terraphase engineering

February 28, 2022

Ms. Renee Purdy
Executive Officer, Los Angeles Regional Water Quality Control Board
320 West 4th Street, Suite 200
Los Angeles, California 90013
Renee.Purdy@waterboards.ca.gov

transmitted via electronic mail to: Renee.Purdy@waterboards.ca.gov

Subject: EA Properties RAW - Cleanup and Abatement Order No. R4-2021-0079 -SKYPARK COMMERCIAL PROPERTIES (ASSESSOR PARCEL NO. 7377-006-906), 24701 – 24777 CRENSHAW BOULEVARD AND 2530, 2540, AND 2600 SKYPARK DRIVE, TORRANCE, CALIFORNIA (SCP NO. 1499)

Dear Ms. Purdy:

On behalf of the City of Torrance (City), Terraphase Engineering Inc. (Terraphase) hereby submits the attached Removal Action Workplan for the East Adjacent Properties (EA RAW) for the above referenced properties (the Site). The EA RAW sets forth removal actions proposed to be implemented to expeditiously investigate and address impacts to the vadose zone, perched groundwater, and regional groundwater within the properties located at 24701–24777 Crenshaw Boulevard and 2530 and 2540 Skypark Drive in Torrance, California (EA Properties), which are east and downgradient of the Hi-Shear Corporation (Hi-Shear) property located at 2600 Skypark Drive (Hi-Shear Property).

The City looks forward to the Los Angeles Regional Board's review and approval of this EA RAW, and to a dialogue with the Regional Board concerning the implementation of its components.

Terraphase and other City representatives would be happy to meet with LARWQCB staff (virtually or in person) to discuss the EA RAW or answer any questions you or your staff may have.

Sincerely,
For Terraphase Engineering Inc.

Charles E. Robinson, PE	Darren Croteau, PG
Principal Engineer	Principal Geologist

Enclosure

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Removal Action Workplan for the East Adjacent Properties

Skypark Commercial Properties – East Adjacent Properties:

24701, 24707, 24747, 24751, and 24777 Crenshaw Boulevard, and 2530 and 2540 Skypark Drive, Torrance, California

Prepared for

City of Torrance
c/o Rutan & Tucker LLP
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Irvine, California 92612

Prepared by

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February 28, 2022

Project Number S042.002.003

File: RAW-EA Properties-S042-002-003-Final

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Acronyms and Abbreviations

µg/L	micrograms per liter
µg/m^3	micrograms per cubic meter
§	Section
§§	Sections
40 CFR	Title 40 Code of Federal Regulations
1,1-DCE	1,1-dichloroethene
1,1,1-TCA	1,1,1-trichloroethane
Alta	Alta Environmental
bgs	below ground surface
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
COC	chemical of concern
CWC	California Water Code
DCA	dichloroethane
DNAPL	dense non-aqueous phase liquid
EA Properties	east-adjacent properties located at 24701, 24707, 24747, and 24777 Crenshaw Boulevard and 2530 and 2540 Skypark Drive in the City of Torrance, California
ECD	electron capture detector
EE/CA	Engineering Evaluation/Cost Analysis
EISB	enhanced in-situ bioremediation
E/IC	engineering/institutional controls
ESL	Environmental Screening Level
Frey	Frey Environmental, Inc.
GE&R	Genesis Engineering and Redevelopment
Groundwater RAW	*Groundwater Removal Action Workplan*
Hi-Shear	Hi-Shear Corporation
Hi-Shear Plume	contaminated groundwater at the Site
Hi-Shear Property	Hi-Shear Corporation property located at 2600 Skypark Drive in Torrance, California
ISCO	in-situ chemical oxidation
LARWQCB	Los Angeles Regional Water Quality Control Board
Lowe's	Lowe's Home Improvement Center
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
MIP	membrane-interface probes
MNA	monitored natural attenuation

NCP	National Oil and Hazardous Substances Pollution Contingency Plan
Order	Regional Water Quality Control Board Cleanup and Abatement Order No. R4-2021-0079
PCE	tetrachloroethene
RAO	Remedial Action Objective
RAP	*Remedial Action Plan*
RAW	*Removal Action Workplan*
RWQCB	Regional Water Quality Control Board
SFRWQCB	San Francisco Regional Water Quality Control Board
SVE	soil-vapor extraction
SWRCB	State Water Resources Control Board
TCE	trichloroethene
Terraphase	Terraphase Engineering Inc.
trans-1,2-DCE	trans-1,2-dichloroethene
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VI	vapor intrusion
VOC	volatile organic compound
WDR	Waste Discharge Requirements
XSD	halogen specific detector

Signatures

All engineering designs, information, conclusions, and recommendations in this document have been prepared under the responsible charge of a California Professional Engineer.

Charles Robinson, PE Principal Engineer	February 28, 2022 Date

All geologic information, conclusions, and recommendations in this document have been prepared by a California Professional Geologist.

Darren Croteau, PG Principal Geologist	February 28, 2022 Date

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1 Introduction

Terraphase Engineering Inc. (Terraphase) prepared this Removal Action Workplan (RAW) under the direction of Rutan & Tucker, LLP, on behalf of the City of Torrance, for submittal to the California Regional Water Quality Control Board (RWQCB), Los Angeles Region (LARWQCB). This RAW sets forth the proposed removal actions to expeditiously address impacted groundwater (at an approximate depth of 85–115 feet below ground surface [bgs]; the "regional groundwater" or "regional aquifer") that migrated from the Hi-Shear Corporation (Hi-Shear) property located at 2600 Skypark Drive (Hi-Shear Property) to the properties located at 24701, 24707, 24747, 24751, and 24777 Crenshaw Boulevard, and 2530 and 2540 Skypark Drive in Torrance, California, that are east and adjacent to the Skypark Commercial Properties (EA Properties [collectively, the Site]; Figures 1 and 2). This RAW also addresses potential health risks and resource impacts arising from chemical releases that impact soil, soil vapor, and perched groundwater at the EA Properties. The EA Properties are divided as follows:

- **EA Property 1:** 24751 and 24777 Crenshaw Boulevard, currently occupied by South Bay Lexus (vehicle dealership);
- **EA Property 2:** 24701, 24707, and 24747 Crenshaw Boulevard, currently occupied by Dasco Engineering Corporation (manufacturer of precision mechanic aircraft and space components); and
- **EA Property 3:** 2530 and 2540 Skypark Drive, currently occupied by Robinson Helicopter.

This RAW follows the *Groundwater Removal Action Workplan* (Groundwater RAW; Terraphase 2022) submitted to the LARWQCB to address halogenated volatile organic compound (VOC) releases. Trichloroethene (TCE) is the most pervasive VOC detected in groundwater beneath the Hi-Shear Property, EA Properties, and residential properties east of Crenshaw. TCE presents a unique vapor intrusion (VI) short duration exposure concern; therefore, itis prioritized over other VOCs in VI investigations. The TCE short-duration exposure concern results from exposures on the order of weeks or days in contrast to multi-decade exposure concerns from other VOCs. The California Environmental Protection Agency, Department of Toxic Substances (DTSC), developed TCE Urgent and Accelerated response levels (DTSC 2014) to prioritize indoor air sampling where TCE presents a potential VI concern. Given its widespread distribution, high detected concentrations, and stringent short-term VI trigger level, TCE is the primary driver for the removal action in the regional groundwater and represents the greatest chemical of concern (COC) risk via VI and impacts to groundwater resources. The Groundwater RAW recommended addressing the Hi-Shear Source (with enhanced in-situ bioremediation [EISB]) and the plume margin (with a Crenshaw Boulevard zero valiant iron treatment barrier). This RAW addresses the Hi Shear plume body that migrated onto the EA Properties from the Hi-Shear Source, as well as presumed releases of VOCs within the EA Properties. This RAW and the Groundwater RAW address releases at the Skypark Commercial Properties.

