C	Tetra Tech		06/01/06	25	ND<0.012	**1.190**	**4.760**	**0.281**	**0.0594 J**	**4.020**	**9.080**	**0.136**	**0.0458 J**
E5	Tetra Tech		06/01/06	15	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
E5	Tetra Tech		06/01/06	20	ND<0.002	ND<0.005	ND<0.005	ND<0.005	ND<0.002	ND<0.005	ND<0.005	ND<0.002	ND<0.002
Number of Samples					12	7	7	6	12	6	6	12	12
Number of Detections					0	3	3	2	3	2	2	4	4
Frequency of Detection					0%	43%	43%	33%	25%	33%	33%	33%	33%
Mean					ND	2	6	0	0	3	7	0	5
Standard Deviation					ND	2	4	0	0	1	3	0	4
Minimum Detected Concentration					ND	1.1	3.1	0.175	0.0594	2.6	4.32	0.114	0.0458
Maximum Detected Concentration					ND	5.1	10	0.281	0.33	4.02	9.08	0.80	8.1

Notes:

mg/kg = milligram per kilogram.
bgs = below ground surface.
U.S. EPA = United States Environmental Protection Agency.
VOCs = volatile organic compounds.
ND = not detected.
ND< = less than the laboratory reporting limit in data from Tetra Tech, 2006 samples or analytical detection limit in data from TEC, 2001.
Consultant listed is the consultant that collected the data. Data from EEI, TSG, and TEC are recorded from TEC, 2001 report.
EEI = Engineering Enterprises, Inc.
TSG = The Source Group, Inc.
TEC = Testa Environmental Corporation
-- = sample not analyzed for compound.
J = analyte was detected; however, analyte concentration is an estimated value between the method detection limit and the practical quantitation limit.

Data qualifiers from TEC, 2001:

(a) Sample date is unknown. The date listed is the date reported.

(b) The analytical method for benzene, toluene, ethylbenzene and xylenes (BTEX) is unknown for all samples reported in TEC, 2001. Table 5-1 lists the method for as U.S. EPA Method 8020; however, the report text states the method is U.S. EPA Method 8260B. It is assumed the analytical method used is U.S. EPA Method 8260B.

(c) The analytical method for n-Butylbenzene and sec-butylbenzene are unknown. The report text indicates the analytical method for VOCs is U.S. EPA Method 8260 for all samples collected by TEC, 2001, so it is assumed that this is the actual analytical method used to analyze VOCs.

(d) Two concentrations are listed for xylenes in sample B-2-40. The higher concentration was assumed to be correct and is listed in this table.

(e)TSG boring 130-195 is not shown on any figure in TEC, 2001. It is assumed to be boring 130-95 on all figures in TEC, 2001.

References:

TEC. 2001. Report on Additional Subsurface Assessment, Former Chemoil Refinery - Eastern Parcel, Signal Hill, California. December 14.
Tetra Tech. 2006. Environmental Due Diligence Site Assessment Results, Former Chemoil Refinery Property, Signal Hill, California. August 8.

Table E-1D

Summary of Analytical Results for Polycyclic Aromatic Hydrocarbons (PAHs) in Soil, East Parcel

Former ChemOil Refinery
Signal Hill, California

Boring	Sample Date	Sample Depth	U.S. EPA Method 8270C - PAHs															
			Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
		feet bgs	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
E1B	6/1/2006	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E1B	6/1/2006	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E1B	6/1/2006	25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E1C	6/1/2006	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E1C	6/1/2006	15	**0.221**	ND	ND	ND	ND	ND	ND	ND	**1.59**	ND	**0.036**	**0.387**	ND	**1.19**	**1.95**	**1.95**
E1C	6/1/2006	25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E3A	6/1/2006	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E5	6/1/2006	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E5	6/1/2006	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E5	6/1/2006	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E5	6/1/2006	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Number of Samples			1	1	1	1	1	1	1	1	1	1	1	1.00	1	1.0	1.00	1
Number of Detections			1	1	1	1	1	1	1	1	1	1	1	1.00	1	1.0	1.00	1
Frequency of Detection			100%	1	1	1	1	1	1	1	1	1	1	1.00	1	1.0	1.00	1
Mean			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Standard Deviation			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Minimum Detected Concentration			0.22	ND	ND	ND	ND	ND	ND	ND	1.6	ND	0.036	0.39	ND	1.2	2.0	2.0
Maximum Detected Concentration			0.22	ND	ND	ND	ND	ND	ND	ND	1.6	ND	0.036	0.39	ND	1.2	2.0	2.0

Notes:

mg/kg = milligram per kilogram.

ft bgs = feet below ground surface.

PAHs = Polycyclic aromatic hydrocarbons.

U.S. EPA = United States Environmental Protection Agency.

ND = Not detected at laboratory reporting limit. See Tetra Tech, 2006 for laboratory reporting limit.

-- = Not analyzed.

References:

Tetra Tech. 2006. Environmental Due Diligence Site Assessment Results, Former Chemoil Refinery Property, Signal Hill, California. August 8.

GROUNDWATER

Table E-1E
Summary of Analytical Results for Metals in Groundwater
Former Chemoil Refinery
Signal Hill, California

Sample ID	Consultant	Data Qualifiers	Sample Date	U.S EPA Method 6010B - Metals																
				Antimony µg/L	Arsenic µg/L	Barium µg/L	Beryllium µg/L	Cadmium µg/L	Chromium µg/L	Cobalt µg/L	Copper µg/L	Lead µg/L	Mercury µg/L	Molybdenum µg/L	Nickel µg/L	Selenium µg/L	Silver µg/L	Thallium µg/L	Vanadium µg/L	Zinc µg/L
MW-2	unknown	(a) (b) (c) (d) (e)	unknown	ND<0.0050	**0.0067**	**0.090**	ND<0.0030	ND<0.0030	**0.030**	ND<0.0030	**0.010**	ND<0.0050	ND<0.0020	ND<0.0050	ND<0.0030	ND<0.0050	ND<0.0030	ND<0.0050	**0.0077**	**0.030**
MW-10	unknown	(a) (b) (c) (d) (e)	unknown	ND<0.0050	**0.26**	**0.060**	ND<0.0030	ND<0.0030	ND<0.0030	ND<0.0030	**0.0072**	ND<0.0050	ND<0.0020	**0.010**	ND<0.0030	ND<0.0050	ND<0.0030	ND<0.0050	ND<0.0030	**0.030**
B-1	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**0.12**	**0.26**	ND<0.0030	ND<0.0030	**0.050**	**0.010**	**0.030**	ND<0.0050	ND<0.0020	**0.080**	**0.020**	ND<0.0050	ND<0.0030	ND<0.0050	**0.070**	**0.10**
B-2	TEC	(a) (b) (c) (d) (e)	2001	**0.0069**	**0.14**	**0.65**	ND<0.0030	ND<0.0030	**0.21**	**0.090**	**0.12**	**0.020**	ND<0.0020	**0.060**	**0.11**	ND<0.0050	ND<0.0030	**0.010**	**0.32**	**0.54**
B-3	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**10.03**	**0.19**	ND<0.0030	ND<0.0030	**0.030**	**0.020**	**0.020**	ND<0.0050	ND<0.0020	**0.030**	**0.020**	ND<0.0050	ND<0.0030	ND<0.0050	**0.070**	**0.10**
B-4	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**0.11**	**0.50**	ND<0.0030	ND<0.0030	**0.060**	**0.020**	**0.030**	ND<0.0050	ND<0.0020	**0.090**	**0.040**	ND<0.0050	ND<0.0030	ND<0.0050	**0.10**	**0.21**
B-5	TEC	(a) (b) (c) (d) (e)	2001	**0.0051**	**0.23**	**2.9**	ND<0.0030	ND<0.0030	**0.35**	**0.27**	**0.30**	**0.11**	ND<0.0020	**0.040**	**0.29**	ND<0.0050	ND<0.0030	**0.020**	**0.50**	**0.72**
B-6	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**0.030**	**0.31**	ND<0.0030	ND<0.0030	**0.030**	**0.050**	**0.040**	ND<0.0050	ND<0.0020	**0.020**	**0.030**	ND<0.0050	ND<0.0030	ND<0.0050	**0.070**	**0.070**
B-7	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**0.10**	**0.69**	ND<0.0030	ND<0.0030	**0.23**	**0.070**	**0.12**	**0.020**	ND<0.0020	**0.060**	**0.11**	ND<0.0050	ND<0.0030	**0.010**	**0.26**	**0.43**
B-8	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**0.040**	**0.33**	ND<0.0030	ND<0.0030	**0.060**	**0.020**	**0.050**	ND<0.0050	ND<0.0020	**0.060**	**0.030**	ND<0.0050	ND<0.0030	ND<0.0050	**0.080**	**0.13**
B-9	TEC	(a) (b) (c) (d) (e)	2001	ND<0.0050	**0.0091**	**215**	ND<0.0030	ND<0.0030	**0.010**	**0.010**	**0.020**	ND<0.0050	ND<0.0020	**0.030**	**0.010**	ND<0.0050	ND<0.0030	ND<0.0050	**0.030**	**0.050**
Number of Samples				11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Number of Detections				2	11	11	0	0	10	9	11	3	0	10	9	0	0	3	10	11
Frequency of Detection				18%	100%	100%	0%	0%	91%	82%	100%	27%	0%	91%	82%	0%	0%	27%	91%	100%
Mean				0.0060	1.0	20	ND	ND	0.11	0.062	0.068	0.050	ND	0.048	0.073	ND	ND	0.013	0.15	0.22
Standard Deviation				0.0013	3.0	65	ND	ND	0.12	0.083	0.087	0.052	ND	0.026	0.090	ND	ND	0.0058	0.16	0.24
Minimum Detected Concentration				0.0051	0.0067	0.060	ND	ND	0.010	0.010	0.0072	0.020	ND	0.010	0.010	ND	ND	0.010	0.0077	0.030
Maximum Detected Concentration				0.0069	10	215	ND	ND	0.35	0.27	0.30	0.11	ND	0.090	0.29	ND	ND	0.020	0.50	0.72

Notes:
µg/L = micrograms per liter.
U.S. EPA = United States Environmental Protection Agency.
ND = not detected.
ND< = Less than analytical detection limit listed.
TEC = Testa Environmental Corporation.

Data qualifiers from TEC, 2001:
MW-1, MW-10, and B-1 through B-9 are reported in TEC, 2001.
(a) Sample date is unknown. The date listed is the date reported.
(b) The consultant is unknown. Data collected for borings B-1 through B-9 are assumed to be collected by TEC, 2001, as it is stated in the report text 9 borings were installed as part of their investigation with the same naming convention.
(c) The sample depth is unknown.
(d) No analytical method is listed in Table 6-2. The report text lists the analytical method for soil as U.S. EPA Method 6010B; therefore, it is assumed this is the correct listed method.
(e) No units are listed in Table 6-2 or in the report text. The units are assumed to be µg/L.

References:
TEC. 2001. Report on Additional Subsurface Assessment, Former Chemoil Refinery - Eastern Parcel, Signal Hill, California. December 14.

Table E-1F
Summary of Analytical Results for Volatile Organic Compounds (VOCs) in Groundwater, East Parcel

Former ChemOil Refinery
Signal Hill, California

Sample ID	Consultant	Sample Date	U.S. EPA Method 8015B		U.S. EPA Method 8020B	U.S EPA Method 8260B - VOCs					
			TPHg mg/L	**TPHd** mg/L	**Bis (2-chloroethyl) ether** µg/L	**tert-Butyl Alcohol** µg/L	**sec-Butylbenzene** µg/L	**Isopropylbenzene** µg/L	**Naphthalene** µg/L	**n-Propylbenzene** µg/L	**o-Xylene** µg/L
MW-2	AA&AI	12/9/2012	ND<0.05	**0.48**	ND<10	ND<10	ND<0.50	ND<0.50	ND<1	ND<0.50	ND<0.50
MW-2	AA&AI	12/27/2013	ND<0.05	ND<0.5	ND<10	ND<10	ND<1	ND<1	ND<3	ND<1	--
MW-2	AA&AI	12/7/2014	ND<0.05	ND<0.5	ND<10	ND<10	ND<1	ND<1	ND<3	ND<1	--
MW-2	AA&AI	12/10/2015	ND<0.05	ND<0.5	ND<10	ND<10	ND<1	ND<1	ND<3	ND<1	--
MW-10	AA&AI	12/9/2012	**0.080**	**2.5**	ND<10	**220**	ND<0.50	**0.71**	**1.3**	**0.51**	**0.65**
MW-10	AA&AI	12/27/2013	ND<0.05	ND<0.5	ND<10	**130**	ND<1	ND<1	ND<3	ND<1	--
MW-10	AA&AI	12/7/2014	ND<0.050	ND<0.5	ND<10	ND<10	ND<1	ND<1	ND<3	ND<1	--
MW-10	AA&AI	12/10/2015	ND<0.050	**0.911**	ND<10	ND<10	ND<1	ND<1	ND<3	ND<1	--
MW-10	AA&AI	12/15/2016	**0.079**	**1.03**	ND<9.5	**15**	ND<1.0	**0.65**	**1.5**	ND<0.50	ND<0.50
B-1	TEC	2001	ND<0.20	--	**1,500**	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	**2.1**
B-2	TEC	2001	ND<0.20	--	ND<110	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
B-3	TEC	2001	ND<0.20	--	ND<110	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
B-4	TEC	2001	ND<0.20	--	**100**	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	**3.0**
B-5	TEC	2001	ND<0.20	--	ND<110	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
B-6	TEC	2001	ND<0.20	--	ND<11	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
B-7	TEC	2001	ND<0.20	--	ND<11	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
B-8	TEC	2001	ND<0.20	--	ND<11	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
B-9	TEC	2001	ND<0.20	--	ND<11	--	ND<5.0	ND<5.0	ND<5.0	ND<5.0	ND<5.0
E1A	Tetra Tech	6/1/2006	--	--	--	--	**1.6**	**8.7**	**11.6**	**9.6**	ND<0.5
E1A	Tetra Tech	6/1/2006	--	--	--	--	**1.7**	**13.3**	**64.7**	**13.2**	ND<0.5
E5	Tetra Tech	6/1/2006	--	--	--	--	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
Number of Samples					18	9	21	21	21	21	15
Number of Detections					2	3	2	4	4	3	3
Frequency of Detection					11%	33%	10%	19%	19%	14%	20%
Mean					800	122	1.7	5.8	20	7.8	1.9
Standard Deviation					990	103	0.071	6.2	30	6.5	1.2
Minimum Detected Concentration					100	15	1.6	0.65	1.3	0.51	0.65
Maximum Detected Concentration					1,500	220	1.7	13	65	13	3.0

Notes:

mg/L = milligram per liter.
µg/L = microgram per liter.
U.S. EPA = United States Environmental Protection Agency.
TPHg = total petroleum hydrocarbons as gasoline.
TPHd - total petroleum hydrocarbons as diesel.
VOCs = volatile organic compounds.
ND = not detected.
ND< = less than the laboratory reporting limit in data from Tetra Tech, 2006 samples or analytical detection limit in data from TEC, 2001.

Data qualifiers from TEC, 2001:

B-1 through B-9 are reported in TEC, 2001.
(a) Sample date is unknown. The date listed is the date reported.
(b) The consultant is unknown. Data collected for borings B-1 through B-9 are assumed to be collected by TEC, 2001, as it is stated in the report text 9 borings were installed as part of their investigation with the same naming convention.
(c) The sample depth is unknown.

References:

Ami Amini & Adini, Inc. (AA&AI). 2017. Groundwater Monitoring Report – Fourth Quarter 2016, Former Chemoil Refinery, 2020 Walnut Avenue, Signal Hill, California. January 15.

AA&AI. 2016. Groundwater Monitoring Report – Fourth Quarter 2015, Former Chemoil Refinery, 2020 Walnut Avenue, Signal Hill, California. January 15.

AA&AI. 2015. Groundwater Monitoring Report – Fourth Quarter 2014, Former Chemoil Refinery, 2020 Walnut Avenue, Signal Hill, California. January 15.

AA&AI. 2014. Groundwater Monitoring Report – Fourth Quarter 2013, Former Chemoil Refinery, 2020 Walnut Avenue, Signal Hill, California. January 15.

TEC. 2013. Report on Groundwater Quality Monitoring Program January 2013, Former Chemoil Refinery, Slic No. 453A, Signal Hill, California. January 15.

TEC. 2001. Report on Additional Subsurface Assessment, Former Chemoil Refinery - Eastern Parcel, Signal Hill, California. December 14.

Tetra Tech. 2006. Environmental Due Diligence Site Assessment Results, Former Chemoil Refinery Property, Signal Hill, California. August 8.

SOIL VAPOR

Table E-1G
Summary of Analytical Results for Volatile Organic Compounds (VOCs) in Soil Vapor, East Parcel
Former ChemOil Refinery
Signal Hill, California

Boring	Sample Date	Depth	U.S EPA Method TO-15 - VOCs							
			Benzene	Toluene	Ethylbenzene	o-Xylene	m,p-Xylenes	Methyl tert-Butyl Ether	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene
		feet bgs	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
E1	6/2/2006	15	<796	<796	**10,800**	<796	<1,592	<796	<1,194	<1,194
Number of Samples			1	1	1	1	1	1	1	1
Number of Detections			0	0	1	0	0	0	0	0
Frequency of Detection			0%	0%	100%	0%	0%	0%	0%	0%
Mean			ND	ND	NE	ND	ND	ND	ND	ND
Standard Deviation			ND	ND	NE	ND	ND	ND	ND	ND
Minimum Detected Concentration			ND	ND	10,800	ND	ND	ND	ND	ND
Maximum Detected Concentration			ND	ND	10,800	ND	ND	ND	ND	ND

Notes:

µg/m³ = microgram per cubic meter.
bgs = below ground surface.
ND = not detected.
ND< = less than the laboratory reporting limit in data from Tetra Tech, 2006 samples or analytical detection limit in data from TEC, 2001.

References:

Tetra Tech. 2006. Environmental Due Diligence Site Assessment Results, Former Chemoil Refinery Property, Signal Hill, California. August 8.

ATTACHMENT E-2

SOIL SCREENING EVALUATION FOR PROTECTION OF GROUNDWATER

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TABLE

ATTACHMENT

1.0 INTRODUCTION

In support of the human health risk assessment (HHRA) for the East Parcel, this appendix presents the soil screening evaluation for the protection of groundwater pathway. The evaluation of chemical concentrations in soil for groundwater protection (soil leaching) is designed to address the potential leaching of chemicals from vadose zone soils and their subsequent impact on groundwater. The potential for chemicals to leach from soil depends on the physical and chemical properties of the chemicals, soil type, pH (for metals), and other site-specific conditions. For example, chemicals with high water solubilities tend to leach more readily than chemicals with lower solubilities. In addition, a chemical's organic-carbon partition coefficient (K_{oc}) is important for assessing the degree of chemical sorption to soil particles; chemicals with a high sorption potential do not tend to leach as readily (i.e., metals and polycyclic aromatic hydrocarbons [PAHs]). Site-specific conditions are also important for assessing whether leaching may occur, such as presence of a cap or cover at the site, soil type (leaching occurs more readily in sandy soils than in clayey or silty soils), amount of rainfall, gradient, etc. Based on the proposed development plans, over 90-percent of the East Parcel will be capped with buildings and an asphalt parking lot, which will further minimize the potential leaching of groundwater.

On the East Parcel, soil samples were collected from soil at 1 to 40 feet below ground surface (bgs). These samples were analyzed for metals, total petroleum hydrocarbons (TPH), volatile organic compounds (VOCs), and PAHs. Leaching of metals is variable based on metal speciation and physical chemical conditions of the soil. In general, metals tend to adsorb readily to soil particles and do not leach as readily. For these reasons, metals were not included in this screening evaluation. All detected TPH, VOCs, and PAHs in soil were included in this screening level evaluation.

The following soil screening levels (SLs) for protection of groundwater were used in this screening evaluation:

For TPH and VOCs

- Los Angeles – Regional Water Quality Control Board (LARWQCB) SLs for soil (LARWQCB, 1996). The Site-specific LARWQCB SLs were developed for the protection of groundwater, as described in *Site Investigation and Site Conceptual Model Report* (Apex-SGI, 2017).

For PAHs

The lowest SL from the following sources,

- San Francisco Bay - Regional Water Quality Control Board (SFRWQCB) environmental screening levels (ESLs) for soil leaching to groundwater (SFRWQCB, 2016); and

- U.S. Environmental Protection Agency (USEPA) regional screening levels (RSLs) for soil leaching to groundwater (USEPA, 2016).

The SFRWQCB ESLs and USEPA RSLs for protection of groundwater were developed for potential leaching of chemicals from vadose-zone soil and subsequent migration to groundwater. The SLs are based on a target groundwater screening levels for groundwater use as a non-drinking water resource. Table E-2A summarizes the soil SLs for protection of groundwater.

As discussed in the HHRA for the East Parcel, it is relevant and appropriate to statistically evaluate the soil data on an area-wide basis. Consistent with USEPA (1989) procedures, when evaluating an RME scenario the lesser of the maximum detected concentration and the 95-percent upper confidence limit of the mean concentration (95UCL) was selected as the appropriate soil exposure point concentration (EPC) for the vadose zone (0 to 30 feet bgs). A USEPA software package, ProUCL Version 5.1.00, was used to estimate the upper confidence limit of the mean concentration (UCL; [typically the 95UCL, but sometimes the 97.5UCL or 99UCL, depending on the data set]). ProUCL and USEPA (2015) guidance make recommendations for estimating UCLs and were developed as tools to support risk assessment. Due to limitations of certain datasets (i.e., limited number of samples or low detection frequency), ProUCL was not used to estimate a UCL. For those analytes with adequate datasets, the ProUCL output spreadsheets are presented in Attachment E-2A. The soil EPCs (EPC_{soil}) used in this HHRA are summarized in Table E-2A.

Based on the screening evaluation for TPH, VOCs, and PAHs, the soil EPCs for TPH C5-C12, naphthalene, and chrysene exceeded the protection of groundwater soil SLs (Table E-2A). Each of these exceedances is discussed in the following bullets:

- The soil EPC for TPH C5-C12 of 1,700 milligrams per kilogram (mg/kg) exceeded the soil SL of 1,000 mg/kg. This low end TPH carbon range is generally evaluated by its components most likely to reflect risk; such as, benzene, toluene, ethylbenzene, and total xylenes (BTEX) and naphthalene. The soil EPCs for BTEX and naphthalene did not exceed their individual protection of groundwater SLs.
- The soil EPC for naphthalene of 3.1 mg/kg exceeded the soil SL of 1.7 mg/kg. The soil EPC of 3.1 mg/kg represents the 95UCL of 11 soil samples analyzed for VOCs by EPA Method 8260B. Naphthalene was only detected at one sample location, E1C, at 5, 15, and 25 feet bgs at concentrations of 0.0050 mg/kg, 4.3 mg/kg, and 9.1 mg/kg, respectively. Soil sample E1C at 15 feet bgs was also analyzed for PAHs by EPA Method 8270C. In this soil sample, naphthalene was detected at 1.2 mg/kg, which is below the soil SL of 1.7 mg/kg. Naphthalene has been detected at the location of E1C at concentrations above and below the soil SL, depending on depth of sample and analytical analysis. Due to low naphthalene concentrations detected in vadose zone soil, high K_{oc} relative to VOCs, and tendency for PAHs to sorb strongly to soil particles, leaching of naphthalene is not expected to occur at the Site to any significant extent.

- The soil EPC for chrysene of 1.6 mg/kg slightly exceeded the soil SL of 1.2 mg/kg. Similar to naphthalene, low chrysene concentration detected in vadose zone soil, high K_{oc} relative to VOCs, and tendency for PAHs to sorb strongly to soil particles, indicates leaching of chrysene is not expected to occur at the Site to any significant extent.

All other TPH (C13-C22 and C23-C44), VOCs, and PAHs were not detected above the laboratory reporting limit or the soil EPCs were below the protection of groundwater soil SLs.

To summarize, although leaching potential of chemicals of potential concern (COPCs) from vadose zone soil into groundwater may be a potential chemical release mechanism, it is not a significant release mechanism for COPCs because of other competing migration pathways (i.e., metals and PAHs are expected to sorb strongly to soil particles and VOCs are expected to volatilize) and the presence of a cap (i.e., buildings and pavement) across the East Parcel in the future.

2.0 REFERENCES

The Source Group, Inc., a Division of Apex Companies, LLC (Apex-SGI). 2017. Site Investigation and Site Conceptual Model Report, Former Chemoil Refinery, Signal Hill, California. March 29.

Los Angeles – Regional Water Quality Control Board (LARWQCB). 1996. Interim Site Assessment & Cleanup Guidebook. Los Angeles and Ventura Counties, Region 4. May.

San Francisco Bay - Regional Water Quality Control Board (SFRWQCB). 2016. Update to Environmental Screening Levels. Revision 3. February.

U.S. Environmental Protection Agency (USEPA). 1989. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part A. Interim Final. Solid Waste and Emergency Response. December.

USEPA. 2015. ProUCL Version 5.1.00 [Software, accompanied by “ProUCL User’s Guide.”]. Prepared for USEPA by Lockheed Martin Environmental Services. EPA/600/R-07/041. October.

USEPA. 2016. Regional Screening Levels for Chemical Contaminants at Superfund Sites. USEPA Region 3, Region 6, and Region 9. May.

TABLE

Table E-2A
Protection of Groundwater Screening Level Evaluation
for the Chemicals of Potential Concern (COPCs) in Soil (0 to 30 feet bgs)

Former ChemOil Refinery
Signal Hill, California

	Soil				
Chemical of Potential Concern	**MDC** (mg/kg)	**95UCL**[1] (mg/kg)	**EPC$_{soil}$**[2] (mg/kg)	**Protection of Groundwater Soil Screening Level (SL)**[3] (mg/kg)	**Does EPC$_{soil}$ exceed SSL?** (Yes/No)
Metals					
Antimony	1.0	0.53	0.53	- -[4]	- -
Arsenic	18	10	10	- -	- -
Barium	450	81	81	- -	- -
Beryllium	ND	NE	ND	- -	- -
Cadmium	ND	NE	ND	- -	- -
Chromium	40	17	17	- -	- -
Cobalt	14	7.0	7.0	- -	- -
Copper	48	14	14	- -	- -
Lead	100	3.8	3.8	- -	- -
Mercury	3.0	0.39	0.39	- -	- -
Molybdenum	0.50	0.39	0.39	- -	- -
Nickel	64	17	17	- -	- -
Selenium	ND	NE	ND	- -	- -
Silver	ND	0.74	0.74	- -	- -
Thallium	2.0	0.90	0.90	- -	- -
Vanadium	120	36	36	- -	- -
Zinc	200	37	37	- -	- -
TPH[6]					
C5-C12	9,150	1,700	1,700	1,000	**Yes**
TPH (C4-C12) Aliphatic	4,575	850	850		
TPH (C4-C12) Aromatic	4,575	850	850		
C13-C22	15,850	3,361	3,361	10,000	No
TPH (C13-C22) Aliphatic	7,925	1,681	1,681		
TPH (C13-C22) Aromatic	7,925	1,681	1,681		
C23-C44	8,238	2,638	2,638	50,000	No
TPH (C23-C44) Aliphatic	4,119	1,319	1,319		
TPH (C23-C44) Aromatic	4,119	1,319	1,319		
VOCs					
Benzene	0.057	NE	0.057	0.15	No
n-Butylbenzene	5.1	1.5	1.5	26	No
sec-Butylbenzene	10	3.4	3.4	26	No
tert-Butylbenzene	0.28	0.18	0.18	26	No
Ethylbenzene	0.82	0.13	0.13	32	No
Isopropylbenzene	4.0	54	4.0	77	No
Naphthalene	9.1	3.1	3.1	1.7	**Yes**
Toluene	0.80	0.076	0.076	16	No
Total Xylenes	8.1	1.5	1.5	180	No
PAHs					
Acenaphthene	0.22	NE	0.22	5.5	No
Acenaphthylene	ND	NE	ND	5.5	No
Anthracene	ND	NE	ND	2.8	No
Benz(a)anthracene	ND	NE	ND	0.0042	No
Benzo(b)fluoranthene	ND	NE	ND	0.041	No
Benzo(k)fluoranthene	ND	NE	ND	0.4	No
Benzo(g,h,i)perylene	ND	NE	ND	27	No
Benzo(a)pyrene	ND	NE	ND	0.004	No
Chrysene	1.6	NE	1.6	1.2	**Yes**
Dibenz(a,h)anthracene	ND	NE	ND	0.013	No
Fluoranthene	0.036	NE	0.036	60	No
Fluorene	0.39	NE	0.39	5.4	No
Indeno(1,2,3-c,d)pyrene	ND	NE	ND	0.13	No
Naphthalene	1.2	NE	1.2	1.7	No
Phenanthrene	2.0	NE	2.0	11	No
Pyrene	2.0	NE	2.0	13	No

Table E-2A
Protection of Groundwater Screening Level Evaluation for the Chemicals of Potential Concern (COPCs) in Soil (0 to 30 feet bgs)
Former ChemOil Refinery
Signal Hill, California

Notes:
95UCL = 95-percent upper confidence limit of the mean.
MDC = maximum detected concentration.
EPC = exposure point concentration.
mg/kg = milligrams per kilogram.
TPH = total petroleum hydrocarbons.
VOC = volatile organic compounds.
PAH = polycyclic aromatic hydrocarbons.
- - = not available (see Note 4).
NE = not estimated (see Note 5).

[1] A summary of the methods used to identify an appropriate 95UCL is provided in Attachment E-2A.

[2] Represents the lesser of the maximum detected concentration and the 95UCL.

[3] Protection of groundwater soil screening levels (SLs) represent Site-specific soil SLs developed using the Los Angeles Regional Water Quality Control Board guidance . Site-specific soil SLs were not available for PAHs; therefore, the lesser of the San Francisco Bay Regional Water Quality Control Board Environmental Screening Levels and U.S. Environmental Protection Agency Regional Screening Levels for protection of groundwater, as a non-drinking water source were used.

[4] Metals were not included in this screening evaluation because leaching of metals is variable based on metal speciation and physical chemical conditions of the soil. In general, metals tend to bind tightly to soil particles.

[5] Due to limitations of chemical dataset, ProUCL was unable to estimate a 95UCL.

[6] In the absence of fractionated TPH data, the TPH data were assumed to be 50 percent aliphatic and 50 percent aromatic.

ATTACHMENT E-2A

PROUCL STATISTICAL EVALUATION, SOIL 0 TO 30 FEET BGS

METALS

ProUCL Statistical Evaluation of Antimony (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

```
                                      General Statistics
        Total Number of Observations    59                Number of Distinct Observations   17
                 Number of Detects      52                       Number of Non-Detects       7
         Number of Distinct Detects     17                Number of Distinct Non-Detects     1
                    Minimum Detect      0.25                      Minimum Non-Detect         0.25
                    Maximum Detect      1                         Maximum Non-Detect         0.25
                  Variance Detects      0.0363                      Percent Non-Detects      11.86%
                      Mean Detects      0.511                               SD Detects       0.19
                    Median Detects      0.5                                 CV Detects       0.373
                  Skewness Detects      1.852                         Kurtosis Detects       2.82
             Mean of Logged Detects     -0.725                    SD of Logged Detects       0.314

                              Normal GOF Test on Detects Only
         Shapiro Wilk Test Statistic    0.677         Normal GOF Test on Detected Observations Only
          5% Shapiro Wilk P Value  5.407E-14         Detected Data Not Normal at 5% Significance Level
           Lilliefors Test Statistic    0.408                       Lilliefors GOF Test
        5% Lilliefors Critical Value    0.122         Detected Data Not Normal at 5% Significance Level
                          Detected Data Not Normal at 5% Significance Level

              Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
                           KM Mean      0.48                  KM Standard Error of Mean      0.0258
                             KM SD      0.196                        95% KM (BCA) UCL        0.525
                    95% KM (t) UCL      0.523         95% KM (Percentile Bootstrap) UCL      0.527
                    95% KM (z) UCL      0.522                  95% KM Bootstrap t UCL        0.531
             90% KM Chebyshev UCL       0.557                  95% KM Chebyshev UCL          0.592
           97.5% KM Chebyshev UCL       0.641                  99% KM Chebyshev UCL          0.737

                          Gamma GOF Tests on Detected Observations Only
                  A-D Test Statistic    5.177                  Anderson-Darling GOF Test
                 5% A-D Critical Value  0.75     Detected Data Not Gamma Distributed at 5% Significance Level
                  K-S Test Statistic    0.368                   Kolmogorov-Smirnov GOF
                 5% K-S Critical Value  0.123    Detected Data Not Gamma Distributed at 5% Significance Level
                       Detected Data Not Gamma Distributed at 5% Significance Level

                              Gamma Statistics on Detected Data Only
                       k hat (MLE)      9.516                    k star (bias corrected MLE)   8.98
                   Theta hat (MLE)      0.0537               Theta star (bias corrected MLE)   0.0569
                      nu hat (MLE)    989.6                         nu star (bias corrected)  933.9
                    Mean (detects)      0.511

                             Gamma ROS Statistics using Imputed Non-Detects
               GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
   GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
                       For such situations, GROS method may yield incorrect values of UCLs and BTVs
                                  This is especially true when the sample size is small.
        For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates
                           Minimum      0.135                                        Mean      0.474
                           Maximum      1                                          Median      0.5
                                SD      0.206                                          CV      0.434
                       k hat (MLE)      6.018                    k star (bias corrected MLE)   5.723
                   Theta hat (MLE)      0.0788               Theta star (bias corrected MLE)   0.0829
                      nu hat (MLE)    710.1                         nu star (bias corrected)  675.3
      Adjusted Level of Significance (β)  0.0459
     Approximate Chi Square Value (675.35, α)  616.1        Adjusted Chi Square Value (675.35, β)  614.6
  95% Gamma Approximate UCL (use when n>=50)   0.52       95% Gamma Adjusted UCL (use when n<50)   0.521

                            Estimates of Gamma Parameters using KM Estimates
                         Mean (KM)      0.48                                      SD (KM)      0.196
                     Variance (KM)      0.0385                           SE of Mean (KM)      0.0258
                        k hat (KM)      5.988                                 k star (KM)      5.695
                       nu hat (KM)    706.6                                  nu star (KM)    672
                    theta hat (KM)      0.0802                            theta star (KM)      0.0843
           80% gamma percentile (KM)    0.636                  90% gamma percentile (KM)      0.749
           95% gamma percentile (KM)    0.851                  99% gamma percentile (KM)      1.067
```

ProUCL Statistical Evaluation of Antimony (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (672.03, α)	612.9	Adjusted Chi Square Value (672.03, β)	611.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.526	95% Gamma Adjusted KM-UCL (use when n<50)	0.528

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.807	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	8.5444E-9	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.344	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.122	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.48	Mean in Log Scale	-0.802
SD in Original Scale	0.198	SD in Log Scale	0.365
95% t UCL (assumes normality of ROS data)	0.523	95% Percentile Bootstrap UCL	0.524
95% BCA Bootstrap UCL	0.531	95% Bootstrap t UCL	0.528
95% H-UCL (Log ROS)	0.521		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.803	KM Geo Mean	0.448
KM SD (logged)	0.362	95% Critical H Value (KM-Log)	1.751
KM Standard Error of Mean (logged)	0.0476	95% H-UCL (KM -Log)	0.52
KM SD (logged)	0.362	95% Critical H Value (KM-Log)	1.751
KM Standard Error of Mean (logged)	0.0476		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.465	Mean in Log Scale	-0.886
SD in Original Scale	0.218	SD in Log Scale	0.531
95% t UCL (Assumes normality)	0.513	95% H-Stat UCL	0.543

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.523	KM H-UCL	0.52
95% KM (BCA) UCL	0.525		

ProUCL Statistical Evaluation of Arsenic (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	59	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	2.5	Mean	7.669
Maximum	18	Median	6
SD	4.165	Std. Error of Mean	0.542
Coefficient of Variation	0.543	Skewness	1.148

Normal GOF Test

Shapiro Wilk Test Statistic	0.856	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.7067E-7	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.164	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.115	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	8.576	95% Adjusted-CLT UCL (Chen-1995)	8.648
		95% Modified-t UCL (Johnson-1978)	8.589

Gamma GOF Test

A-D Test Statistic	1.141	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.754	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.141	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.116	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.992	k star (bias corrected MLE)	3.8
Theta hat (MLE)	1.921	Theta star (bias corrected MLE)	2.018
nu hat (MLE)	471	nu star (bias corrected)	448.4
MLE Mean (bias corrected)	7.669	MLE Sd (bias corrected)	3.934
		Approximate Chi Square Value (0.05)	400.3
Adjusted Level of Significance	0.0459	Adjusted Chi Square Value	399.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	8.591	95% Adjusted Gamma UCL (use when n<50)	8.615

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.951	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.0385	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.128	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.115	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.916	Mean of logged Data	1.907
Maximum of Logged Data	2.89	SD of logged Data	0.508