This RAW recommends EISB to address the Hi-Shear plume body that migrated onto the EA Properties, consistent with the Groundwater RAW. In addition, apparent releases of tetrachloroethene (PCE), and 1,1,1-trichloroethane (1,1,1-TCA) have occurred on EA Property 1, in the vicinity of former degreasing operations, that have impacted the vadose zone and perched groundwater. This RAW proposes soil vapor extraction (SVE) to address the vadose zone impacts resulting from those releases and in-situ chemical oxidation (ISCO) using ozone to address perched groundwater. Therefore, this RAW addresses the apparent impacts on the EA Properties including:

- TCE-impacted regional groundwater migrating from the Hi-Shear Source areas;
- Vadose zone impacts from releases on the EA Properties; and
- Perched groundwater impacts from apparent releases on the EA Properties.

To better define the nature and extent of the TCE-impacted regional groundwater and PCE and 1,1,1-TCA releases on the EA Properties, this RAW also proposes soil, soil vapor, and groundwater sampling be conducted prior to implementation of the remedies. The investigation work is necessary to support an estimation of the mass flux of contaminants migrating to and beneath the EA Properties from the Hi-Shear Source to further define the regional groundwater impacts on the EA Properties, since groundwater data is limited on the EA Properties. This additional regional groundwater data will inform the EISB design.

The investigation work is also necessary to better define the apparent releases to the vadose zone and perched groundwater from the former degreaser area within EA Property 1, and to evaluate if a former sewer line was also a source of vadose zone and perched groundwater contamination. These data will similarly inform the designs of the vadose zone and perched groundwater remedies.

Like the Groundwater RAW, this RAW was prepared in accordance with Title 40, Code of Federal Regulations (CFR), Part 300 (National Oil and Hazardous Substances Pollution Contingency Plan [NCP]), Section (§) 300.415; DTSC guidance memorandum *Removal Action Workplans – Senate Bill 1706,* dated September 23, 1998; California Health and Safety Code, Division 20, Chapter 6.8, Article 5, §§25323 and 25323.1; and California Water Code (CWC) §§13300, 13301, and 13304.

This RAW was also prepared in accordance with California State Water Resource Control Board Resolution 92-49, which defines how judgements and decisions are to be made in the selection of appropriate remedial technologies and alternatives to remediate contaminated groundwater and protect public health and the environment.

Lastly, this RAW was completed in general accordance with United States Environmental Protection Agency's (USEPA) August 1993 *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* with an Engineering Evaluation/Cost Analysis (EE/CA).

This RAW is necessary to address specific releases at the Hi-Shear Property that have impacted regional groundwater which flows unabated from the Hi-Shear source areas and flows with groundwater beneath the EA Properties. Additionally, the EA Properties vadose zone and perched groundwater have been affected by apparent VOC releases, causing potential VI concerns within the EA Properties.

This removal action focuses on remediating VOC contaminant mass in the soil, soil vapor, perched groundwater, and regional groundwater from apparent sources on the EA Properties, as well as regional groundwater migrating from the Hi-Shear Property to receptors within the EA Properties.

This RAW selects removal actions for the regional groundwater to meet the groundwater screening criteria for the evaluation of the VI pathway, including TCE trigger levels for indoor air sampling (DTSC 2014) and Environmental Screening Levels (ESLs; San Francisco RWQCB [SFRWQCB] 2020), as well as maximum contaminant levels (MCLs) in drinking water for the regional aquifer.[1] Additionally, with the implementation of this groundwater RAW, VOC concentrations are expected to be reduced in soil vapor to meet ESLs and reduce the VI potential, and in the perched groundwater, to also meet groundwater screening criteria for the evaluation of the VI pathway (SFRWQCB 2020).

Sections 1.1 and 1.2 include the regulatory basis and objectives for this RAW. This RAW includes a description of the Hi-Shear Source and the EA Properties (Section 2); a summary of subsurface characterization work performed on the Hi-Shear Property and EA Properties (Section 3); the nature and extent of chemical impacts (Section 4); the evidence of releases on the EA Properties and data gaps and proposed investigation activities (Section 5); Remedial Action Objectives (RAOs; Section 6); and a comparison of feasible removal alternatives to achieve the remedial objectives (Section 7).

The selected remedies for this RAW are organized and discussed in relation to the Hi-Shear Source and apparent releases from the degreaser operations on EA Property 1 (Section 8). As mentioned previously, the selected remedies include:

- EISB for regional groundwater;
- SVE for the vadose zone impacts; and
- ISCO using ozone for the perched groundwater impacts.

Public participation programs, reporting, cost and schedule, and references are discussed in Sections 9, 10, 11, and 12, respectively.

This RAW is designed to immediately abate the Hi-Shear plume body that has migrated onto the EA Properties, and to remediate areas of the vadose zone and perched groundwater where releases have occurred to reduce the VI potential.

1.1 Regulatory Basis for the RAW

In its August 28, 2018, letter to Hi-Shear's counsel, the LARWQCB referenced the CWC §13267 Order dated October 29, 2009, issued to Hi-Shear, and states that:

> "The TCE plume, which originated from the Hi-Shear Site, continues to migrate offsite and downgradient from the Site east-southeast since 1992, and has crossed past Crenshaw Boulevard and Pennsylvania Avenue. The offsite extent of this Hi-Shear VOC groundwater plume has not been fully delineated.

[1] https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Chemicalcontaminants.html

> … Hi-Shear is responsible for cleanup of not only the onsite but also offsite portions of the TCE and other VOC plumes that originated from the Hi-Shear Site such that the approved cleanup goals MCLs and notification levels (NLs) are met in a reasonable amount of time as required in State Water Resources Control Board (SWRCB) Resolution No. 92-49." (LARWQCB 2018)

Additionally, the LARWQCB issued Cleanup and Abatement Order No. R4-2021-0079 (Order) on June 18, 2021. The Order cites to CWS §§13304 and 13267 as the supporting legal authority for its issuance. The Order also requires remedial action and states:

> "For each Property, the Dischargers identified with the Property shall develop a comprehensive Remedial Action Plan(s) (RAP) for cleanup of wastes in the soil matrix, soil vapor, and groundwater originating from the Property and submit it to the Regional Board for review and approval. The RAP shall include, at a minimum:
>
> i. Evaluation of the technology(ies) proposed for remediation of soil matrix, soil vapor, and groundwater
> ii. Description of the selection criteria for choosing the proposed method over other potential remedial options. Discuss the technical merit, suitability of the selected method under the given Site conditions and waste constituents present, economic and technological feasibility, and immediate and/or future benefits to the people of the state
> iii. Description of any pilot projects intended to be implemented
> iv. Estimation of cumulative mass of wastes to be removed with the selected method. Include all calculations and methodology used to obtain this estimate
> v. A proposed schedule for completion of the RAP."

Additionally, as outlined in 40 CFR § 300.410 of the NCP, assessment of a release that may warrant mitigation through a removal action shall be undertaken, if warranted, "as promptly as possible."[2]

Assessment of the Hi-Shear Property release areas and impact to underlying and off-site downgradient groundwater has been occurring under the oversight of the LARWQCB for approximately 30 years, during which time the Hi-Shear Plume has migrated and grown with additional contaminant mass migrating from the Hi-Shear releases to beneath commercial/industrial and residential receptors. Additionally, recent sampling within the shallow vadose zone and perched groundwater at the EA Properties indicate separate releases of PCE and 1,1,1-TCA may have occurred. [3]

As a result of Hi-Shear evaluations under LARWQCB oversight, substantial data exist indicating releases of VOCs in historical VOC use areas within the Hi-Shear Property. The data further demonstrate that if left unmitigated, the VOC groundwater plume emanating from the Hi-Shear Property will migrate further downgradient into and beneath the EA Properties, and off-gas VOCs from groundwater to soil

[2] 40 CFR §300.410 (b).

[3] In accordance with 40 CFR §300.415 (a)(1) of the NCP, the RWQCB, as the lead agency, shall consider the Site investigation data and current Site conditions to determine if a removal action is warranted.

vapor beneath these properties. Additionally, the apparent releases of PCE and 1,1,1-TCA in the area of EA Property 1 have impacted soil vapor and perched groundwater, which may create a potential VI risk to workers within EA Property 1 (although the *Human Health Risk Assessment of Soil Exposure, Vapor Intrusion Investigation to Indoor Air, and Indoor Air Report* [Environmental Health Decisions 2021] did not identify any risk to workers).

Pursuant to 40 CFR § 300.415 (b)(2), the factors to be considered in determining the appropriateness of a removal action include:

- "Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants;
- Actual or potential contamination of drinking water supplies or sensitive ecosystems;
- Hazardous substances or pollutants or contaminants in drums, barrels, tanks, or other bulk containers, that may pose a threat of release;
- High levels of hazardous substances or pollutants or contaminants in soil largely at or near that surface that may migrate;
- Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released;
- Threat of fire or explosion;
- The availability of other appropriate federal or state response mechanisms to respond to the release; and
- Other situations or factors that may pose threats to public health or welfare of the United States or the environment."[4]

Of these factors, the VOCs in the regional groundwater migrating from the Hi-Shear Property and within the soil vapor and perched groundwater within the EA Properties present the following potential impacts to resources and risks to residents, requiring the removal action outlined in this RAW:[3]

- "Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants;
- Actual or potential contamination of drinking water supplies or sensitive ecosystems; and
- High levels of hazardous substances or pollutants or contaminants in soil largely at or near that surface that may migrate."

In addition to the potential health threats for unacceptable indoor air exposures to VOCs from TCE (in the regional groundwater beneath the EA Properties) and PCE and 1,1-DCE (in the soil vapor and perched groundwater within the EA Properties), the TCE Hi-Shear Plume degrades the regional groundwater rendering it unsuitable for use as drinking water because VOC concentrations occur above the LARWQCB Basin Plan's (2019) water quality objectives. Existing designated beneficial uses for Site groundwater include municipal and domestic supply, industrial service supply, industrial process supply,

[4] 40 CFR §300.415 (b)(2).

and agricultural supply (LARWQCB 2019). As the quality of these waters is high and suitable for municipal supply use, the Basin Plan further requires that SWRCB Resolution 92-49 be followed to implement remedial measures to achieve water quality objectives within a reasonable time frame. In addition, the West Coast Basin Barrier Project limits groundwater extraction in this area to manage saltwater intrusion.

Therefore, in accordance with the provisions of the NCP and SWRCB Resolution 92-49, this RAW addresses the impacted regional aquifer within the EA Properties migrating from the Hi-Shear Property, as well as VOCs within the soil vapor and perched groundwater within the EA Properties, to diminish potential exposure from VI in the commercial EA Properties, by remediating the regional groundwater within the EA Properties and remediating the shallow soil vapor occurring in the vadose zone and by remediating the perched groundwater.

1.2 Objectives of the RAW

The RAOs set forth in this RAW include:

- Further delineate VOC sources on the EA Properties and quantify VOC mass flux in regional groundwater migrating from the Hi-Shear Property to and beneath the EA Properties;
- Reduce the potential for VI risk on the EA Properties by addressing the VOC-impacted regional groundwater that continues to migrate from the Hi-Shear Property;
- Reduce the potential for VI risk on the EA Properties by addressing the principal cause of the soil vapor and perched groundwater contamination in that area (apparent releases from the degreasers on EA Property 1); and
- Achieve water quality objectives in the regional groundwater and the perched groundwater within a reasonable time frame.

2 Site Description

A portion of the Site is located within Los Angeles County Assessor's parcel number 7377-006-906, which is owned by the City of Torrance but has been leased to Hi-Shear since approximately 1954 (2600 Skypark Drive), and with other portions being leased by the City of Torrance to other commercial entities within the EA Properties.

The approximately 12.25-acre Hi-Shear Property, located at 2600 Skypark Drive, was formerly part of historical Hi-Shear operations that included an additional approximately 13.75 acres adjoining to the west.

The EA Properties (Figure 2) are divided into the following three properties:

- **EA Property 1** covers approximately 9.64 acres, and includes 24751 and 24777 Crenshaw Boulevard, currently occupied by South Bay Lexus (vehicle dealership);
- **EA Property 2** covers approximately 2.6 acres, and includes 24701, 24707, and 24747 Crenshaw Boulevard, currently occupied by Dasco Engineering Corporation (manufacturer of precision mechanic aircraft and space components); and
- **EA Property 3** covers approximately 1.6 acres, and includes 2530 and 2540 Skypark Drive, currently occupied by Robinson Helicopter.

2.1 Land and Chemical Usage

The Hi-Shear Property has been used for manufacturing and commercial purposes since at least 1954. Prior to 2006, the Hi-Shear Property was a 26-acre property that included the western 13.75-acre area currently occupied by Lowe's Home Improvement Center (Lowe's). The LARWQCB provided environmental oversight of the Lowe's area and issued closure of the top 10 feet of soil at that property (LARWQCB 2006). Hi-Shear reportedly retains the environmental liabilities associated with the entire 26-acre property. Hi-Shear's current long-term lease with the City of Torrance appears to extend to 2054.

The EA Properties have been used for manufacturing and commercial purposes since at least 1957. EA Property 1 was first occupied by Aeronca Manufacturing Corporation from approximately 1957 until at least 1982. Excellon Industries, a dissolved subsidiary of Esterline Technologies Corporation, operated at EA Property 1 from approximately 1980 to approximately mid-2003. Excellon Acquisition, LLC then operated at EA Property 1 from mid-2003 to September 2005. EA Property 1 operations have included, at different times, manufacturing and testing of aerospace equipment and manufacturing of equipment to fabricate printed circuit boards. Since 2006, EA Property 1 has been occupied by South Bay Lexus (Genesis Engineering and Redevelopment [GE&R] 2021).

EA Property 2 development was completed in 1969 and has been occupied by Dasco Engineering since approximately 1996. EA Property 3 was first developed between 1958 and 1960 and has been occupied by Robinson Helicopter Company since 1978, and various commercial sublessees including a swimsuit distributor and a gymnastics school (GE&R 2021).

The EA Properties are bounded by Skypark Drive to the north, Crenshaw Boulevard to the east, Torrance Municipal Airport to the south, and the Hi-Shear Property to the west. Operations at the adjacent and upgradient Hi-Shear property began in 1954 and included extensive aerospace-related manufacturing and maintenance (GE&R 2021; Terraphase 2022). TCE was extensively used at the Hi-Shear Property and large releases occurred, creating the High-Shear plume that is the subject of remediation in the Groundwater RAW (Terraphase 2022). The High-Shear plume extends across the EA Properties to Crenshaw Boulevard. The extent of the regional groundwater plume to the east, beyond Crenshaw Boulevard, is not fully defined; however, the VOC levels in the regional groundwater start to decrease significantly approximately 600 feet east of Crenshaw Boulevard.

Beyond Skypark Drive to the north is a shopping plaza that includes a Home Depot and other retail businesses. East of Crenshaw Boulevard is a residential neighborhood located within the City of Lomita. VOCs were used on all three EA Properties and a summary of the reported chemicals and operations using these chemicals is presented below. A detailed description of EA Properties' chemical use and operations is presented in the Site Conceptual Model (GE&R 2021a).

2.1.1 EA Property 1

Aeronca Manufacturing Corporation appears to have used PCE and 1,1,1-TCA in two degreasers at 24751 Crenshaw Boulevard starting around 1967. The degreasers were located in the eastern portion of the currently unoccupied building on EA Property 1. Permits from the South Coast Air Quality Management District for the degreasers operated by Aeronca Manufacturing Corporation indicated the use of PCE and 1,1,1-TCA (GE&R 2021). Excellon Industries also reportedly used degreasers on EA Property 1 and 1,1,1-TCA was the primary solvent used during their operations (GE&R 2021a).

A sewer line was also associated with the currently unoccupied building (Figure 3). Information presented in the *Site Conceptual Model* (GE&R 2021a) indicates that a drain was located in the northeast corner of the building where degreasing operations occurred. The sewer line reportedly exited in the northeast corner of the building.

2.1.2 EA Properties 2 and 3

Two paint booths were formerly located in the southern building of EA Property 2 and permitted by the South Coast Air Quality Management District. Unspecified solvents were alleged to have been used in the paint booths and stored on EA Property 2. In addition, the hazardous materials business plan for EA Property 2 indicated chlorinated solvents were used, but the solvents were not specified (GE&R 2021a). In addition, 1,1,1-TCA was used in spray booths and stored on EA Property 3 (GE&R 2021a).