Assuming Lognormal Distribution

95% H-UCL	8.688	90% Chebyshev (MVUE) UCL	9.235
95% Chebyshev (MVUE) UCL	9.957	97.5% Chebyshev (MVUE) UCL	10.96
99% Chebyshev (MVUE) UCL	12.93		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	8.561	95% Jackknife UCL	8.576
95% Standard Bootstrap UCL	8.549	95% Bootstrap-t UCL	8.683
95% Hall's Bootstrap UCL	8.649	95% Percentile Bootstrap UCL	8.576
95% BCA Bootstrap UCL	8.695		
90% Chebyshev(Mean, Sd) UCL	9.296	95% Chebyshev(Mean, Sd) UCL	10.03
97.5% Chebyshev(Mean, Sd) UCL	11.06	99% Chebyshev(Mean, Sd) UCL	13.07

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	10.03

ProUCL Statistical Evaluation of Barium (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	59	Number of Distinct Observations	45
		Number of Missing Observations	0
Minimum	15	Mean	69.12
Maximum	450	Median	54
SD	67.94	Std. Error of Mean	8.845
Coefficient of Variation	0.983	Skewness	3.933

Normal GOF Test

Shapiro Wilk Test Statistic	0.606	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.223	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.115	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	83.9	95% Adjusted-CLT UCL (Chen-1995)	88.51
		95% Modified-t UCL (Johnson-1978)	84.66

Gamma GOF Test

A-D Test Statistic	1.448	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.762	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.11	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.117	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.155	k star (bias corrected MLE)	2.056
Theta hat (MLE)	32.08	Theta star (bias corrected MLE)	33.61
nu hat (MLE)	254.3	nu star (bias corrected)	242.7
MLE Mean (bias corrected)	69.12	MLE Sd (bias corrected)	48.2
		Approximate Chi Square Value (0.05)	207.6
Adjusted Level of Significance	0.0459	Adjusted Chi Square Value	206.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	80.79	95% Adjusted Gamma UCL (use when n<50)	81.11

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.961	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.126	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0703	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.115	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.708	Mean of logged Data	3.986
Maximum of Logged Data	6.109	SD of logged Data	0.654

Assuming Lognormal Distribution

95% H-UCL	79.2	90% Chebyshev (MVUE) UCL	84.82
95% Chebyshev (MVUE) UCL	93.16	97.5% Chebyshev (MVUE) UCL	104.7
99% Chebyshev (MVUE) UCL	127.5		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	83.67	95% Jackknife UCL	83.9
95% Standard Bootstrap UCL	83.95	95% Bootstrap-t UCL	95.14
95% Hall's Bootstrap UCL	159.4	95% Percentile Bootstrap UCL	85.08
95% BCA Bootstrap UCL	90.17		
90% Chebyshev(Mean, Sd) UCL	95.65	95% Chebyshev(Mean, Sd) UCL	107.7
97.5% Chebyshev(Mean, Sd) UCL	124.4	99% Chebyshev(Mean, Sd) UCL	157.1

Suggested UCL to Use

95% Approximate Gamma UCL	80.79

ProUCL Statistical Evaluation of Chromium (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	59	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	5	Mean	12.76
Maximum	40	Median	10
SD	7.666	Std. Error of Mean	0.998
Coefficient of Variation	0.601	Skewness	1.468

Normal GOF Test

Shapiro Wilk Test Statistic	0.828	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	4.8381E-9	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.251	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.115	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	14.43	95% Adjusted-CLT UCL (Chen-1995)	14.61
		95% Modified-t UCL (Johnson-1978)	14.46

Gamma GOF Test

A-D Test Statistic	1.903	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.755	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.213	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.116	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.557	k star (bias corrected MLE)	3.387
Theta hat (MLE)	3.588	Theta star (bias corrected MLE)	3.768
nu hat (MLE)	419.7	nu star (bias corrected)	399.7
MLE Mean (bias corrected)	12.76	MLE Sd (bias corrected)	6.935
		Approximate Chi Square Value (0.05)	354.4
Adjusted Level of Significance	0.0459	Adjusted Chi Square Value	353.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	14.4	95% Adjusted Gamma UCL (use when n<50)	14.44

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.932	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.00334	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.183	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.115	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.609	Mean of logged Data	2.399
Maximum of Logged Data	3.689	SD of logged Data	0.528

Assuming Lognormal Distribution

95% H-UCL	14.46	90% Chebyshev (MVUE) UCL	15.39
95% Chebyshev (MVUE) UCL	16.63	97.5% Chebyshev (MVUE) UCL	18.37
99% Chebyshev (MVUE) UCL	21.77		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	14.4	95% Jackknife UCL	14.43
95% Standard Bootstrap UCL	14.4	95% Bootstrap-t UCL	14.75
95% Hall's Bootstrap UCL	14.63	95% Percentile Bootstrap UCL	14.49
95% BCA Bootstrap UCL	14.55		
90% Chebyshev(Mean, Sd) UCL	15.76	95% Chebyshev(Mean, Sd) UCL	17.11
97.5% Chebyshev(Mean, Sd) UCL	19	99% Chebyshev(Mean, Sd) UCL	22.69

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	17.11

ProUCL Statistical Evaluation of Cobalt (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

```
                                            General Statistics
              Total Number of Observations    59                       Number of Distinct Observations    20
                                                                        Number of Missing Observations    0
                                   Minimum    1.5                                                 Mean    6.197
                                   Maximum    14                                                Median    5
                                        SD    3.317                                  Std. Error of Mean    0.432
                  Coefficient of Variation    0.535                                           Skewness    0.886

                                             Normal GOF Test
                Shapiro Wilk Test Statistic   0.893                  Shapiro Wilk GOF Test
                 5% Shapiro Wilk P Value  1.9408E-5          Data Not Normal at 5% Significance Level
                   Lilliefors Test Statistic   0.17                    Lilliefors GOF Test
                5% Lilliefors Critical Value   0.115         Data Not Normal at 5% Significance Level
                                Data Not Normal at 5% Significance Level

                                       Assuming Normal Distribution
          95% Normal UCL                                          95% UCLs (Adjusted for Skewness)
                     95% Student's-t UCL    6.918                  95% Adjusted-CLT UCL (Chen-1995)    6.96
                                                                  95% Modified-t UCL (Johnson-1978)    6.927

                                             Gamma GOF Test
                         A-D Test Statistic   0.679           Anderson-Darling Gamma GOF Test
                       5% A-D Critical Value   0.755   Detected data appear Gamma Distributed at 5% Significance Level
                         K-S Test Statistic   0.135          Kolmogorov-Smirnov Gamma GOF Test
                       5% K-S Critical Value   0.116      Data Not Gamma Distributed at 5% Significance Level
                 Detected data follow Appr. Gamma Distribution at 5% Significance Level

                                            Gamma Statistics
                               k hat (MLE)    3.771                      k star (bias corrected MLE)    3.591
                           Theta hat (MLE)    1.643                  Theta star (bias corrected MLE)    1.726
                              nu hat (MLE)   445                             nu star (bias corrected)   423.7
                 MLE Mean (bias corrected)    6.197                           MLE Sd (bias corrected)    3.27
                                                                   Approximate Chi Square Value (0.05)   377
              Adjusted Level of Significance   0.0459                         Adjusted Chi Square Value   375.9

                                       Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)    6.965          95% Adjusted Gamma UCL (use when n<50)    6.985

                                            Lognormal GOF Test
                Shapiro Wilk Test Statistic   0.967               Shapiro Wilk Lognormal GOF Test
                    5% Shapiro Wilk P Value   0.227        Data appear Lognormal at 5% Significance Level
                   Lilliefors Test Statistic   0.107              Lilliefors Lognormal GOF Test
                5% Lilliefors Critical Value   0.115        Data appear Lognormal at 5% Significance Level
                             Data appear Lognormal at 5% Significance Level

                                          Lognormal Statistics
                  Minimum of Logged Data    0.405                                 Mean of logged Data    1.686
                  Maximum of Logged Data    2.639                                   SD of logged Data    0.537

                                     Assuming Lognormal Distribution
                              95% H-UCL    7.132                            90% Chebyshev (MVUE) UCL    7.595
                   95% Chebyshev (MVUE) UCL    8.221                          97.5% Chebyshev (MVUE) UCL    9.088
                   99% Chebyshev (MVUE) UCL   10.79

                              Nonparametric Distribution Free UCL Statistics
                   Data appear to follow a Discernible Distribution at 5% Significance Level

                                    Nonparametric Distribution Free UCLs
                              95% CLT UCL    6.907                                   95% Jackknife UCL    6.918
                    95% Standard Bootstrap UCL    6.906                               95% Bootstrap-t UCL    7.019
                      95% Hall's Bootstrap UCL    6.939                        95% Percentile Bootstrap UCL    6.908
                        95% BCA Bootstrap UCL    6.934
                  90% Chebyshev(Mean, Sd) UCL    7.492                        95% Chebyshev(Mean, Sd) UCL    8.079
                97.5% Chebyshev(Mean, Sd) UCL    8.893                        99% Chebyshev(Mean, Sd) UCL   10.49

                                           Suggested UCL to Use
                    95% Approximate Gamma UCL    6.965
```

ProUCL Statistical Evaluation of Copper (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

```
                                        General Statistics
          Total Number of Observations   59                 Number of Distinct Observations   28
                                                            Number of Missing Observations     0
                               Minimum    1.5                                          Mean   11.58
                               Maximum   48                                          Median    9
                                    SD    9.203                              Std. Error of Mean    1.198
              Coefficient of Variation    0.794                                      Skewness    1.698

                                         Normal GOF Test
           Shapiro Wilk Test Statistic    0.832                Shapiro Wilk GOF Test
             5% Shapiro Wilk P Value  8.0090E-9        Data Not Normal at 5% Significance Level
             Lilliefors Test Statistic    0.177                  Lilliefors GOF Test
           5% Lilliefors Critical Value    0.115        Data Not Normal at 5% Significance Level
                              Data Not Normal at 5% Significance Level

                                   Assuming Normal Distribution
     95% Normal UCL                                        95% UCLs (Adjusted for Skewness)
                  95% Student's-t UCL   13.59                95% Adjusted-CLT UCL (Chen-1995)   13.84
                                                              95% Modified-t UCL (Johnson-1978)   13.63

                                          Gamma GOF Test
                   A-D Test Statistic    0.708             Anderson-Darling Gamma GOF Test
                  5% A-D Critical Value    0.763    Detected data appear Gamma Distributed at 5% Significance Level
                   K-S Test Statistic    0.0876           Kolmogorov-Smirnov Gamma GOF Test
                  5% K-S Critical Value    0.117    Detected data appear Gamma Distributed at 5% Significance Level
                        Detected data appear Gamma Distributed at 5% Significance Level

                                         Gamma Statistics
                           k hat (MLE)    1.968                      k star (bias corrected MLE)    1.879
                       Theta hat (MLE)    5.888                  Theta star (bias corrected MLE)    6.166
                          nu hat (MLE)  232.2                          nu star (bias corrected)  221.7
               MLE Mean (bias corrected)   11.58                           MLE Sd (bias corrected)    8.452
                                                            Approximate Chi Square Value (0.05)  188.2
         Adjusted Level of Significance    0.0459                       Adjusted Chi Square Value  187.5

                                    Assuming Gamma Distribution
95% Approximate Gamma UCL (use when n>=50)   13.64        95% Adjusted Gamma UCL (use when n<50)   13.7

                                         Lognormal GOF Test
           Shapiro Wilk Test Statistic    0.976             Shapiro Wilk Lognormal GOF Test
              5% Shapiro Wilk P Value    0.527        Data appear Lognormal at 5% Significance Level
             Lilliefors Test Statistic    0.0836              Lilliefors Lognormal GOF Test
           5% Lilliefors Critical Value    0.115        Data appear Lognormal at 5% Significance Level
                              Data appear Lognormal at 5% Significance Level

                                       Lognormal Statistics
             Minimum of Logged Data    0.405                              Mean of logged Data    2.175
             Maximum of Logged Data    3.871                                SD of logged Data    0.753

                                   Assuming Lognormal Distribution
                             95% H-UCL   14.36                       90% Chebyshev (MVUE) UCL   15.41
              95% Chebyshev (MVUE) UCL   17.13                     97.5% Chebyshev (MVUE) UCL   19.52
              99% Chebyshev (MVUE) UCL   24.21

                             Nonparametric Distribution Free UCL Statistics
                       Data appear to follow a Discernible Distribution at 5% Significance Level

                                  Nonparametric Distribution Free UCLs
                           95% CLT UCL   13.56                              95% Jackknife UCL   13.59
              95% Standard Bootstrap UCL   13.55                          95% Bootstrap-t UCL   13.96
                 95% Hall's Bootstrap UCL   13.99                  95% Percentile Bootstrap UCL   13.47
                   95% BCA Bootstrap UCL   13.86
           90% Chebyshev(Mean, Sd) UCL   15.18                    95% Chebyshev(Mean, Sd) UCL   16.81
         97.5% Chebyshev(Mean, Sd) UCL   19.07                    99% Chebyshev(Mean, Sd) UCL   23.51

                                         Suggested UCL to Use
             95% Approximate Gamma UCL   13.64
```

ProUCL Statistical Evaluation of Lead (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	59	Number of Distinct Observations	15
Number of Detects	58	Number of Non-Detects	1
Number of Distinct Detects	14	Number of Distinct Non-Detects	1
Minimum Detect	0.5	Minimum Non-Detect	0.25
Maximum Detect	100	Maximum Non-Detect	0.25
Variance Detects	167.3	Percent Non-Detects	1.695%
Mean Detects	3.983	SD Detects	12.94
Median Detects	2	CV Detects	3.248
Skewness Detects	7.425	Kurtosis Detects	56.01
Mean of Logged Detects	0.637	SD of Logged Detects	0.92

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.221	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.404	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.116	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	3.919	KM Standard Error of Mean	1.671
KM SD	12.72	95% KM (BCA) UCL	7.356
95% KM (t) UCL	6.713	95% KM (Percentile Bootstrap) UCL	7.258
95% KM (z) UCL	6.668	95% KM Bootstrap t UCL	20.64
90% KM Chebyshev UCL	8.932	95% KM Chebyshev UCL	11.2
97.5% KM Chebyshev UCL	14.35	99% KM Chebyshev UCL	20.55

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	5.015	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.79	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.236	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.121	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.797	k star (bias corrected MLE)	0.767
Theta hat (MLE)	4.998	Theta star (bias corrected MLE)	5.192
nu hat (MLE)	92.43	nu star (bias corrected)	88.98
Mean (detects)	3.983		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	3.915
Maximum	100	Median	2
SD	12.83	CV	3.278
k hat (MLE)	0.735	k star (bias corrected MLE)	0.709
Theta hat (MLE)	5.329	Theta star (bias corrected MLE)	5.525
nu hat (MLE)	86.7	nu star (bias corrected)	83.63
Adjusted Level of Significance (β)	0.0459		
Approximate Chi Square Value (83.63, α)	63.55	Adjusted Chi Square Value (83.63, β)	63.11
95% Gamma Approximate UCL (use when n>=50)	5.152	95% Gamma Adjusted UCL (use when n<50)	5.188

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	3.919	SD (KM)	12.72
Variance (KM)	161.9	SE of Mean (KM)	1.671
k hat (KM)	0.0949	k star (KM)	0.101
nu hat (KM)	11.2	nu star (KM)	11.96
theta hat (KM)	41.3	theta star (KM)	38.67
80% gamma percentile (KM)	2.773	90% gamma percentile (KM)	10.49
95% gamma percentile (KM)	22.73	99% gamma percentile (KM)	61.84

ProUCL Statistical Evaluation of Lead (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (11.96, α)	5.202	Adjusted Chi Square Value (11.96, β)	5.09
95% Gamma Approximate KM-UCL (use when n>=50)	9.013	95% Gamma Adjusted KM-UCL (use when n<50)	9.211

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.9	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	5.5694E-5	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.107	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.116	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.918	Mean in Log Scale	0.598
SD in Original Scale	12.83	SD in Log Scale	0.96
95% t UCL (assumes normality of ROS data)	6.711	95% Percentile Bootstrap UCL	7.213
95% BCA Bootstrap UCL	9.184	95% Bootstrap t UCL	20.29
95% H-UCL (Log ROS)	3.852		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.602	KM Geo Mean	1.827
KM SD (logged)	0.942	95% Critical H Value (KM-Log)	2.276
KM Standard Error of Mean (logged)	0.124	95% H-UCL (KM -Log)	3.77
KM SD (logged)	0.942	95% Critical H Value (KM-Log)	2.276
KM Standard Error of Mean (logged)	0.124		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	3.917	Mean in Log Scale	0.591
SD in Original Scale	12.83	SD in Log Scale	0.979
95% t UCL (Assumes normality)	6.71	95% H-Stat UCL	3.927

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL	3.77

ProUCL Statistical Evaluation of Mercury (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	58	Number of Distinct Observations	4
		Number of Missing Observations	1
Number of Detects	5	Number of Non-Detects	53
Number of Distinct Detects	3	Number of Distinct Non-Detects	1
Minimum Detect	0.11	Minimum Non-Detect	0.1
Maximum Detect	3	Maximum Non-Detect	0.1
Variance Detects	1.662	Percent Non-Detects	91.38%
Mean Detects	0.694	SD Detects	1.289
Median Detects	0.12	CV Detects	1.857
Skewness Detects	2.236	Kurtosis Detects	5
Mean of Logged Detects	-1.494	SD of Logged Detects	1.45

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.555	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.472	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.151	KM Standard Error of Mean	0.0554
KM SD	0.377	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.244	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.242	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.317	95% KM Chebyshev UCL	0.393
97.5% KM Chebyshev UCL	0.497	99% KM Chebyshev UCL	0.702

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.294	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.708	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.504	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.371	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.554	k star (bias corrected MLE)	0.355
Theta hat (MLE)	1.253	Theta star (bias corrected MLE)	1.955
nu hat (MLE)	5.54	nu star (bias corrected)	3.549
Mean (detects)	0.694		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.069
Maximum	3	Median	0.01
SD	0.393	CV	5.692
k hat (MLE)	0.396	k star (bias corrected MLE)	0.387
Theta hat (MLE)	0.174	Theta star (bias corrected MLE)	0.178
nu hat (MLE)	45.97	nu star (bias corrected)	44.93
Adjusted Level of Significance (β)	0.0459		
Approximate Chi Square Value (44.93, α)	30.55	Adjusted Chi Square Value (44.93, β)	30.25
95% Gamma Approximate UCL (use when n>=50)	0.101	95% Gamma Adjusted UCL (use when n<50)	0.102

ProUCL Statistical Evaluation of Mercury (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.151	SD (KM)	0.377
Variance (KM)	0.142	SE of Mean (KM)	0.0554
k hat (KM)	0.161	k star (KM)	0.164
nu hat (KM)	18.62	nu star (KM)	18.99
theta hat (KM)	0.942	theta star (KM)	0.923
80% gamma percentile (KM)	0.176	90% gamma percentile (KM)	0.453
95% gamma percentile (KM)	0.817	99% gamma percentile (KM)	1.857

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (18.99, α)	10.11	Adjusted Chi Square Value (18.99, β)	9.948
95% Gamma Approximate KM-UCL (use when n>=50)	0.284	95% Gamma Adjusted KM-UCL (use when n<50)	0.289

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.574	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.467	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0616	Mean in Log Scale	-8.934
SD in Original Scale	0.394	SD in Log Scale	4.054
95% t UCL (assumes normality of ROS data)	0.148	95% Percentile Bootstrap UCL	0.165
95% BCA Bootstrap UCL	0.264	95% Bootstrap t UCL	1.067
95% H-UCL (Log ROS)	22.4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.233	KM Geo Mean	0.107
KM SD (logged)	0.443	95% Critical H Value (KM-Log)	1.857
KM Standard Error of Mean (logged)	0.0651	95% H-UCL (KM -Log)	0.132
KM SD (logged)	0.443	95% Critical H Value (KM-Log)	1.857
KM Standard Error of Mean (logged)	0.0651		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.106	Mean in Log Scale	-2.866
SD in Original Scale	0.387	SD in Log Scale	0.573
95% t UCL (Assumes normality)	0.191	95% H-Stat UCL	0.0777

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.393

ProUCL Statistical Evaluation of Molybdenum (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	59	Number of Distinct Observations	20
Number of Detects	45	Number of Non-Detects	14
Number of Distinct Detects	20	Number of Distinct Non-Detects	1
Minimum Detect	0.25	Minimum Non-Detect	0.25
Maximum Detect	0.5	Maximum Non-Detect	0.25
Variance Detects	0.00754	Percent Non-Detects	23.73%
Mean Detects	0.398	SD Detects	0.0868
Median Detects	0.4	CV Detects	0.218
Skewness Detects	-0.195	Kurtosis Detects	-1.381
Mean of Logged Detects	-0.945	SD of Logged Detects	0.23

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.875	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.165	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.363	KM Standard Error of Mean	0.0129
KM SD	0.098	95% KM (BCA) UCL	0.386
95% KM (t) UCL	0.385	95% KM (Percentile Bootstrap) UCL	0.384
95% KM (z) UCL	0.384	95% KM Bootstrap t UCL	0.385
90% KM Chebyshev UCL	0.402	95% KM Chebyshev UCL	0.419
97.5% KM Chebyshev UCL	0.444	99% KM Chebyshev UCL	0.492

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.564	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.748	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.161	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.132	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	20.26	k star (bias corrected MLE)	18.93
Theta hat (MLE)	0.0197	Theta star (bias corrected MLE)	0.0211
nu hat (MLE)	1824	nu star (bias corrected)	1703
Mean (detects)	0.398		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.163	Mean	0.359
Maximum	0.5	Median	0.36
SD	0.105	CV	0.292
k hat (MLE)	11.31	k star (bias corrected MLE)	10.74
Theta hat (MLE)	0.0318	Theta star (bias corrected MLE)	0.0334
nu hat (MLE)	1334	nu star (bias corrected)	1268
Adjusted Level of Significance (β)	0.0459		
Approximate Chi Square Value (N/A, α)	1186	Adjusted Chi Square Value (N/A, β)	1184
95% Gamma Approximate UCL (use when n>=50)	0.384	95% Gamma Adjusted UCL (use when n<50)	0.385

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.363	SD (KM)	0.098
Variance (KM)	0.00961	SE of Mean (KM)	0.0129
k hat (KM)	13.73	k star (KM)	13.04
nu hat (KM)	1620	nu star (KM)	1539
theta hat (KM)	0.0265	theta star (KM)	0.0279
80% gamma percentile (KM)	0.444	90% gamma percentile (KM)	0.497
95% gamma percentile (KM)	0.543	99% gamma percentile (KM)	0.637

ProUCL Statistical Evaluation of Molybdenum (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	1449	Adjusted Chi Square Value (N/A, β)	1446
95% Gamma Approximate KM-UCL (use when n>=50)	0.386	95% Gamma Adjusted KM-UCL (use when n<50)	0.386

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.876	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.155	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.36	Mean in Log Scale	-1.064
SD in Original Scale	0.103	SD in Log Scale	0.3
95% t UCL (assumes normality of ROS data)	0.383	95% Percentile Bootstrap UCL	0.382
95% BCA Bootstrap UCL	0.383	95% Bootstrap t UCL	0.384
95% H-UCL (Log ROS)	0.386		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.05	KM Geo Mean	0.35
KM SD (logged)	0.273	95% Critical H Value (KM-Log)	1.704
KM Standard Error of Mean (logged)	0.036	95% H-UCL (KM -Log)	0.386
KM SD (logged)	0.273	95% Critical H Value (KM-Log)	1.704
KM Standard Error of Mean (logged)	0.036		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.334	Mean in Log Scale	-1.214
SD in Original Scale	0.14	SD in Log Scale	0.526
95% t UCL (Assumes normality)	0.364	95% H-Stat UCL	0.389

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.385	KM H-UCL	0.386
95% KM (BCA) UCL	0.386		

ProUCL Statistical Evaluation of Nickel (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	59	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	2.5	Mean	10.96
Maximum	64	Median	8
SD	10.82	Std. Error of Mean	1.408
Coefficient of Variation	0.987	Skewness	3.32

Normal GOF Test

Shapiro Wilk Test Statistic	0.64	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.224	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.115	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	13.31	95% Adjusted-CLT UCL (Chen-1995)	13.92
		95% Modified-t UCL (Johnson-1978)	13.41

Gamma GOF Test

A-D Test Statistic	1.925	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.763	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.154	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.117	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.949	k star (bias corrected MLE)	1.861
Theta hat (MLE)	5.623	Theta star (bias corrected MLE)	5.888
nu hat (MLE)	230	nu star (bias corrected)	219.6
MLE Mean (bias corrected)	10.96	MLE Sd (bias corrected)	8.032
		Approximate Chi Square Value (0.05)	186.3
Adjusted Level of Significance	0.0459	Adjusted Chi Square Value	185.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	12.92	95% Adjusted Gamma UCL (use when n<50)	12.97

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.944	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.0154	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.137	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.115	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.916	Mean of logged Data	2.116
Maximum of Logged Data	4.159	SD of logged Data	0.695

Assuming Lognormal Distribution

95% H-UCL	12.72	90% Chebyshev (MVUE) UCL	13.64
95% Chebyshev (MVUE) UCL	15.06	97.5% Chebyshev (MVUE) UCL	17.02
99% Chebyshev (MVUE) UCL	20.88		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	13.27	95% Jackknife UCL	13.31
95% Standard Bootstrap UCL	13.3	95% Bootstrap-t UCL	14.72
95% Hall's Bootstrap UCL	22.41	95% Percentile Bootstrap UCL	13.49
95% BCA Bootstrap UCL	14.24		
90% Chebyshev(Mean, Sd) UCL	15.18	95% Chebyshev(Mean, Sd) UCL	17.1
97.5% Chebyshev(Mean, Sd) UCL	19.75	99% Chebyshev(Mean, Sd) UCL	24.97

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	17.1

ProUCL Statistical Evaluation of Silver (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	59	Number of Distinct Observations	3
Number of Detects	2	Number of Non-Detects	57
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	0.5	Minimum Non-Detect	0.15
Maximum Detect	5	Maximum Non-Detect	0.15
Variance Detects	10.13	Percent Non-Detects	96.61%
Mean Detects	2.75	SD Detects	3.182
Median Detects	2.75	CV Detects	1.157
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	0.458	SD of Logged Detects	1.628

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.238	KM Standard Error of Mean	0.115
KM SD	0.627	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.431	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.428	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.584	95% KM Chebyshev UCL	0.741
97.5% KM Chebyshev UCL	0.959	99% KM Chebyshev UCL	1.387

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	1.038	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2.648	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	4.154	nu star (bias corrected)	N/A
Mean (detects)	2.75		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.238	SD (KM)	0.627
Variance (KM)	0.393	SE of Mean (KM)	0.115
k hat (KM)	0.144	k star (KM)	0.148
nu hat (KM)	17.03	nu star (KM)	17.49
theta hat (KM)	1.65	theta star (KM)	1.606
80% gamma percentile (KM)	0.257	90% gamma percentile (KM)	0.705
95% gamma percentile (KM)	1.314	99% gamma percentile (KM)	3.084

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0459
Approximate Chi Square Value (17.49, α)	9.027	Adjusted Chi Square Value (17.49, β)	8.874
95% Gamma Approximate KM-UCL (use when n>=50)	0.462	95% Gamma Adjusted KM-UCL (use when n<50)	0.469

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0939	Mean in Log Scale	-17.28
SD in Original Scale	0.653	SD in Log Scale	7.971
95% t UCL (assumes normality of ROS data)	0.236	95% Percentile Bootstrap UCL	0.255
95% BCA Bootstrap UCL	0.357	95% Bootstrap t UCL	19.22
95% H-UCL (Log ROS)	1.173E+12		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.817	KM Geo Mean	0.162
KM SD (logged)	0.476	95% Critical H Value (KM-Log)	1.878
KM Standard Error of Mean (logged)	0.0876	95% H-UCL (KM -Log)	0.205
KM SD (logged)	0.476	95% Critical H Value (KM-Log)	1.878
KM Standard Error of Mean (logged)	0.0876		

ProUCL Statistical Evaluation of Silver (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.166	Mean in Log Scale	-2.487
SD in Original Scale	0.643	SD in Log Scale	0.596
95% t UCL (Assumes normality)	0.306	95% H-Stat UCL	0.116

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use	
95% KM (Chebyshev) UCL	0.741

ProUCL Statistical Evaluation of Thallium (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

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                                         General Statistics
          Total Number of Observations    59                    Number of Distinct Observations    16
                     Number of Detects    53                           Number of Non-Detects     6
            Number of Distinct Detects    16                  Number of Distinct Non-Detects     1
                      Minimum Detect     0.25                            Minimum Non-Detect     0.25
                      Maximum Detect     2                               Maximum Non-Detect     0.25
                     Variance Detects    0.167                            Percent Non-Detects    10.17%
                         Mean Detects    0.708                                  SD Detects     0.409
                       Median Detects    0.5                                    CV Detects     0.577
                     Skewness Detects    1.365                            Kurtosis Detects     1.025
               Mean of Logged Detects   -0.48                         SD of Logged Detects     0.502

                                 Normal GOF Test on Detects Only
          Shapiro Wilk Test Statistic    0.762          Normal GOF Test on Detected Observations Only
          5% Shapiro Wilk P Value  6.246E-11           Detected Data Not Normal at 5% Significance Level
             Lilliefors Test Statistic    0.374                         Lilliefors GOF Test
          5% Lilliefors Critical Value    0.121           Detected Data Not Normal at 5% Significance Level
                             Detected Data Not Normal at 5% Significance Level

                   Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
                             KM Mean    0.662                          KM Standard Error of Mean    0.0536
                               KM SD    0.408                                  95% KM (BCA) UCL     0.753
                      95% KM (t) UCL    0.751                 95% KM (Percentile Bootstrap) UCL     0.752
                      95% KM (z) UCL    0.75                            95% KM Bootstrap t UCL     0.761
                 90% KM Chebyshev UCL    0.823                            95% KM Chebyshev UCL     0.895
               97.5% KM Chebyshev UCL    0.997                            99% KM Chebyshev UCL     1.195

                             Gamma GOF Tests on Detected Observations Only
                    A-D Test Statistic    4.702                     Anderson-Darling GOF Test
                  5% A-D Critical Value    0.754     Detected Data Not Gamma Distributed at 5% Significance Level
                    K-S Test Statistic    0.361                     Kolmogorov-Smirnov GOF
                  5% K-S Critical Value    0.123     Detected Data Not Gamma Distributed at 5% Significance Level
                         Detected Data Not Gamma Distributed at 5% Significance Level

                                   Gamma Statistics on Detected Data Only
                           k hat (MLE)    3.873                         k star (bias corrected MLE)     3.666
                       Theta hat (MLE)    0.183                     Theta star (bias corrected MLE)     0.193
                          nu hat (MLE)   410.5                             nu star (bias corrected)    388.6
                        Mean (detects)    0.708

                               Gamma ROS Statistics using Imputed Non-Detects
              GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
        GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
                          For such situations, GROS method may yield incorrect values of UCLs and BTVs
                                  This is especially true when the sample size is small.
            For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates
                               Minimum    0.01                                             Mean     0.644
                               Maximum    2                                              Median     0.5
                                    SD    0.433                                              CV     0.672
                           k hat (MLE)    1.903                         k star (bias corrected MLE)     1.818
                       Theta hat (MLE)    0.338                     Theta star (bias corrected MLE)     0.354
                          nu hat (MLE)   224.6                             nu star (bias corrected)    214.5
           Adjusted Level of Significance (β)    0.0459
      Approximate Chi Square Value (214.51, α)   181.6           Adjusted Chi Square Value (214.51, β)    180.9
 95% Gamma Approximate UCL (use when n>=50)    0.761       95% Gamma Adjusted UCL (use when n<50)     0.764