2.2 Regional Geology and Hydrogeology

The Site is located within the West Coast Basin, which is a subbasin in the southwest portion of the larger Los Angeles Basin. The West Coast Basin is constrained to the west by Santa Monica Bay, on the south by the San Pedro Bay and Palos Verdes Hills, to the east by the Newport-Inglewood Uplift, and on the north by the Ballona Escarpment (Water Replenishment District of Southern California 2019). On a regional scale, the primary hydrostratigraphic units within the subbasin are, from youngest to oldest, the Lakewood, San Pedro, and the Pico Formations. Generally, these units consist of thick sequences of unconsolidated marine and continental deposits that are primarily of Pleistocene and Pilocene age (Reichard et al. 2003).

The unconsolidated Pleistocene sediments comprising the Lakewood Formation are heterogeneous with sandy silts and silty sands interbedded within sands that gradually grade to coarser and thicker material with depth (Reichard et al. 2003). Beneath the Site, this hydrostratigraphic unit is approximately 200 feet thick and is characterized by gravel, sand, sandy silt, silt, and clays (GE&R 2021c). The Lakewood Formation also contains the Gage Aquifer, which is greater than 100 feet thick in the immediate proximity of the Site and consists primarily of sands with lesser amounts of gravel and thin lenses of silts and clays (Reichard et al. 2003; GE&R 2021c).

The San Pedro hydrostratigraphic unit lies immediately below the Lakewood Formation, within the Site area, and contains an extensive 40- to 100-foot-thick clay unit, below which lies the Silverado Aquifer (GE&R 2021c). The Silverado Aquifer consists mainly of sands and gravels with interbedded silt and clay along with occurrences of bluish-grey marine-deposited sand, gravel silt, and clay (Reichard et al. 2003). The aquifer is estimated to be between 250 and 550 feet thick within the general region surrounding the Site (GE&R 2021c). Beneath the Silverado Aquifer lies the upper portion of the Pliocene-age Pico formation, which is described as semi-consolidated sand, silt, and marine clay and forms a lower transmissive zone beneath the San Pedro Formation (Reichard et al. 2003).

The regional groundwater flow directions near the Site are largely controlled by the groundwater injection associated with the West Coast Basin Barrier Project to the west and groundwater extractions to the east (Alta Environmental [Alta] 2017). The West Coast Basin Barrier Project has been operational since the early to mid-1960s and includes a series of north-south oriented injection wells over a 9-mile extent; the closest injection well to the Skypark Commercial Properties is approximately 2.75 miles to the west-northwest (Land et al. 2004). The barrier project has injected water into the Gage, Silverado, and Lower San Pedro aquifers to mitigate the intrusion of saltwater into these freshwater systems (Camp, Dresser, and McKee 1989). Thus, groundwater gradients measured at the Site have generally exhibited an east to southeast regional gradient since the mid-1990s (Alta 2017; GE&R 2021c).

The closest public water supply well appears to be approximately 1.2 miles south–southeast and cross-gradient from the Hi-Shear Plume and does not appear to have chlorinated VOC impacts associated with the Hi-Shear Plume.[5] The closest downgradient water supply wells are located approximately 2.6 miles from the Site and are screened at depths greater than 200 feet bgs (BBL Environmental Services, Inc. 2001). The closest downgradient active well is State well 1910033-022 operated by the California Water Service Company. The well is located over 3 miles from the Site, as shown on GeoTracker (SWRCB 2021) and is screened at an approximate depth of 480 feet bgs. Given the distance of these wells from the Site, and the known chemical concentrations downgradient of the Site, existing data does not indicate that there is a material threat to current drinking water resources at this time.

2.3 Site Geology and Hydrogeology

Geology at the High-Shear Property consists predominantly of silt and clay within the upper 15 to 25 feet of ground surface. This low-permeability unit is consistently encountered across all geologic borings extending from Lowe's on the west side of the Site to the east side of Pennsylvania Avenue, nearly 3,000 feet in distance (GE&R 2021c). Clays and silts are thickest in the western portions of the Site (commonly 20 to 25 feet thick) and generally thin out to approximately 15 feet thick at the central portion of EA Property 1, extending across Crenshaw Boulevard to the east. Beneath this shallow low-permeable unit is a sand and silty sand interval that is typically 15 to 25 feet in thickness (GE&R 2021c).

Geology at the EA Properties consists predominantly of silt and clay within the upper 15 to 25 feet below ground surface (bgs). This low-permeability unit is consistently encountered across the EA Properties (GE&R 2021c). Underlying this shallow low-permeable unit is sand and silty sand that extends to approximately 50 feet bgs (GE&R 2021c; BBJ Group 2021).

A discontinuous unit consisting of silt and clay has been identified beneath this sand and silty sand unit in multiple areas at the EA Properties and beneath Crenshaw Boulevard. Where present, this silt and clay interval is encountered at approximately 40 to 70 feet bgs and ranges in thickness between 10 and 40 feet (GE&R 2021c; BBJ Group 2021). Soil classifications conducted during investigation activities characterize the clay as having high plasticity and commonly grayish brown to greenish gray, grading to dark bluish gray with depth (GE&R 2021). Perched groundwater has also historically been identified immediately above the clay layer or within the unit's interbeds (GE&R 2021c). The perched groundwater is limited to the portion of EA Property 1 and off site to the south and east. This perched groundwater zone has been reported to dip to the west and northwest (GE&R 2021). Locations where perched groundwater have been identified are shown on Figure 6.

Perched groundwater has periodically been observed on the High-Shear Property at the top of the clay intervals. Perched groundwater was not observed during drilling in 2013, 2015, or 2016 (Alta Environmental [Alta] 2017) but was observed on Site in 2020 at multiple borings at depths between 55 and 65 feet bgs (GE&R 2021c).

Perched groundwater was observed on EA Property 1 in 2016 and 2020 at multiple borings at depths between 56.5 and 66 feet bgs (GE&R 2021c). Groundwater was also observed on EA Property 2 in boring VP-105 at a depth of 46.5 bgs, and off site across Crenshaw Boulevard in 2019 at depths between 41 and 56 feet bgs, with the depth to perched groundwater decreasing to the north. Perched groundwater appears to be primarily limited to the southern portion of EA Property 1 and extends onto the adjacent former Nike Missile Base. At this time, no monitoring wells are screened in the perched groundwater zone. This data gap is discussed further in Section 5.

The regional groundwater/Gage Aquifer is first encountered at a depth between approximately 80 to 90 feet bgs and extends across the High Shear and EA Properties and continues to the east beneath Crenshaw Boulevard (GE&R 2021c). The depth of the regional Gage Aquifer extends to approximately 225 feet bgs at the Torrance Municipal Airport to more than 600 feet approximately 1 mile southeast of the EA Properties within the regional Gage Aquifer (Alta 2017).

At the High Shear and EA Properties, the Gage Aquifer material includes high permeability, poorly graded and silty fine sand (GE&R 2021c). An aquifer test was conducted in March 2013, and subsequent data analyses suggest an average hydraulic conductivity value of approximately 50 feet per day for the Gage Aquifer beneath the adjacent Hi-Shear Property (Alta 2013). In addition, routine groundwater monitoring events conducted on and off Site, and the EA Properties, indicate the direction of horizontal groundwater flow is generally towards the east or southeast with a calculated horizontal gradient of approximately 0.001 to 0.002 feet per foot (Alta 2017; GE&R 2021b). However, limited groundwater information is available on the EA Properties as only four groundwater monitoring wells have been installed on these properties. Of these four monitoring wells, only two are screened across first encountered groundwater (MW-12 on EA Property 1 and MW-8 on EA Property 3). Monitoring wells MW-12 and MW-8 are screeded from 90 to 115 and 95 to 120 feet bgs, respectively. Two additional groundwater monitoring wells are collocated with monitoring well MW-12 and are screened at deeper intervals in the Gage Aquifer. Monitoring wells MW-35 and MW-39 are screened from 140 to 150 and 240 to 250 feet bgs, respectively. These four wells provide very limited regional groundwater information on the EA Properties and this data gap is discussed further in Section 5.

An upward hydraulic gradient of 0.004 has been observed in the intermediate/deep well pair MW-35/MW-39 at EA Property 1. Vertical groundwater gradients are variable in the EA Properties vicinity with both upward and downward directions identified within the Gage Aquifer (GE&R 2021c).