                               Estimates of Gamma Parameters using KM Estimates
                             Mean (KM)    0.662                                          SD (KM)     0.408
                         Variance (KM)    0.167                                  SE of Mean (KM)     0.0536
                            k hat (KM)    2.629                                       k star (KM)     2.507
                           nu hat (KM)   310.3                                       nu star (KM)    295.8
                        theta hat (KM)    0.252                                   theta star (KM)     0.264
              80% gamma percentile (KM)    0.964                        90% gamma percentile (KM)     1.222
              95% gamma percentile (KM)    1.464                        99% gamma percentile (KM)     1.994
```

ProUCL Statistical Evaluation of Thallium (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (295.83, α)	257	Adjusted Chi Square Value (295.83, β)	256.1
95% Gamma Approximate KM-UCL (use when n>=50)	0.762	95% Gamma Adjusted KM-UCL (use when n<50)	0.764

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.85	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	5.2673E-7	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.344	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.121	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.658	Mean in Log Scale	-0.591
SD in Original Scale	0.416	SD in Log Scale	0.584
95% t UCL (assumes normality of ROS data)	0.748	95% Percentile Bootstrap UCL	0.752
95% BCA Bootstrap UCL	0.758	95% Bootstrap t UCL	0.761
95% H-UCL (Log ROS)	0.762		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.572	KM Geo Mean	0.565
KM SD (logged)	0.545	95% Critical H Value (KM-Log)	1.92
KM Standard Error of Mean (logged)	0.0717	95% H-UCL (KM -Log)	0.752
KM SD (logged)	0.545	95% Critical H Value (KM-Log)	1.92
KM Standard Error of Mean (logged)	0.0717		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.649	Mean in Log Scale	-0.642
SD in Original Scale	0.426	SD in Log Scale	0.681
95% t UCL (Assumes normality)	0.742	95% H-Stat UCL	0.795

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.895

ProUCL Statistical Evaluation of Vanadium (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	59	Number of Distinct Observations	29
		Number of Missing Observations	0
Minimum	9.5	Mean	25.63
Maximum	120	Median	20
SD	17.41	Std. Error of Mean	2.267
Coefficient of Variation	0.679	Skewness	3.064

Normal GOF Test

Shapiro Wilk Test Statistic	0.728	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	4.419E-14	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.198	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.115	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	29.42	95% Adjusted-CLT UCL (Chen-1995)	30.32
		95% Modified-t UCL (Johnson-1978)	29.57

Gamma GOF Test

A-D Test Statistic	1.551	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.148	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.116	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.476	k star (bias corrected MLE)	3.311
Theta hat (MLE)	7.372	Theta star (bias corrected MLE)	7.741
nu hat (MLE)	410.2	nu star (bias corrected)	390.7
MLE Mean (bias corrected)	25.63	MLE Sd (bias corrected)	14.08
		Approximate Chi Square Value (0.05)	345.9
Adjusted Level of Significance	0.0459	Adjusted Chi Square Value	344.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	28.95	95% Adjusted Gamma UCL (use when n<50)	29.04

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.0269	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.117	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.115	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.251	Mean of logged Data	3.093
Maximum of Logged Data	4.787	SD of logged Data	0.52

Assuming Lognormal Distribution

95% H-UCL	28.73	90% Chebyshev (MVUE) UCL	30.56
95% Chebyshev (MVUE) UCL	33	97.5% Chebyshev (MVUE) UCL	36.39
99% Chebyshev (MVUE) UCL	43.05		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	29.36	95% Jackknife UCL	29.42
95% Standard Bootstrap UCL	29.35	95% Bootstrap-t UCL	31.01
95% Hall's Bootstrap UCL	33.21	95% Percentile Bootstrap UCL	29.68
95% BCA Bootstrap UCL	30.61		
90% Chebyshev(Mean, Sd) UCL	32.43	95% Chebyshev(Mean, Sd) UCL	35.51
97.5% Chebyshev(Mean, Sd) UCL	39.78	99% Chebyshev(Mean, Sd) UCL	48.18

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	35.51

ProUCL Statistical Evaluation of Zinc (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	59	Number of Distinct Observations	34
		Number of Missing Observations	0
Minimum	10	Mean	32.71
Maximum	200	Median	26
SD	25.63	Std. Error of Mean	3.337
Coefficient of Variation	0.784	Skewness	4.952

Normal GOF Test

Shapiro Wilk Test Statistic	0.583	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.193	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.115	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	38.29	95% Adjusted-CLT UCL (Chen-1995)	40.5
		95% Modified-t UCL (Johnson-1978)	38.65

Gamma GOF Test

A-D Test Statistic	1.046	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.107	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.116	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.409	k star (bias corrected MLE)	3.247
Theta hat (MLE)	9.597	Theta star (bias corrected MLE)	10.08
nu hat (MLE)	402.2	nu star (bias corrected)	383.1
MLE Mean (bias corrected)	32.71	MLE Sd (bias corrected)	18.16
		Approximate Chi Square Value (0.05)	338.7
Adjusted Level of Significance	0.0459	Adjusted Chi Square Value	337.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	37	95% Adjusted Gamma UCL (use when n<50)	37.11

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.961	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.121	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0674	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.115	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.303	Mean of logged Data	3.334
Maximum of Logged Data	5.298	SD of logged Data	0.514

Assuming Lognormal Distribution

95% H-UCL	36.4	90% Chebyshev (MVUE) UCL	38.7
95% Chebyshev (MVUE) UCL	41.77	97.5% Chebyshev (MVUE) UCL	46.03
99% Chebyshev (MVUE) UCL	54.38		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	38.2	95% Jackknife UCL	38.29
95% Standard Bootstrap UCL	38.24	95% Bootstrap-t UCL	42.7
95% Hall's Bootstrap UCL	62.54	95% Percentile Bootstrap UCL	38.44
95% BCA Bootstrap UCL	42.44		
90% Chebyshev(Mean, Sd) UCL	42.72	95% Chebyshev(Mean, Sd) UCL	47.26
97.5% Chebyshev(Mean, Sd) UCL	53.55	99% Chebyshev(Mean, Sd) UCL	65.92

Suggested UCL to Use

95% Approximate Gamma UCL	37

TOTAL PETROLEUM HYDROCARBONS (TPH)

ProUCL Statistical Evaluation of Total Petroleum Hydrocarbon (C5-C12) (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	38	Number of Distinct Observations	14
		Number of Missing Observations	14
Number of Detects	10	Number of Non-Detects	28
Number of Distinct Detects	10	Number of Distinct Non-Detects	4
Minimum Detect	5.72	Minimum Non-Detect	1
Maximum Detect	9150	Maximum Non-Detect	20
Variance Detects	9895973	Percent Non-Detects	73.68%
Mean Detects	2183	SD Detects	3146
Median Detects	462	CV Detects	1.441
Skewness Detects	1.462	Kurtosis Detects	1.421
Mean of Logged Detects	5.332	SD of Logged Detects	3.052

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.753	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.266	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.262	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	575.4	KM Standard Error of Mean	309.1
KM SD	1807	95% KM (BCA) UCL	1131
95% KM (t) UCL	1097	95% KM (Percentile Bootstrap) UCL	1102
95% KM (z) UCL	1084	95% KM Bootstrap t UCL	1513
90% KM Chebyshev UCL	1503	95% KM Chebyshev UCL	1923
97.5% KM Chebyshev UCL	2506	99% KM Chebyshev UCL	3651

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.604	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.816	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.234	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.288	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.294	k star (bias corrected MLE)	0.272
Theta hat (MLE)	7435	Theta star (bias corrected MLE)	8020
nu hat (MLE)	5.873	nu star (bias corrected)	5.444
Mean (detects)	2183		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	574.5
Maximum	9150	Median	0.01
SD	1832	CV	3.189
k hat (MLE)	0.0976	k star (bias corrected MLE)	0.107
Theta hat (MLE)	5885	Theta star (bias corrected MLE)	5346
nu hat (MLE)	7.42	nu star (bias corrected)	8.167
Adjusted Level of Significance (β)	0.0434		
Approximate Chi Square Value (8.17, α)	2.832	Adjusted Chi Square Value (8.17, β)	2.703
95% Gamma Approximate UCL (use when n>=50)	1657	95% Gamma Adjusted UCL (use when n<50)	1736

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	575.4	SD (KM)	1807
Variance (KM)	3267041	SE of Mean (KM)	309.1
k hat (KM)	0.101	k star (KM)	0.111
nu hat (KM)	7.701	nu star (KM)	8.426
theta hat (KM)	5678	theta star (KM)	5189
80% gamma percentile (KM)	459.1	90% gamma percentile (KM)	1591
95% gamma percentile (KM)	3313	99% gamma percentile (KM)	8675

ProUCL Statistical Evaluation of Total Petroleum Hydrocarbon (C5-C12) (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (8.43, α)	2.984	Adjusted Chi Square Value (8.43, β)	2.851
95% Gamma Approximate KM-UCL (use when n>=50)	1625	95% Gamma Adjusted KM-UCL (use when n<50)	1700

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.848	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.229	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.262	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	574.6	Mean in Log Scale	-2.427
SD in Original Scale	1832	SD in Log Scale	5.94
95% t UCL (assumes normality of ROS data)	1076	95% Percentile Bootstrap UCL	1073
95% BCA Bootstrap UCL	1272	95% Bootstrap t UCL	1540
95% H-UCL (Log ROS)	7.391E+10		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.43	KM Geo Mean	4.18
KM SD (logged)	2.774	95% Critical H Value (KM-Log)	4.926
KM Standard Error of Mean (logged)	0.476	95% H-UCL (KM -Log)	1856
KM SD (logged)	2.774	95% Critical H Value (KM-Log)	4.926
KM Standard Error of Mean (logged)	0.476		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	575.9	Mean in Log Scale	1.448
SD in Original Scale	1832	SD in Log Scale	2.927
95% t UCL (Assumes normality)	1077	95% H-Stat UCL	3703

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use	
Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	1700

ProUCL Statistical Evaluation of Total Petroleum Hydrocarbon (C13-C22) (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	38	Number of Distinct Observations	16
		Number of Missing Observations	14
Number of Detects	14	Number of Non-Detects	24
Number of Distinct Detects	14	Number of Distinct Non-Detects	3
Minimum Detect	7.59	Minimum Non-Detect	1
Maximum Detect	15850	Maximum Non-Detect	25
Variance Detects	29328150	Percent Non-Detects	63.16%
Mean Detects	3639	SD Detects	5416
Median Detects	517.5	CV Detects	1.488
Skewness Detects	1.427	Kurtosis Detects	0.783
Mean of Logged Detects	5.891	SD of Logged Detects	2.894

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.726	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.295	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1342	KM Standard Error of Mean	609.6
KM SD	3621	95% KM (BCA) UCL	2552
95% KM (t) UCL	2370	95% KM (Percentile Bootstrap) UCL	2322
95% KM (z) UCL	2344	95% KM Bootstrap t UCL	3203
90% KM Chebyshev UCL	3171	95% KM Chebyshev UCL	3999
97.5% KM Chebyshev UCL	5149	99% KM Chebyshev UCL	7407

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.63	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.833	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.216	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.248	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.299	k star (bias corrected MLE)	0.282
Theta hat (MLE)	12176	Theta star (bias corrected MLE)	12885
nu hat (MLE)	8.369	nu star (bias corrected)	7.909
Mean (detects)	3639		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1341
Maximum	15850	Median	0.01
SD	3670	CV	2.737
k hat (MLE)	0.102	k star (bias corrected MLE)	0.112
Theta hat (MLE)	13141	Theta star (bias corrected MLE)	12023
nu hat (MLE)	7.754	nu star (bias corrected)	8.476
Adjusted Level of Significance (β)	0.0434		
Approximate Chi Square Value (8.48, α)	3.013	Adjusted Chi Square Value (8.48, β)	2.88
95% Gamma Approximate UCL (use when n>=50)	3771	95% Gamma Adjusted UCL (use when n<50)	3946

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1342	SD (KM)	3621
Variance (KM)	13112803	SE of Mean (KM)	609.6
k hat (KM)	0.137	k star (KM)	0.144
nu hat (KM)	10.43	nu star (KM)	10.94
theta hat (KM)	9773	theta star (KM)	9318
80% gamma percentile (KM)	1411	90% gamma percentile (KM)	3954
95% gamma percentile (KM)	7442	99% gamma percentile (KM)	17649

ProUCL Statistical Evaluation of Total Petroleum Hydrocarbon (C13-C22) (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (10.94, α)	4.54	Adjusted Chi Square Value (10.94, β)	4.369
95% Gamma Approximate KM-UCL (use when n>=50)	3234	95% Gamma Adjusted KM-UCL (use when n<50)	3361

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.889	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.187	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1341	Mean in Log Scale	0.432
SD in Original Scale	3670	SD in Log Scale	5.191
95% t UCL (assumes normality of ROS data)	2346	95% Percentile Bootstrap UCL	2344
95% BCA Bootstrap UCL	2669	95% Bootstrap t UCL	3242
95% H-UCL (Log ROS)	2.023E+9		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.243	KM Geo Mean	9.42
KM SD (logged)	3.285	95% Critical H Value (KM-Log)	5.732
KM Standard Error of Mean (logged)	0.558	95% H-UCL (KM -Log)	45847
KM SD (logged)	3.285	95% Critical H Value (KM-Log)	5.732
KM Standard Error of Mean (logged)	0.558		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1343	Mean in Log Scale	2.386
SD in Original Scale	3669	SD in Log Scale	3.422
95% t UCL (Assumes normality)	2348	95% H-Stat UCL	108029

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use	
Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	3361

ProUCL Statistical Evaluation of Total Petroleum Hydrocarbon (C23-C44) (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	38	Number of Distinct Observations	24
		Number of Missing Observations	14
Number of Detects	22	Number of Non-Detects	16
Number of Distinct Detects	21	Number of Distinct Non-Detects	3
Minimum Detect	5.04	Minimum Non-Detect	1
Maximum Detect	8238	Maximum Non-Detect	48
Variance Detects	5009281	Percent Non-Detects	42.11%
Mean Detects	1347	SD Detects	2238
Median Detects	42.65	CV Detects	1.662
Skewness Detects	1.828	Kurtosis Detects	3.107
Mean of Logged Detects	4.678	SD of Logged Detects	2.707

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.672	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.347	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	781.4	KM Standard Error of Mean	297.4
KM SD	1791	95% KM (BCA) UCL	1308
95% KM (t) UCL	1283	95% KM (Percentile Bootstrap) UCL	1296
95% KM (z) UCL	1271	95% KM Bootstrap t UCL	1506
90% KM Chebyshev UCL	1674	95% KM Chebyshev UCL	2078
97.5% KM Chebyshev UCL	2638	99% KM Chebyshev UCL	3740

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.76	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.859	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.254	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.202	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.277	k star (bias corrected MLE)	0.269
Theta hat (MLE)	4870	Theta star (bias corrected MLE)	5004
nu hat (MLE)	12.17	nu star (bias corrected)	11.84
Mean (detects)	1347		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	781.8
Maximum	8238	Median	9.1
SD	1815	CV	2.322
k hat (MLE)	0.138	k star (bias corrected MLE)	0.144
Theta hat (MLE)	5682	Theta star (bias corrected MLE)	5419
nu hat (MLE)	10.46	nu star (bias corrected)	10.96
Adjusted Level of Significance (β)	0.0434		
Approximate Chi Square Value (10.96, α)	4.553	Adjusted Chi Square Value (10.96, β)	4.382
95% Gamma Approximate UCL (use when n>=50)	1883	95% Gamma Adjusted UCL (use when n<50)	1956

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	781.4	SD (KM)	1791
Variance (KM)	3207742	SE of Mean (KM)	297.4
k hat (KM)	0.19	k star (KM)	0.193
nu hat (KM)	14.47	nu star (KM)	14.66
theta hat (KM)	4105	theta star (KM)	4052
80% gamma percentile (KM)	1010	90% gamma percentile (KM)	2362
95% gamma percentile (KM)	4064	99% gamma percentile (KM)	8777

ProUCL Statistical Evaluation of Total Petroleum Hydrocarbon (C23-C44) (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (14.66, α)	7.023	Adjusted Chi Square Value (14.66, β)	6.804
95% Gamma Approximate KM-UCL (use when n>=50)	1631	95% Gamma Adjusted KM-UCL (use when n<50)	1683

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.849	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.179	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	781.4	Mean in Log Scale	2.473
SD in Original Scale	1815	SD in Log Scale	3.604
95% t UCL (assumes normality of ROS data)	1278	95% Percentile Bootstrap UCL	1267
95% BCA Bootstrap UCL	1359	95% Bootstrap t UCL	1607
95% H-UCL (Log ROS)	316189		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.979	KM Geo Mean	19.66
KM SD (logged)	2.917	95% Critical H Value (KM-Log)	5.15
KM Standard Error of Mean (logged)	0.496	95% H-UCL (KM -Log)	16365
KM SD (logged)	2.917	95% Critical H Value (KM-Log)	5.15
KM Standard Error of Mean (logged)	0.496		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	784.3	Mean in Log Scale	3.19
SD in Original Scale	1814	SD in Log Scale	2.967
95% t UCL (Assumes normality)	1281	95% H-Stat UCL	25407

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	2638

VOLATILE ORGANIC COMPOUNDS (VOCs)

ProUCL Statistical Evaluation of n-Butylbenzene (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	12	Number of Distinct Observations	4
		Number of Missing Observations	40
Number of Detects	3	Number of Non-Detects	9
Number of Distinct Detects	3	Number of Distinct Non-Detects	1
Minimum Detect	1.1	Minimum Non-Detect	0.005
Maximum Detect	5.1	Maximum Non-Detect	0.005
Variance Detects	5.216	Percent Non-Detects	75%
Mean Detects	2.463	SD Detects	2.284
Median Detects	1.19	CV Detects	0.927
Skewness Detects	1.729	Kurtosis Detects	N/A
Mean of Logged Detects	0.633	SD of Logged Detects	0.864

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.767	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.378	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.62	KM Standard Error of Mean	0.5
KM SD	1.415	95% KM (BCA) UCL	N/A
95% KM (t) UCL	1.518	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	1.443	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	2.121	95% KM Chebyshev UCL	2.8
97.5% KM Chebyshev UCL	3.744	99% KM Chebyshev UCL	5.598

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	2.012	k star (bias corrected MLE)	N/A
Theta hat (MLE)	1.225	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	12.07	nu star (bias corrected)	N/A
Mean (detects)	2.463		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.623
Maximum	5.1	Median	0.01
SD	1.476	CV	2.368
k hat (MLE)	0.251	k star (bias corrected MLE)	0.244
Theta hat (MLE)	2.48	Theta star (bias corrected MLE)	2.554
nu hat (MLE)	6.033	nu star (bias corrected)	5.858
Adjusted Level of Significance (β)	0.029		
Approximate Chi Square Value (5.86, α)	1.568	Adjusted Chi Square Value (5.86, β)	1.255
95% Gamma Approximate UCL (use when n>=50)	2.329	95% Gamma Adjusted UCL (use when n<50)	N/A

ProUCL Statistical Evaluation of n-Butylbenzene (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.62	SD (KM)	1.415
Variance (KM)	2.002	SE of Mean (KM)	0.5
k hat (KM)	0.192	k star (KM)	0.199
nu hat (KM)	4.601	nu star (KM)	4.784
theta hat (KM)	3.232	theta star (KM)	3.108
80% gamma percentile (KM)	0.815	90% gamma percentile (KM)	1.874
95% gamma percentile (KM)	3.195	99% gamma percentile (KM)	6.835

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (4.78, α)	1.054	Adjusted Chi Square Value (4.78, β)	0.815
95% Gamma Approximate KM-UCL (use when n>=50)	2.813	95% Gamma Adjusted KM-UCL (use when n<50)	3.635

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.788	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.369	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.68	Mean in Log Scale	-2.284
SD in Original Scale	1.453	SD in Log Scale	2.223
95% t UCL (assumes normality of ROS data)	1.434	95% Percentile Bootstrap UCL	1.412
95% BCA Bootstrap UCL	1.833	95% Bootstrap t UCL	3.12
95% H-UCL (Log ROS)	46.53		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.816	KM Geo Mean	0.022
KM SD (logged)	2.592	95% Critical H Value (KM-Log)	6.273
KM Standard Error of Mean (logged)	0.917	95% H-UCL (KM -Log)	85.45
KM SD (logged)	2.592	95% Critical H Value (KM-Log)	6.273
KM Standard Error of Mean (logged)	0.917		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.618	Mean in Log Scale	-4.335
SD in Original Scale	1.479	SD in Log Scale	3.019
95% t UCL (Assumes normality)	1.384	95% H-Stat UCL	900.5

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.518

ProUCL Statistical Evaluation of sec-Butylbenzene (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	12	Number of Distinct Observations	4
		Number of Missing Observations	40
Number of Detects	3	Number of Non-Detects	9
Number of Distinct Detects	3	Number of Distinct Non-Detects	1
Minimum Detect	3.1	Minimum Non-Detect	0.005
Maximum Detect	10	Maximum Non-Detect	0.005
Variance Detects	12.97	Percent Non-Detects	75%
Mean Detects	5.953	SD Detects	3.601
Median Detects	4.76	CV Detects	0.605
Skewness Detects	1.327	Kurtosis Detects	N/A
Mean of Logged Detects	1.665	SD of Logged Detects	0.593

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.918	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.296	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.492	KM Standard Error of Mean	1.049
KM SD	2.966	95% KM (BCA) UCL	N/A
95% KM (t) UCL	3.375	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	3.217	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	4.638	95% KM Chebyshev UCL	6.063
97.5% KM Chebyshev UCL	8.04	99% KM Chebyshev UCL	11.93

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	4.354	k star (bias corrected MLE)	N/A
Theta hat (MLE)	1.367	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	26.12	nu star (bias corrected)	N/A
Mean (detects)	5.953		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.496
Maximum	10	Median	0.01
SD	3.096	CV	2.07
k hat (MLE)	0.212	k star (bias corrected MLE)	0.215
Theta hat (MLE)	7.057	Theta star (bias corrected MLE)	6.973
nu hat (MLE)	5.087	nu star (bias corrected)	5.149
Adjusted Level of Significance (β)	0.029		
Approximate Chi Square Value (5.15, α)	1.222	Adjusted Chi Square Value (5.15, β)	0.957
95% Gamma Approximate UCL (use when n>=50)	6.305	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.492	SD (KM)	2.966
Variance (KM)	8.796	SE of Mean (KM)	1.049
k hat (KM)	0.253	k star (KM)	0.245
nu hat (KM)	6.075	nu star (KM)	5.889
theta hat (KM)	5.895	theta star (KM)	6.081
80% gamma percentile (KM)	2.152	90% gamma percentile (KM)	4.484
95% gamma percentile (KM)	7.262	99% gamma percentile (KM)	14.68

ProUCL Statistical Evaluation of sec-Butylbenzene (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (5.89, α)	1.584	Adjusted Chi Square Value (5.89, β)	1.269
95% Gamma Approximate KM-UCL (use when n>=50)	5.549	95% Gamma Adjusted KM-UCL (use when n<50)	6.925

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.977	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.237	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.852	Mean in Log Scale	-0.48
SD in Original Scale	2.936	SD in Log Scale	1.631
95% t UCL (assumes normality of ROS data)	3.374	95% Percentile Bootstrap UCL	3.321
95% BCA Bootstrap UCL	3.749	95% Bootstrap t UCL	5.952
95% H-UCL (Log ROS)	18.22		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.558	KM Geo Mean	0.0285
KM SD (logged)	3.025	95% Critical H Value (KM-Log)	7.247
KM Standard Error of Mean (logged)	1.069	95% H-UCL (KM -Log)	2052
KM SD (logged)	3.025	95% Critical H Value (KM-Log)	7.247
KM Standard Error of Mean (logged)	1.069		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.49	Mean in Log Scale	-4.077
SD in Original Scale	3.099	SD in Log Scale	3.472
95% t UCL (Assumes normality)	3.097	95% H-Stat UCL	40054

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	3.375

ProUCL Statistical Evaluation of tert-Butylbenzene (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	11	Number of Distinct Observations	3
		Number of Missing Observations	41
Number of Detects	2	Number of Non-Detects	9
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	0.175	Minimum Non-Detect	0.005
Maximum Detect	0.281	Maximum Non-Detect	0.005
Variance Detects	0.00562	Percent Non-Detects	81.82%
Mean Detects	0.228	SD Detects	0.075
Median Detects	0.228	CV Detects	0.329
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-1.506	SD of Logged Detects	0.335

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0455	KM Standard Error of Mean	0.0379
KM SD	0.0889	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.114	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.108	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.159	95% KM Chebyshev UCL	0.211
97.5% KM Chebyshev UCL	0.282	99% KM Chebyshev UCL	0.423

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	18.17	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.0126	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	72.67	nu star (bias corrected)	N/A
Mean (detects)	0.228		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0455	SD (KM)	0.0889
Variance (KM)	0.00791	SE of Mean (KM)	0.0379
k hat (KM)	0.262	k star (KM)	0.251
nu hat (KM)	5.771	nu star (KM)	5.53
theta hat (KM)	0.174	theta star (KM)	0.181
80% gamma percentile (KM)	0.0663	90% gamma percentile (KM)	0.137
95% gamma percentile (KM)	0.22	99% gamma percentile (KM)	0.442

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0278
Approximate Chi Square Value (5.53, α)	1.405	Adjusted Chi Square Value (5.53, β)	1.096
95% Gamma Approximate KM-UCL (use when n>=50)	0.179	95% Gamma Adjusted KM-UCL (use when n<50)	0.23

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0723	Mean in Log Scale	-3.178
SD in Original Scale	0.0842	SD in Log Scale	1.111
95% t UCL (assumes normality of ROS data)	0.118	95% Percentile Bootstrap UCL	0.116
95% BCA Bootstrap UCL	0.129	95% Bootstrap t UCL	0.182
95% H-UCL (Log ROS)	0.239		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.609	KM Geo Mean	0.00996
KM SD (logged)	1.466	95% Critical H Value (KM-Log)	3.959
KM Standard Error of Mean (logged)	0.625	95% H-UCL (KM -Log)	0.183
KM SD (logged)	1.466	95% Critical H Value (KM-Log)	3.959
KM Standard Error of Mean (logged)	0.625		

ProUCL Statistical Evaluation of tert-Butylbenzene (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0435	Mean in Log Scale	-5.176
SD in Original Scale	0.0942	SD in Log Scale	1.817
95% t UCL (Assumes normality)	0.095	95% H-Stat UCL	0.449

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.114	KM H-UCL	0.183
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

ProUCL Statistical Evaluation of Ethylbenzene (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	45	Number of Distinct Observations	12
		Number of Missing Observations	7
Number of Detects	9	Number of Non-Detects	36
Number of Distinct Detects	9	Number of Distinct Non-Detects	3
Minimum Detect	0.0088	Minimum Non-Detect	0.002
Maximum Detect	0.82	Maximum Non-Detect	0.012
Variance Detects	0.0819	Percent Non-Detects	80%
Mean Detects	0.227	SD Detects	0.286
Median Detects	0.0594	CV Detects	1.261
Skewness Detects	1.319	Kurtosis Detects	1.015
Mean of Logged Detects	-2.561	SD of Logged Detects	1.744

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.803	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.276	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.047	KM Standard Error of Mean	0.0238
KM SD	0.151	95% KM (BCA) UCL	0.0852
95% KM (t) UCL	0.087	95% KM (Percentile Bootstrap) UCL	0.0869
95% KM (z) UCL	0.0861	95% KM Bootstrap t UCL	0.132
90% KM Chebyshev UCL	0.118	95% KM Chebyshev UCL	0.151
97.5% KM Chebyshev UCL	0.196	99% KM Chebyshev UCL	0.284

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.486	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.765	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.226	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.293	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.577	k star (bias corrected MLE)	0.458
Theta hat (MLE)	0.394	Theta star (bias corrected MLE)	0.495
nu hat (MLE)	10.38	nu star (bias corrected)	8.252
Mean (detects)	0.227		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0088	Mean	0.0534
Maximum	0.82	Median	0.01
SD	0.15	CV	2.816
k hat (MLE)	0.501	k star (bias corrected MLE)	0.483
Theta hat (MLE)	0.106	Theta star (bias corrected MLE)	0.111
nu hat (MLE)	45.13	nu star (bias corrected)	43.46
Adjusted Level of Significance (β)	0.0447		
Approximate Chi Square Value (43.46, α)	29.34	Adjusted Chi Square Value (43.46, β)	28.95
95% Gamma Approximate UCL (use when n>=50)	0.0791	95% Gamma Adjusted UCL (use when n<50)	0.0801

ProUCL Statistical Evaluation of Ethylbenzene (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.047	SD (KM)	0.151
Variance (KM)	0.0227	SE of Mean (KM)	0.0238
k hat (KM)	0.0974	k star (KM)	0.106
nu hat (KM)	8.769	nu star (KM)	9.518
theta hat (KM)	0.482	theta star (KM)	0.444
80% gamma percentile (KM)	0.0353	90% gamma percentile (KM)	0.128
95% gamma percentile (KM)	0.272	99% gamma percentile (KM)	0.726

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (9.52, α)	3.643	Adjusted Chi Square Value (9.52, β)	3.523
95% Gamma Approximate KM-UCL (use when n>=50)	0.123	95% Gamma Adjusted KM-UCL (use when n<50)	0.127

95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.898	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.194	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0458	Mean in Log Scale	-8.465
SD in Original Scale	0.153	SD in Log Scale	4.055
95% t UCL (assumes normality of ROS data)	0.0841	95% Percentile Bootstrap UCL	0.0865
95% BCA Bootstrap UCL	0.105	95% Bootstrap t UCL	0.142
95% H-UCL (Log ROS)	51.37		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.483	KM Geo Mean	0.00416
KM SD (logged)	1.636	95% Critical H Value (KM-Log)	3.173
KM Standard Error of Mean (logged)	0.259	95% H-UCL (KM -Log)	0.0347
KM SD (logged)	1.636	95% Critical H Value (KM-Log)	3.173
KM Standard Error of Mean (logged)	0.259		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0472	Mean in Log Scale	-5.449
SD in Original Scale	0.152	SD in Log Scale	1.682
95% t UCL (Assumes normality)	0.0853	95% H-Stat UCL	0.0402

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

djusted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	0.127

ProUCL Statistical Evaluation of Isopropylbenzene (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	11	Number of Distinct Observations	3
		Number of Missing Observations	41
Number of Detects	2	Number of Non-Detects	9
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	2.6	Minimum Non-Detect	0.005
Maximum Detect	4.02	Maximum Non-Detect	0.005
Variance Detects	1.008	Percent Non-Detects	81.82%
Mean Detects	3.31	SD Detects	1.004
Median Detects	3.31	CV Detects	0.303
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	1.173	SD of Logged Detects	0.308

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.606	KM Standard Error of Mean	0.559
KM SD	1.31	95% KM (BCA) UCL	N/A
95% KM (t) UCL	1.618	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	1.525	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	2.282	95% KM Chebyshev UCL	3.041
97.5% KM Chebyshev UCL	4.095	99% KM Chebyshev UCL	6.165

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	21.4	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.155	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	85.58	nu star (bias corrected)	N/A
Mean (detects)	3.31		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.606	SD (KM)	1.31
Variance (KM)	1.717	SE of Mean (KM)	0.559
k hat (KM)	0.214	k star (KM)	0.216
nu hat (KM)	4.705	nu star (KM)	4.755
theta hat (KM)	2.833	theta star (KM)	2.803
80% gamma percentile (KM)	0.83	90% gamma percentile (KM)	1.831
95% gamma percentile (KM)	3.058	99% gamma percentile (KM)	6.393

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0278
Approximate Chi Square Value (4.76, α)	1.041	Adjusted Chi Square Value (4.76, β)	0.79
95% Gamma Approximate KM-UCL (use when n>=50)	2.768	95% Gamma Adjusted KM-UCL (use when n<50)	3.647

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.11	Mean in Log Scale	-0.365
SD in Original Scale	1.194	SD in Log Scale	1.023
95% t UCL (assumes normality of ROS data)	1.763	95% Percentile Bootstrap UCL	1.675
95% BCA Bootstrap UCL	1.875	95% Bootstrap t UCL	2.598
95% H-UCL (Log ROS)	3.133		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.122	KM Geo Mean	0.0162
KM SD (logged)	2.498	95% Critical H Value (KM-Log)	6.307
KM Standard Error of Mean (logged)	1.065	95% H-UCL (KM -Log)	53.5
KM SD (logged)	2.498	95% Critical H Value (KM-Log)	6.307
KM Standard Error of Mean (logged)	1.065		

ProUCL Statistical Evaluation of Isopropylbenzene (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.604	Mean in Log Scale	-4.689
SD in Original Scale	1.375	SD in Log Scale	2.9
95% t UCL (Assumes normality)	1.355	95% H-Stat UCL	476.6

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.618	KM H-UCL	53.5
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

ProUCL Statistical Evaluation of Naphthalene (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	11	Number of Distinct Observations	3
		Number of Missing Observations	41
Number of Detects	3	Number of Non-Detects	8
Number of Distinct Detects	3	Number of Distinct Non-Detects	1
Minimum Detect	0.005	Minimum Non-Detect	0.005
Maximum Detect	9.08	Maximum Non-Detect	0.005
Variance Detects	20.61	Percent Non-Detects	72.73%
Mean Detects	4.468	SD Detects	4.539
Median Detects	4.32	CV Detects	1.016
Skewness Detects	0.147	Kurtosis Detects	N/A
Mean of Logged Detects	-0.543	SD of Logged Detects	4.135

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.999	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.18	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.222	KM Standard Error of Mean	1.025
KM SD	2.774	95% KM (BCA) UCL	N/A
95% KM (t) UCL	3.079	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	2.908	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	4.296	95% KM Chebyshev UCL	5.688
97.5% KM Chebyshev UCL	7.621	99% KM Chebyshev UCL	11.42

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	0.332	k star (bias corrected MLE)	N/A
Theta hat (MLE)	13.44	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	1.994	nu star (bias corrected)	N/A
Mean (detects)	4.468		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.005	Mean	1.226
Maximum	9.08	Median	0.01
SD	2.908	CV	2.372
k hat (MLE)	0.199	k star (bias corrected MLE)	0.205
Theta hat (MLE)	6.16	Theta star (bias corrected MLE)	5.97
nu hat (MLE)	4.378	nu star (bias corrected)	4.517
Adjusted Level of Significance (β)	0.0278		
Approximate Chi Square Value (4.52, α)	0.936	Adjusted Chi Square Value (4.52, β)	0.703
95% Gamma Approximate UCL (use when n>=50)	5.916	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.222	SD (KM)	2.774
Variance (KM)	7.698	SE of Mean (KM)	1.025
k hat (KM)	0.194	k star (KM)	0.202
nu hat (KM)	4.27	nu star (KM)	4.439
theta hat (KM)	6.298	theta star (KM)	6.058
80% gamma percentile (KM)	1.618	90% gamma percentile (KM)	3.697
95% gamma percentile (KM)	6.284	99% gamma percentile (KM)	13.39

ProUCL Statistical Evaluation of Naphthalene (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (4.44, α)	0.902	Adjusted Chi Square Value (4.44, β)	0.676
95% Gamma Approximate KM-UCL (use when n>=50)	6.013	95% Gamma Adjusted KM-UCL (use when n<50)	8.029

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.823	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.353	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.219	Mean in Log Scale	-12.51
SD in Original Scale	2.912	SD in Log Scale	9.535
95% t UCL (assumes normality of ROS data)	2.81	95% Percentile Bootstrap UCL	2.83
95% BCA Bootstrap UCL	3.695	95% Bootstrap t UCL	2362
95% H-UCL (Log ROS)	5.644E+44		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.001	KM Geo Mean	0.0183
KM SD (logged)	2.756	95% Critical H Value (KM-Log)	6.912
KM Standard Error of Mean (logged)	1.018	95% H-UCL (KM -Log)	336.5
KM SD (logged)	2.756	95% Critical H Value (KM-Log)	6.912
KM Standard Error of Mean (logged)	1.018		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.22	Mean in Log Scale	-4.506
SD in Original Scale	2.911	SD in Log Scale	3.146
95% t UCL (Assumes normality)	2.811	95% H-Stat UCL	3769

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	3.079

ProUCL Statistical Evaluation of Toluene (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	45	Number of Distinct Observations	8
		Number of Missing Observations	7
Number of Detects	6	Number of Non-Detects	39
Number of Distinct Detects	6	Number of Distinct Non-Detects	2
Minimum Detect	0.0068	Minimum Non-Detect	0.002
Maximum Detect	0.8	Maximum Non-Detect	0.005
Variance Detects	0.0792	Percent Non-Detects	86.67%
Mean Detects	0.279	SD Detects	0.281
Median Detects	0.213	CV Detects	1.007
Skewness Detects	1.527	Kurtosis Detects	2.695
Mean of Logged Detects	-1.955	SD of Logged Detects	1.643

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.862	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.262	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.039	KM Standard Error of Mean	0.0217
KM SD	0.133	95% KM (BCA) UCL	0.0762
95% KM (t) UCL	0.0755	95% KM (Percentile Bootstrap) UCL	0.075
95% KM (z) UCL	0.0747	95% KM Bootstrap t UCL	0.0955
90% KM Chebyshev UCL	0.104	95% KM Chebyshev UCL	0.134
97.5% KM Chebyshev UCL	0.175	99% KM Chebyshev UCL	0.255

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.259	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.718	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.198	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.342	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.865	k star (bias corrected MLE)	0.543
Theta hat (MLE)	0.323	Theta star (bias corrected MLE)	0.514
nu hat (MLE)	10.37	nu star (bias corrected)	6.52
Mean (detects)	0.279		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0068	Mean	0.0459
Maximum	0.8	Median	0.01
SD	0.133	CV	2.887
k hat (MLE)	0.537	k star (bias corrected MLE)	0.516
Theta hat (MLE)	0.0856	Theta star (bias corrected MLE)	0.0891
nu hat (MLE)	48.29	nu star (bias corrected)	46.4
Adjusted Level of Significance (β)	0.0447		
Approximate Chi Square Value (46.40, α)	31.77	Adjusted Chi Square Value (46.40, β)	31.37
95% Gamma Approximate UCL (use when n>=50)	0.0671	95% Gamma Adjusted UCL (use when n<50)	0.0679

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.039	SD (KM)	0.133
Variance (KM)	0.0177	SE of Mean (KM)	0.0217
k hat (KM)	0.0859	k star (KM)	0.095
nu hat (KM)	7.734	nu star (KM)	8.552
theta hat (KM)	0.454	theta star (KM)	0.41
80% gamma percentile (KM)	0.0251	90% gamma percentile (KM)	0.101
95% gamma percentile (KM)	0.227	99% gamma percentile (KM)	0.635

ProUCL Statistical Evaluation of Toluene (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (8.55, α)	3.059	Adjusted Chi Square Value (8.55, β)	2.951
95% Gamma Approximate KM-UCL (use when n>=50)	0.109	95% Gamma Adjusted KM-UCL (use when n<50)	0.113

95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.872	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.281	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0382	Mean in Log Scale	-8.636
SD in Original Scale	0.135	SD in Log Scale	4.008
95% t UCL (assumes normality of ROS data)	0.072	95% Percentile Bootstrap UCL	0.0751
95% BCA Bootstrap UCL	0.0889	95% Bootstrap t UCL	0.122
95% H-UCL (Log ROS)	32.69		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.647	KM Geo Mean	0.00353
KM SD (logged)	1.548	95% Critical H Value (KM-Log)	3.053
KM Standard Error of Mean (logged)	0.253	95% H-UCL (KM -Log)	0.0239
KM SD (logged)	1.548	95% Critical H Value (KM-Log)	3.053
KM Standard Error of Mean (logged)	0.253		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0391	Mean in Log Scale	-5.636
SD in Original Scale	0.134	SD in Log Scale	1.604
95% t UCL (Assumes normality)	0.0728	95% H-Stat UCL	0.0275

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0755

ProUCL Statistical Evaluation of Total Xylenes (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	45	Number of Distinct Observations	12
		Number of Missing Observations	7
Number of Detects	9	Number of Non-Detects	36
Number of Distinct Detects	9	Number of Distinct Non-Detects	3
Minimum Detect	0.014	Minimum Non-Detect	0.002
Maximum Detect	8.1	Maximum Non-Detect	0.012
Variance Detects	10.86	Percent Non-Detects	80%
Mean Detects	2.577	SD Detects	3.296
Median Detects	0.13	CV Detects	1.279
Skewness Detects	0.863	Kurtosis Detects	-0.949
Mean of Logged Detects	-0.957	SD of Logged Detects	2.579

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.777	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.327	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.517	KM Standard Error of Mean	0.274
KM SD	1.73	95% KM (BCA) UCL	0.982
95% KM (t) UCL	0.977	95% KM (Percentile Bootstrap) UCL	0.958
95% KM (z) UCL	0.967	95% KM Bootstrap t UCL	1.258
90% KM Chebyshev UCL	1.338	95% KM Chebyshev UCL	1.709
97.5% KM Chebyshev UCL	2.225	99% KM Chebyshev UCL	3.238

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.813	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.798	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.286	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.3	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.353	k star (bias corrected MLE)	0.309
Theta hat (MLE)	7.306	Theta star (bias corrected MLE)	8.334
nu hat (MLE)	6.349	nu star (bias corrected)	5.566
Mean (detects)	2.577		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.523
Maximum	8.1	Median	0.01
SD	1.747	CV	3.339
k hat (MLE)	0.224	k star (bias corrected MLE)	0.224
Theta hat (MLE)	2.337	Theta star (bias corrected MLE)	2.338
nu hat (MLE)	20.15	nu star (bias corrected)	20.14
Adjusted Level of Significance (β)	0.0447		
Approximate Chi Square Value (20.14, α)	10.96	Adjusted Chi Square Value (20.14, β)	10.73
95% Gamma Approximate UCL (use when n>=50)	0.962	95% Gamma Adjusted UCL (use when n<50)	0.982

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.517	SD (KM)	1.73
Variance (KM)	2.992	SE of Mean (KM)	0.274
k hat (KM)	0.0893	k star (KM)	0.0982
nu hat (KM)	8.04	nu star (KM)	8.837
theta hat (KM)	5.788	theta star (KM)	5.265
80% gamma percentile (KM)	0.349	90% gamma percentile (KM)	1.365
95% gamma percentile (KM)	3.004	99% gamma percentile (KM)	8.288

ProUCL Statistical Evaluation of Total Xylenes (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (8.84, α)	3.229	Adjusted Chi Square Value (8.84, β)	3.117
95% Gamma Approximate KM-UCL (use when n>=50)	1.415	95% Gamma Adjusted KM-UCL (use when n<50)	1.466

95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.836	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.246	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.516	Mean in Log Scale	-9.457
SD in Original Scale	1.75	SD in Log Scale	5.843
95% t UCL (assumes normality of ROS data)	0.954	95% Percentile Bootstrap UCL	0.965
95% BCA Bootstrap UCL	1.121	95% Bootstrap t UCL	1.4
95% H-UCL (Log ROS)	10480683		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.163	KM Geo Mean	0.00572
KM SD (logged)	2.367	95% Critical H Value (KM-Log)	4.227
KM Standard Error of Mean (logged)	0.374	95% H-UCL (KM -Log)	0.426
KM SD (logged)	2.367	95% Critical H Value (KM-Log)	4.227
KM Standard Error of Mean (logged)	0.374		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.519	Mean in Log Scale	-4.748
SD in Original Scale	1.749	SD in Log Scale	2.299
95% t UCL (Assumes normality)	0.957	95% H-Stat UCL	0.508

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	1.466

ATTACHMENT E-3

FATE AND TRANSPORT MODELING

TABLE OF CONTENTS

LIST OF ATTACHMENTS

Attachment E-3A	Soil Boring Logs
Attachment E-3B	Output of Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings From Groundwater

1.0 INTRODUCTION

In support of the human health risk assessment (HHRA) for the East Parcel, this appendix presents the methodology for fate and transport modeling used to estimate exposure point concentrations (EPCs) in indoor air resulting from volatilization of volatile organic compounds (VOCs) from subsurface sources. According to the U.S. Environmental Protection Agency (USEPA, 2016), a compound is assumed to be volatile if it has a Henry's Law constant greater than 1×10^{-5} and a molecular weight less than 200 grams per mole (g/mole).

The fate and transport modeling incorporates site-specific data into analytical models that simulate vapor migration of VOCs. The Johnson and Ettinger (1991) vapor intrusion model, recommended and provided by the Department of Toxic Substances Control (DTSC, 2014), was used to estimate vapor emissions from groundwater into indoor air. The conceptual approach to modeling, the calculations, and the modeling results are described in the following sections.

2.0 CONCEPTUAL MODEL

Volatile compounds can be released from the subsurface into indoor air resulting in an indirect exposure to contaminants in soil, soil vapor, and groundwater. The modeling addressed chemical sources in soil vapor for a reasonable maximum exposure (RME) scenario. Specifically, the modeling included calculations for the following exposure pathway:

- Volatilization of chemicals from groundwater, migration of vapors to the soil surface, and mixing with indoor air for the hypothetical commercial/industrial worker receptor.

Soil vapor data was collected from a single point, E1, at a depth of 15 feet below ground surface (bgs) in the northern portion of the East Parcel during the 2006 investigation by Tetra Tech. Due to limited soil vapor data (i.e., one soil vapor point) and to the age of the data (i.e., more than 10 years old) in the East Parcel, the vapor intrusion exposure pathway was evaluated using groundwater data from the East Parcel. Groundwater data is comprised of grab groundwater samples and groundwater monitoring data from wells MW-2 and MW-10. Groundwater samples from the East Parcel are sampled primarily from first encountered groundwater at approximately 30 feet bgs. The groundwater data used in this HHRA are presented in Attachment E-1 of the HHRA. The groundwater sample locations are shown in Figure E3-1 of the HHRA.

Using the groundwater EPCs, the fate and transport modeling was performed and a concentration in indoor air for each VOC detected was estimated. Site conditions were generalized to create a simplified conceptual model to estimate vapor concentrations in indoor air. Details of the approach and assumptions used for each hypothetical source and transport mechanism are discussed below.

2.1 Sources of VOC Vapors

Vapor sources were modeled based on the following assumptions:

- VOCs are uniformly distributed in groundwater; and
- The concentrations of VOCs remain constant over time.

These assumptions are highly conservative because the distribution of VOCs is likely more limited than was assumed, and because the mass of the source will deplete over time as natural attenuation processes occur, thereby lowering actual concentrations in the source over time.

2.2 Chemical Transport Mechanisms

The models simulate the following transport mechanisms:

- Chemical partitioning between phases;
- Vapor migration from groundwater to the soil surface; and
- Mixing of vapor emissions with indoor air.

2.2.1 Chemical Partitioning Between Phases

Chemicals are assumed to partition between groundwater (EPC_{gw}), soil vapor ($EPC_{soil\ vapor}$), and ambient air under equilibrium conditions.

2.2.2 Vapor Migration from Groundwater to Soil Surface

Vertical migration of chemicals in groundwater to the soil surface was assumed to occur by steady-state diffusion induced by a chemical concentration gradient between the soil-vapor source and the soil surface. The indoor air pathway analysis accounted for the effects of steady-state advection induced by an assumed pressure differential between the exterior and interior of the building. Chemical diffusion of soil vapor through the vadose zone and building foundations (indoor only) was characterized by effective diffusion coefficients, D_s^{eff} (vadose zone) and D_f^{eff} (building foundations). Advection of chemicals dissolved in soil moisture was assumed to be negligible. This assumption is conservative because soil moisture tends to migrate downward, decreasing the overall flux of chemical toward the surface. Chemical and biological transformations were conservatively assumed not to occur during migration to the surface.

2.2.3 Mixing of Vapor Emissions with Indoor Air

The analysis of indoor air simulated vapor-phase advection and diffusion of chemicals near the building foundation. Vapor diffusion of chemicals upward was assumed to occur through a foundation. Advective transport through a region generated by the pressure differential between inside (lower pressure) and outside (higher pressure) of the building was simulated. Such underpressurization is generally induced by temperature differentials, wind loading, and operation of devices such as furnaces and exhaust fans. Underpressurization is highly variable over time, but was conservatively assumed to be constant in modeling. This approach is highly conservative for periods when structures are neutrally or positively pressurized, as these conditions will inhibit migration of soil vapor into the building. The mixing of vapor-phase chemicals with ambient indoor air was simulated using a building of volume (V_b) that is ventilated at a constant exchange rate (*ER*), resulting in an indoor air concentration ($C_{building}$ or $EPC_{indoor\ air}$).

3.0 CALCULATIONS

This section presents the equations, variables, and model assumptions used as inputs to calculate vapor emissions from groundwater to indoor air. Using the DTSC version of the Johnson and Ettinger (1991) model (DTSC, 2014), vapor concentrations in indoor air from groundwater were estimated for the hypothetical commercial/industrial worker receptor. This model accounts for advection and diffusion in the vadose zone and building foundation and mixing in the building interior.

As presented by USEPA (2004), for vapor migration from groundwater to indoor air, concentrations in indoor air were estimated based on the following equations:

$$C_{building} = C_{source} \times \propto \qquad \text{or} \qquad EPC_{indoor\ air} = EPC_{gw} \times H' \times \propto$$

where:

$$\alpha = \frac{\left[\left(\frac{D_T^{eff} \times A_B}{Q_{building} \times L_T}\right) \times \exp\left(\frac{Q_{soil} \times L_{crack}}{D_{crack} \times A_{crack}}\right)\right]}{\left[\exp\left(\frac{Q_{soil} \times L_{crack}}{D_{crack} \times A_{crack}}\right) + \left(\frac{D_T^{eff} \times A_B}{Q_{building} \times L_T}\right) + \left(\frac{D_T^{eff} \times A_B}{Q_{soil} \times L_T}\right) \times \left[\exp\left(\frac{Q_{soil} \times L_{crack}}{D_{crack} \times A_{crack}}\right) - 1\right]\right]}$$

where:

$C_{building}$/$EPC_{indoor\ air}$ = EPC in indoor air (microgram per cubic meter [µg/m^3]);
C_{source} = Vapor concentration at source of contamination (µg/m^3);
For groundwater, C_{source} = EPC_{gw} x H';
EPC_{gw} EPC in groundwater (µg/L x 1,000 L/m^3));
H' = Dimensionless Henry's law constant (chemical-specific);
α = Steady-state attenuation coefficient (unitless);
D_T^{eff} = Total overall effective diffusion coefficient (square centimeter per second [cm^2/s]);
A_B = Area of enclosed space below grade (square centimeter [cm^2]);
$Q_{building}$ = Building ventilation rate (cubic centimeter per second [cm^3/s]);
L_T = Source-building separation (centimeter [cm]);
Q_{soil} = Volumetric flow rate of soil vapor into the enclosed space (cm^3/s);
L_{crack} = Enclosed space foundation or slab thickness (cm);
A_{crack} = Area of total cracks (cm^2); and
D_{crack} = Effective diffusion coefficient through the cracks (cm^2/s)
(assumed equivalent to D_i^{eff} of soil layer (i) in contact with the floor).

A more detailed description of the equations and input parameters used in this model are provided in the User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings (USEPA, 2004).

The following sections discuss the input parameters used in the fate and transport modeling for vapor migration from groundwater to indoor air.

3.1 Source Concentrations

Vapor emissions were modeled for the Site using source concentrations from groundwater (EPC_{gw}). Groundwater EPCs are summarized in Table E4-5 of the HHRA, respectively. Source concentrations in groundwater represent the maximum detected concentration. Based on the model, the soil vapor EPCs ($EPC_{soil\ vapor}$) and indoor air EPCs ($EPC_{indoor\ air}$) are presented in Table E4-5 of the HHRA.

3.2 Site-Specific Properties

The Site is generally underlain by deposits of unconsolidated, laterally discontinuous sequences of silt and fine to coarse-grained sand. Coarse-grained soils consist of sand (SP) and silty sand (SM); whereas, subordinate fine-grained soils consist of silt (ML and MH) and, to a lesser degree, clay (CL). First encountered groundwater occurs at approximately 30 feet bgs. Based on Tetra Tech's soil boring logs for the East Parcel (Tetra Tech, 2006), vadose zone soil consists primarily of coarse-grained sand and silty sand. Soil boring logs are provided in Attachment E-3A.

Since the predominant soil type within the vadose zone is essentially sand, DTSC (2014) default soil properties for "sand" were used in the fate and transport model for vapor migration from soil vapor to outdoor air.

3.3 Chemical-Specific Properties

The values for the dimensionless Henry's Law constant, organic carbon-water partition coefficient (K_{oc}), and molecular diffusion coefficients in air and water, D_i and D_w, for each VOC were obtained from DTSC (2014).

The properties used in the fate and transport model (DTSC, 2014) for vapor migration from soil vapor to indoor air are summarized in the table below.

Equation Variables – Vapor Migration from Soil Gas or Groundwater to Indoor Air

Properties	Symbol	Assumed Value
Depth Below Grade to Bottom of Enclosed Space Floor	L_F	15 cm
Depth Below Grade to Water Table	L_{WT}	914.4 cm (30 feet)
SCS Soil Type Directly Above Water Table Vadose Zone SCS Soil Type	- -	Sand (S)
Average Soil/Groundwater Temperature	T_s	24°C
Average Vapor Flow Rate into Building	Q_{Soil}	5 L/m
Vadose Zone SCS soil type (used to estimate soil vapor permeability	- -	Sand (S)

Equation Variables – Vapor Migration from Soil Gas or Groundwater to Indoor Air		
Properties	**Symbol**	**Assumed Value**
Vadose Zone Soil Dry Bulk Density	ρ_b	1.66 g/cm^3
Vadose Zone Soil Total porosity	θ_T	0.375
Vadose Zone Soil Water-filled porosity	θ_w	0.054
Vadose Zone Soil Air-filled porosity	θ_a	0.321

The spreadsheets containing the input parameters and results of the Johnson and Ettinger (1991) model, for subsurface vapor intrusion into buildings (DTSC, 2014) are provided in Attachment E-3B.

The results are summarized in Section 5.0, following a discussion of uncertainties (Section 4.0), which may have influenced the estimation of vapor emission estimates and corresponding EPCs and health risks.

4.0 UNCERTAINTY ANALYSIS

The procedures used in evaluating vapor migration and estimating EPCs are subject to various degrees of uncertainty. A significant amount of conservatism has been incorporated into the fate and transport modeling process to address this uncertainty. Specifically, the Johnson and Ettinger (1991) model employs a series of simplified, analytical solutions to chemical transport, often resulting in overestimation of EPCs. The conservatism inherent to the formulation of these models is supplemented by additional conservatism associated with selection of model input data and conceptualization of site conditions imposed by model users. As a result of this multilevel conservatism, actual EPCs and corresponding health risks are likely to be significantly lower than were estimated for the inhalation exposure pathway. These conservative aspects of the fate and transport modeling process are further discussed below.

4.1 Model Formulation

The conservative aspects of the vapor migration models include simplified representation or complete omission of the following processes that affect transport, for example:

- Loss mechanisms - The absence of loss mechanisms such as biodegradation and vapor-phase adsorption result in overestimation of vapor emissions to indoor air, yielding higher EPCs.
- Depleting contaminant source - The use of a nondepleting, constant source results in an unlimited supply of contaminated vapor and an overestimation of vapor emissions to indoor air, yielding higher EPCs.
- Water movement - The assumed absence of water (and dissolved chemical) movement through unsaturated soil results in an overestimation of chemical mass in vapor-phase available for transport to indoor air, yielding higher EPCs.
- Neutral or positive pressurization - The assumption of continuously under-pressurized buildings neglects significant periods where neutral or positive pressurized conditions exist, thereby over-estimating advective transport of contaminated vapors to indoor air, yielding higher EPCs.
- One-dimensional transport - The assumption of vapor transport under a single (vertical) dimension ignores the potential for vapor migration in multiple directions away from the source area, resulting in an over-estimation of vapor emissions and higher EPCs.

Under actual field conditions, the combined effect of these processes typically results in significantly lower EPCs than those estimated in this HHRA.

4.2 Model Input Data

As previously indicated, various model input data characterizing soil physical properties and building parameters used in this analysis correspond to conservative default values adopted by DTSC (2014). Use of conservative default values for the above-mentioned parameters also likely results in over-estimation of vapor emissions to indoor air, maximizing estimates of EPCs.

4.3 Conceptualization of Site Conditions

As previously indicated, site conditions were generalized to create a simplified conceptual model for simulation of vapor emissions at the Site. As a result, many components of this conceptualization are based on highly conservative assumptions, including:

- Outdoor and indoor points of exposure are assumed to directly overlie locations of maximum detected VOC concentrations in groundwater.
- VOCs are assumed to be uniformly distributed in groundwater, with no spatial and temporal changes in concentrations.

As a result of this conservative conceptualization, estimated vapor emissions to indoor air are maximized, yielding higher EPCs. As stated in Hers, et al. (2003), “If there is information only on contamination depth, the range in [vapor attenuation] can vary 3-4 orders of magnitude. When information on soil properties is also available, the uncertainty…is reduced resulting in [vapor attenuation] that vary over two orders of magnitude. When good quality site-specific data is available for both soil properties (e.g., moisture content) and building properties (e.g., ventilation rate, mixing height), it may be possible to reduce the uncertainty…to approximately one order of magnitude.”

5.0 RESULTS

The groundwater EPCs and their respective indoor air concentrations were used to estimate hazard indices and excess cancer risks from assumed exposure to VOCs migrating from groundwater to indoor air. The groundwater and indoor air EPCs are presented in Table E4-5 of the HHRA. The spreadsheets containing the results of the Johnson and Ettinger (1991) model, for subsurface vapor intrusion into buildings (DTSC, 2014) from soil vapor are provided in Attachment E-3B.

6.0 REFERENCES

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ATTACHMENT E-3A

SOIL BORING LOGS

Tetra Tech, Inc.
348 W. Hospitality Ln. Suite 100
San Bernardino, CA 92408
Telephone: (909) 381-1674
Telefax (909) 889-1391

SOIL BORING LOG

BORING/WELL ID: E-1

CLIENT: GEM, Inc.
PROJECT NUMBER: 18116-04
LOCATION: Signal Hill

GEOLOGIST: D. Bertolacci
REVIEWED BY:
DATE(S) DRILLED:
DRILLING COMPANY:

TOTAL DEPTH:
BOREHOLE DIA.:
DRILLING METHOD:
SAMPLING METHOD:

Depth (ft. bgs)	Sample Recovery	Blow Counts	Sample Number	Sampling Time	Soil (ppm) FID/PID	Breathing Zone (ppm) FID/PID	Lithologic Contact (ft. bgs)	GROUP SYMBOL	Color	Moisture	% Gravel	% Sand	% Non-plastic Fines	% Plastic Fines	Grading	Plasticity (Fines)	Angularity (Sand / Gravel)	Grain Size Range (Sand)	Grain Size Range (Gravel)	Max. Grain Size (Gravel)	Comments / Well Construction
									GROUP NAME / GEOLOGIC DESCRIPTION / ADDITIONAL MODIFIERS												
									See CPT logs												
5																					
10																					
									Soil vapor probe @ 15' bgs												
15																					
				0932					begin purging 7-volumes												
				0934					end purge												
			E1-060206-SV-15'	0934					Start sampling												
				1014					finish sampling												
Notes:								See USCS flow Chart	Use Munsell color chart	Dry Moist Wet	> 1/4 inch	visible -1/4 in.	visible with hand lens	not visible	W G U P	high med low non	A Sa Sr R	V. Fine Fine Med Coarse	V. Fine Fine Med Coarse	inches	odor, staining, mineralogy, stucture, cementation, HCl reaction

<5-5%=trace, 10%=few, 15-25%=little, 30-45%=some, 50+%=mostly (cobbles only)
Well Graded - 5 consecutive seive sizes, % decreases with each decreasing particle size
Poorly Graded - one or more particle sizes missing (Gap Graded), or
all particles basically same size (Uniformly Graded)

subsurface exploration log 2.2.xls
Rev. 10/28/2005

Tetra Tech, Inc.
348 W. Hospitality Ln. Suite 100
San Bernardino, CA 92408
Telephone: (909) 381-1674
Telefax: (909) 889-1391

SOIL BORING LOG

BORING/WELL ID: E-14

CLIENT: GEM, Inc.
PROJECT NUMBER: 18116-04
LOCATION: Former Chemoil Refinery

GEOLOGIST: D. Bertolacci
REVIEWED BY:
DATE(S) DRILLED: 06/01 / 2006
DRILLING COMPANY: Gregg Drilling, Inc.

TOTAL DEPTH:
BOREHOLE DIA.: 1.25"
DRILLING METHOD: CPT/DP
SAMPLING METHOD: ~~Acetate~~ Brass Sleeve

Depth (ft bgs)	Sample Recovery	Blow Counts	Sample Number	Sampling Time	Soil (ppm) FID/PID	Breathing Zone (ppm) FID/PID	Lithologic Contact (ft bgs)	GROUP SYMBOL	Color	Moisture	% Gravel	% Sand	% Non-plastic Fines	% Plastic Fines	Grading	Plasticity (Fines)	Angularity (Sand / Gravel)	Grain Size Range (Sand)	Grain Size Range (Gravel)	Max. Grain Size (Gravel)	GROUP NAME / GEOLOGIC DESCRIPTION / ADDITIONAL MODIFIERS	Comments / Well Construction
																					See CPT logs	
5																						
10																						
15																						
20																						
25																						
30		▼																				
35	X		E14-060106 GW1	1225	—	0.0																
40	X		E14-060106 GW2	1410	—	0.0																
Notes								See USCS flow Chart	Use Munsell color chart	Dry Moist Wet	> 1/4 inch	visible - 1/4 in	visible with hand lens	not visible	W G U F	high med low non	A Sa Sr R	V. Fine Fine Med Coarse	V. Fine Fine Med Coarse	inches		odor, staining, mineralogy, stucture, cementation, HCl reaction

<5-5%=trace, 10%=few, 15-25%=little, 30-45%=some, 50+%=mostly (cobbles only)
Well Graded - 5 consecutive seive sizes, % decreases with each decreasing particle size
Poorly Graded - one or more particle sizes missing (Gap Graded), or
all particles basically same size (Uniformly Graded)

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SOIL BORING LOG

BORING/WELL ID: E-1B

CLIENT: GEM, Inc.
PROJECT NUMBER: 18116-04
LOCATION: Former Chemoil Refinery

GEOLOGIST: D. Bertolacci
REVIEWED BY:
DATE(S) DRILLED: 06/01/2006
DRILLING COMPANY: Gregg Drilling, Inc.

TOTAL DEPTH: 26'
BOREHOLE DIA.: 1.25"
DRILLING METHOD: CPT/DP
SAMPLING METHOD: ~~Acetate~~ Brass Sleeve

Depth (ft. bgs)	Sample Recovery	Blow Counts	Sample Number	Sampling Time	Soil (ppm) FID/PID	Breathing Zone (ppm) FID/PID	Lithologic Contact (ft. bgs)	GROUP SYMBOL	Color	Moisture	% Gravel	% Sand	% Non-plastic Fines	% Plastic Fines	Grading	Plasticity (Fines)	Angularity (Sand / Gravel)	Grain Size Range (Sand)	Grain Size Range (Gravel)	Max. Grain Size (Gravel)	Comments / Well Construction
									GROUP NAME / GEOLOGIC DESCRIPTION / ADDITIONAL MODIFIERS												
5	X		E1B-060106-5'	1500	156 +	0.0		SM	dk br	slight M	–	60	35	5	P	P	< non-low Sr	VF	–	–	slight odor no staining
10																					
15	X		E1B-060106-15'	1515	140 +	0.0		SP	Grey	dry	–	100	–	–	P	–	Sr	VF-F	–	–	slight staining
20																					
25	X		E1B-060106-25'	1630	160 +	0.0		SP	Gray	As above											strong odor & staining
30																					
35																					
40																					
Notes								See USCS flow Chart	Use Munsell color chart	Dry Moist Wet	> 1/4 inch	visible - 1/4 in.	visible with hand lens	not visible	W G U P	high med low non	A Sa Sr R	V. Fine Fine Med Coarse	V. Fine Fine Med Coarse	inches	odor, staining, mineralogy, stucture, cementation, HCl reaction

<5-5%=trace, 10%=few, 15-25%=little, 30-45%=some, 50+%=mostly (cobbles only)
Well Graded - 5 consecutive seive sizes, % decreases with each decreasing particle size
Poorly Graded - one or more particle sizes missing (Gap Graded), or
all particles basically same size (Uniformly Graded)

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San Bernardino, CA 92408
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Telefax (909) 889-1391

SOIL BORING LOG

BORING/WELL ID: E-1C

CLIENT: GEM, Inc.
PROJECT NUMBER: 18116-04
LOCATION: Former Chemoil Refinery

GEOLOGIST: D. Bertolacci
REVIEWED BY:
DATE(S) DRILLED: 06/01 / 2006
DRILLING COMPANY: Gregg Drilling, Inc

TOTAL DEPTH:
BOREHOLE DIA: 1.25"
DRILLING METHOD: CPT/DP
SAMPLING METHOD: ~~Acetate~~ Brass Sleeve

Depth (ft. bgs)	Sample Recovery	Blow Counts	Sample Number	Sampling Time	FID/PID Soil (ppm)	FID/PID Breathing Zone (ppm)	Lithologic Contact (ft. bgs)	GROUP SYMBOL	Color	Moisture	% Gravel	% Sand	% Non-plastic Fines	% Plastic Fines	Grading	Plasticity (Fines)	Angularity (Sand / Gravel)	Grain Size Range (Sand)	Grain Size Range (Gravel)	Max. Grain Size (Gravel)	Comments / Well Construction
5	X		E1C 060106 5'	1550	28.3	0.0		SM	dk br	sl m	—	70	30	—	P	non	SR	VF-F	—	—	Strong odor
10																					
15	X		E1C 060106 15'	1605	173 x	0.0		SP	dk gray/gray to very dk gray/gray	M	—	100	—	—	P	—	SR	F (to VF)	—	—	[illegible] very strong odor & staining (free product observed)
20																					
25	X		E1C 060106 25'	1625	40 *	0.0		SP	dk black												very strong odor & staining
30																					
35																					
40																					
Notes								See USCS flow Chart	Use Munsell color chart	Dry Moist Wet	> 1/4 inch	visible - 1/4 in.	visible with hand lens	not visible	W G U P	high med low non	A SA SR R	V. Fine Fine Med Coarse	V. Fine Fine Med Coarse	Inches	odor, staining, mineralogy, stucture, cementation, HCl reaction

GROUP NAME / GEOLOGIC DESCRIPTION / ADDITIONAL MODIFIERS

<5-5%=trace, 10%=few, 15-25%=little, 30-45%=some, 50+%=mostly (modifies only)
Well Graded - 5 consecutive sieve sizes, % decreases with each decreasing particle size
Poorly Graded - one or more particle sizes missing (Gap Graded), or all particles basically same size (Uniformly Graded)

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SOIL BORING LOG

BORING/WELL ID: E-34

CLIENT: GEM, Inc.
PROJECT NUMBER: 18116-04
LOCATION: Former Chemoil Refinery

GEOLOGIST: D. Bertolacci
REVIEWED BY:
DATE(S) DRILLED: 06/01/2006
DRILLING COMPANY: Gregg Drilling, Inc.

TOTAL DEPTH: ~~E-34~~ 11'
BOREHOLE DIA.: 1.25"
DRILLING METHOD: CPT/DP
SAMPLING METHOD: ~~Acetate~~ Brass Sleeve

GROUP NAME / GEOLOGIC DESCRIPTION / ADDITIONAL MODIFIERS

Depth (ft bgs)	Sample Recovery	Blow Counts	Sample Number	Sampling Time	Soil (ppm) FID/PID	Breathing Zone (ppm) FID/PID	Lithologic Contact (ft. bgs)	GROUP SYMBOL	Color	Moisture	% Gravel	% Sand	% Non-plastic Fines	% Plastic Fines	Grading	Plasticity (Fines)	Angularity (Sand / Gravel)	Grain Size Range (Sand)	Grain Size Range (Gravel)	Max. Grain Size (Gravel)	Comments / Well Construction
5																					
10	X		E-34-060106-10'	1150	53 +	0.0		SP-SM	dk br	M	–	90	10	<5	P	non/low	Sr	F-M	–	–	no odor or staining
Notes:								See USCS flow Chart	Use Munsell color chart	Dry Moist Wet	> 1/4 inch	visible -1/4 in	visible with hand lens	not visible	W G U P	high med low non	A Sa Sr R	V. Fine Fine Med Coarse	V. Fine Fine Med Coarse	Inches	odor, staining, mineralogy, stucture, cementation, HCl reaction

<5%=trace, 10%=few, 15-25%=little, 30-45%=some, 50+%=mostly (cobbles only)
Well Graded - 5 consecutive seive sizes, % decreases with each decreasing particle size
Poorly Graded - one or more particle sizes missing (Gap Graded), or
all particles basically same size (Uniformly Graded)

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SOIL BORING LOG

BORING/WELL ID: E-5

CLIENT: GEM, Inc
PROJECT NUMBER: 18116-04
LOCATION: Former Chemoil Refinery

GEOLOGIST: D. Bertolacci
REVIEWED BY:
DATE(S) DRILLED: 06/01/2006
DRILLING COMPANY: Gregg Drilling, Inc.

TOTAL DEPTH: 50'
BOREHOLE DIA.: 1.25"
DRILLING METHOD: CPT/DP
SAMPLING METHOD: ~~Acetate~~ Brass Sleeve

Depth (ft. bgs)	Sample Recovery	Blow Counts	Sample Number	Sampling Time	Soil (ppm) FID/PID	Breathing Zone (ppm) FID/PID	Lithologic Contact (ft. bgs)	GROUP SYMBOL	Color	Moisture	% Gravel	% Sand	% Non-plastic Fines	% Plastic Fines	Grading	Plasticity (Fines)	Angularity (Sand / Gravel)	Grain Size Range (Sand)	Grain Size Range (Gravel)	Max. Grain Size (Gravel)	Comments / Well Construction
			hand auger					SP-SM	red brown	dry	MA	90	10	—	P	non	Sr	VF-F	—	—	no odor, no staining
									Poorly graded sand w/ silt												
5	X		E5-060106-5'	1010	0.0	0.0		SM	dk br	Slight M	—	80	20	—	P	non	Sr	VF	—	—	no odor or staining
10	X		E5-060106-10'	1055	5.3	0.0		SM	As above												no odor or staining
15	X		E5-060106-15'	1110	21.2 +	0.0		SP	lt yell br	dry	-	100	<5	-	P	non	Sr	VF-F	-	—	no odor or staining
		▼	GW@20'																		
20	X	≡	E5-060106-20'		56.2 +	0.0		SP	As above, saturated, light grey to brown												no odor
	X		E5-060106-GW1	1010	—	0.0															
25																					
30																					
35																					
40																					
Notes 50			to 50' in CPT boring					See USCS flow Chart	Use Munsell color chart	Dry Moist Wet	> 1/4 inch	visible - 1/4 in	visible with hand lens	not visible	W G U P	high med low non	A Sa Sr R	V. Fine Fine Med Coarse	V. Fine Fine Med Course	Inches	odor, staining, mineralogy, stucture, cementation, HCl reaction

<5-5%=trace, 10%=few, 15-25%=little, 30-45%=some, 50+%=mostly (cobbles only)
Well Graded - 5 consecutive seive sizes, % decreases with each decreasing particle size
Poorly Graded - one or more particle sizes missing (Gap Graded), or
all particles basically same size (Uniformly Graded)

subsurface exploration log 2.2.xls
Rev 5/12/2006

ATTACHMENT E-3B

OUTPUT OF JOHNSON AND ETTINGER MODEL FOR SUBSURFACE VAPOR INTRUSION INTO BUILDINGS FROM GROUNDWATER

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Reset to
Defaults

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Bis(2-chloroethyl)ether**

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES ☐

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES ☒

Results Summary					**Risk-Based Groundwater Concentration**	
Soil Gas Conc. (C_{source}) ($\mu g/m^3$)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard	Cancer Risk $= 10^{-6}$ ($\mu g/L$)	Noncancer HQ = 1 ($\mu g/L$)
9.69E+02	1.2E-04	1.2E-01	6.9E-06	NA	NA	NA

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W ($\mu g/L$)	Chemical
111444	1.50E+03	Bis(2-chloroethyl)ether

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (^{o}C)
15	914.4	S	24

ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
S			S	1.66	0.375	0.054

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	1.0E-06	1	70	25	25	250	8	1
	Used to calculate risk-based groundwater concentration.						(NEW)	(NEW)

END

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

Reset to Defaults

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **sec-Butylbenzene**

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES ☐

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES ☒ X

Results Summary					Risk-Based Groundwater Concentration	
Soil Gas Conc. (C_{source}) (μg/m^3)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) (μg/m^3)	Cancer Risk	Noncancer Hazard	Cancer Risk = 10^{-6} (μg/L)	Noncancer HQ = 1 (μg/L)
6.70E+02	8.9E-05	6.0E-02	NA	3.4E-05	NA	NA

ENTER Chemical CAS No. (numbers only, no dashes)	**ENTER** Initial groundwater conc., C_W (μg/L)	Chemical
135988	1.70E+00	**sec-Butylbenzene**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	**ENTER** Depth below grade to water table, L_{WT} (cm)	**ENTER** SCS soil type directly above water table	**ENTER** Average soil/ groundwater temperature, T_S (^oC)	**ENTER** Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	914.4	S	24	5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)		**ENTER** User-defined vandose zone soil vapor permeability, k_v (cm^2)	**ENTER** Vadose zone SCS soil type	**ENTER** Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	**ENTER** Vadose zone soil total porosity, n^V (unitless)	**ENTER** Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
S	**OR**		S	1.66	0.375	0.054

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Target risk for carcinogens, TR (unitless)	**ENTER** Target hazard quotient for noncarcinogens, THQ (unitless)	**ENTER** Averaging time for carcinogens, AT_C (yrs)	**ENTER** Averaging time for noncarcinogens, AT_{NC} (yrs)	**ENTER** Exposure duration, ED (yrs)	**ENTER** Exposure frequency, EF (days/yr)	**ENTER** Exposure Time ET (hrs/day)	**ENTER** Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	1.0E-06	1	70	25	25	250	8	1
	Used to calculate risk-based groundwater concentration.						(NEW)	(NEW)

END

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Cumene**

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES ☐

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES ☒

Results Summary

Soil Gas Conc. (C_{source}) (μg/m^3)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) (μg/m^3)	Cancer Risk	Noncancer Hazard	Risk-Based Groundwater Concentration: Cancer Risk = 10^{-6} (μg/L)	Risk-Based Groundwater Concentration: Noncancer HQ = 1 (μg/L)
5.71E+03	1.0E-04	5.8E-01	NA	3.3E-04	NA	NA

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
98828	1.30E+01	**Cumene**

MESSAGE: See VLOOKUP table comments on chemical properties and/or toxicity criteria for this chemical.

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)
15	914.4	S	24

ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
S			S	1.66	0.375	0.054

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	1.0E-06	1	70	25	25	250	8	1
	Used to calculate risk-based groundwater concentration.						(NEW)	(NEW)

END

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

Reset to Defaults

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Naphthalene**

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES ☐

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES ☒

ENTER Chemical CAS No. (numbers only, no dashes)	**ENTER** Initial groundwater conc., C_W (μg/L)	Chemical
91203	6.50E+01	**Naphthalene**

Results Summary					Risk-Based Groundwater Concentration	
Soil Gas Conc. (C_{source}) (μg/m³)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) (μg/m³)	Cancer Risk	Noncancer Hazard	Cancer Risk $= 10^{-6}$ (μg/L)	Noncancer HQ = 1 (μg/L)
1.09E+03	1.0E-04	1.1E-01	3.1E-07	8.6E-03	NA	NA

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	**ENTER** Depth below grade to water table, L_{WT} (cm)	**ENTER** SCS soil type directly above water table	**ENTER** Average soil/ groundwater temperature, T_S (°C)
15	914.4	S	24

ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)		**ENTER** User-defined vandose zone soil vapor permeability, k_v (cm²)	**ENTER** Vadose zone SCS soil type	**ENTER** Vadose zone soil dry bulk density, ρ_b^V (g/cm³)	**ENTER** Vadose zone soil total porosity, n^V (unitless)	**ENTER** Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)
S	**OR**		S	1.66	0.375	0.054

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

NEW=> Commercial

ENTER Target risk for carcinogens, TR (unitless)	**ENTER** Target hazard quotient for noncarcinogens, THQ (unitless)	**ENTER** Averaging time for carcinogens, AT_C (yrs)	**ENTER** Averaging time for noncarcinogens, AT_{NC} (yrs)	**ENTER** Exposure duration, ED (yrs)	**ENTER** Exposure frequency, EF (days/yr)	**ENTER** Exposure Time ET (hrs/day)	**ENTER** Air Exchange Rate ACH $(hour)^{-1}$
1.0E-06	1	70	25	25	250	8	1
Used to calculate risk-based groundwater concentration.						(NEW)	(NEW)

END

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

Reset to Defaults

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **n-Propylbenzene**

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES ☐

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES ☒ X

Results Summary					Risk-Based Groundwater Concentration	
Soil Gas Conc. (C_{source}) (μg/m^3)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) (μg/m^3)	Cancer Risk	Noncancer Hazard	Cancer Risk = 10^{-6} (μg/L)	Noncancer HQ = 1 (μg/L)
5.25E+03	1.0E-04	5.3E-01	NA	1.2E-04	NA	NA

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
103651	1.30E+01	n-Propylbenzene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)
15	914.4	S	24

ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
S			S	1.66	0.375	0.054

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	1.0E-06	1	70	25	25	250	8	1
	Used to calculate risk-based groundwater concentration.						(NEW)	(NEW)

END

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Reset to Defaults

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

Scenario: **Commercial**
Chemical: **o-Xylene**

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES ☐

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES ☒

Results Summary					Risk-Based Groundwater Concentration	
Soil Gas Conc. (C_{source}) (μg/m^3)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) (μg/m^3)	Cancer Risk	Noncancer Hazard	Cancer Risk = 10^{-6} (μg/L)	Noncancer HQ = 1 (μg/L)
6.01E+02	1.1E-04	6.8E-02	NA	1.6E-04	NA	NA

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
95476	3.00E+00	o-Xylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)
15	914.4	S	24

ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
S			S	1.66	0.375	0.054

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	1.0E-06	1	70	25	25	250	8	1
	Used to calculate risk-based groundwater concentration.						(NEW)	(NEW)

END

ATTACHMENT E-4

PROUCL STATISTICAL EVALUATION, SOIL 0 TO 10 FEET BGS

METALS

ProUCL Statistical Evaluation of Antimony (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	27	Number of Distinct Observations	6
Number of Detects	26	Number of Non-Detects	1
Number of Distinct Detects	5	Number of Distinct Non-Detects	1
Minimum Detect	0.36	Minimum Non-Detect	0.25
Maximum Detect	1	Maximum Non-Detect	0.25
Variance Detects	0.0439	Percent Non-Detects	3.704%
Mean Detects	0.585	SD Detects	0.21
Median Detects	0.5	CV Detects	0.358
Skewness Detects	1.536	Kurtosis Detects	0.666
Mean of Logged Detects	-0.586	SD of Logged Detects	0.302

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.592	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.464	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.17	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.572	KM Standard Error of Mean	0.0415
KM SD	0.211	95% KM (BCA) UCL	0.64
95% KM (t) UCL	0.643	95% KM (Percentile Bootstrap) UCL	0.642
95% KM (z) UCL	0.64	95% KM Bootstrap t UCL	0.659
90% KM Chebyshev UCL	0.697	95% KM Chebyshev UCL	0.753
97.5% KM Chebyshev UCL	0.831	99% KM Chebyshev UCL	0.985

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	5.171	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.744	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.457	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.171	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	10.31	k star (bias corrected MLE)	9.144
Theta hat (MLE)	0.0567	Theta star (bias corrected MLE)	0.0639
nu hat (MLE)	536	nu star (bias corrected)	475.5
Mean (detects)	0.585		

Gamma ROS Statistics using Imputed Non-Detects

Minimum	0.238	Mean	0.572
Maximum	1	Median	0.5
SD	0.216	CV	0.378
k hat (MLE)	8.697	k star (bias corrected MLE)	7.755
Theta hat (MLE)	0.0657	Theta star (bias corrected MLE)	0.0737
nu hat (MLE)	469.6	nu star (bias corrected)	418.8
Adjusted Level of Significance (β)	0.0401		
Approximate Chi Square Value (418.78, α)	372.3	Adjusted Chi Square Value (418.78, β)	369.6
95% Gamma Approximate UCL (use when n>=50)	0.643	95% Gamma Adjusted UCL (use when n<50)	0.648

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.572	SD (KM)	0.211
Variance (KM)	0.0447	SE of Mean (KM)	0.0415
k hat (KM)	7.332	k star (KM)	6.542
nu hat (KM)	395.9	nu star (KM)	353.2
theta hat (KM)	0.078	theta star (KM)	0.0875
80% gamma percentile (KM)	0.747	90% gamma percentile (KM)	0.871
95% gamma percentile (KM)	0.983	99% gamma percentile (KM)	1.216

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (353.25, α)	310.7	Adjusted Chi Square Value (353.25, β)	308.1
95% Gamma Approximate KM-UCL (use when n>=50)	0.651	95% Gamma Adjusted KM-UCL (use when n<50)	0.656

ProUCL Statistical Evaluation of Antimony (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.646	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.446	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.17	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.574	Mean in Log Scale	-0.609
SD in Original Scale	0.213	SD in Log Scale	0.319
95% t UCL (assumes normality of ROS data)	0.644	95% Percentile Bootstrap UCL	0.643
95% BCA Bootstrap UCL	0.648	95% Bootstrap t UCL	0.663
95% H-UCL (Log ROS)	0.642		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.616	KM Geo Mean	0.54
KM SD (logged)	0.328	95% Critical H Value (KM-Log)	1.839
KM Standard Error of Mean (logged)	0.0643	95% H-UCL (KM -Log)	0.642
KM SD (logged)	0.328	95% Critical H Value (KM-Log)	1.839
KM Standard Error of Mean (logged)	0.0643		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.568	Mean in Log Scale	-0.641
SD in Original Scale	0.224	SD in Log Scale	0.413
95% t UCL (Assumes normality)	0.641	95% H-Stat UCL	0.669

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.643	KM H-UCL	0.642
95% KM (BCA) UCL	0.64		

ProUCL Statistical Evaluation of Barium (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	27	Number of Distinct Observations	23
		Number of Missing Observations	0
Minimum	30	Mean	103
Maximum	450	Median	76
SD	87.43	Std. Error of Mean	16.83
Coefficient of Variation	0.849	Skewness	3.067

Normal GOF Test

Shapiro Wilk Test Statistic	0.618	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.923	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.291	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.167	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	131.7	95% Adjusted-CLT UCL (Chen-1995)	141.3
		95% Modified-t UCL (Johnson-1978)	133.4

Gamma GOF Test

A-D Test Statistic	1.527	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.753	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.216	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.17	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.727	k star (bias corrected MLE)	2.448
Theta hat (MLE)	37.78	Theta star (bias corrected MLE)	42.07
nu hat (MLE)	147.2	nu star (bias corrected)	132.2
MLE Mean (bias corrected)	103	MLE Sd (bias corrected)	65.83
		Approximate Chi Square Value (0.05)	106.6
Adjusted Level of Significance	0.0401	Adjusted Chi Square Value	105.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	127.7	95% Adjusted Gamma UCL (use when n<50)	129.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.916	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.923	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.164	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.401	Mean of logged Data	4.44
Maximum of Logged Data	6.109	SD of logged Data	0.57

Assuming Lognormal Distribution

95% H-UCL	125.2	90% Chebyshev (MVUE) UCL	133.4
95% Chebyshev (MVUE) UCL	149	97.5% Chebyshev (MVUE) UCL	170.6
99% Chebyshev (MVUE) UCL	213.1		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	130.7	95% Jackknife UCL	131.7
95% Standard Bootstrap UCL	129.7	95% Bootstrap-t UCL	172.2
95% Hall's Bootstrap UCL	270.6	95% Percentile Bootstrap UCL	134
95% BCA Bootstrap UCL	145.4		
90% Chebyshev(Mean, Sd) UCL	153.5	95% Chebyshev(Mean, Sd) UCL	176.3
97.5% Chebyshev(Mean, Sd) UCL	208.1	99% Chebyshev(Mean, Sd) UCL	270.4

Suggested UCL to Use

95% H-UCL	125.2

ProUCL Statistical Evaluation of Chromium (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	27	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	7.5	Mean	17.59
Maximum	40	Median	16
SD	8.289	Std. Error of Mean	1.595
Coefficient of Variation	0.471	Skewness	0.833

Normal GOF Test

Shapiro Wilk Test Statistic	0.919	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.923	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.153	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.167	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	20.31	95% Adjusted-CLT UCL (Chen-1995)	20.49
		95% Modified-t UCL (Johnson-1978)	20.36

Gamma GOF Test

A-D Test Statistic	0.526	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.748	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.171	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.169	Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.881	k star (bias corrected MLE)	4.363
Theta hat (MLE)	3.604	Theta star (bias corrected MLE)	4.032
nu hat (MLE)	263.6	nu star (bias corrected)	235.6
MLE Mean (bias corrected)	17.59	MLE Sd (bias corrected)	8.422
		Approximate Chi Square Value (0.05)	201.1
Adjusted Level of Significance	0.0401	Adjusted Chi Square Value	199

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	20.61	95% Adjusted Gamma UCL (use when n<50)	20.82

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.946	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.923	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.168	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.167	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.015	Mean of logged Data	2.762
Maximum of Logged Data	3.689	SD of logged Data	0.472

Assuming Lognormal Distribution

95% H-UCL	21.19	90% Chebyshev (MVUE) UCL	22.6
95% Chebyshev (MVUE) UCL	24.85	97.5% Chebyshev (MVUE) UCL	27.99
99% Chebyshev (MVUE) UCL	34.15		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	20.22	95% Jackknife UCL	20.31
95% Standard Bootstrap UCL	20.25	95% Bootstrap-t UCL	20.68
95% Hall's Bootstrap UCL	20.81	95% Percentile Bootstrap UCL	20.22
95% BCA Bootstrap UCL	20.31		
90% Chebyshev(Mean, Sd) UCL	22.38	95% Chebyshev(Mean, Sd) UCL	24.55
97.5% Chebyshev(Mean, Sd) UCL	27.56	99% Chebyshev(Mean, Sd) UCL	33.47

Suggested UCL to Use

95% Student's-t UCL	20.31

ProUCL Statistical Evaluation of Cobalt (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