The High-Shear and EA Properties lie within the Coastal Plain of Los Angeles (West Coast) groundwater basin. The beneficial uses designated for Site groundwater include municipal and domestic supply, industrial service supply, industrial process supply, and agricultural supply (LARWQCB 2019).

3 Subsurface Characterization

Since 1991, numerous characterization investigations have been performed and conceptual site models have been prepared for the Hi-Shear Plume. Remedial action programs have been conducted at the Hi-Shear Property under LARWQCB oversight to target soil, soil vapor, and groundwater impacts. The COCs associated with the Hi-Shear Property are chlorinated solvents, principally TCE and PCE. The presence of TCE in the regional groundwater presents a potential short-term VI exposure concern. As previously explained, this RAW addresses the Hi-Shear Plume body located between the Hi-Shear Source area and the plume margin located approximately at Crenshaw Boulevard, both of which were addressed in the Groundwater RAW.

In addition to Hi-Shear, other parties named in the Order have recently performed or have identified proposed data gap investigations within the shallow soil source areas on EA Property 1 (Frey Environmental, Inc. [Frey] 2021) or on the off-site former Nike Missile facility adjacent to EA Property 1 to the south (MK Environmental Consulting, Inc. 2021; BBJ Group 2021).

The most recent groundwater monitoring event that is available was conducted by Hi-Shear in November 2020 (off-site wells only) and is documented in the *Second Semi-Annual 2020 Groundwater Monitoring Report* (GE&R 2021b).

3.1 Groundwater on Hi-Shear Property and Prior Remediation

The first groundwater monitoring wells at the Hi-Shear Property were installed in or before 1991. Groundwater concentrations of TCE over 100,000 micrograms per liter (µg/L) were reported at the Hi-Shear Property in on-site monitoring wells in the 1990s, during a period of lower groundwater elevations. Before initial pilot groundwater remediation on the Hi-Shear Property was performed beginning in 2013, groundwater concentrations of TCE ranged up to 42,000 µg/L in on-site well MW-15. PCE was also commonly detected in on-site monitoring wells, though at lower concentrations than TCE. The reason for the decrease in concentrations between the 1990s and 2013 is not certain but may be related to rising groundwater elevations or soil-vapor extraction activities performed at the Hi-Shear Property. The TCE-impacted groundwater plume extended at least 500 feet off-site from the Hi-Shear Property to the east across Crenshaw Boulevard. At the time of Hi-Shear's pilot groundwater remedial activities, the plume characterization was not bounded to the north, south, or east. At that time, based on concentrations observed in well clusters screened at varying depths, Hi-Shear's consultant, Alta, suggested that the chlorinated solvents in the groundwater plume were primarily migrating horizontally from the Hi-Shear Source in the aquifer rather than vertically (Alta 2012).

Groundwater remedial action programs at the Hi-Shear Property have included two EISB pilot tests in a limited area followed by one round of injection at the Hi-Shear Property. In February 2012, Alta prepared a *Conceptual Remedial Action Plan* and the EISB remedial option was selected (Alta 2012). Before the pilot tests were conducted at the Hi-Shear Property, work plans were submitted to the LARWQCB (Alta 2014a, 2014b, and 2016a). The first pilot test was conducted in August 2013, followed by a second pilot test in October 2015—both applications being upgradient of well MW-15. The pilot tests consisted of EISB supplemented with bioaugmentation and chemical reduction. Following the pilot tests, Alta prepared a *Groundwater Remedial Action Plan* (Alta 2016b) which evaluated a broad range of remedial technologies and alternatives in general accordance with the NCP selection criteria. The 2016 *Groundwater Remedial Action Plan* selected the EISB technology, which included one round of injection of EISB in 77 dual-nested injection wells. The well locations and screening intervals, permitting, mixing and injection procedures, groundwater monitoring, and post-injection reporting were included in Alta's *Groundwater Remedial Action Plan*.

This injection program was conducted by Alta between January 31 and April 5, 2017 (Alta 2017). The remedial effort lowered VOC concentrations near the injection wells with the highest reduction of VOCs around the pilot test, upgradient of monitoring well MW-15. The historical highest concentration of TCE in groundwater at MW-15 was 56,000 µg/L in August 2011 but was reduced to 12 µg/L in March 2018, approximately 1 year after the 2017 injection event program. As shown in the most recent groundwater sampling event in December 2019, the sustained TCE concentration of 22 µg/L in well MW-15 demonstrated that where enough product was injected, the selected remedial technology of EISB reduced VOC concentrations (GE&R 2021b).

Other areas of the Hi-Shear Property with elevated VOC concentrations, such as monitoring well MW-18 (with its highest historical TCE concentration of 77,000 µg/L in August 2011), did not show similar large VOC reductions. As shown on Figure 4, the TCE concentration in groundwater at MW-18 was reported at 5,100 µg/L in December 2019, its most recent sampling event (GE&R 2021b).

While some areas exhibited VOC reductions, much of the groundwater plume at the Hi-Shear Property does not appear to have been sufficiently treated. This conclusion is evident in areas where individual VOC concentrations exceed 1 percent of their pure-phase solubilities (14,720 and 2,000 µg/L for TCE and PCE, respectively) which, consistent with the USEPA rule of thumb (1992), is considered indicative of the probable occurrence of dense non-aqueous phase liquid (DNAPL).

As EISB only dechlorinates VOCs dissolved in water, DNAPL often requires a long-term iterative EISB strategy to dissolve the reserve of DNAPL found in the formation into the groundwater over time. Other possible reasons for the limited success of the Hi-Shear EISB treatment include poor implementation of the EISB remedy resulting from insufficient product application, poor substrate to VOC contact or poor distribution of the substrate, and/or insufficient geochemistry alteration. It does appear that the first round of injection was sufficient to remediate much of the central plume area near the Hi-Shear property border which effectively bifurcated the groundwater plume with the apparent reduction of VOCs immediately downgradient of the more persistent non-aqueous phase liquid (where releases appear to have occurred on the Hi-Shear Property), creating the Hi-Shear Source.

Hi-Shear installed four groundwater monitoring wells (MW-8, MW-12, MW-35, and MW-39) at the EA Properties. Wells MW-8 and MW-12 are screened from 95 to 120 and 90 to 115 feet bgs, respectively, MW-35 is an intermediate monitoring well (150 feet total depth), and MW-39 is a deep monitoring well (250 feet total depth). All wells on the EA Properties, except for deep monitoring well MW-39, appear to be impacted with VOCs—primarily TCE; however, the impacts appear to have been influenced from cross contamination caused during well installation.[5] As shown on Figure 4, TCE concentrations were reported at 10,000 µg/L in Well MW-12 (EA Property 1) and at 5,000 µg/L at well MW-8 (EA Property 3) in December 2019.

The closest upgradient monitoring wells to the EA Properties from the Hi-Shear Property, are MW-13 and MW-34, located in the southeast corner of the Hi-Shear Property. These two wells, along with, MW-21 (installed along Crenshaw Boulevard), were last sampled in 2019 and 2020, when concentrations of TCE and PCE ranged from 6.3 to 130 and 26.8 to 190 µg/L, respectively.

3.2 EA Properties Investigations

The subsurface characterization data for the EA Properties is derived primarily from investigations performed by Hi-Shear, beginning in 1991. More recent investigations on the EA Properties include:

- 2015 and 2016: *Interim Offsite Assessment*, 2530-2540 Skypark Drive and 24701-247474 Crenshaw Boulevard (EA Properties 2 and 3; Alta 2016c);
- 2021: *Screening Level Vapor Intrusion Human Health Risk Assessment Report,* 2530-2540 Skypark Drive (EA Property 3; Stantec 2021a), and *Screening Level Vapor Intrusion Human Health Risk Assessment Report*, 24701-247474 Crenshaw Boulevard (EA Property 2; Stantec 2021b);
- Chemical Inventory Survey, *Indoor Air Quality Investigation and Sub-Slab Soil Vapor Sampling Report*, 24751-24777 Crenshaw Boulevard (EA Property 1; Frey 2021a);
- *Human Health Risk Assessment of Soil Exposure, Vapor Intrusion Investigation to Indoor Air, and Indoor Air Report* (Environmental Health Decisions 2021); and
- *Subsurface Soil Investigation*, 24751-24777 Crenshaw Boulevard (EA Property 1; Frey 2021b).