```
                                   General Statistics
       Total Number of Observations  27                        Number of Distinct Observations  13
                                                              Number of Missing Observations  0
                            Minimum   3.5                                                Mean  8.111
                            Maximum  14                                                Median  8
                                 SD   3.286                                 Std. Error of Mean  0.632
           Coefficient of Variation   0.405                                          Skewness  0.207

                                    Normal GOF Test
         Shapiro Wilk Test Statistic  0.922                 Shapiro Wilk GOF Test
       5% Shapiro Wilk Critical Value  0.923       Data Not Normal at 5% Significance Level
            Lilliefors Test Statistic  0.16                   Lilliefors GOF Test
         5% Lilliefors Critical Value  0.167     Data appear Normal at 5% Significance Level
                  Data appear Approximate Normal at 5% Significance Level

                               Assuming Normal Distribution
     95% Normal UCL                                     95% UCLs (Adjusted for Skewness)
                  95% Student's-t UCL  9.19               95% Adjusted-CLT UCL (Chen-1995)  9.178
                                                          95% Modified-t UCL (Johnson-1978)  9.194

                                     Gamma GOF Test
                   A-D Test Statistic  0.74             Anderson-Darling Gamma GOF Test
                 5% A-D Critical Value  0.747  Detected data appear Gamma Distributed at 5% Significance Level
                   K-S Test Statistic  0.175          Kolmogorov-Smirnov Gamma GOF Test
                 5% K-S Critical Value  0.168     Data Not Gamma Distributed at 5% Significance Level
             Detected data follow Appr. Gamma Distribution at 5% Significance Level

                                    Gamma Statistics
                         k hat (MLE)   5.953                     k star (bias corrected MLE)   5.316
                     Theta hat (MLE)   1.363                 Theta star (bias corrected MLE)   1.526
                        nu hat (MLE)  321.5                         nu star (bias corrected)  287.1
           MLE Mean (bias corrected)   8.111                           MLE Sd (bias corrected)   3.518
                                                          Approximate Chi Square Value (0.05)  248.8
        Adjusted Level of Significance  0.0401                         Adjusted Chi Square Value  246.6

                               Assuming Gamma Distribution
 95% Approximate Gamma UCL (use when n>=50))  9.358      95% Adjusted Gamma UCL (use when n<50)  9.444

                                   Lognormal GOF Test
          Shapiro Wilk Test Statistic  0.917          Shapiro Wilk Lognormal GOF Test
       5% Shapiro Wilk Critical Value  0.923       Data Not Lognormal at 5% Significance Level
            Lilliefors Test Statistic  0.173            Lilliefors Lognormal GOF Test
         5% Lilliefors Critical Value  0.167       Data Not Lognormal at 5% Significance Level
                        Data Not Lognormal at 5% Significance Level

                                  Lognormal Statistics
            Minimum of Logged Data  1.253                               Mean of logged Data  2.007
            Maximum of Logged Data  2.639                                 SD of logged Data  0.434

                              Assuming Lognormal Distribution
                          95% H-UCL   9.625                      90% Chebyshev (MVUE) UCL  10.25
             95% Chebyshev (MVUE) UCL  11.21                    97.5% Chebyshev (MVUE) UCL  12.53
             99% Chebyshev (MVUE) UCL  15.14

                        Nonparametric Distribution Free UCL Statistics
               Data appear to follow a Discernible Distribution at 5% Significance Level

                            Nonparametric Distribution Free UCLs
                         95% CLT UCL   9.151                              95% Jackknife UCL   9.19
           95% Standard Bootstrap UCL   9.148                            95% Bootstrap-t UCL   9.203
              95% Hall's Bootstrap UCL   9.106                   95% Percentile Bootstrap UCL   9.13
               95% BCA Bootstrap UCL   9.037
         90% Chebyshev(Mean, Sd) UCL  10.01                    95% Chebyshev(Mean, Sd) UCL  10.87
       97.5% Chebyshev(Mean, Sd) UCL  12.06                    99% Chebyshev(Mean, Sd) UCL  14.4

                                  Suggested UCL to Use
                  95% Student's-t UCL  9.19
```

ProUCL Statistical Evaluation of Copper (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	27	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	3	Mean	16.87
Maximum	48	Median	14
SD	10.39	Std. Error of Mean	1.999
Coefficient of Variation	0.616	Skewness	1.214

Normal GOF Test

Shapiro Wilk Test Statistic	0.891	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.923	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.163	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.167	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	20.28	95% Adjusted-CLT UCL (Chen-1995)	20.66
		95% Modified-t UCL (Johnson-1978)	20.36

Gamma GOF Test

A-D Test Statistic	0.389	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.752	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.12	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.169	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.953	k star (bias corrected MLE)	2.649
Theta hat (MLE)	5.713	Theta star (bias corrected MLE)	6.368
nu hat (MLE)	159.4	nu star (bias corrected)	143.1
MLE Mean (bias corrected)	16.87	MLE Sd (bias corrected)	10.36
		Approximate Chi Square Value (0.05)	116.4
Adjusted Level of Significance	0.0401	Adjusted Chi Square Value	114.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	20.73	95% Adjusted Gamma UCL (use when n<50)	21.01

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.974	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.923	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.102	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.099	Mean of logged Data	2.647
Maximum of Logged Data	3.871	SD of logged Data	0.625

Assuming Lognormal Distribution

95% H-UCL	22.15	90% Chebyshev (MVUE) UCL	23.54
95% Chebyshev (MVUE) UCL	26.49	97.5% Chebyshev (MVUE) UCL	30.6
99% Chebyshev (MVUE) UCL	38.66		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	20.16	95% Jackknife UCL	20.28
95% Standard Bootstrap UCL	20.12	95% Bootstrap-t UCL	20.81
95% Hall's Bootstrap UCL	20.85	95% Percentile Bootstrap UCL	20.3
95% BCA Bootstrap UCL	20.56		
90% Chebyshev(Mean, Sd) UCL	22.87	95% Chebyshev(Mean, Sd) UCL	25.58
97.5% Chebyshev(Mean, Sd) UCL	29.35	99% Chebyshev(Mean, Sd) UCL	36.76

Suggested UCL to Use

95% Student's-t UCL	20.28

ProUCL Statistical Evaluation of Lead (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	27	Number of Distinct Observations	14
Number of Detects	26	Number of Non-Detects	1
Number of Distinct Detects	13	Number of Distinct Non-Detects	1
Minimum Detect	0.5	Minimum Non-Detect	0.25
Maximum Detect	100	Maximum Non-Detect	0.25
Variance Detects	362.6	Percent Non-Detects	3.704%
Mean Detects	6.904	SD Detects	19.04
Median Detects	3	CV Detects	2.758
Skewness Detects	5.052	Kurtosis Detects	25.67
Mean of Logged Detects	1.161	SD of Logged Detects	0.905

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.264	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.48	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.17	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	6.657	KM Standard Error of Mean	3.605
KM SD	18.37	95% KM (BCA) UCL	13.87
95% KM (t) UCL	12.81	95% KM (Percentile Bootstrap) UCL	13.77
95% KM (z) UCL	12.59	95% KM Bootstrap t UCL	58.93
90% KM Chebyshev UCL	17.47	95% KM Chebyshev UCL	22.37
97.5% KM Chebyshev UCL	29.17	99% KM Chebyshev UCL	42.52

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.182	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.783	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.356	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.178	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.773	k star (bias corrected MLE)	0.709
Theta hat (MLE)	8.931	Theta star (bias corrected MLE)	9.731
nu hat (MLE)	40.2	nu star (bias corrected)	36.89
Mean (detects)	6.904		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	6.649
Maximum	100	Median	3
SD	18.72	CV	2.816
k hat (MLE)	0.645	k star (bias corrected MLE)	0.598
Theta hat (MLE)	10.3	Theta star (bias corrected MLE)	11.11
nu hat (MLE)	34.86	nu star (bias corrected)	32.32
Adjusted Level of Significance (β)	0.0401		
Approximate Chi Square Value (32.32, α)	20.32	Adjusted Chi Square Value (32.32, β)	19.71
95% Gamma Approximate UCL (use when n>=50)	10.57	95% Gamma Adjusted UCL (use when n<50)	10.9

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	6.657	SD (KM)	18.37
Variance (KM)	337.3	SE of Mean (KM)	3.605
k hat (KM)	0.131	k star (KM)	0.141
nu hat (KM)	7.095	nu star (KM)	7.64
theta hat (KM)	50.67	theta star (KM)	47.06
80% gamma percentile (KM)	6.893	90% gamma percentile (KM)	19.56
95% gamma percentile (KM)	37.04	99% gamma percentile (KM)	88.4

ProUCL Statistical Evaluation of Lead (mg/kg) in Soil

Former Chemoil Refinery
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Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (7.64, α)	2.528	Adjusted Chi Square Value (7.64, β)	2.344
95% Gamma Approximate KM-UCL (use when n>=50)	20.12	95% Gamma Adjusted KM-UCL (use when n<50)	21.7

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.798	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.204	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.17	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	6.665	Mean in Log Scale	1.088
SD in Original Scale	18.71	SD in Log Scale	0.965
95% t UCL (assumes normality of ROS data)	12.81	95% Percentile Bootstrap UCL	13.87
95% BCA Bootstrap UCL	17.94	95% Bootstrap t UCL	59.7
95% H-UCL (Log ROS)	7.559		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.067	KM Geo Mean	2.905
KM SD (logged)	0.995	95% Critical H Value (KM-Log)	2.515
KM Standard Error of Mean (logged)	0.195	95% H-UCL (KM -Log)	7.787
KM SD (logged)	0.995	95% Critical H Value (KM-Log)	2.515
KM Standard Error of Mean (logged)	0.195		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	6.653	Mean in Log Scale	1.041
SD in Original Scale	18.72	SD in Log Scale	1.085
95% t UCL (Assumes normality)	12.8	95% H-Stat UCL	8.932

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	22.37

ProUCL Statistical Evaluation of Mercury (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	26	Number of Distinct Observations	4
		Number of Missing Observations	1
Number of Detects	3	Number of Non-Detects	23
Number of Distinct Detects	3	Number of Distinct Non-Detects	1
Minimum Detect	0.11	Minimum Non-Detect	0.1
Maximum Detect	3	Maximum Non-Detect	0.1
Variance Detects	2.774	Percent Non-Detects	88.46%
Mean Detects	1.077	SD Detects	1.666
Median Detects	0.12	CV Detects	1.547
Skewness Detects	1.732	Kurtosis Detects	N/A
Mean of Logged Detects	-1.076	SD of Logged Detects	1.884

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.753	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.384	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.213	KM Standard Error of Mean	0.134
KM SD	0.557	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.441	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.433	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.614	95% KM Chebyshev UCL	0.796
97.5% KM Chebyshev UCL	1.049	99% KM Chebyshev UCL	1.545

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	0.545	k star (bias corrected MLE)	N/A
Theta hat (MLE)	1.976	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	3.27	nu star (bias corrected)	N/A
Mean (detects)	1.077		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.133
Maximum	3	Median	0.01
SD	0.585	CV	4.399
k hat (MLE)	0.314	k star (bias corrected MLE)	0.303
Theta hat (MLE)	0.424	Theta star (bias corrected MLE)	0.439
nu hat (MLE)	16.32	nu star (bias corrected)	15.77
Adjusted Level of Significance (β)	0.0398		
Approximate Chi Square Value (15.77, α)	7.8	Adjusted Chi Square Value (15.77, β)	7.43
95% Gamma Approximate UCL (use when n>=50)	0.269	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.213	SD (KM)	0.557
Variance (KM)	0.311	SE of Mean (KM)	0.134
k hat (KM)	0.146	k star (KM)	0.154
nu hat (KM)	7.569	nu star (KM)	8.029
theta hat (KM)	1.461	theta star (KM)	1.377
80% gamma percentile (KM)	0.237	90% gamma percentile (KM)	0.633
95% gamma percentile (KM)	1.164	99% gamma percentile (KM)	2.695

ProUCL Statistical Evaluation of Mercury (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (8.03, α)	2.752	Adjusted Chi Square Value (8.03, β)	2.552
95% Gamma Approximate KM-UCL (use when n>=50)	0.621	95% Gamma Adjusted KM-UCL (use when n<50)	0.669

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.77	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.377	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.125	Mean in Log Scale	-11.47
SD in Original Scale	0.587	SD in Log Scale	6.051
95% t UCL (assumes normality of ROS data)	0.321	95% Percentile Bootstrap UCL	0.352
95% BCA Bootstrap UCL	0.475	95% Bootstrap t UCL	3.399
95% H-UCL (Log ROS)	6.369E+8		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.161	KM Geo Mean	0.115
KM SD (logged)	0.653	95% Critical H Value (KM-Log)	2.106
KM Standard Error of Mean (logged)	0.157	95% H-UCL (KM -Log)	0.188
KM SD (logged)	0.653	95% Critical H Value (KM-Log)	2.106
KM Standard Error of Mean (logged)	0.157		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.168	Mean in Log Scale	-2.774
SD in Original Scale	0.578	SD in Log Scale	0.822
95% t UCL (Assumes normality)	0.362	95% H-Stat UCL	0.127

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.441

ProUCL Statistical Evaluation of Molybdenum (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	27	Number of Distinct Observations	12
Number of Detects	23	Number of Non-Detects	4
Number of Distinct Detects	11	Number of Distinct Non-Detects	1
Minimum Detect	0.26	Minimum Non-Detect	0.25
Maximum Detect	0.5	Maximum Non-Detect	0.25
Variance Detects	0.0052	Percent Non-Detects	14.81%
Mean Detects	0.433	SD Detects	0.0721
Median Detects	0.46	CV Detects	0.167
Skewness Detects	-0.746	Kurtosis Detects	-0.453
Mean of Logged Detects	-0.852	SD of Logged Detects	0.182

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.849	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.914	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.22	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.18	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.406	KM Standard Error of Mean	0.0181
KM SD	0.092	95% KM (BCA) UCL	0.434
95% KM (t) UCL	0.437	95% KM (Percentile Bootstrap) UCL	0.434
95% KM (z) UCL	0.436	95% KM Bootstrap t UCL	0.434
90% KM Chebyshev UCL	0.46	95% KM Chebyshev UCL	0.485
97.5% KM Chebyshev UCL	0.519	99% KM Chebyshev UCL	0.586

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.399	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.742	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.22	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.181	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	33.85	k star (bias corrected MLE)	29.47
Theta hat (MLE)	0.0128	Theta star (bias corrected MLE)	0.0147
nu hat (MLE)	1557	nu star (bias corrected)	1355
Mean (detects)	0.433		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.26	Mean	0.413
Maximum	0.5	Median	0.42
SD	0.0828	CV	0.2
k hat (MLE)	23.95	k star (bias corrected MLE)	21.31
Theta hat (MLE)	0.0172	Theta star (bias corrected MLE)	0.0194
nu hat (MLE)	1293	nu star (bias corrected)	1151
Adjusted Level of Significance (β)	0.0401		
Approximate Chi Square Value (N/A, α)	1073	Adjusted Chi Square Value (N/A, β)	1068
95% Gamma Approximate UCL (use when n>=50)	0.443	95% Gamma Adjusted UCL (use when n<50)	0.445

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.406	SD (KM)	0.092
Variance (KM)	0.00847	SE of Mean (KM)	0.0181
k hat (KM)	19.46	k star (KM)	17.32
nu hat (KM)	1051	nu star (KM)	935.3
theta hat (KM)	0.0209	theta star (KM)	0.0234
80% gamma percentile (KM)	0.485	90% gamma percentile (KM)	0.535
95% gamma percentile (KM)	0.579	99% gamma percentile (KM)	0.667

ProUCL Statistical Evaluation of Molybdenum (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (935.28, α)	865.3	Adjusted Chi Square Value (935.28, β)	861
95% Gamma Approximate KM-UCL (use when n>=50)	0.439	95% Gamma Adjusted KM-UCL (use when n<50)	0.441

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.833	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.914	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.212	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.18	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.412	Mean in Log Scale	-0.907
SD in Original Scale	0.0836	SD in Log Scale	0.216
95% t UCL (assumes normality of ROS data)	0.44	95% Percentile Bootstrap UCL	0.438
95% BCA Bootstrap UCL	0.437	95% Bootstrap t UCL	0.438
95% H-UCL (Log ROS)	0.445		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.931	KM Geo Mean	0.394
KM SD (logged)	0.251	95% Critical H Value (KM-Log)	1.789
KM Standard Error of Mean (logged)	0.0494	95% H-UCL (KM -Log)	0.444
KM SD (logged)	0.251	95% Critical H Value (KM-Log)	1.789
KM Standard Error of Mean (logged)	0.0494		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.387	Mean in Log Scale	-1.034
SD in Original Scale	0.13	SD in Log Scale	0.475
95% t UCL (Assumes normality)	0.43	95% H-Stat UCL	0.477

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.437	KM H-UCL	0.444
95% KM (BCA) UCL	0.434		

ProUCL Statistical Evaluation of Nickel (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	27	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	4.5	Mean	14.57
Maximum	64	Median	12
SD	11.56	Std. Error of Mean	2.225
Coefficient of Variation	0.793	Skewness	3.135

Normal GOF Test

Shapiro Wilk Test Statistic	0.681	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.923	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.196	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.167	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	18.37	95% Adjusted-CLT UCL (Chen-1995)	19.67
		95% Modified-t UCL (Johnson-1978)	18.59

Gamma GOF Test

A-D Test Statistic	0.597	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.122	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.17	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.636	k star (bias corrected MLE)	2.368
Theta hat (MLE)	5.53	Theta star (bias corrected MLE)	6.156
nu hat (MLE)	142.3	nu star (bias corrected)	127.8
MLE Mean (bias corrected)	14.57	MLE Sd (bias corrected)	9.472
		Approximate Chi Square Value (0.05)	102.7
Adjusted Level of Significance	0.0401	Adjusted Chi Square Value	101.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	18.14	95% Adjusted Gamma UCL (use when n<50)	18.39

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.946	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.923	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.107	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.504	Mean of logged Data	2.478
Maximum of Logged Data	4.159	SD of logged Data	0.619

Assuming Lognormal Distribution

95% H-UCL	18.58	90% Chebyshev (MVUE) UCL	19.75
95% Chebyshev (MVUE) UCL	22.21	97.5% Chebyshev (MVUE) UCL	25.63
99% Chebyshev (MVUE) UCL	32.34		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	18.23	95% Jackknife UCL	18.37
95% Standard Bootstrap UCL	18.18	95% Bootstrap-t UCL	20.77
95% Hall's Bootstrap UCL	34.96	95% Percentile Bootstrap UCL	18.61
95% BCA Bootstrap UCL	19.8		
90% Chebyshev(Mean, Sd) UCL	21.25	95% Chebyshev(Mean, Sd) UCL	24.27
97.5% Chebyshev(Mean, Sd) UCL	28.47	99% Chebyshev(Mean, Sd) UCL	36.71

Suggested UCL to Use

95% Adjusted Gamma UCL	18.39

ProUCL Statistical Evaluation of Thallium (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	27	Number of Distinct Observations	7
Number of Detects	26	Number of Non-Detects	1
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	0.33	Minimum Non-Detect	0.25
Maximum Detect	2	Maximum Non-Detect	0.25
Variance Detects	0.21	Percent Non-Detects	3.704%
Mean Detects	0.894	SD Detects	0.458
Median Detects	1	CV Detects	0.512
Skewness Detects	0.71	Kurtosis Detects	-0.434
Mean of Logged Detects	-0.238	SD of Logged Detects	0.514

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.848	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.267	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.17	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.87	KM Standard Error of Mean	0.0897
KM SD	0.457	95% KM (BCA) UCL	1.015
95% KM (t) UCL	1.023	95% KM (Percentile Bootstrap) UCL	1.019
95% KM (z) UCL	1.018	95% KM Bootstrap t UCL	1.04
90% KM Chebyshev UCL	1.14	95% KM Chebyshev UCL	1.262
97.5% KM Chebyshev UCL	1.431	99% KM Chebyshev UCL	1.763

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.741	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.748	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.279	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.172	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.122	k star (bias corrected MLE)	3.672
Theta hat (MLE)	0.217	Theta star (bias corrected MLE)	0.244
nu hat (MLE)	214.3	nu star (bias corrected)	190.9
Mean (detects)	0.894		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.121	Mean	0.866
Maximum	2	Median	1
SD	0.473	CV	0.547
k hat (MLE)	3.225	k star (bias corrected MLE)	2.891
Theta hat (MLE)	0.268	Theta star (bias corrected MLE)	0.299
nu hat (MLE)	174.2	nu star (bias corrected)	156.1
Adjusted Level of Significance (β)	0.0401		
Approximate Chi Square Value (156.14, α)	128.3	Adjusted Chi Square Value (156.14, β)	126.6
95% Gamma Approximate UCL (use when n>=50)	1.054	95% Gamma Adjusted UCL (use when n<50)	1.067

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.87	SD (KM)	0.457
Variance (KM)	0.209	SE of Mean (KM)	0.0897
k hat (KM)	3.624	k star (KM)	3.246
nu hat (KM)	195.7	nu star (KM)	175.3
theta hat (KM)	0.24	theta star (KM)	0.268
80% gamma percentile (KM)	1.23	90% gamma percentile (KM)	1.518
95% gamma percentile (KM)	1.786	99% gamma percentile (KM)	2.365

ProUCL Statistical Evaluation of Thallium (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (175.28, α)	145.7	Adjusted Chi Square Value (175.28, β)	143.9
95% Gamma Approximate KM-UCL (use when n>=50)	1.047	95% Gamma Adjusted KM-UCL (use when n<50)	1.06

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.868	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.92	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.273	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.17	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.87	Mean in Log Scale	-0.283
SD in Original Scale	0.467	SD in Log Scale	0.557
95% t UCL (assumes normality of ROS data)	1.023	95% Percentile Bootstrap UCL	1.017
95% BCA Bootstrap UCL	1.028	95% Bootstrap t UCL	1.041
95% H-UCL (Log ROS)	1.097		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.28	KM Geo Mean	0.755
KM SD (logged)	0.54	95% Critical H Value (KM-Log)	2.006
KM Standard Error of Mean (logged)	0.106	95% H-UCL (KM -Log)	1.081
KM SD (logged)	0.54	95% Critical H Value (KM-Log)	2.006
KM Standard Error of Mean (logged)	0.106		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.866	Mean in Log Scale	-0.306
SD in Original Scale	0.473	SD in Log Scale	0.616
95% t UCL (Assumes normality)	1.021	95% H-Stat UCL	1.145

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	1.262

ProUCL Statistical Evaluation of Vanadium (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

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                                      General Statistics
            Total Number of Observations   27                     Number of Distinct Observations   21
                                                                   Number of Missing Observations    0
                                 Minimum   15                                                Mean   35.11
                                 Maximum  120                                              Median   31
                                      SD   21.49                                Std. Error of Mean    4.136
                Coefficient of Variation    0.612                                        Skewness    2.424

                                       Normal GOF Test
              Shapiro Wilk Test Statistic   0.759                  Shapiro Wilk GOF Test
           5% Shapiro Wilk Critical Value   0.923        Data Not Normal at 5% Significance Level
                Lilliefors Test Statistic   0.175                   Lilliefors GOF Test
             5% Lilliefors Critical Value   0.167        Data Not Normal at 5% Significance Level
                        Data Not Normal at 5% Significance Level

                               Assuming Normal Distribution
     95% Normal UCL                                        95% UCLs (Adjusted for Skewness)
                      95% Student's-t UCL   42.17             95% Adjusted-CLT UCL (Chen-1995)   43.98
                                                              95% Modified-t UCL (Johnson-1978)   42.49

                                       Gamma GOF Test
                       A-D Test Statistic   0.713            Anderson-Darling Gamma GOF Test
                    5% A-D Critical Value   0.75     Detected data appear Gamma Distributed at 5% Significance Level
                       K-S Test Statistic   0.128           Kolmogorov-Smirnov Gamma GOF Test
                    5% K-S Critical Value   0.169    Detected data appear Gamma Distributed at 5% Significance Level
                  Detected data appear Gamma Distributed at 5% Significance Level

                                      Gamma Statistics
                             k hat (MLE)    3.792                      k star (bias corrected MLE)    3.395
                         Theta hat (MLE)    9.259                  Theta star (bias corrected MLE)   10.34
                            nu hat (MLE)  204.8                           nu star (bias corrected)  183.4
                 MLE Mean (bias corrected)   35.11                          MLE Sd (bias corrected)   19.05
                                                              Approximate Chi Square Value (0.05)  153
            Adjusted Level of Significance   0.0401                       Adjusted Chi Square Value  151.3

                                Assuming Gamma Distribution
95% Approximate Gamma UCL (use when n>=50)   42.07         95% Adjusted Gamma UCL (use when n<50)   42.56

                                     Lognormal GOF Test
              Shapiro Wilk Test Statistic   0.924             Shapiro Wilk Lognormal GOF Test
           5% Shapiro Wilk Critical Value   0.923     Data appear Lognormal at 5% Significance Level
                Lilliefors Test Statistic   0.128              Lilliefors Lognormal GOF Test
             5% Lilliefors Critical Value   0.167     Data appear Lognormal at 5% Significance Level
                    Data appear Lognormal at 5% Significance Level

                                    Lognormal Statistics
                  Minimum of Logged Data    2.708                             Mean of logged Data    3.421
                  Maximum of Logged Data    4.787                               SD of logged Data    0.517

                              Assuming Lognormal Distribution
                               95% H-UCL   42.76                       90% Chebyshev (MVUE) UCL   45.61
                  95% Chebyshev (MVUE) UCL   50.53                     97.5% Chebyshev (MVUE) UCL   57.34
                  99% Chebyshev (MVUE) UCL   70.73

                        Nonparametric Distribution Free UCL Statistics
                Data appear to follow a Discernible Distribution at 5% Significance Level

                             Nonparametric Distribution Free UCLs
                              95% CLT UCL   41.91                                95% Jackknife UCL   42.17
                 95% Standard Bootstrap UCL   41.85                              95% Bootstrap-t UCL   45.79
                   95% Hall's Bootstrap UCL   72.44                      95% Percentile Bootstrap UCL   42.3
                       95% BCA Bootstrap UCL   45.3
              90% Chebyshev(Mean, Sd) UCL   47.52                      95% Chebyshev(Mean, Sd) UCL   53.14
            97.5% Chebyshev(Mean, Sd) UCL   60.94                      99% Chebyshev(Mean, Sd) UCL   76.26

                                     Suggested UCL to Use
                   95% Adjusted Gamma UCL   42.56
```

ProUCL Statistical Evaluation of Zinc (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	27	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	22	Mean	43.78
Maximum	200	Median	40
SD	33.29	Std. Error of Mean	6.407
Coefficient of Variation	0.761	Skewness	4.211

Normal GOF Test

Shapiro Wilk Test Statistic	0.509	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.923	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.309	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.167	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	54.71	95% Adjusted-CLT UCL (Chen-1995)	59.87
		95% Modified-t UCL (Johnson-1978)	55.57

Gamma GOF Test

A-D Test Statistic	1.683	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.749	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.202	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.169	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.846	k star (bias corrected MLE)	3.443
Theta hat (MLE)	11.38	Theta star (bias corrected MLE)	12.71
nu hat (MLE)	207.7	nu star (bias corrected)	185.9
MLE Mean (bias corrected)	43.78	MLE Sd (bias corrected)	23.59
		Approximate Chi Square Value (0.05)	155.4
Adjusted Level of Significance	0.0401	Adjusted Chi Square Value	153.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	52.38	95% Adjusted Gamma UCL (use when n<50)	52.99

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.83	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.923	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.162	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.091	Mean of logged Data	3.644
Maximum of Logged Data	5.298	SD of logged Data	0.467

Assuming Lognormal Distribution

95% H-UCL	50.92	90% Chebyshev (MVUE) UCL	54.3
95% Chebyshev (MVUE) UCL	59.67	97.5% Chebyshev (MVUE) UCL	67.13
99% Chebyshev (MVUE) UCL	81.78		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	54.32	95% Jackknife UCL	54.71
95% Standard Bootstrap UCL	54.1	95% Bootstrap-t UCL	67.57
95% Hall's Bootstrap UCL	97.62	95% Percentile Bootstrap UCL	55.7
95% BCA Bootstrap UCL	63.3		
90% Chebyshev(Mean, Sd) UCL	63	95% Chebyshev(Mean, Sd) UCL	71.71
97.5% Chebyshev(Mean, Sd) UCL	83.79	99% Chebyshev(Mean, Sd) UCL	107.5

Suggested UCL to Use

95% Student's-t UCL	54.71	or 95% Modified-t UCL	55.57
or 95% H-UCL	50.92		

TOTAL PETROLEUM HYDROCARBONS (TPH)

ProUCL Statistical Evaluation of Total Petroleum Hydrocarbon (C5-C12) (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	29	Number of Distinct Observations	8
		Number of Missing Observations	11
Number of Detects	4	Number of Non-Detects	25
Number of Distinct Detects	4	Number of Distinct Non-Detects	4
Minimum Detect	7.4	Minimum Non-Detect	1
Maximum Detect	830	Maximum Non-Detect	20
Variance Detects	158883	Percent Non-Detects	86.21%
Mean Detects	235.2	SD Detects	398.6
Median Detects	51.65	CV Detects	1.695
Skewness Detects	1.94	Kurtosis Detects	3.782
Mean of Logged Detects	3.874	SD of Logged Detects	2.218

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.705	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.388	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	33.39	KM Standard Error of Mean	32.49
KM SD	151.5	95% KM (BCA) UCL	N/A
95% KM (t) UCL	88.65	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	86.82	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	130.8	95% KM Chebyshev UCL	175
97.5% KM Chebyshev UCL	236.3	99% KM Chebyshev UCL	356.6

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.427	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.691	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.295	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.414	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.413	k star (bias corrected MLE)	0.27
Theta hat (MLE)	569.8	Theta star (bias corrected MLE)	871.5
nu hat (MLE)	3.302	nu star (bias corrected)	2.159
Mean (detects)	235.2		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	32.45
Maximum	830	Median	0.01
SD	154.4	CV	4.758
k hat (MLE)	0.115	k star (bias corrected MLE)	0.126
Theta hat (MLE)	281.4	Theta star (bias corrected MLE)	256.8
nu hat (MLE)	6.687	nu star (bias corrected)	7.329
Adjusted Level of Significance (β)	0.0407		
Approximate Chi Square Value (7.33, α)	2.353	Adjusted Chi Square Value (7.33, β)	2.188
95% Gamma Approximate UCL (use when n>=50)	101.1	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	33.39	SD (KM)	151.5
Variance (KM)	22952	SE of Mean (KM)	32.49
k hat (KM)	0.0486	k star (KM)	0.0665
nu hat (KM)	2.817	nu star (KM)	3.859
theta hat (KM)	687.4	theta star (KM)	501.8
80% gamma percentile (KM)	10.59	90% gamma percentile (KM)	69.11
95% gamma percentile (KM)	190.7	99% gamma percentile (KM)	643.7

ProUCL Statistical Evaluation of Total Petroleum Hydrocarbon (C5-C12) (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (3.86, α)	0.667	Adjusted Chi Square Value (3.86, β)	0.595
95% Gamma Approximate KM-UCL (use when n>=50)	193.2	95% Gamma Adjusted KM-UCL (use when n<50)	216.4

95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.893	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.271	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	32.5	Mean in Log Scale	-4.938
SD in Original Scale	154.4	SD in Log Scale	5.074
95% t UCL (assumes normality of ROS data)	81.26	95% Percentile Bootstrap UCL	89.43
95% BCA Bootstrap UCL	121.6	95% Bootstrap t UCL	2628
95% H-UCL (Log ROS)	16922025		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.56	KM Geo Mean	1.75
KM SD (logged)	1.523	95% Critical H Value (KM-Log)	3.181
KM Standard Error of Mean (logged)	0.331	95% H-UCL (KM -Log)	13.95
KM SD (logged)	1.523	95% Critical H Value (KM-Log)	3.181
KM Standard Error of Mean (logged)	0.331		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	34.08	Mean in Log Scale	0.51
SD in Original Scale	154	SD in Log Scale	1.831
95% t UCL (Assumes normality)	82.74	95% H-Stat UCL	31.41

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	216.4

ProUCL Statistical Evaluation of Total Petroleum Hydrocarbon (C13-C22) (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	29	Number of Distinct Observations	10
		Number of Missing Observations	11
Number of Detects	8	Number of Non-Detects	21
Number of Distinct Detects	8	Number of Distinct Non-Detects	3
Minimum Detect	9.2	Minimum Non-Detect	1
Maximum Detect	6540	Maximum Non-Detect	25
Variance Detects	5197802	Percent Non-Detects	72.41%
Mean Detects	1246	SD Detects	2280
Median Detects	121.5	CV Detects	1.83
Skewness Detects	2.267	Kurtosis Detects	5.215
Mean of Logged Detects	5.055	SD of Logged Detects	2.468

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.64	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.322	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	344.6	KM Standard Error of Mean	248.3
KM SD	1251	95% KM (BCA) UCL	791.6
95% KM (t) UCL	766.9	95% KM (Percentile Bootstrap) UCL	782.8
95% KM (z) UCL	752.9	95% KM Bootstrap t UCL	2808
90% KM Chebyshev UCL	1089	95% KM Chebyshev UCL	1427
97.5% KM Chebyshev UCL	1895	99% KM Chebyshev UCL	2815

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.488	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.792	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.245	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.316	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.328	k star (bias corrected MLE)	0.288
Theta hat (MLE)	3799	Theta star (bias corrected MLE)	4321
nu hat (MLE)	5.247	nu star (bias corrected)	4.612
Mean (detects)	1246		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	343.7
Maximum	6540	Median	0.01
SD	1273	CV	3.704
k hat (MLE)	0.104	k star (bias corrected MLE)	0.116
Theta hat (MLE)	3308	Theta star (bias corrected MLE)	2959
nu hat (MLE)	6.025	nu star (bias corrected)	6.735
Adjusted Level of Significance (β)	0.0407		
Approximate Chi Square Value (6.74, α)	2.026	Adjusted Chi Square Value (6.74, β)	1.876
95% Gamma Approximate UCL (use when n>=50)	1142	95% Gamma Adjusted UCL (use when n<50)	1234

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	344.6	SD (KM)	1251
Variance (KM)	1564044	SE of Mean (KM)	248.3
k hat (KM)	0.0759	k star (KM)	0.091
nu hat (KM)	4.403	nu star (KM)	5.281
theta hat (KM)	4539	theta star (KM)	3785
80% gamma percentile (KM)	206.8	90% gamma percentile (KM)	878.7
95% gamma percentile (KM)	2007	99% gamma percentile (KM)	5734

ProUCL Statistical Evaluation of Total Petroleum Hydrocarbon (C13-C22) (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (5.28, α)	1.284	Adjusted Chi Square Value (5.28, β)	1.172
95% Gamma Approximate KM-UCL (use when n>=50)	1417	95% Gamma Adjusted KM-UCL (use when n<50)	1553

95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.921	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.203	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	343.9	Mean in Log Scale	-1.477
SD in Original Scale	1273	SD in Log Scale	5.15
95% t UCL (assumes normality of ROS data)	746	95% Percentile Bootstrap UCL	786.1
95% BCA Bootstrap UCL	1014	95% Bootstrap t UCL	2919
95% H-UCL (Log ROS)	1.030E+9		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.436	KM Geo Mean	4.203
KM SD (logged)	2.561	95% Critical H Value (KM-Log)	4.815
KM Standard Error of Mean (logged)	0.513	95% H-UCL (KM -Log)	1148
KM SD (logged)	2.561	95% Critical H Value (KM-Log)	4.815
KM Standard Error of Mean (logged)	0.513		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	345.8	Mean in Log Scale	1.416
SD in Original Scale	1272	SD in Log Scale	2.833
95% t UCL (Assumes normality)	747.8	95% H-Stat UCL	3815

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use	
Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	1553

ProUCL Statistical Evaluation of Total Petroleum Hydrocarbon (C23-C44) (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	29	Number of Distinct Observations	18
		Number of Missing Observations	11
Number of Detects	16	Number of Non-Detects	13
Number of Distinct Detects	15	Number of Distinct Non-Detects	3
Minimum Detect	5.25	Minimum Non-Detect	1
Maximum Detect	3880	Maximum Non-Detect	48
Variance Detects	1741969	Percent Non-Detects	44.83%
Mean Detects	650.1	SD Detects	1320
Median Detects	18.8	CV Detects	2.03
Skewness Detects	2.016	Kurtosis Detects	2.758
Mean of Logged Detects	3.996	SD of Logged Detects	2.329

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.55	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.41	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	360.1	KM Standard Error of Mean	192.2
KM SD	1002	95% KM (BCA) UCL	741.6
95% KM (t) UCL	687.1	95% KM (Percentile Bootstrap) UCL	698.5
95% KM (z) UCL	676.3	95% KM Bootstrap t UCL	1052
90% KM Chebyshev UCL	936.8	95% KM Chebyshev UCL	1198
97.5% KM Chebyshev UCL	1561	99% KM Chebyshev UCL	2273

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.903	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.847	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.289	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.234	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.281	k star (bias corrected MLE)	0.27
Theta hat (MLE)	2314	Theta star (bias corrected MLE)	2409
nu hat (MLE)	8.989	nu star (bias corrected)	8.637
Mean (detects)	650.1		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	358.7
Maximum	3880	Median	6.5
SD	1021	CV	2.845
k hat (MLE)	0.136	k star (bias corrected MLE)	0.145
Theta hat (MLE)	2642	Theta star (bias corrected MLE)	2479
nu hat (MLE)	7.875	nu star (bias corrected)	8.393
Adjusted Level of Significance (β)	0.0407		
Approximate Chi Square Value (8.39, α)	2.965	Adjusted Chi Square Value (8.39, β)	2.775
95% Gamma Approximate UCL (use when n>=50)	1015	95% Gamma Adjusted UCL (use when n<50)	1085

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	360.1	SD (KM)	1002
Variance (KM)	1004519	SE of Mean (KM)	192.2
k hat (KM)	0.129	k star (KM)	0.139
nu hat (KM)	7.489	nu star (KM)	8.048
theta hat (KM)	2789	theta star (KM)	2596
80% gamma percentile (KM)	366.4	90% gamma percentile (KM)	1055
95% gamma percentile (KM)	2011	99% gamma percentile (KM)	4832

ProUCL Statistical Evaluation of Total Petroleum Hydrocarbon (C23-C44) (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (8.05, α)	2.763	Adjusted Chi Square Value (8.05, β)	2.581
95% Gamma Approximate KM-UCL (use when n>=50)	1049	95% Gamma Adjusted KM-UCL (use when n<50)	1123

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.824	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.215	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	359.8	Mean in Log Scale	1.874
SD in Original Scale	1020	SD in Log Scale	3.192
95% t UCL (assumes normality of ROS data)	682	95% Percentile Bootstrap UCL	692.1
95% BCA Bootstrap UCL	828.8	95% Bootstrap t UCL	1096
95% H-UCL (Log ROS)	36518		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.415	KM Geo Mean	11.19
KM SD (logged)	2.511	95% Critical H Value (KM-Log)	4.733
KM Standard Error of Mean (logged)	0.494	95% H-UCL (KM -Log)	2474
KM SD (logged)	2.511	95% Critical H Value (KM-Log)	4.733
KM Standard Error of Mean (logged)	0.494		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	362.3	Mean in Log Scale	2.507
SD in Original Scale	1019	SD in Log Scale	2.682
95% t UCL (Assumes normality)	684.3	95% H-Stat UCL	5674

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	1561

VOLATILE ORGANIC COMPOUNDS (VOCs)

ProUCL Statistical Evaluation of Ethylbenzene (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	33	Number of Distinct Observations	8
		Number of Missing Observations	7
Number of Detects	6	Number of Non-Detects	27
Number of Distinct Detects	6	Number of Distinct Non-Detects	2
Minimum Detect	0.0088	Minimum Non-Detect	0.002
Maximum Detect	0.82	Maximum Non-Detect	0.005
Variance Detects	0.123	Percent Non-Detects	81.82%
Mean Detects	0.234	SD Detects	0.351
Median Detects	0.0205	CV Detects	1.501
Skewness Detects	1.272	Kurtosis Detects	-0.0745
Mean of Logged Detects	-2.955	SD of Logged Detects	1.992

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.717	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.392	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0441	KM Standard Error of Mean	0.0311
KM SD	0.163	95% KM (BCA) UCL	0.0956
95% KM (t) UCL	0.0969	95% KM (Percentile Bootstrap) UCL	0.0995
95% KM (z) UCL	0.0954	95% KM Bootstrap t UCL	1.182
90% KM Chebyshev UCL	0.138	95% KM Chebyshev UCL	0.18
97.5% KM Chebyshev UCL	0.239	99% KM Chebyshev UCL	0.354

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.802	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.746	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.377	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.351	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.433	k star (bias corrected MLE)	0.327
Theta hat (MLE)	0.54	Theta star (bias corrected MLE)	0.714
nu hat (MLE)	5.191	nu star (bias corrected)	3.929
Mean (detects)	0.234		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0088	Mean	0.0507
Maximum	0.82	Median	0.01
SD	0.164	CV	3.237
k hat (MLE)	0.483	k star (bias corrected MLE)	0.459
Theta hat (MLE)	0.105	Theta star (bias corrected MLE)	0.11
nu hat (MLE)	31.86	nu star (bias corrected)	30.29
Adjusted Level of Significance (β)	0.0419		
Approximate Chi Square Value (30.29, α)	18.72	Adjusted Chi Square Value (30.29, β)	18.25
95% Gamma Approximate UCL (use when n>=50)	0.082	95% Gamma Adjusted UCL (use when n<50)	0.0841

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0441	SD (KM)	0.163
Variance (KM)	0.0267	SE of Mean (KM)	0.0311
k hat (KM)	0.0731	k star (KM)	0.0867
nu hat (KM)	4.825	nu star (KM)	5.72
theta hat (KM)	0.604	theta star (KM)	0.509
80% gamma percentile (KM)	0.0244	90% gamma percentile (KM)	0.11
95% gamma percentile (KM)	0.257	99% gamma percentile (KM)	0.752

ProUCL Statistical Evaluation of Ethylbenzene (mg/kg) in Soil
Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (5.72, α)	1.498	Adjusted Chi Square Value (5.72, β)	1.391
95% Gamma Approximate KM-UCL (use when n>=50)	0.169	95% Gamma Adjusted KM-UCL (use when n<50)	0.182

95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.799	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.318	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.325	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0426	Mean in Log Scale	-10.51
SD in Original Scale	0.166	SD in Log Scale	5.015
95% t UCL (assumes normality of ROS data)	0.0917	95% Percentile Bootstrap UCL	0.0928
95% BCA Bootstrap UCL	0.124	95% Bootstrap t UCL	1.298
95% H-UCL (Log ROS)	19479		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.622	KM Geo Mean	0.00362
KM SD (logged)	1.477	95% Critical H Value (KM-Log)	3.072
KM Standard Error of Mean (logged)	0.282	95% H-UCL (KM -Log)	0.024
KM SD (logged)	1.477	95% Critical H Value (KM-Log)	3.072
KM Standard Error of Mean (logged)	0.282		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0444	Mean in Log Scale	-5.551
SD in Original Scale	0.166	SD in Log Scale	1.501
95% t UCL (Assumes normality)	0.0932	95% H-Stat UCL	0.0273

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.18

ProUCL Statistical Evaluation of Toluene (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	33	Number of Distinct Observations	4
		Number of Missing Observations	7
Number of Detects	2	Number of Non-Detects	31
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	0.0068	Minimum Non-Detect	0.002
Maximum Detect	0.29	Maximum Non-Detect	0.005
Variance Detects	0.0401	Percent Non-Detects	93.94%
Mean Detects	0.148	SD Detects	0.2
Median Detects	0.148	CV Detects	1.349
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-3.114	SD of Logged Detects	2.654

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0109	KM Standard Error of Mean	0.0121
KM SD	0.0494	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.0315	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0309	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0473	95% KM Chebyshev UCL	0.0638
97.5% KM Chebyshev UCL	0.0867	99% KM Chebyshev UCL	0.132

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	0.523	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.284	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	2.091	nu star (bias corrected)	N/A
Mean (detects)	0.148		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0109	SD (KM)	0.0494
Variance (KM)	0.00244	SE of Mean (KM)	0.0121
k hat (KM)	0.0485	k star (KM)	0.0643
nu hat (KM)	3.204	nu star (KM)	4.246
theta hat (KM)	0.224	theta star (KM)	0.169
80% gamma percentile (KM)	0.00317	90% gamma percentile (KM)	0.0219
95% gamma percentile (KM)	0.0618	99% gamma percentile (KM)	0.213

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0419
Approximate Chi Square Value (4.25, α)	0.821	Adjusted Chi Square Value (4.25, β)	0.749
95% Gamma Approximate KM-UCL (use when n>=50)	0.0562	95% Gamma Adjusted KM-UCL (use when n<50)	0.0616

95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00899	Mean in Log Scale	-26.34
SD in Original Scale	0.0505	SD in Log Scale	11.08
95% t UCL (assumes normality of ROS data)	0.0239	95% Percentile Bootstrap UCL	0.0264
95% BCA Bootstrap UCL	0.0441	95% Bootstrap t UCL	85.95
95% H-UCL (Log ROS)	N/A		

ProUCL Statistical Evaluation of Toluene (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.027	KM Geo Mean	0.00241
KM SD (logged)	0.872	95% Critical H Value (KM-Log)	2.293
KM Standard Error of Mean (logged)	0.215	95% H-UCL (KM -Log)	0.00503
KM SD (logged)	0.872	95% Critical H Value (KM-Log)	2.293
KM Standard Error of Mean (logged)	0.215		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0111	Mean in Log Scale	-5.956
SD in Original Scale	0.0501	SD in Log Scale	0.931
95% t UCL (Assumes normality)	0.0259	95% H-Stat UCL	0.00589

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	0.0867

ProUCL Statistical Evaluation of Total Xylenes (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

General Statistics

Total Number of Observations	33	Number of Distinct Observations	7
		Number of Missing Observations	7
Number of Detects	5	Number of Non-Detects	28
Number of Distinct Detects	5	Number of Distinct Non-Detects	2
Minimum Detect	0.014	Minimum Non-Detect	0.002
Maximum Detect	3.4	Maximum Non-Detect	0.01
Variance Detects	2.231	Percent Non-Detects	84.85%
Mean Detects	0.729	SD Detects	1.494
Median Detects	0.058	CV Detects	2.048
Skewness Detects	2.232	Kurtosis Detects	4.984
Mean of Logged Detects	-2.207	SD of Logged Detects	2.077

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.578	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.456	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.112	KM Standard Error of Mean	0.113
KM SD	0.582	95% KM (BCA) UCL	0.319
95% KM (t) UCL	0.304	95% KM (Percentile Bootstrap) UCL	0.317
95% KM (z) UCL	0.298	95% KM Bootstrap t UCL	3.651
90% KM Chebyshev UCL	0.452	95% KM Chebyshev UCL	0.606
97.5% KM Chebyshev UCL	0.819	99% KM Chebyshev UCL	1.239

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.732	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.731	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.385	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.378	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.355	k star (bias corrected MLE)	0.275
Theta hat (MLE)	2.056	Theta star (bias corrected MLE)	2.65
nu hat (MLE)	3.548	nu star (bias corrected)	2.752
Mean (detects)	0.729		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.119
Maximum	3.4	Median	0.01
SD	0.589	CV	4.953
k hat (MLE)	0.322	k star (bias corrected MLE)	0.313
Theta hat (MLE)	0.369	Theta star (bias corrected MLE)	0.38
nu hat (MLE)	21.28	nu star (bias corrected)	20.68
Adjusted Level of Significance (β)	0.0419		
Approximate Chi Square Value (20.68, α)	11.36	Adjusted Chi Square Value (20.68, β)	11
95% Gamma Approximate UCL (use when n>=50)	0.217	95% Gamma Adjusted UCL (use when n<50)	0.224

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.112	SD (KM)	0.582
Variance (KM)	0.338	SE of Mean (KM)	0.113
k hat (KM)	0.0372	k star (KM)	0.054
nu hat (KM)	2.456	nu star (KM)	3.566
theta hat (KM)	3.016	theta star (KM)	2.077
80% gamma percentile (KM)	0.0198	90% gamma percentile (KM)	0.188
95% gamma percentile (KM)	0.612	99% gamma percentile (KM)	2.366

ProUCL Statistical Evaluation of Total Xylenes (mg/kg) in Soil

Former Chemoil Refinery
2020 Walnut Avenue
Signal Hill, California

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (3.57, α)	0.558	Adjusted Chi Square Value (3.57, β)	0.504
95% Gamma Approximate KM-UCL (use when n>=50)	0.717	95% Gamma Adjusted KM-UCL (use when n<50)	0.794

95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.884	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.268	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.111	Mean in Log Scale	-11.48
SD in Original Scale	0.591	SD in Log Scale	5.752
95% t UCL (assumes normality of ROS data)	0.285	95% Percentile Bootstrap UCL	0.315
95% BCA Bootstrap UCL	0.42	95% Bootstrap t UCL	5.767
95% H-UCL (Log ROS)	4364354		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.607	KM Geo Mean	0.00367
KM SD (logged)	1.609	95% Critical H Value (KM-Log)	3.261
KM Standard Error of Mean (logged)	0.313	95% H-UCL (KM -Log)	0.0338
KM SD (logged)	1.609	95% Critical H Value (KM-Log)	3.261
KM Standard Error of Mean (logged)	0.313		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.114	Mean in Log Scale	-5.074
SD in Original Scale	0.59	SD in Log Scale	1.545
95% t UCL (Assumes normality)	0.288	95% H-Stat UCL	0.049

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	0.819

ATTACHMENT E-5

RISK CHARACTERIZATION TABLES

Table E-5A
Risk Characterization of Direct Exposure to COPCs in Soil for the Hypothetical Onsite Construction/Utility Trench Worker Receptor

Former ChemOil Refinery
Signal Hill, California

		Noncarcinogenic Effects			Carcinogenic Effects		
Chemical of Potential Concern	**Exposure Point Concentration (EPC_{soil})** (mg/kg)	**Subhronic Oral Reference Dose (sRfDo)** (mg/kg-day)	**Subchronic Inhalation Reference Concentration (sRfCi)** ($\mu g/m^3$)	**Hazard Quotient (HQ)** (unitless)	**Oral Slope Factor (SFo)** $(mg/kg\text{-}day)^{-1}$	**Inhalation Unit Risk (IUR)** $(\mu g/m^3)^{-1}$	**Excess Cancer Risk** (unitless)
Metals							
Antimony	6.43E-01	4.00E-04	- -	9 E-03	- -	- -	- -
[1] Arsenic	1.16E+01	3.50E-06	1.50E-02	See Note 1	9.50E+00	3.30E-03	See Note 1
Barium	1.25E+02	2.00E-01	5.00E+00	1 E-02	- -	- -	- -
Chromium	2.03E+01	1.50E+00	- -	5 E-04	- -	- -	- -
Cobalt	9.19E+00	3.00E-04	6.00E-03	4 E-01	- -	9.00E-03	3 E-07
Copper	2.03E+01	4.00E-02	- -	2 E-03	- -	- -	- -
[2] Lead	2.24E+01	- -	- -	See Note 2	- -	- -	See Note 2
Mercury	4.41E-01	1.60E-04	3.00E-02	1 E-02	- -	- -	- -
Molybdenum	4.44E-01	5.00E-03	- -	3 E-04	- -	- -	- -
Nickel	1.84E+01	1.10E-02	1.40E-02	3 E-01	- -	2.60E-04	2 E-08
Thallium	1.26E+00	1.00E-05	- -	4 E-01	- -	- -	- -
Vanadium	4.26E+01	5.00E-03	- -	2 E-01	- -	- -	- -
Zinc	5.56E+01	3.00E-01	- -	6 E-04	- -	- -	- -
TPH							
TPH (C4-C12) Aliphatic	1.08E+02	4.00E-02	7.00E+02	8 E-03	- -	- -	- -
[3] TPH (C4-C12) Aromatic	1.08E+02	- -	- -	- -	- -	- -	- -
TPH (C13-C22) Aliphatic	7.77E+02	1.00E-01	3.00E+02	2 E-02	- -	- -	- -
TPH (C13-C22) Aromatic	7.77E+02	3.00E-02	5.00E+01	8 E-02	- -	- -	- -
[4] TPH (C23-C44) Aliphatic	7.81E+02	2.00E+00	- -	1 E-03	- -	- -	- -
[4] TPH (C23-C44) Aromatic	7.81E+02	4.00E-02	- -	1 E-01	- -	- -	- -
VOCs							
Benzene	5.70E-02	1.20E-02	3.00E+00	2 E-05	1.00E-01	2.90E-05	2 E-10
Ethylbenzene	1.80E-01	1.00E+00	1.00E+03	5 E-07	1.10E-02	2.50E-06	8 E-11
Naphthalene	5.00E-03	2.00E-01	3.00E+00	5 E-07	1.20E-01	3.40E-05	2 E-11
Toluene	8.67E-02	8.00E-01	3.00E+02	4 E-07	- -	- -	- -
Total Xylenes	8.19E-01	2.00E-01	3.00E+02	1 E-05	- -	- -	- -
PAHs							
Acenaphthene	2.21E-01	6.00E-01	2.40E+02	4 E-06	- -	- -	- -
Chrysene	1.59E+00	- -	- -	- -	7.30E-03	1.10E-05	2 E-09
Fluoranthene	3.60E-02	4.00E-02	1.40E+02	8 E-06	- -	- -	- -
Fluorene	3.87E-01	4.00E-01	1.60E+02	9 E-06	- -	- -	- -
Naphthalene	5.00E-03	2.00E-01	3.00E+00	5 E-07	1.20E-01	3.40E-05	2 E-11
Phenanthrene	1.95E+00	3.00E-01	1.20E+03	6 E-05	- -	- -	- -
Pyrene	1.95E+00	3.00E-01	1.20E+02	6 E-05	- -	- -	- -
			Total Hazard Index (HI)=	**2**	**Total Excess Cancer Risk (CR)=**		**3 E-07**

Notes:

mg/kg = milligrams per kilogram.

mg/kg-day = milligrams per kilogram body weight per day.

$\mu g/m^3$ = micrograms per cubic meter.

TPH = total petroleum hydrocarbons.

VOC = volatile organic compounds.

PAH = polycyclic aromatic hydrocarbons.

- - = Not available.

[1] For arsenic, the maximum detected concentration from soil 0 to 15 feet bgs was 6.9 mg/kg, which is less than 12 mg/kg (acceptable ambient background level in Southern California soil [Chernoff et. al.])

[2] For lead, the maximum detected concentration from soil 0 to 15 feet bgs was 71 mg/kg, which is less than 320 mg/kg (California Human Health Screening Level [CHHSL; OEHHA, 2009])

[3] The aromatic fraction of this hydrocarbon range is evaluated by its more toxic components (i.e., benzene, toluene, ethylbenzene, and xylenes [BTEX]; DTSC, 2013).

[4] Inhalation exposure not evaluated due to low volatility of COPCs in this hydrocarbon range (DTSC, 2013).

References:

Chernoff, G., W. Bosan, and D. Oudiz. Determination of a Southern California Regional Background Arsenic Concentration in Soil. http://www.dtsc.ca.gov/upload/Background-Arsenic.pdf

DTSC. 2013. Preliminary Endangerment Assessment Guidance Manual. October.

OEHHA. 2009. Revised California Human Health Screening Levels for Lead. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment. September.

Table E-5B
Risk Characterization of Direct Exposure to COPCs in Soil
for the Hypothetical Onsite Commercial/Industrial Worker Receptor
Former ChemOil Refinery
Signal Hill, California

		Noncarcinogenic Effects			Carcinogenic Effects		
Chemical of Potential Concern	**Exposure Point Concentration (EPC$_{soil}$)** (mg/kg)	**Chronic Oral Reference Dose (cRfDo)** (mg/kg-day)	**Chronic Inhalation Reference Concentration (cRfCi)** (µg/m^3)	**Hazard Quotient (HQ)** (unitless)	**Oral Slope Factor (SFo)** (mg/kg-day)$^{-1}$	**Inhalation Unit Risk (IUR)** (µg/m^3)$^{-1}$	**Excess Cancer Risk** (unitless)
Metals							
Antimony	6.43E-01	4.00E-04	- -	2 E-03	- -	- -	- -
[1] Arsenic	1.16E+01	3.50E-06	1.50E-02	See Note 1	9.50E+00	3.30E-03	See Note 1
Barium	1.25E+02	2.00E-01	5.00E-01	2 E-03	- -	- -	- -
Chromium	2.03E+01	1.50E+00	- -	1 E-04	- -	- -	- -
Cobalt	9.19E+00	3.00E-04	6.00E-03	3 E-02	- -	9.00E-03	5 E-09
Copper	2.03E+01	4.00E-02	- -	5 E-04	- -	- -	- -
[2] Lead	2.24E+01	- -	- -	See Note 2	- -	- -	See Note 2
Mercury	4.41E-01	1.60E-04	3.00E-02	3 E-03	- -	- -	- -
Molybdenum	4.44E-01	5.00E-03	- -	9 E-05	- -	- -	- -
Nickel	1.84E+01	1.10E-02	1.40E-02	6 E-03	- -	2.60E-04	3 E-10
Thallium	1.26E+00	1.00E-05	- -	1 E-01	- -	- -	- -
Vanadium	4.26E+01	5.00E-03	1.00E-01	4 E-02	- -	- -	- -
Zinc	5.56E+01	3.00E-01	- -	2 E-04	- -	- -	- -
TPH							
TPH (C4-C12) Aliphatic	1.08E+02	4.00E-02	7.00E+02	2 E-03	- -	- -	- -
[3] TPH (C4-C12) Aromatic	1.08E+02	- -	- -	- -	- -	- -	- -
TPH (C13-C22) Aliphatic	7.77E+02	1.00E-01	3.00E+02	7 E-03	- -	- -	- -
TPH (C13-C22) Aromatic	7.77E+02	3.00E-02	5.00E+01	2 E-02	- -	- -	- -
[4] TPH (C23-C44) Aliphatic	7.81E+02	2.00E+00	- -	3 E-04	- -	- -	- -
[4] TPH (C23-C44) Aromatic	7.81E+02	4.00E-02	- -	4 E-02	- -	- -	- -
VOCs							
Benzene	5.70E-02	4.00E-03	3.00E+00	1 E-05	1.00E-01	2.90E-05	2 E-09
Ethylbenzene	1.80E-01	1.00E-01	1.00E+03	2 E-06	1.10E-02	2.50E-06	6 E-10
Naphthalene	5.00E-03	2.00E-02	3.00E+00	2 E-07	1.20E-01	3.40E-05	2 E-10
Toluene	8.67E-02	8.00E-02	3.00E+02	9 E-07	- -	- -	- -
Total Xylenes	8.19E-01	2.00E-01	1.00E+02	4 E-06	- -	- -	- -
PAHs							
Acenaphthene	2.21E-01	6.00E-02	2.40E+02	9 E-06	- -	- -	- -
Chrysene	1.59E+00	- -	- -	- -	7.30E-03	1.10E-05	1 E-08
Fluoranthene	3.60E-02	4.00E-02	1.40E+02	2 E-06	- -	- -	- -
Fluorene	3.87E-01	4.00E-02	1.60E+02	2 E-05	- -	- -	- -
Naphthalene	5.00E-03	2.00E-02	3.00E+00	2 E-07	1.20E-01	3.40E-05	2 E-10
Phenanthrene	1.95E+00	3.00E-01	1.20E+03	2 E-05	- -	- -	- -
Pyrene	1.95E+00	3.00E-02	1.20E+02	2 E-04	- -	- -	- -
		Total Hazard Index (HI)=		**0.3**	**Total Excess Cancer Risk (CR)=**		**2 E-08**

Notes:

mg/kg = milligrams per kilogram.

mg/kg-day = milligrams per kilogram body weight per day.

µg/m^3 = micrograms per cubic meter.

TPH = total petroleum hydrocarbons.

VOC = volatile organic compounds.

PAH = polycyclic aromatic hydrocarbons.

\- - = Not available.

[1] For arsenic, the maximum detected concentration from soil 0 to 15 feet bgs was 6.9 mg/kg, which is less than 12 mg/kg (acceptable ambient background level in Southern California soil [Chernoff et. al.])

[2] For lead, the maximum detected concentration from soil 0 to 15 feet bgs was 71 mg/kg, which is less than 320 mg/kg (California Human Health Screening Level [CHHSL; OEHHA, 2009])

[3] The aromatic fraction of this hydrocarbon range is evaluated by its more toxic components (i.e., benzene, toluene, ethylbenzene, and xylenes [BTEX]; DTSC, 2013).

[4] Inhalation exposure not evaluated due to low volatility of COPCs in this hydrocarbon range (DTSC, 2013).

References:

Chernoff, G., W. Bosan, and D. Oudiz. Determination of a Southern California Regional Background Arsenic Concentration in Soil. http://www.dtsc.ca.gov/upload/Background-Arsenic.pdf

DTSC. 2013. Preliminary Endangerment Assessment Guidance Manual. October.

OEHHA. 2009. Revised California Human Health Screening Levels for Lead. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment. September.

Table E-5C
Risk Characterization of Inhalation of COPCs Volatilizing from Groundwater into Indoor Air for the Hypothetical Onsite Commercial/Industrial Worker Receptor

Former ChemOil Refinery
Signal Hill, California

Chemical of Potential Concern	Exposure Point Concentration ($EPC_{indoor\ air}$) (µg/m^3)	Noncarcinogenic Effects: Chronic Inhalation Reference Concentration (cRfCi) (µg/m^3)	Noncarcinogenic Effects: Hazard Quotient (HQ) (unitless)	Carcinogenic Effects: Inhalation Unit Risk (IUR) (µg/m^3)$^{-1}$	Carcinogenic Effects: Excess Cancer Risk (unitless)
Volatile Organic Compounds					
Bis (2-chloroethyl) ether	1.18E-01	- -	- -	7.10E-04	7 E-06
tert-Butyl Alcohol	- -	- -	- -	- -	- -
sec-Butylbenzene	5.97E-02	4.00E+02	3 E-05	- -	- -
Isopropylbenzene	5.75E-01	4.00E+02	3 E-04	- -	- -
Naphthalene	1.13E-01	3.00E+00	9 E-03	3.40E-05	3 E-07
n-Propylbenzene	5.28E-01	1.00E+03	1 E-04	- -	- -
o-Xylene	6.85E-02	1.00E+02	2 E-04	- -	- -
		Total Hazard Index (HI)=	**0.009**	**Total Excess Cancer Risk (CR)=**	**7 E-06**

Notes:

µg/m^3 = micrograms per cubic meter.

VOC = volatile organic compounds.

- - = Not available.

APPENDIX F

MONITORED NATURAL ATTENUATION PERFORMANCE MONITORING PLAN

APPENDIX F
MONITORED NATURAL ATTENUATION PERFORMANCE MONITORING PLAN

Former Chemoil Refinery
Site Cleanup Program Number 0453A
Site ID No. 2047W00
Global ID SL 2047W2348

2020 Walnut Avenue
Signal Hill, California

093-CHEMOIL-001

Prepared For:

Signal Hill Enterprises, LLC
1900 South Norfolk Street, Suite 350
San Mateo, California 94403

and

RE | Solutions, LLC
2880 Bryant Street
Denver, Colorado 80211

Prepared By:

SGI environmental
APEX

299 West Hillcrest Drive, Suite 220
Thousand Oaks, CA 91360

July 13, 2017

Prepared and Reviewed By:

CHuff

Casey Huff
Staff Geologist

Kirsten L Duey

Kirsten Duey
Project Manager

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1.0 INTRODUCTION

The Source Group, Inc., a division of Apex Companies, LLC (Apex-SGI), has prepared this monitored natural attenuation (MNA) performance monitoring plan (MNA Plan) on behalf of Signal Hill Enterprises, LLC (SHE) and RE | Solutions, LLC (RES). The subject property is the former Chemoil Refinery located at 2020 Walnut Avenue in Signal Hill, California (Site, Figure F-1). As detailed in the Response Plan (Apex-SGI, 2017), MNA has been selected as the remedial approach for the dissolved phase groundwater plume located downgradient from the Site. Figure F-2 identifies the offsite area subject to this MNA Plan (defined as the MNA Area).

Natural attenuation is the reduction in concentration, mass, toxicity, and/or mobility of contaminants via dispersion, sorption, dilution, volatilization, and biodegradation. Consistent with U.S. Environmental Protection Agency guidance (USEPA, 2004), the overall objectives of an MNA performance monitoring program are as follows:

1. Demonstrate that natural attenuation is occurring according to expectations;
2. Detect changes in environmental conditions that may reduce the efficacy of any of the natural attenuation processes;
3. Identify any potentially toxic and/or mobile transformation products;
4. Verify that the plume is not expanding downgradient, laterally or vertically;
5. Verify no unacceptable impact to downgradient receptors;
6. Detect new releases of contaminants to the environment that could impact the effectiveness of the natural attenuation remedy;
7. Demonstrate the efficacy of institutional controls that were put in place to protect potential receptors; and
8. Verify attainment of remediation objectives.

This MNA Plan proposes long term activities to monitor and evaluate trends in offsite groundwater to meet the objectives indicated above. Should changes to this MNA performance monitoring plan become warranted (such as a modification of the sampling program or a cessation of MNA performance monitoring), a Revised MNA Plan will be submitted to the Los Angeles Regional Water Quality Control Board (LARWQCB) for review and approval.

1.1 Site Background

Soil and underlying groundwater at the Site are impacted by historic petroleum releases from a former oil refinery which operated on the Site from 1922 until 1994. For reference, benzene, gasoline range total petroleum hydrocarbon (TPHg), and diesel range total petroleum hydrocarbon (TPHd) isoconcentration maps are provided as Figures F-3, F-4, and F-5. A Response Plan has been prepared which proposes active onsite remediation including operation of a bio-sparge barrier along the downgradient edge of the property. Concentrations in offsite groundwater are expected to decline over time with the implementation of these planned remedial activities and MNA has been proposed for the offsite, dissolved phase portion off the plume. As detailed in the Response Plan, an MNA approach is proposed for groundwater downgradient from the Site based on the following:

- Current offsite downgradient soil vapor concentrations do not pose a significant potential risk to resident's human health based on USEPA criteria;
- Groundwater is not considered a source of drinking water in the vicinity of the Site;
- Concentrations of petroleum constituents downgradient from the Site are expected to stabilize and subsequently decline as reduced mass flux associated with upgradient source removal/remediation propagates downgradient; and
- There are no sensitive receptors (e.g., groundwater supply wells in the vicinity of and downgradient to the Site).