Primary impacts identified have been in soil, soil vapor and groundwater and the primary COCs identified in these investigations are chlorinated VOCs, principally TCE, PCE, 1,1-dichloroethene (1,1-DCE), and Freon 113. Impacts to soil, soil vapor and groundwater are discussed in the sections below. Recent shallow soil investigations were performed on EA Property 1 with the installation of 18 membrane-interface probes (MIPs; Frey 2021b) and on the off-site former Nike Missile facility located adjacent to EA Property 1 to the south (GE&R 2020). A comprehensive description of previous investigations on the EA Properties is included in the *Updated Site Conceptual Model* (GE&R 2021a). The results of soil, soil vapor, and groundwater investigations at the EA Properties are described below.

[5] Well MW-35 was drilled and installed to 150 feet bgs, through a zone at 90 to 115 feet bgs with a detected TCE concentration of 10,000 µg/L. Well MW-35 was not installed with an outer (conductor) casing, which are typically used as barriers to minimize the potential for vertical cross contamination to wells installed in deeper zones. Since a conductor casing was not installed, and based on groundwater data collected from this well, it appears that cross contamination occurred during the well installation process. Well MW-35 has been sampled three times since installation in March, June, and November 2020 and concentrations have decreased with each sampling event—from 5,890 µg/L in March, to 3,100 µg/L in June, and 1,180 µg/L in November.

3.3 Soil

Approximately 210 soil samples have been collected and analyzed for VOCs on the EA Properties. TCE, PCE, cis-1,2-dichloroethene (cis-1,2-DCE), and 1,1-DCE were all detected in soil samples collected, primarily on EA Property 1. The following maximum detected concentrations in soil were highest on EA Property 1:

- PCE: 3.39 milligrams per kilogram (mg/kg) (at 55 feet bgs in VP-50, located at the border of the former Nike Base)
- TCE: 0.223 mg/kg TCE (at 40 feet bgs in VP-25)
- Cis-1,2-DCE: 0.0419 mg/kg (at 40 feet bgs in VP-25)
- 1,1-DCE: 6.320 mg/kg (at 55 feet bgs in VP-50, located at the border of the former Nike Base property)

The highest concentrations in soil were detected in soil samples collected from borings VP-25 and VP-50 (Figure 3). Maximum detected concentrations in soil on EA Properties 2 and 3, respectively, were lower:

- PCE: 0.28 and 0.012 mg/kg
- TCE: 0.037 and 0.0042 mg/kg
- Cis-1,2-DCE: 0.011 and 0.0049 mg/kg

3.4 Soil Vapor

Potential soil vapor impacts exist within the EA Properties. The most pervasive and highest concentration constituents detected in soil vapor are TCE, PCE, and 1,1-DCE. TCE is detected in soil vapor across the Hi-Shear and EA Properties, with the highest concentrations detected on the Hi-Shear Property. PCE and 1,1-DCE are also prevalent in soil vapor across the Hi-Shear and EA Properties, but the highest vapor concentrations of PCE and 1,1-DCE were detected in the southern portion of EA Property 1.

Soil-vapor probes were first installed at the EA Properties in 2014 as a part of a larger investigation of the neighboring Hi-Shear Property (GE&R 2016). These probes included VP-25 in the northern center of EA Property 1, VP-26 on the northern edge of EA Property 3, and VP-31 in the northeast corner of EA Property 2. Initial concentrations of PCE detected in well VP-25, located in the northern portion of EA Property 1, ranged from a minimum concentration of 18,600 micrograms per cubic meter (μg/m^3) at 15 feet bgs to 1,540,000 μg/m^3 at 45 feet bgs. TCE detections from this sampling event ranged from 7,930 μg/m^3 at 5 feet bgs to 874,000 μg/m^3 at 65 feet bgs. 1,1-DCE and vinyl chloride (VC) were also detected above screening levels at maximum concentrations of 124,000 and 208 μg/m^3, respectively, at 65 feet bgs.

Six soil vapor probes, VP-42 and VP-46 through VP-50 were installed at EA Property 1 in 2016. The first sampling of these probes was conducted in May and June of 2016, where PCE was detected at a maximum concentration of 35,900,000 μg/m^3 at a depth of 85 feet bgs in VP-49 (located adjacent to the former degreaser area), and TCE was detected at a maximum concentration of 1,650,000 μg/m^3 at 85 feet bgs in VP-48. A second sampling event was conducted in January and March 2020, and the highest PCE and TCE concentrations detected were both in VP-50 at 53 feet bgs at 71,500,000 and 4,100,000 µg/m^3, respectively.

An additional six probes, VP-106 through VP-109, VP-113 and VP-114, were installed in January 2020 on EA Property 1 and within the area of the former Nike Missile Base, which is currently utilized as a parking lot and associated with the Lexus car dealership.

In the overall sampling of the 13 total soil vapor probes installed on EA Property 1, shallow PCE concentrations were observed to increase with proximity to the northeast corner of the unoccupied building. At 5 feet bgs, PCE concentrations ranged from 201 µg/m^3 in VP-106 to 17,700,000 µg/m^3 in VP-49. VP-106 is located on the east side of the 24777 building, and VP-49 is located just outside the northeast corner of the 24571 building, where the former sewer line of the former degreaser exits the building. Of these probes, PCE was detected at a maximum concentration of 35,900,000 µg/m3 in VP-49, located near the former degreasing operations, at a depth of 85 feet bgs. The highest PCE concentrations were detected at the deepest probe depths in five of the six soil vapor probes. PCE was also detected at elevated concentrations of 17,700,000 and 27,900,000 µg/m^3 at 5 and 15 feet bgs in VP-49. The concentrations in VP-49 decreased to 11,500,000 and 5,880,000 µg/m^3 at 25 and 45 feet bgs, respectively. Vapor probes VP-42 and VP-49 are both located along the former sewer line near the currently unoccupied building EA Property 1. The high soil vapor concentrations at shallow depths suggest that a release of chlorinated solvents from the sewer line may have occurred.

Elevated concentrations of 1,1-DCE were detected in soil vapor probes on EA Property 1. In the 5-foot probes, 1,1-DCE was detected at 5,070,000 µg/m^3 in probe VP-49 located near the former degreaser and sewer line in sampling conducted in 2016 and 1,470,000 µg/m^3 in sampling conducted in 2020. Elevated concentrations of 1,1-DCE was also detected in VP-49 at 15, 25, and 45 feet bgs, with the highest concentration detected at 45 feet bgs at 13,300,000 µg/m^3 in 2016 sampling. The highest 1,1-DCE concentrations were detected at VP-50, located in the southern portion of EA Property 1 south of the former degreasing operations, at 53 feet bgs at 86,700,000 µg/m^3.

TCE was detected at a maximum concentration of 1,650,000 µg/m^3 in VP-48, located north of the unoccupied building on Property 1, at 85 feet bgs. The highest TCE concentrations were detected at the deepest sampling depth in five of the six soil vapor probes, suggesting that the source of the TCE vapor plume originates in the regional groundwater migrating from the Hi-Shear Property.

Shallow TCE concentrations, however, do not follow the same trend as the PCE concentrations. The lowest concentration of TCE at 5 feet bgs is 79 µg/m^3 in VP-49, with the highest at 42,300 µg/m^3 in VP-46. VP-46 is located in the northwest corner of EA Property 1, near the border with the Hi-Shear Property.

3.5 Off-property Soil Vapor

Ten soil vapor wells were installed south of EA Property 1 on the Torrance Airport, in the area of the former Nike Missile Base. Most of the probes in this area were installed to a maximum depth of 45 to 60 feet bgs due to perched groundwater, and only one of the probes was installed 85 feet bgs (VP-112). Four of the ten probes, VP-108, VP-109, VP-113, and VP-114, are located in an area of the former Nike

Missile Base that is currently in use as a parking lot by the Lexus car dealership. Shallow concentrations of PCE in these probes range from 5,590 µg/m^3 in VP-109 to 25,400 µg/m^3 in VP-108. Of these four wells, VP-109 is located furthest southeast from EA Property 1, while VP-108 is located on the EA Property 1 border along the line of the former 24571 building sewer. Shallow concentrations of TCE show a similar trend, with concentrations ranging from 237 µg/m^3 in VP-113 to 1,580 µg/m^3 in VP-108, both of which were installed at 5 feet bgs.