This MNA performance monitoring plan has been designed for the Site and is detailed in the remaining sections of this document.

2.0 MNA PLAN

This section details activities that are proposed in order to meet the eight objectives identified by USEPA for MNA performance monitoring plans. Rationale and proposed activities are described below, with the performance criteria goals identified in the section that follows.

Performance Monitoring Objective	Proposed Action to Meet Objective
1. Demonstrate that natural attenuation is occurring;	Upon implementation of onsite remedial activities, stable, followed by decreasing concentrations trends in the MNA Area are expected. A monitoring well network and sampling program will be used to monitor trends of COPCs in the MNA Area as detailed in Section 3. Statistical evaluation of groundwater data will be used to demonstrate that natural attenuation is occurring. The statistical evaluation method and performance criteria used to indicate whether natural attenuation is occurring is summarized below in Section 2.1 under Performance Criteria No. 1.
2. Detect changes in environmental conditions that may reduce the efficacy of any of the natural attenuation processes;	Environmental conditions in the subsurface that could affect the efficacy of the natural attenuation process include changes in groundwater flow rates or directions that would impact plume stability; or changes in the geochemical environment (i.e., redox conditions). Monitoring parameters will include field measurements of pH, dissolved oxygen (DO), and oxidation reduction potential (ORP). In addition, a baseline round of geochemical parameters will be collected and evaluated to identify whether long term monitoring of geochemical parameters is warranted. The list of proposed monitoring parameters is included in Section 3. Wells will be gauged during sampling activities for depth-to-water and potentiometric maps will be prepared and used to monitor groundwater flow direction.
3. Identify any potentially toxic and/or mobile transformation products;	The biodegradation of BTEX produce non-toxic end products (e.g., carbon dioxide and water). Toxic or mobile transformation products are not expected as a result of the upgradient remedial actions proposed for the Site.

Performance Monitoring Objective	Proposed Action to Meet Objective
4. Verify that the plume is not expanding downgradient, laterally or vertically;	A monitoring program has been developed that can detect changes in both the plume size and concentration. The program well network consists of monitoring locations downgradient of the Site (detailed in Section 3). Plume maps will be included as part of the semi-annual reports prepared for the Site. A discussion of any changes to the plume size or shape will be included in the reports and in the event that trends indicate an expanding plume, response actions will be proposed. Three new monitoring wells are proposed for the MNA Area with deeper screened intervals than the existing network to monitor the potential for vertical migration.
5. Verify no unacceptable impact to downgradient receptors;	Potential offsite residential receptors are located in the MNA Area. As documented in the Response Plan, data collected to date have indicated that current subsurface conditions do not pose a significant risk to these offsite residential receptors. The MNA program will include an evaluation of data to verify that concentrations do not increase to unacceptable levels. The performance criteria summarized in Section 2.2 under Performance Criteria No. 2 will be used to determine whether response actions are warranted.
6. Detect new releases of contaminants to the environment that could impact the effectiveness of the natural attenuation remedy;	Petroleum refining operations ceased in 1994 and the refinery infrastructure has been removed. Thus, no new releases in relation to past facility operation will occur. Potential new releases or potential on-site migration of constituents unrelated to Site activities (if they occur) will be detected by the monitoring program which is proposed for on-site active remedial operation.
7. Demonstrate the efficacy of institutional controls that were put in place to protect potential receptors; and	Institutional controls are not required or being implemented in the MNA Area; therefore, the objective to demonstrate the efficiency of institutional controls does not apply.
8. Verify attainment of remediation objectives.	Ultimate remedial objectives in the MNA area are groundwater quality objectives. The laboratory detection limits compared to groundwater quality objectives for all COPCs are included in Table F-1.

2.1 Performance Criteria

Performance criteria set forth required standards to demonstrate that monitoring objectives are being met. For the monitoring activities specified above, the following two performance criteria have been identified:

Performance Criteria No. 1 - Criteria to Demonstrate That Natural Attenuation is Occurring

To demonstrate that natural attenuation is occurring, a method to track TPH and volatile organic compound (VOC) concentrations over time will be required. A Mann-Kendall Statistical Test will be conducted for TPH as gasoline (TPHg), TPH as diesel (TPHd), and benzene concentrations detected in monitoring wells located in the MNA Area with levels that are above Water Quality Objectives. The Mann-Kendall test results, based on an 80% confidence level, will be used to determine whether the plume strength is decreasing, stable, or increasing. Analytical detection limits should be able to identify concentrations equal to or less than the ultimate remedial objective of MCLs. The Mann-Kendall analysis on groundwater concentrations in the MNA Area will begin after a minimum of four rounds of samples are collected following start-up of the onsite bio-sparge barrier.

Performance Criteria No. 2 - Criteria to Demonstrate That There is No Unacceptable Impact to Downgradient Receptors

To demonstrate that there are no unacceptable potential risks to downgradient receptors, groundwater concentrations of contaminants of interest (COIs) in the residential portion of the MNA Area will be compared with applicable groundwater trigger levels for vapor intrusion concerns based on residential land use. COIs were identified as any volatile organic compound (VOC) detected in groundwater since third quarter 2012 in MNA program wells (Section 3.3) and western property boundary wells, which include monitoring wells MW-1 and MW-13, and barrier monitoring wells (BMW-1 through BMW-12).

The groundwater trigger levels were estimated using the Johnson and Ettinger (1991) vapor intrusion model, recommended and provided by the Department of Toxic Substances Control (DTSC; CalEPA, 2014). This model estimates risk-based groundwater concentrations that result in acceptable human health risks and/or hazards associated with subsurface vapor migration from groundwater and inhalation of VOCs in indoor air.

Site-specific geotechnical data and a simplified conceptual model was used to model vapor migration from groundwater into indoor air. The Site is generally underlain by deposits of unconsolidated, laterally discontinuous sequences of silt and fine to coarse-grained sand. Coarse-grained soils consist of sand (SP) and silty sand (SM); whereas, subordinate fine-grained soils consist of silt (ML and MH) and, to a lesser degree, clay (CL). First encountered groundwater in the offsite residential area occurs at approximately 13 feet bgs. As described in Appendix D titled Derived Site-Specific Soil Vapor Screening Levels of the *Response Plan and Remedial Technology Evaluation* (Apex-SGI, 2017), geotechnical data from on Site soils most closely fit with the "silt" USDA soil textural classification. A review of logs from historical borings advanced in the MNA Area shows that this on Site soil classification is consistent with the soils observed in the MNA Area at approximately 0 to 13 feet bgs. Therefore, Silt (SI) was selected as the Vadose Zone Soil Type the reported geotechnical values for on Site soil were used as model input parameters. In accordance with DTSC (2014), default values of 24 degrees Celsius for average soil temperature and 15 centimeters (cm) for depth to the bottom of an enclosed space floor for slab-on-grade construction were used as vapor intrusion model input parameters.

The following table summarizes the Site-specific properties input into the DTSC J/E model for potential vapor migration from groundwater to indoor air in the MNA Area.

Model Variables – Vapor Migration from Soil Vapor to Indoor Air

Properties	**Symbol**	**Assumed Value**
Depth Below Grade to Bottom of Enclosed Space Floor (default)	L_F	15 cm
Depth Below Grade to Water Table (13 feet)	L_S	396.2 cm
Soil Type Directly Above Water Table (Site-specific)	- -	Silt (SI)
Average Soil/Groundwater Temperature (default)	T_s	24°C
Vadose Zone Soil Type (Site-specific)	- -	Silt (SI)
Vadose Zone Soil Dry Bulk Density (Site-specific)	ρ_b	1.46 g/cm^3
Vadose Zone Soil Total Porosity (Site-specific)	θ_T	0.465 cm^3/cm^3
Vadose Zone Soil Water-Filled Porosity (Site-specific)	θ_w	0.172 cm^3/cm^3
Average Vapor Flow Rate into Building (default)	Q_{soil}	5 L/min
Residential Exposure Factors		
Averaging Time for Carcinogens	AT_C	70 years
Averaging Time for Noncarcinogens	AT_{NC}	26 years
Exposure Duration	ED	26 years
Exposure Frequency	EF	350 days/year
Exposure Time	ET	24 hours/day
Air Exchange Rate	ACH	0.5 hour^{-1}

cm = centimeter
cm^3/cm^3 = cubic centimeter per cubic centimeter
g/cm^3 = gram per cubic centimeter
L/min = liter per minute

The spreadsheets containing the input parameters and results of the DTSC J/E model for subsurface vapor intrusion into buildings for the residential exposure scenario are provided in Attachment F-1.

The COIs and their respective groundwater trigger levels for Performance Criteria No. 2 are summarized in the following table.

Chemical	**Groundwater Trigger Level**	**Current Maximum Concentration in residential portion of MNA Area** Note 1
Benzene	11 µg/L	<0.5 µg/L at all locations, except <2.5 µg/L at MW-19
DIPE	240,000 µg/L	<1.0 µg/L at all locations, except <5.0 µg/L at MW-19
Ethylbenzene	120 µg/L	<0.5 µg/L at all locations, except <2.5 µg/L at MW-19
Naphthalene	130 µg/L	75 µg/L at MW-16
Toluene	36,000 µg/L	<0.5 µg/L at all locations, except <2.5 µg/L at MW-19
1,2,4-TMB	1,200 µg/L	<0.5 µg/L at all locations, except <2.5 µg/L at MW-19
1,3,5-TMB	4,100 µg/L	<0.5 µg/L at all locations, except <2.5 µg/L at MW-19
Xylenes	13,000 µg/L	<1.0 µg/L at all locations, except <5.0 µg/L at MW-19

µg/L = micrograms per liter
DIPE = Diisopropyl ether
1,2,4-TMB = 1,2,4-Trimethylbenzene
1,3,5-TMB = 1,3,5-Trimethylbenzene
Note 1 Based on Quarter 4, 2016 sampling results, highest detection from MW-14, MW-15, MW-16, MW-18, and MW-19 (AA&AI, 2017)

In the event that analysis of groundwater monitoring data does not meet objectives for either Performance Criteria No. 1 or No. 2, response actions (i.e., additional investigation or remediation) will be considered and proposed in the semi-annual reports issued for the Site.

3.0 MONITORING NETWORK DESIGN AND SCHEDULE

The current Groundwater-Monitoring Program (GMP) well network monitors the shallow water-bearing zone identified at the Site. The GMP was been established through past reports and correspondences between SHE and the LARWQCB. The MNA performance monitoring program proposed in the following sections will replace the current GMP program in the MNA Area for the Site. Upon LARWQCB approval of the Response Plan, groundwater in the MNA Area will be monitored under the MNA performance monitoring program as proposed in the following sections.

3.1 Baseline Geochemical Sampling

One set of baseline geochemical data will be collected from select MNA wells to gain an understanding of the site geochemistry as it relates to biodegradation processes. A minimum of three MNA wells will be sampled and analyzed for the following parameters:

- dissolved gases (methane, ethane, ethene, and carbon dioxide)
- dissolved arsenic
- nitrate
- manganese
- ferrous iron
- sulfate

3.2 Monitoring Parameters

The ongoing monitoring program will include analysis of groundwater samples for TPHg and TPHd by USEPA Method 8015M, and VOCs by USEPA Method 8260B. All samples will be handled under chain-of-custody protocol to a California-certified laboratory for analysis.

In addition, the following field measurements will be collected during sample collection:

- depth-to-water
- conductivity
- temperature
- pH
- Oxidation-Reduction Potential (ORP)
- dissolved oxygen

3.3 Monitoring Points and Schedule

Locations of MNA program wells are shown on Figure F-2.

The proposed sampling frequency for groundwater monitoring wells is summarized in the following table.

Groundwater Monitoring Program

Well ID	Sampling Frequency
MW-1A	Semi-Annual
MW-12	Semi-Annual
MW-14	Semi-Annual
MW-15	Semi-Annual
MW-16	Semi-Annual
MW-17	Semi-Annual
MW-18	Semi-Annual
MW-19	Semi-Annual

As detailed in Section 3.7 of the Response Plan, three new wells screened at deeper intervals than existing wells are proposed to be installed within the MNA Area. Location of these wells along with proposed screen intervals are shown on Figure F-2. A determination of whether these wells should be added to the groundwater monitoring program at a semi-annual frequency will be made after initial sampling results from the wells are obtained.

4.0 REPORTING

Performance monitoring activities will be reported to the LARWQCB in semi-annual reports prepared for the Site. Each semi-annual report will include a discussion of data summarizing results of MNA program, including the following:

- Tables summarizing the groundwater elevation data;
- Potentiometric maps displaying the interpreted groundwater flow direction;
- Tables summarizing the groundwater analytical data;
- TPHg, TPHd, and benzene isoconcentration maps;
- VOC trend charts for the select monitoring wells;
- Mann-Kendall analysis of data collected from wells within the MNA Area which have benzene, TPHg, or TPHd detections. The Mann-Kendall analysis will begin after a minimum of four rounds of samples are collected following implementation of onsite remedial actions; and
- A comparison of analytical data collected from the MNA Area to the performance criteria outlined in Section 2.1.

The semi-annual reports will be submitted to the LARWQCB by July 15th for second quarter monitoring activities and January 15th for fourth quarter monitoring activities each year.

5.0 REFERENCES

Ami Adini & Associates, Inc. (AA&AI). 2017. Groundwater Monitoring Report – Fourth Quarter 2016, Former Chemoil Refinery, 2020 Walnut Avenue, Signal Hill, California. January 15.

Apex-SGI. 2017. Response Plan and Remedial Technology Evaluation Report for Former Chemoil Refinery. June 13.

USEPA, 2004. Performance Monitoring of MNA Remedies of VOCs in Ground Water. April.

6.0 LIMITATIONS

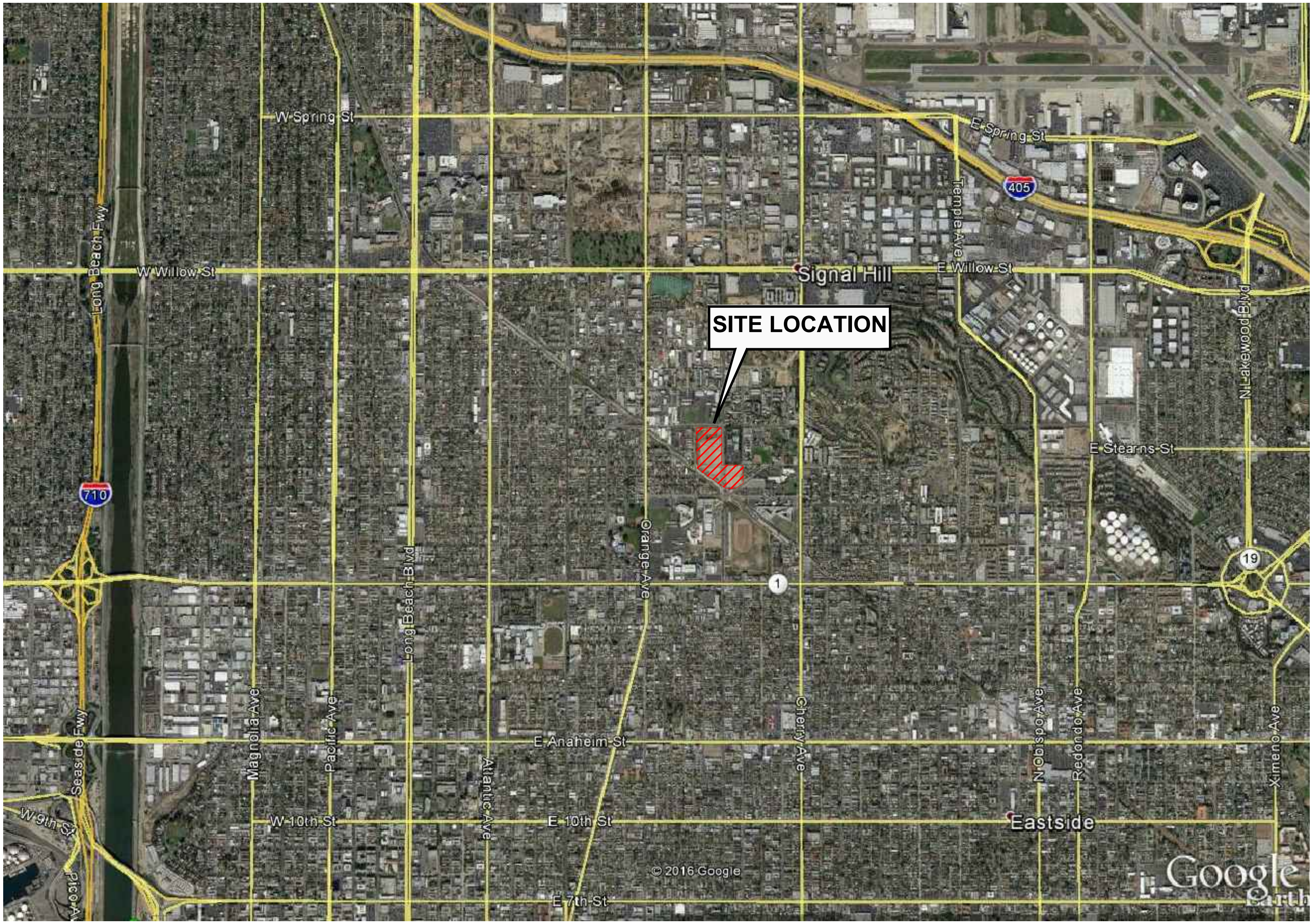
This document has been prepared for the exclusive use of SHE, RES, and their representatives as it pertains to the affected property as described above. Any interpretation of the data represents our professional opinions, and is based in part on information supplied by the client. These opinions and information are based on currently available data and are arrived at in accordance with currently accepted hydrogeologic and engineering practices at this time and location.

The data presented in this transmittal are intended only for the purpose, site location, and project indicated. This report is not a definitive study of contamination at the site and should not be interpreted as such. The data reported are limited by the scope of the work as defined by the request of the client, the time, availability of access to the site, and information passed to Apex-SGI.

There are no representations or guarantees that the sampling points are representative of the entire site. Data collected in response to this work may reflect the conditions at specific locations at a specific point in time and does not reflect subsurface variations that may exist between sampling points. These variations cannot be anticipated nor can they be entirely accounted for even with exhaustive additional testing. No other interpretations, warranties, guarantees, expressed or implied, are included or intended in the contents of this transmittal.

As required, all proposed work will be performed under the direct supervision of a Professional Geologist or Registered Civil Engineer as defined in the Registered Geologist Act of the California Code of Regulations.

FIGURES


SITE LOCATION

SGI environmental APEX

299 WEST HILLCREST DR. SUITE 220
THOUSAND OAKS, CA 91360

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

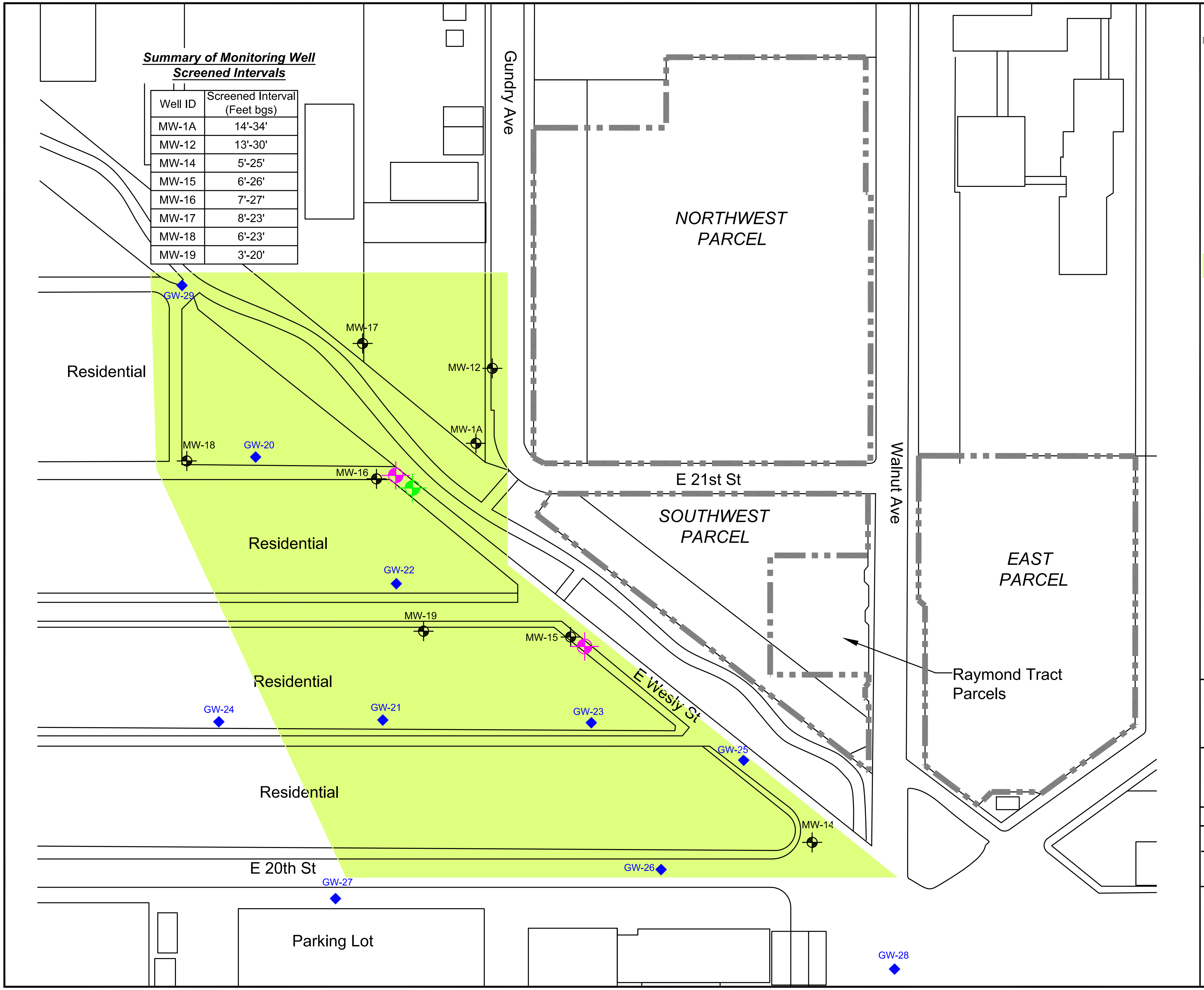
SITE LOCATION MAP

N

PROJECT NO.	DATE	DR.BY:	APP. BY:
093-CHEMOIL-001	05/30/17	ZA	KD

0 2500 5000
HORIZONTAL SCALE IN FEET

FIGURE F-1



Summary of Monitoring Well Screened Intervals

Well ID	Screened Interval (Feet bgs)
MW-1A	14'-34'
MW-12	13'-30'
MW-14	5'-25'
MW-15	6'-26'
MW-16	7'-27'
MW-17	8'-23'
MW-18	6'-23'
MW-19	3'-20'

LEGEND

▬ ▪ ▪ ▬	Site Boundary
MW-16 ⊕	Off-Site Groundwater Monitoring Well Locations
GW-29 ◆	Grab Groundwater Sample Locations, Geosyntec, 2012
⊕	Proposed New Monitoring Well, 55-65 Feet BGS Screen
⊕	Proposed New Monitoring Well, 75-85 Feet BGS Screen
BGS	Below Ground Surface
🟩	Monitored Natural Attenuation Area

SITE MAP

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

PROJECT NO.	DATE	DRAWN BY:	APP. BY:
093-CHEMOIL-001	05/30/17	ZA	KD

0 120 240
HORIZONTAL SCALE IN FEET

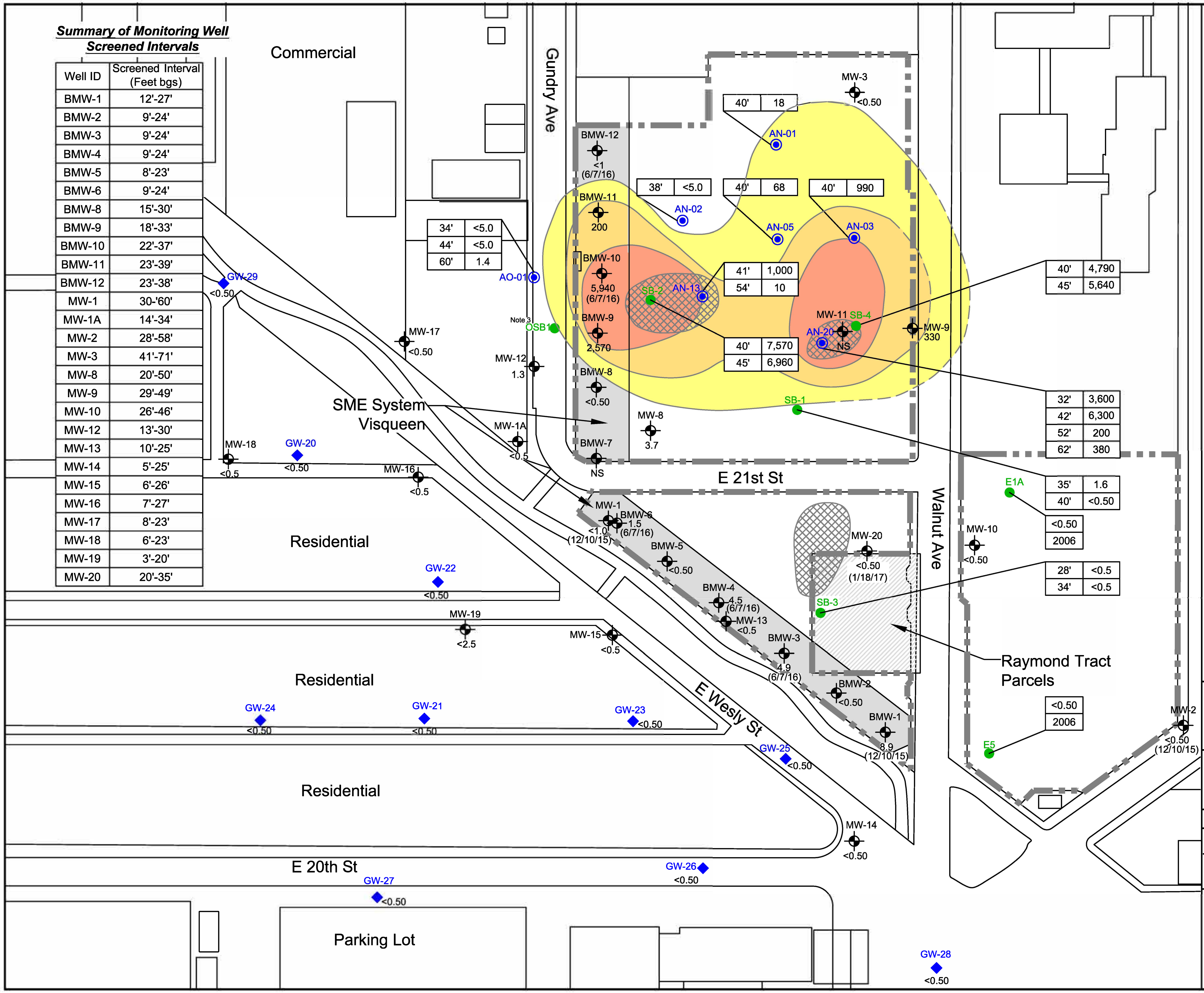
SGI environmental APEX

3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

N

FIGURE F-2

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\App\App F\Fig. F-2-Site Map.dwg, 7/11/2017 12:07:10 PM



Summary of Monitoring Well Screened Intervals

Well ID	Screened Interval (Feet bgs)
BMW-1	12'-27'
BMW-2	9'-24'
BMW-3	9'-24'
BMW-4	9'-24'
BMW-5	8'-23'
BMW-6	9'-24'
BMW-8	15'-30'
BMW-9	18'-33'
BMW-10	22'-37'
BMW-11	23'-39'
BMW-12	23'-38'
MW-1	30-'60'
MW-1A	14'-34'
MW-2	28'-58'
MW-3	41'-71'
MW-8	20'-50'
MW-9	29'-49'
MW-10	26'-46'
MW-12	13'-30'
MW-13	10'-25'
MW-14	5'-25'
MW-15	6'-26'
MW-16	7'-27'
MW-17	8'-23'
MW-18	6'-23'
MW-19	3'-20'
MW-20	20'-35'

LEGEND

▬ ▪ ▬	Site Boundary
MW-16 ⊕	Groundwater Monitoring Well Locations
AN-01 ◉	Grab Groundwater Sample Locations, APEX, 2017
SB-2 ●	Grab Groundwater Sample Locations, Geosyntec, 2012. Samples Collected for First Encountered Groundwater.
GW-29 ◆	Grab Groundwater Sample Locations, Geosyntec, 2012
40' | 18	Depth in feet bgs; Benzene Concentration in µg/L
bgs	Below Ground Surface
µg/L	Micrograms per Liter
<0.50	Indicated Compound Not Detected at Concentration at or Above the Laboratory Reporting Limit Shown
NS	Not Sampled
SME	Subsurface Metabolism Enhancement
—	Isoconcentration Contour, Dashed Where Inferred
▨	Area of Observed or Suspected LNAPL
🟨	Concentrations > 10 µg/L
🟧	Concentrations > 100 µg/L
🟥	Concentrations > 1,000 µg/L

Note:
1. Locations sampled during Quarter 4, 2016 unless otherwise indicated.
2. With the exception of MW-20, monitoring wells were sampled by Ami Adini & Associates.
3. OSBI was advanced and sampled prior to installation of the SME barrier. Results no longer representative are not shown.

SUMMARY OF BENZENE CONCENTRATIONS IN GROUNDWATER

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

PROJECT NO.	DATE	DRAWN BY:	APP. BY:
093-CHEMOIL-001	01/23/17	ZA	KD

0 120 240
HORIZONTAL SCALE IN FEET

SGI environmental
APEX
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

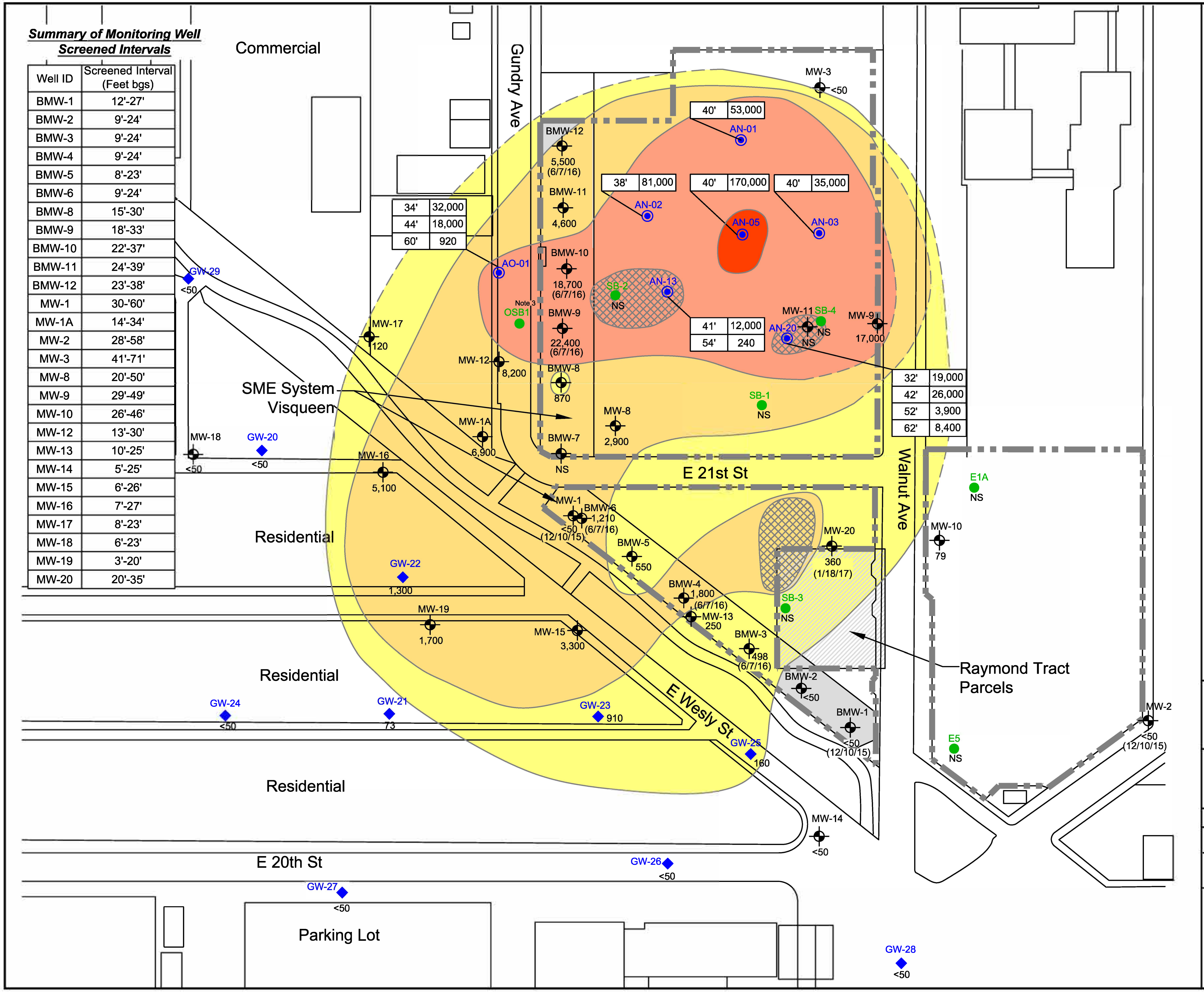
N

FIGURE
F-3

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\App\MNA Plan\Fig.x-3-Summari of Benzene Concentrations in GW.dwg, 5/30/2017 2:44:15 PM

Summary of Monitoring Well Screened Intervals

Well ID	Screened Interval (Feet bgs)
BMW-1	12'-27'
BMW-2	9'-24'
BMW-3	9'-24'
BMW-4	9'-24'
BMW-5	8'-23'
BMW-6	9'-24'
BMW-8	15'-30'
BMW-9	18'-33'
BMW-10	22'-37'
BMW-11	24'-39'
BMW-12	23'-38'
MW-1	30'-60'
MW-1A	14'-34'
MW-2	28'-58'
MW-3	41'-71'
MW-8	20'-50'
MW-9	29'-49'
MW-10	26'-46'
MW-12	13'-30'
MW-13	10'-25'
MW-14	5'-25'
MW-15	6'-26'
MW-16	7'-27'
MW-17	8'-23'
MW-18	6'-23'
MW-19	3'-20'
MW-20	20'-35'



LEGEND

▬ ▪ ▪ ▬	Site Boundary
MW-16 ⌖	Groundwater Monitoring Well Locations
AN-01 ◎	Grab Groundwater Sample Locations, APEX, 2017
SB-2 ●	Grab Groundwater Sample Locations, Tetratech, 2006
GW-29 ◆	Grab Groundwater Sample Locations, Geosyntec, 2012. Samples Collected for First Encountered Groundwater.
40' | 35,000	Depth in feet bgs — TPHg Concentration in µg/L
bgs	Below Ground Surface
µg/L	Micrograms per Liter
<50	Indicated Compound Not Detected at Concentration at or Above the Laboratory Reporting Limit Shown
NS	Not Sampled
SME	Subsurface Metabolism Enhancement
—	Isoconcentration Contour, Dashed Where Inferred
▨	Area of Observed or Suspected LNAPL
🟨	Concentrations > 100 µg/L
🟧	Concentrations > 1,000 µg/L
🟧	Concentrations > 10,000 µg/L
🟥	Concentrations > 100,000 µg/L

Note:
1. Locations sampled during Quarter 4, 2016 unless otherwise indicated.
2.With the exception of MW-20, monitoring wells were sampled by Ami Adini & Associates.
3. OSBI was advanced and sampled prior to installation of the SME barrier. Results no longer representative are not shown.