Shallow PCE and TCE concentrations decrease with distance from the EA Property 1 boundary. PCE concentrations at 5 feet bgs have been detected above the commercial screening level of 67 µg/m^3 furthest south in soil vapor wells VP-109 and VP-116, approximately 225 south and 445 feet southwest of the EA Property 1 boundary, respectively. TCE concentrations at 5 feet bgs have been detected above the commercial screening level of 100 µg/m^3 furthest south in soil vapor well VP-109.

PCE and TCE concentrations at deeper depths in the four EA Property 1 adjacent soil vapor wells tend to decrease eastward, with PCE concentrations at 40 to 45 feet bgs ranging from 1,260 µg/m^3 in VP-109 to 26,800,000 µg/m^3 in VP-114, and TCE concentrations at 40 to 45 feet bgs ranging from below laboratory detection limits in VP-109 to 231,000 µg/m^3 in VP-114.

Deep PCE and TCE vapor concentrations also decrease with distance from the EA Property 1 border and overall plume. PCE has been detected at the commercial screening level at 55 feet bgs in VP-131, the furthest south soil vapor well installed along Crenshaw Boulevard on the former Nike Missile Base. TCE was detected above the commercial screening level at 65 feet bgs in VP-112, but below the screening level at 85 feet bgs and in all soil vapor wells further south.

Overall, the highest vapor concentrations of PCE and TCE within the EA Properties have been detected near the southern EA Property 1 boundary. The elevated concentrations of PCE, particularly in the shallow sampling depths, indicate a source from EA Property 1, whereas lower but increasing with depth TCE concentrations indicate a source from the regional TCE plume originating from the Hi-Shear Source areas.

As described in Section 5, and as part of the removal action implementation, additional soil vapor data are proposed to be collected on EA Property 1 and off Site on the former Nike Missile Base to further delineate the extent of soil vapor impacts in these areas.

EA Properties Groundwater

Groundwater at the EA Properties has been encountered in two distinct zones. Perched groundwater has been encountered in four locations on the EA Properties (VP-105 on EA Property 2 and at VP-42, VP-50, and VP-106 on EA Property 1). In addition, 12 of the soil-vapor probes south and southeast of EA Property 1 encountered perched groundwater during installation. The perched groundwater at these locations varied in depth from 41 to 66.5 feet bgs.

Regional groundwater is encountered at approximately 85 to 90 feet bgs. The first regional groundwater monitoring well installed at the EA Properties was MW-8, which was installed on the northern portion of EA Property 3 in 1992. Additional monitoring wells MW-12, installed in 2001, and MW-35 and MW-39, installed in 2020, are co-located at the northwest corner of the 24777 Crenshaw Boulevard building on EA Property 1.

Wells MW-8 (EA Property 3) and MW-12 are designated shallow wells and are screened from 95 to 120 and 90 to 115 feet bgs, respectively. MW-35 is an intermediate monitoring well (screened from 140 to the total depth of 150 feet bgs), and MW-39 is a deep monitoring well (screened from 240 to the total depth of 250 feet bgs). As mentioned previously, groundwater information is limited on the EA Properties and, due to this data gap, information on groundwater flow and chemistry are also limited. Additional groundwater characterization is proposed as part of this RAW in Section 6.

Three of the four wells on the EA Properties (MW-8, MW-12, and MW-35) have had significant VOC detections. PCE has been detected above screening levels at a maximum concentration of 1,200 µg/L in December 2011 in MW-8, and 2,500 µg/L in April 2010 in MW-12. More recent PCE concentrations (2019) were 70 and 100 µg/L (MW-8 and MW-12, respectively).

All wells on the EA Properties, except for deep monitoring well MW-39, appear to be impacted with VOCs—primarily TCE; however, the impacts to well MW-35 appear to have been influenced from cross contamination caused during well installation.[6] TCE concentrations were reported at 10,000 µg/L in Well MW-12 (EA Property 1) and 5,000 µg/L in well MW-8 (EA Property 3) in December 2019.

TCE concentrations have varied over time in wells MW-8 and MW-12. From the first sampling event in 1993 through 1997, TCE concentrations in MW-8 averaged approximately 2,300 µg/L. From 1997 to 2007, concentrations rose to a maximum of 76,000 µg/L, after which they gradually decreased to just below 30,000 µg/L in early 2015. TCE concentrations in MW-8 sharply decreased from 2015 until early 2017, averaging approximately 700 µg/L until the most recent sampling event in December 2019, which detected a higher concentration of 5,100 µg/L. TCE concentrations in MW-12 have remained comparatively stable, slowly increasing from the first sampling event at a concentration of 2,900 µg/L in 2001 to a high of 19,000 µg/L in late 2017. This concentration has decreased to 10,000 µg/L in the most recent sampling event.

The closest upgradient monitoring wells to the EA Properties from the Hi-Shear Property, are MW-13 and MW-34, located in the southeast corner of the Hi-Shear Property. Based on the available data, these two wells, along with, MW-21 (installed along Crenshaw Boulevard), were last sampled in 2019 and 2020, when concentrations of TCE and PCE ranged from 6.3 to 130 and 26.8 to 190 µg/L, respectively.

PCE, TCE, and 1,1-DCE were detected in groundwater at concentrations up to 36,600, 2,870 and 56,000 micrograms per liter (µg/L), respectively, and cis-1,2-DCE, trans-1,2-dichloroethene (trans-1,2-DCE), and VC were also detected in select samples. Perched groundwater was observed on the Hi-Shear Property

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[6] Well MW-35 was drilled and installed to 150 feet bgs, through a zone at 90 to 115 feet bgs with a detected TCE concentration of 10,000 µg/L. Well MW-35 was not installed with an outer (conductor) casing, which are typically used as barriers to minimize the potential for vertical cross contamination to wells installed in deeper zones. Since a conductor casing was not installed, and based on groundwater data collected from this well, it appears that cross contamination occurred during the well installation process. Well MW-35 has been sampled three times since installation in March, June, and November 2020 and concentrations have decreased with each sampling event—from 5,890 µg/L in March, to 3,100 µg/L in June, and 1,180 µg/L in November.

at depths between 48 and 58.8 feet bgs. PCE, TCE, and cis-1,2-DCE were detected in groundwater at concentrations up to 66,000, 53,000, and 220,000 µg/L, respectively. Cis-1,2-DCE, trans-1,2-DCE, and VC were detected only in boring VP-122 on the Hi-Shear Property. Perched groundwater has also been observed off Site across Crenshaw Boulevard in 2019 at depths between 41 and 56 feet bgs, with the depth to perched groundwater decreasing to the north. Chemicals of potential concern PCE, TCE, cis-1,2-DCE, and 1,1-DCE were only detected in boring VP-63.

The closest upgradient monitoring wells to the EA Properties from the Hi-Shear Property, MW-13 and MW-34, are located in the southeast corner of the Hi-Shear Property. These two wells, along with, MW-21 (installed along Crenshaw Boulevard), were last sampled in 2019 and 2020, when concentrations of TCE and PCE ranged from 6.3 to 130 and 26.8 to 190 µg/L, respectively.

Perched groundwater has also been encountered in four locations on the EA Properties—VP-105 on EA Property 2 and at VP-42, VP-50, and VP-106 on EA Property 1. The perched groundwater ranges in elevation from 38.15 feet above mean sea level in VP-110 to 22.94 feet above mean sea level in VP-42, i.e., approximately 53 to 59 feet bgs.

3.6 Groundwater Remediation on Hi-Shear Property and Effect on EA Properties

EISB pilot tests were implemented on the Hi-Shear property to assess the effectiveness of this technology in the known TCE and PCE source area. The first pilot test was conducted in August 2013, followed by a second pilot test in October 2015—both applications were upgradient of well MW-15, located near the EA Property 1 and 3 border. The pilot tests consisted of EISB supplemented with bioaugmentation and chemical reduction and injections of EISB substrate in 77 dual-nested injection wells.