SUMMARY OF TPHg (C4-C12) CONCENTRATIONS IN GROUNDWATER

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

PROJECT NO.	DATE	DRAWN BY:	APP. BY:
093-CHEMOIL-001	01/23/17	ZA	KD

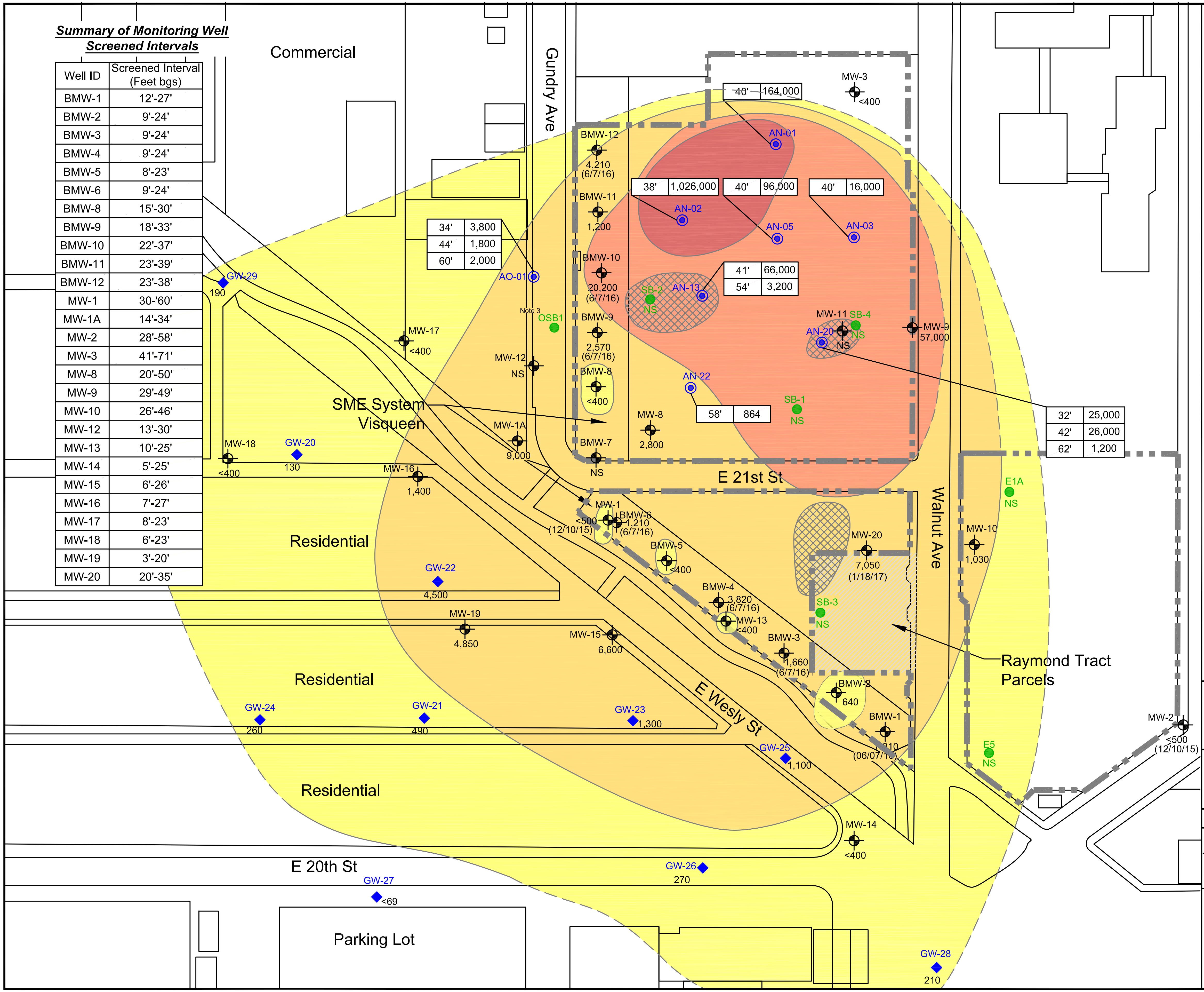
0 120 240
HORIZONTAL SCALE IN FEET

SGI environmental
APEX
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

N

FIGURE
F-4

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\App\MNA Plan\Fig.x-4-Summary of TPHg (C4-C12) in GW.dwg, 6/1/2017 11:37:26 AM



Summary of Monitoring Well Screened Intervals

Well ID	Screened Interval (Feet bgs)
BMW-1	12'-27'
BMW-2	9'-24'
BMW-3	9'-24'
BMW-4	9'-24'
BMW-5	8'-23'
BMW-6	9'-24'
BMW-8	15'-30'
BMW-9	18'-33'
BMW-10	22'-37'
BMW-11	23'-39'
BMW-12	23'-38'
MW-1	30'-60'
MW-1A	14'-34'
MW-2	28'-58'
MW-3	41'-71'
MW-8	20'-50'
MW-9	29'-49'
MW-10	26'-46'
MW-12	13'-30'
MW-13	10'-25'
MW-14	5'-25'
MW-15	6'-26'
MW-16	7'-27'
MW-17	8'-23'
MW-18	6'-23'
MW-19	3'-20'
MW-20	20'-35'

LEGEND

▬ ▪ ▪ ▬	Site Boundary
MW-16 ⌖	Groundwater Monitoring Well Locations
◎ AN-01	Grab Groundwater Sample Locations, APEX, 2017
● SB-2	Grab Groundwater Sample Locations, Tetra Tek, 2006. Samples Collected for First Encountered Groundwater.
◆ GW-29	Grab Groundwater Sample Locations, Geosyntec, 2012
40' | 18	Depth in feet bgs; TPHd Concentration in µg/L
bgs	Below Ground Surface
µg/L	Micrograms per Liter
<0.50	Indicated Compound Not Detected at Concentration at or Above the Laboratory Reporting Limit Shown
NS	Not Sampled
SME	Subsurface Metabolism Enhancement
—	Isoconcentration Contour, Dashed Where Inferred
▨	Area of Observed or Suspected LNAPL
🟨	Concentrations > 100 µg/L
🟧	Concentrations > 1,000 µg/L
🟧	Concentrations > 10,000 µg/L
🟥	Concentrations > 100,000 µg/L

Note:
1. Locations sampled during Quarter 4, 2016 unless otherwise indicated.
2.With the exception of MW-20, monitoring wells were sampled by Ami Adini & Associates.
3. OSBI was advanced and sampled prior to installation of the SME barrier. Results no longer representative are not shown.

SUMMARY OF TPHd (C13-C22) CONCENTRATIONS IN GROUNDWATER

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

PROJECT NO.	DATE	DRAWN BY:	APP. BY:
093-CHEMOIL-001	05/30/17	ZA	KD

0 120 240
HORIZONTAL SCALE IN FEET

SGI environmental APEX
299 WEST HILLCREST DR., SUITE 220
THOUSAND OAKS, CA 91360

N

FIGURE
F-5

TABLE

Table F-1

Comparison of Laboratory Detection Limits to Groundwater Quality Objectives

Former ChemOil Refinery
Signal Hill, California

Constituent[Note 1]	Groundwater Quality Objective[Note 2] (micrograms per liter)	Laboratory Detection Limit (micrograms per liter)
Benzene	1.0	0.5
1,2-Dichloroethane	0.5	0.5
cis-1,2-Dichloroethene	6.0	0.5
Ethylbenzene	300	0.5
Tetrachloroethylene	5.0	0.5
tert-Butyl Alcohol	260	10
sec-Butylbenzene	260	0.5
n-Butylbenzene	260	0.5
Naphthalene	17	2.0
n-Propylbenzene	260	0.5
1,2,4-Trimethylbenzene	330	0.5

[Note 1] Constituent list obtained from Chemoil Investigation Report (Apex-SGI, 2017) which identifies concentrations in groundwater that exceed the California MCL or State Water Resource Control Board (SWRQB) drinking water notification level.

[Note 2] California MCL or State Water Resource Control Board (SWRQB) drinking water notification level.

ATTACHMENT F-1

OUTPUT OF JOHNSON AND ETTINGER MODEL FOR SUBSURFACE VAPOR INTRUSION INTO BUILDINGS FROM GROUNDWATER

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

Reset to Defaults

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Benzene**

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES ☒ X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES ☐

Results Summary					Risk-Based Groundwater Concentration	
Soil Gas Conc. (C_{source}) (μg/m^3)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) (μg/m^3)	Cancer Risk	Noncancer Hazard	Cancer Risk = 10^{-6} (μg/L)	Noncancer HQ = 1 (μg/L)
2.18E+02	3.9E-05	8.5E-03	NA	NA	1.1E+01	3.7E+02

MESSAGE: Values of Csource and Cbuilding (INTERCALCS worksheet) are based on unity and do not represent actual values.

MESSAGE: Attenuation factor < 6E-05 is unreasonably low.

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
71432		**Benzene**

MESSAGE: See VLOOKUP table comments on chemical properties and/or toxicity criteria for this chemical.

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)
15	396.2	SI	24

ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SI			SI	1.46	0.465	0.172

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

NEW=> Residential

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
1.0E-06	1	70	26	26	350	24	0.5
						(NEW)	(NEW)

Used to calculate risk-based groundwater concentration.

END

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

Reset to Defaults

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Diisopropyl ether (DIPE)**

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES ☒ X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES ☐

Results Summary					Risk-Based Groundwater Concentration	
Soil Gas Conc. (C_{source}) (μg/m^3)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) (μg/m^3)	Cancer Risk	Noncancer Hazard	Cancer Risk = 10^{-6} (μg/L)	Noncancer HQ = 1 (μg/L)
1.01E+02	3.0E-05	3.0E-03	NA	NA	NA	2.4E+05

MESSAGE: Values of Csource and Cbuilding (INTERCALCS worksheet) are based on unity and do not represent actual values.

MESSAGE: Attenuation factor < 6E-05 is unreasonably low.

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
108203		**Diisopropyl ether (DIPE)**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	396.2	SI	24	5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SI			SI	1.46	0.465	0.172

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	1.0E-06	1	70	26	26	350	24	0.5
	Used to calculate risk-based groundwater concentration.						(NEW)	(NEW)

END

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Reset to Defaults

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Ethylbenzene**

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES ☒

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES ☐

Results Summary					Risk-Based Groundwater Concentration	
Soil Gas Conc. (C_{source}) (μg/m³)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) (μg/m³)	Cancer Risk	Noncancer Hazard	Cancer Risk = 10^{-6} (μg/L)	Noncancer HQ = 1 (μg/L)
3.05E+02	3.0E-05	9.1E-03	NA	NA	1.2E+02	1.1E+05

MESSAGE: Values of Csource and Cbuilding (INTERCALCS worksheet) are based on unity and do not represent actual values.

MESSAGE: Attenuation factor < 6E-05 is unreasonably low.

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
100414		**Ethylbenzene**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)
15	396.2	SI	24

ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SI			SI	1.46	0.465	0.172

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

NEW=> Residential

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
1.0E-06	1	70	26	26	350	24	0.5
Used to calculate risk-based groundwater concentration.						(NEW)	(NEW)

END

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

Reset to Defaults

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Naphthalene**

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES ☒

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES ☐

Results Summary					Risk-Based Groundwater Concentration	
Soil Gas Conc. (C_{source}) ($\mu g/m^3$)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard	Cancer Risk $= 10^{-6}$ ($\mu g/L$)	Noncancer HQ = 1 ($\mu g/L$)
1.68E+01	3.9E-05	6.6E-04	NA	NA	1.3E+02	4.8E+03

MESSAGE: Values of Csource and Cbuilding (INTERCALCS worksheet) are based on unity and do not represent actual values.

MESSAGE: Attenuation factor < 6E-05 is unreasonably low.

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W ($\mu g/L$)	Chemical
91203		**Naphthalene**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (^oC)
15	396.2	SI	24

ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
	OR		Lookup Soil Parameters			
SI			SI	1.46	0.465	0.172

MORE ↓

Lookup Receptor Parameters

NEW=> Residential

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
1.0E-06	1	70	26	26	350	24	0.5
Used to calculate risk-based groundwater concentration.						(NEW)	(NEW)

END

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

Reset to Defaults

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

Scenario: **Residential**
Chemical: **Toluene**

Results Summary					Risk-Based Groundwater Concentration	
Soil Gas Conc. (C_{source}) ($\mu g/m^3$)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard	Cancer Risk = 10^{-6} ($\mu g/L$)	Noncancer HQ = 1 ($\mu g/L$)
2.59E+02	3.4E-05	8.8E-03	NA	NA	NA	3.6E+04

MESSAGE: Values of Csource and Cbuilding (INTERCALCS worksheet) are based on unity and do not represent actual values.

MESSAGE: Attenuation factor < 6E-05 is unreasonably low.

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W ($\mu g/L$)	Chemical
108883		**Toluene**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (^{o}C)
15	396.2	SI	24

ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type Lookup Soil Parameters	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SI			SI	1.46	0.465	0.172

MORE ↓

Lookup Receptor Parameters

NEW=> Residential

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
1.0E-06	1	70	26	26	350	24	0.5
Used to calculate risk-based groundwater concentration.						(NEW)	(NEW)

END

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

Reset to Defaults

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **1,2,4-Trimethylbenzene**

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES ☒ X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES ☐

Results Summary					Risk-Based Groundwater Concentration	
Soil Gas Conc. (C_{source}) ($\mu g/m^3$)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard	Cancer Risk $= 10^{-6}$ ($\mu g/L$)	Noncancer HQ = 1 ($\mu g/L$)
2.37E+02	2.7E-05	6.3E-03	NA	NA	NA	1.2E+03

MESSAGE: Values of Csource and Cbuilding (INTERCALCS worksheet) are based on unity and do not represent actual values.

MESSAGE: Attenuation factor < 6E-05 is unreasonably low.

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W ($\mu g/L$)	Chemical
95636		**1,2,4-Trimethylbenzene**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)
15	396.2	SI	24

ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
5

MORE ↓

Lookup Soil Parameters

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SI			SI	1.46	0.465	0.172

MORE ↓

Lookup Receptor Parameters

	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	1.0E-06	1	70	26	26	350	24	0.5
	Used to calculate risk-based groundwater concentration.						(NEW)	(NEW)

END

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Reset to Defaults

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **1,3,5-Trimethylbenzene**

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES ☐

Results Summary					**Risk-Based Groundwater Concentration**	
Soil Gas Conc. (C_{source}) ($\mu g/m^3$)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard	Cancer Risk = 10^{-6} ($\mu g/L$)	Noncancer HQ = 1 ($\mu g/L$)
3.37E+02	2.6E-05	8.8E-03	NA	NA	NA	4.1E+03

MESSAGE: Values of Csource and Cbuilding (INTERCALCS worksheet) are based on unity and do not represent actual values.

MESSAGE: Risk and/or HQ (or risk-based groundwater concentration) is based on route-to-route extrapolation.
MESSAGE: Attenuation factor < 6E-05 is unreasonably low.

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W ($\mu g/L$)	Chemical
108678		1,3,5-Trimethylbenzene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)
15	396.2	SI	24

ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SI			SI	1.46	0.465	0.172

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

NEW=> Residential

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
1.0E-06	1	70	26	26	350	24	0.5
Used to calculate risk-based groundwater concentration.						(NEW)	(NEW)

END

USEPA GW-SCREEN
Version 3.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Groundwater

Reset to Defaults

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **m-Xylene**

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES ☒ X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES ☐

Results Summary					**Risk-Based Groundwater Concentration**	
Soil Gas Conc. (C_{source}) (µg/m^3)	Attenuation Factor (alpha) (unitless)	Indoor Air Conc. ($C_{building}$) (µg/m^3)	Cancer Risk	Noncancer Hazard	Cancer Risk = 10^{-6} (µg/L)	Noncancer HQ = 1 (µg/L)
2.78E+02	3.0E-05	8.3E-03	NA	NA	NA	1.3E+04

MESSAGE: Values of Csource and Cbuilding (INTERCALCS worksheet) are based on unity and do not represent actual values.

MESSAGE: Attenuation factor < 6E-05 is unreasonably low.

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
108383		**m-Xylene**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)
15	396.2	SI	24

ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	**OR**	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type Lookup Soil Parameters	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SI			SI	1.46	0.465	0.172

MORE ↓

Lookup Receptor Parameters

NEW=> Residential

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
1.0E-06	1	70	26	26	350	24	0.5
Used to calculate risk-based groundwater concentration.						(NEW)	(NEW)

END

APPENDIX G

SITE REDEVELOPMENT SOIL MANAGEMENT PLAN

APPENDIX G
SITE REDEVELOPMENT SOIL MANAGEMENT PLAN

Former Chemoil Refinery
Site Cleanup Program Number 0453A
Site ID No. 2047W00
Global ID SL 2047W2348

2020 Walnut Avenue
Signal Hill, California

093-CHEMOIL-001

Prepared For:

Signal Hill Enterprises, LLC
1900 South Norfolk Street, Suite 350
San Mateo, California 94403

and

RE | Solutions, LLC
2880 Bryant Street
Denver, Colorado 80211

Prepared By:

SGI environmental
APEX

299 West Hillcrest Drive, Suite 220
Thousand Oaks, CA 91360

July 13, 2017

Prepared and Reviewed By:

Kirsten L Duey

Kirsten Duey
Senior Engineer/Project Manager

Steve Hickey, P.E.
Senior Engineer

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

On behalf of Signal Hill Enterprises, LLC (SHE) and RE | Solutions, LLC (RES), The Source Group, Inc., a division of Apex Companies, LLC. (Apex-SGI), has prepared this *Soil Management Plan* (Plan) for the former Chemoil Refinery property located at 2020 Walnut Avenue Signal Hill, California (the Site). This Plan will be used in support of pending redevelopment activities at the above referenced Site. Currently, environmental remediation and monitoring is ongoing at the Site under the direction of the Los Angeles Regional Water Quality Control Board (LARWQCB). This Plan will be used as a guidance document for handling potentially impacted soil during redevelopment activities.

1.1 Project Description

The Site is approximately 8.2 acres, located north of the intersection of East 20th Street, East Wesley Drive, Walnut Avenue, and Alamitos Avenue. The Site is divided into areas referred to as the East Parcel, the Northwest Parcel, and the Southwest Parcel. All parcels are currently vacant. The division of the Site into the above-indicated parcels is shown on Figure G-1. Plans are currently underway to redevelop the Site into a light industrial/commercial complex. As a component of redevelopment, grading and potential excavation of the redevelopment area will be required to assure that geotechnical parameters within the near surface soil are achieved and/or for the establishment of underground utility trenches (hereafter referred to as Site Preparation Activities). Given the former use of the property as an oil refinery, and known impact in soil, the potential exists to encounter impacted soils during these activities. Utilizing this Plan, the Environmental Consultant (EC) for the project will guide the Construction Contractor (CC) in proper handling and storage of impacted and potentially impacted soils, which may be encountered during Site Preparation Activities.

1.2 Purpose and Objective

This SMP was prepared to provide guidance for handling potentially contaminated soil. This SMP will provide Site management and workers with procedures for internal and agency notifications, excavation/grading oversight, air and safety monitoring, soil segregation and monitoring, soil sampling and analysis, waste characterization and profiling, waste recycling and disposal procedures, record keeping and reporting in areas of known or encountered impacts. This Plan was prepared to govern Site Preparation Activities associated with future redevelopment and/or intrusive work at the Site, such as soil excavation, trenching, and backfilling.

1.3 Project Responsibilities

The CC will be responsible for implementing provisions outlined in this SMP. An EC will be responsible for field observations and photoionization detector (PID) screening, collection of any soil samples required, and for coordinating the disposition of excavated/disturbed soil as defined in this SMP.

It is the responsibility of all contractors to adhere to this SMP, project specifications, and site safety.

All on-Site personnel handling or conducting intrusive work in contaminated soils shall be trained in accordance with Occupational Safety and Health Administration (OSHA) regulations for hazardous waste operations. These regulations are based on the Code of Federal Regulations (CFR) 1910.120 (e) and 8 CCR 5192, which states that "general site workers" shall receive a minimum of 40 hours of classroom training and a minimum of three days of field training. This training provides precautions and protective measures to reduce or eliminate hazardous materials/waste hazards at the work place.

2.0 BACKGROUND

This section provides a summary of Site history and subsurface conditions. Further details can be found in the Site Investigation and Site Conceptual Model Report (Apex-SGI, 2017a).

The Site operated as an oil refinery from the early 1920s until the 1990s. All the above ground structures were dismantled in early 1997. It has been reported that known below ground structures, including piping, sumps, footings, and foundations, were also removed at that time. Currently the Site is vacant, and does not contain any above ground storage tanks (ASTs) or known underground storage tanks (USTs). The site currently consists of exposed surface soils, with perimeter chain link fencing and stormwater controls. A few temporary above ground facilities are onsite; associated with groundwater remediation activities.

2.1 Chemicals of Potential Concern in Soil and Soil Vapor

Soil and underlying groundwater at the Site are impacted by historic petroleum releases. Historically, light non-aqueous phase liquid (LNAPL) presence was reported at three onsite locations. The LNAPL occurrences were characterized as heavy crude oil or lubricating oil, or a combination of naphtha, kerosene, and gas oil. Primary chemicals of potential concern (COPCs) present in Site soils and soil vapor as identified in Apex-SGI's Site Investigation and Site Conceptual Model Report (Apex-SGI, 2017a) consist of:

Soil

- Total petroleum hydrocarbons (TPH) in the C4-C12, C13-C22, and C23-C44 ranges
- Volatile organic compounds (VOC)
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Metals

Soil Vapor

- VOCs

2.2 Surface Topography and Ground Cover

The upper soils range from two to seven feet in depth and are classified as fill, consisting of silty sand with intermittent gravels and some intermixed debris. The upper fill is underlain by a silt or silty fine grained sand.

All three parcels are generally flat, with scattered earthen berms or hummocks, and slope toward the south and southeast from a topographic high of approximately 45 feet above mean sea level at the northern boundary. The parcels are separated by public surface streets with East 21st Street dividing the north and south parcels and North Walnut Avenue dividing the east and west parcels.

3.0 PLANNING AND NOTIFICATIONS

3.1 Utility Clearance and Protection

All locations where ground is to be disturbed will be cleared of potential utilities by Underground Service Alert (USA). USA will be contacted at least 72 hours prior to commencing any excavation work. It is anticipated that Site Preparation Activities will progress in stages. To accommodate this, USA will be contacted prior to moving to new areas of the Site that are outside of prior USA notified area(s).

3.2 Health & Safety

Excavation and soil management activities will be completed with safety as the foremost concern to minimize the potential for accidents, injuries, contaminant exposures, and or illnesses. Per OSHA requirements, a site-specific Health and Safety Plan (HASP) will be developed, implemented, reviewed and followed by all personnel working at the Site. The EC will generally also provide their site-specific HASP and this may be used for the CC (with EC approval) if they do not provide their own HASP. All work will be performed as minimum safety Level D. This may be upgraded depending on the area of the site where excavation is planned, expected conditions change, and by field-encountered conditions during digging.

3.3 Protection of Existing Wells

The Site has existing remediation and groundwater monitoring wells installed across the property. Once the redevelopment plan is finalized with planned building footprints and other features, the EC will determine which wells require abandonment and which wells will remain in place and require protection during grading activities. Any well abandonments will occur prior to redevelopment activities under direction from the EC and under a permit issued by the County of Los Angeles.

The EC will communicate to the CC which wells will remain in place prior to the start of earthwork activities. Groundwater monitoring wells are constructed using PVC casing and are thus susceptible to breakage during earth moving activities. In some cases, wellheads may be lowered to an elevation below the lowest grading elevations, capped and marked. The temporary wellhead elevation will be established for each excavation area. These wellheads should be restored to final grade level following excavation during the backfill and compaction activities and accurately marked to avoid future damage. A detailed map showing all well locations will be provided to all field personnel to facilitate the protection and preservation of this equipment/infrastructure prior to earthwork activities.

3.4 SCAQMD Permitting

Prior to the start of field work, the South Coast Air Quality Management District (SCAQMD) will be notified of the planned excavation of VOC-impacted soil as required by SCAQMD Rule 1166. Since there is potential for greater than 2,000 cubic yards (cy) of VOC contaminated soil will require excavation or disturbance, a Site-specific VOC Contaminated Soil Mitigation Plan will be prepared and submitted to the SCAQMD for approval.

4.0 SOIL MANAGEMENT GENERAL ACTIVITIES

This section outlines the general soil management guidelines that shall be implemented by parties involved in Site Preparation or other soil intrusive activities during future redevelopment of the Site.

4.1 Soil Management Plan Designated Areas

Contractors or personnel working at the Site should be aware that there may be locations with contaminants that exceed soil screening levels. Personnel working at the Site are required to adhere to this SMP. The planned redevelopment has been divided into three Designated Areas for the purpose of soil screening, segregation, analysis and re-use/disposal. The three Designated Areas as identified on Figure G-1 are as follows:

- The East Parcel;
- The Northwest Parcel; and
- The Southwest Parcel.

Excavated soil from these areas shall not be combined with one another nor should soil be moved to a different area from its origin without prior approval from the EC.

4.2 General Site Control and Soil Handling Procedures

The following procedures shall be followed during all soil intrusive activities conducted during property redevelopment:

- Any stockpiled soil shall be covered with plastic sheeting or tarps and will not be stockpiled in or near storm drains;
- Specified areas shall be identified and used for stockpiling soil that does not pass field screening to minimize cross-contamination with clean soil;
- The access to the excavated areas shall be controlled to prevent unauthorized persons accessing exposed soil; and
- Access to the work zones where soil will be disturbed shall be controlled using caution tape, cones, fencing, steel plates, or other measures to clearly designate the active work area and to prevent access by the public.

4.3 Dust/Vapor Control Measures

As necessary, dust control measures shall be utilized during all excavation, soil segregation, soil stockpiling, transport, and compaction activities to prevent or control surface and air movement of dust from disturbed soil surfaces. As necessary, the following dust control measures shall be utilized:

- All active construction activities within the Soil Management Plan Designated Areas shall be watered at least twice daily;

- All trucks hauling soil, sand, or other loose materials excavated from the Site shall be covered or shall maintain at least two feet of freeboard; and
- If visible soil material is carried onto adjacent public streets, the streets shall be swept with water sweepers as necessary to maintain them free of material.

4.4 Decontamination

Decontamination procedures shall be developed and followed to minimize the equipment contamination during excavation activities. The procedures should include removing loose soil from the vehicle exterior using dry methods, such as brushing, scraping or vacuuming. Soil not removed by dry methods, should be cleaned by pressure washing or steam cleaning.

4.5 Storm Water Control

Storm water pollution controls shall be implemented by the CCs to minimize sediment runoff in storm water, which could include soil containing contaminants of concern. Procedures to prevent erosion and sediment runoff from the Site shall include grading the Site, installing storm water control devices such as temporary earth berms or erecting silt fences around the perimeter of exposed soil at the Site. Straw bale barriers or sediment traps are required to protect any existing catch basins or drainage channels. A separate storm water pollution prevention plan shall be provided by the CC's Qualified Stormwater Plan Developer (QSD) prior to beginning Site activities.

5.0 FIELD SCREENING AND SOIL SEGREGATION

During any Site Preparation Activities, visual observation and field screening measurements will be conducted by the EC. Initial field screening measurements will consist of the following and observations/measurements will be noted and documented on field forms by the EC:

- Odorous soil;
- Stained or discolored soil;
- Presence of free-phase petroleum product;
- Any encountered subsurface features; and
- Photoionization detector (PID) field screening readings, further detailed in the following section.

5.1 PID Field Screening Methodology

A (PID) or other organic vapor detecting device shall be present during grading and excavation activities. Field screening using a PID shall be conducted pursuant to SCAQMD Rule 1166 and shall be conducted continuously by the EC during soil intrusive activities. PID field screening procedures are summarized as follows:

- The PID shall be calibrated daily, utilizing hexane gas or other equivalent method with prior approval from SCAQMD;
- The PID probe inlet should be placed no more than three inches from the surface of the excavated soil and while slowly moving the probe across the soil surface, the instrument readout shall be observed; and
- The maximum meter reading shall be recorded at a minimum of every 15 minutes on a Rule 1166 Soil Monitoring Record.

5.1.1 Trigger Levels

The following trigger levels and associated actions will be implemented during intrusive fieldwork at the Site:

PID Measurement or Visual Condition	Required Mitigation Measures
Less than 50 parts per million by volume (PPMV) with no visual or odor indicators	• Stockpiled as Site soils for reuse.
Greater than 50 PPMV but less than 1,000 PPMV	• Affected work area and soil load sprayed with water and/or vapor suppressant;

or less than 50 PPMV but with visual or odor indicators	• Placed in segregated stockpiles, bins or drums for additional laboratory analysis; • Stockpiles covered with plastic sheeting and are secured so that no portion of the contaminated soil is exposed to the atmosphere. During handling the stockpile, only the working face of the stockpile may be uncovered; • May not be used as backfill for the Site without prior approval from SCAQMD and LARWQCB; and • Managed according to Section 6.2.
Greater than 1,000 PPMV	• SCAQMD notification within one hour of detection; • Affected work area and soil load sprayed with water and/or vapor suppressant; and • Soil immediately loaded into SCAQMD approved sealed containers or loaded in trucks for immediate offsite disposal, unless prior written approval from SCAQMD.

6.0 STOCKPILE MANAGEMENT AND SOIL REUSE/DISPOSAL REQUIREMENTS

This section describes the monitoring of VOC emission and dust, and management of stockpiles with contaminated soil. In general, and as indicated in Section 5.0, field observations (i.e., visual staining, strong odors, PID readings of greater than 50 ppmv) will serve as the first line of screening. Soil with PID readings of less than 50 ppmv will be segregated from contaminated soil and will be reused during redevelopment activities.

Stockpile management of contaminated soil will be handled as described in the following section.

6.1 Handling of Contaminated Soil

As mentioned previously, soil that is field screened and determined to contain greater than 1,000 ppmv when measured within three inches of the soil with a calibrated PID will immediately be loaded into SCAQMD approved sealed containers or loaded in trucks for immediate offsite disposal, unless prior written approval from SCAQMD is received.

Soil that is field screened and determined to contain greater than 50 ppmv (but less than 1,000 ppmv) or appears impacted by visual/odor screening observations will be staged in stockpiles no greater than 1,000 cubic yards and will be characterized for offsite disposal or onsite treatment with prior approval from SCAQMD and LARWQCB. The stockpiles will be placed on plastic liner of 30-mil or greater. During construction, the piles will be lightly sprayed with water and covered with plastic sheeting of 10-mil or greater. Plastic sheeting will be secured with sandbags.

Soil that is planned for offsite disposal will be sampled in accordance with the receiving facilities' guidelines. Approximate sampling frequency is as follows:

- A minimum of one (1) 4-point composite sample will be collected from stockpiles of less than 100 cubic yards;
- Three (3) 4-point composite soil samples per 500 cubic yards in a stockpile containing up to 1,000 cubic yards; and
- Five (5) 4-point composite soil samples for the first 1,000 cubic yards and one (1) sample for each additional 500 cubic yards in a stockpile containing up to 5,000 cubic yards.

In the event that contaminated soil is treated onsite for reuse in lieu of offsite disposal, a separate Workplan detailing proposed treatment methodologies and confirmation sampling criteria will be submitted to RWQCB and SCAQMD for approval.

7.0 WRITTEN RECORDS AND REPORTING

At the completion of the redevelopment activities, a report will be prepared by the EC that summarizes the findings of the field observations, laboratory results, and final disposition of any excavated soil. A map will be provided which documents any underground features (not expected) that are unearthed during redevelopment. The headspace log forms will be presented as appendices to the report. If applicable, copies of receipts pertaining to the disposition of the soil will be appended to the report.

8.0 LIMITATIONS

This Plan was prepared to address potential TPH, VOCs, PAHs, and metals present in the soil at the Site and current known site conditions, regulations and laws. This Plan does not address issues related to groundwater, other chemicals or future site conditions that may be encountered during construction projects, including but not limited to, demolition and construction debris, asphalt, concrete, and asbestos-containing materials. If such materials are encountered during a construction project, contractors and workers are responsible for complying with all applicable laws pertaining to the handling and disposal of these materials.

The site-related activities may be subject to federal, state, and local laws and regulations, including those published by U.S. Environmental protection Agency (USEPA), the SCAQMD, California Environmental Protection Agency (Cal-EPA), Los Angeles County, and the City of Signal Hill. These regulations address issues such as health and safety, hazardous waste, dust generation, storm water, and community right-to-know. It is the responsibility of the parties involved to ensure that all construction and maintenance activities abide by current applicable laws and regulations.

Apex-SGI disclaims any responsibility for any unauthorized use of this SMP. It is understood that while this SMP is intended to provide guidance and establish a framework for the management of potential chemical impacts in the subsurface soil to protect human health and the environment, this SMP shall not create any warranties or obligations to RES/SHE as to implementation, adequacy, or success of protective measures under this SMP.

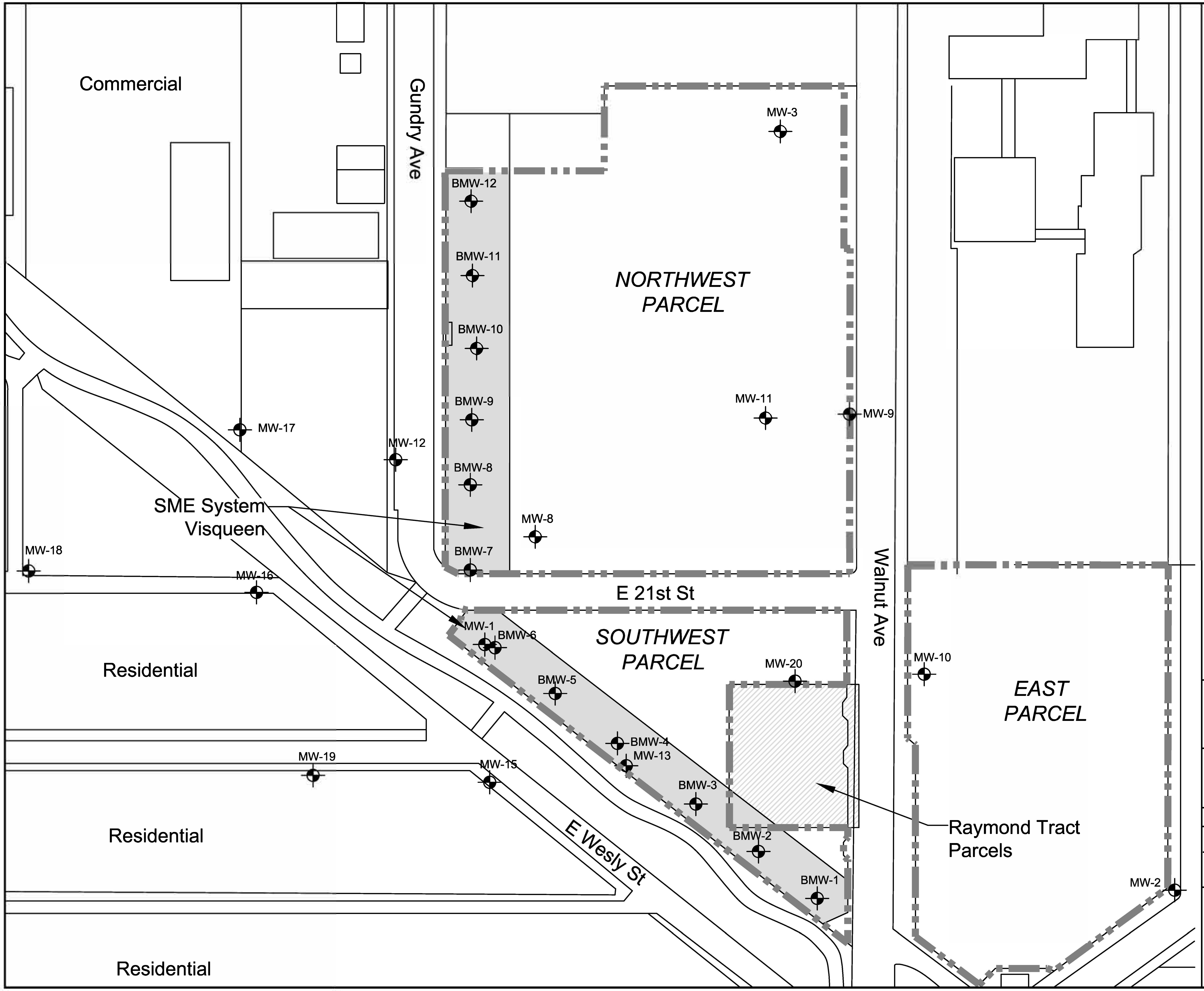
9.0 REFERENCES

The Source Group, Inc., A Division of Apex Companies, LLC (Apex-SGI). 2017a. Site Investigation and Conceptual Model Report for Former Chemoil Refinery. March 29.

The Source Group, Inc., A Division of Apex Companies, LLC (Apex-SGI). 2017b. Response Plan and Remedial Technology Evaluation for Former Chemoil Refinery. June 13.

FIGURES

S:\Clients A - F\ChemOil Refinery\Reports\Response Plan\App\SMP\Fig.1-2-Site Map.dwg, 5/11/2017 11:26:48 AM



LEGEND

▬ ▪ ▪ ▬	Site Boundary
MW-16 ⊕	Groundwater Monitoring Well Locations
SME	Subsurface Metabolic Enhancement

SITE MAP

FORMER CHEMOIL REFINERY
2020 WALNUT AVENUE
SIGNAL HILL, CA

PROJECT NO.	DATE	DRAWN BY:	APP. BY:
01-CHEMOIL-001	02/08/17	ZA	KD

0 100 200
HORIZONTAL SCALE IN FEET

SGI environmental
APEX
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

N

FIGURE G-1