This injection program was conducted by Alta between January 31 and April 5, 2017 (Alta 2017). As a result, the remedial effort showed success lowering VOC concentrations near the injection wells with the highest reduction of VOCs around the pilot test, upgradient of monitoring well MW-15. The historical highest concentration of TCE in groundwater at MW-15 was 56,000 µg/L in August 2011 and reduced to 12 µg/L in March 2018, approximately 1 year after the 2017 injection event program. As shown in the most recent groundwater sampling event in December 2019, the sustained TCE concentration of 22 µg/L in well MW-15 has demonstrated, where enough product was injected, the selected remedial technology of EISB was successful (GE&R 2021b).

After implementation of the pilot remedial program at the Hi-Shear Property in 2017, the VOC concentrations were reduced primarily along the eastern boundary of the Hi-Shear Property, downgradient (east) of known source areas on the property, where only dissolved contaminant constituents appear present, bifurcating the historical VOC plume.

While the remedial efforts resulted in reduction of VOC concentrations in groundwater at the Hi-Shear Property (primarily at the eastern boundary in the vicinity of groundwater monitoring well MW-15), they did not reduce VOC concentrations in the portion of the plume that had already migrated beyond the Hi-Shear Property and beneath and beyond the EA Properties. This incomplete remedial effort allows further migration of the VOC plume east of Crenshaw Boulevard into the residential community within the City of Lomita.

This progress suggests that the pilot remedial technology selected (EIS) and implemented by Hi-Shear effectively reduces VOCs in groundwater containing the dissolved constituents; however, since it was a limited pilot study, it was not implemented in the regional groundwater downgradient from the Hi-Shear Property. Though concentrations of TCE in groundwater have decreased in groundwater monitoring well MW-8, near the northern edge of the Site, concentrations have not decreased in well MW-12 in the center of the Site or in well MW-20 in Crenshaw Boulevard.

Other areas of the Hi-Shear Property with elevated VOC concentrations, such as monitoring well MW-18, located further upgradient from the EA Properties (with its highest historical TCE concentration of 77,000 µg/L in August 2011), did not show similar large VOC reductions. TCE concentration in groundwater at MW-18 was reported at 5,100 µg/L in December 2019, its most recent sampling event (GE&R 2021b).

While some areas exhibited VOC reductions, much of the groundwater plume at the Hi-Shear Property was not sufficiently treated. This is evident in areas where individual VOC concentrations exceed 1 percent of their pure-phase solubilities (14,720 and 2,000 µg/L for TCE and PCE, respectively) suggesting possible DNAPL. As previously discussed, areas with potential DNAPL present require long term repetitious EISB injections to destroy contaminants in the aqueous phase to increase dissolution of VOCs into groundwater. This process requires more time to exhaust the reservoir of DNAPL occurring in the soil matrix.

While TCE concentrations in monitoring well MW-15, near the EA Properties' border with the Hi-Shear Property, have decreased following the EISB injection program at Hi-Shear, elevated TCE concentrations persist and will pose a risk to the EA Properties, which lie immediately downgradient of the Hi-Shear injection and TCE source areas.

4 Nature and Extent of Chemical Impacts

The nature and extent of chemicals impacts identified at the EA Properties are discussed below by media.

4.1 Soil

The highest VOC concentrations in soil at the EA Properties were detected on EA Property 1. PCE, TCE, and 1,1-DCE were the most frequently detected chemical (GE&R 2021). Except for TCE, the highest PCE and 1,1-DCE detections are on the DCH sublease area of EA Property 1, in the vicinity of the former degreasers. Though the highest detections are found at 55 feet bgs in boring VP-50 located in the southern portion of the DCH sublease of EA Property 1, these detections may be influenced by perched groundwater which was encountered at approximately 57 feet bgs. Shallower PCE and 1,1-DCE detections are centered around borings MIP-7 and MIP-8 in the vicinity of the former degreasers.

4.2 Soil Vapor

Elevated PCE, TCE, and 1,1-DCE are present in soil vapor across the EA Properties. TCE in soil vapor is present over a large area of the Hi-Shear Property and the EA Properties (Figures 13, 14, and 15). The highest TCE concentrations in soil vapor are detected on the Hi-Shear Property (shallow depths) with lesser concentrations being detected on the EA Properties at deeper depths. The higher, deeper TCE soil-vapor detections on the EA Properties indicate that its source is the regional groundwater TCE plume migrating from the Hi-Shear Property.

At 5 feet bgs, PCE concentrations are highest in vapor probe VP-49 on EA Property 1 on the north side of the unoccupied building. PCE detected at 5 feet bgs extends off EA Property 1 in all directions, but concentrations decrease with distance away from VP-49 until they are not detected (Figure 10). At 45 feet bgs, PCE concentrations are highest of any interval sampled (Figure 11), with detections exceeding 20,000,000 $\mu g/m^3$, centered around southern portion of EA Property 1 in vapor probe VP-114 to the east on the former Nike Missile Base. Like the 5-foot interval, concentrations decrease with distance off EA Property 1. The 45-foot interval detections may be related to off-gassing from perched groundwater, which occurs in the southern portion of EA Property 1 and is also present to the south on the former Nike Missile Base where elevated concentrations of PCE and 1,1-DCE are detected (see Section 5.3). PCE concentrations remain elevated at 85 feet bgs (Figure 12), with the highest detections in vapor probes VP-48 and VP-49 on EA Property 1. Similar to the 5- and 45-foot intervals, concentrations decrease with distance away from EA Property 1. Concentrations of 1,1-DCE mirror those of PCE, with elevated concentrations detected at 5, 45, and 85 feet bgs (Figures 16, 17, and 18), and the highest concentrations centered around the southern portion of EA Property 1 and the unoccupied building. Like PCE, the center of mass is located around vapor probes VP-49, VP-50, and VP-114.

4.3 Groundwater

Groundwater at the EA Properties has been encountered in two discrete zones—perched groundwater which occurs at approximately 45 to 65 feet bgs, and regional groundwater which occurs at approximately 80 to 90 feet bgs. However, sparce groundwater data is available on the EA Properties. Perched groundwater has been encountered between 45 and 65 feet bgs in soil vapor probes advanced in the southern portion of EA Property 1 and off Site to the south and east, yet no groundwater monitoring wells are completed in the perched groundwater zone. As for regional groundwater, only two shallow zone monitoring wells are completed on the EA Properties, well MW-8 on Property 3 and well MW-12 on Property 1. No shallow regional groundwater data is available on the remainder of the EA Properties.

Chlorinated VOCs identified in groundwater at the EA Properties include TCE, PCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, VC, 1,1-dichloroethane, 1,1,1-TCA, 1,2-dichloroethane, and 1,1,2-trichloroethane. Other constituents reported in the groundwater include benzene, toluene, hexavalent chromium, 1,4-dioxane, and perchlorate. Of these, the most prevalent impacts are from TCE, PCE, and 1,1-DCE.

Perched groundwater has been encountered in the southern portion of EA Property 1 and extends to the south and east on to the former Nike Missile base and into the City of Lomita. Perched groundwater was not encountered further north on EA Property 1. The primary impacts to perched groundwater are from PCE and 1,1-DCE, and the highest concentrations are from grab groundwater samples collected from vapor probes VP-50 in the southern portion of EA Property 1, south of the unoccupied building where degreasing operations occurred, and VP-114 located just east of EA Property 1 on the former Nike Missile Base. PCE and 1,1-DCE detections in perched groundwater attenuate with distance away from EA Property 1 until they are not detected on the former Nike Missile Base property.

The principal impacts to regional groundwater are from significant releases on the High-Shear Property, as described in the Groundwater RAW (Terraphase 2022). Historical high concentrations of TCE suggest that DNAPL appears to be present in the regional aquifer, with VOC affected groundwater emanating from the Hi-Shear Property as it flows through the Hi-Shear Source. After implementation of the pilot remedial program at the Hi-Shear Property in 2017, the VOC concentrations were reduced primarily along the eastern, downgradient, boundary of the Hi-Shear Property, along the border of the EA Properties. However, significant concentrations and mass of TCE have migrated onto the EA Properties, with the highest current concentration of 10,000 μg/L being detected in monitoring well MW-12.

While the remedial efforts by High-Shear resulted in reduction of VOC concentrations in groundwater at the Hi-Shear Property (primarily at the eastern boundary in the vicinity of groundwater monitoring well MW-15), they did not reduce VOC concentrations in the portion of the plume that had already migrated beyond the Hi-Shear Property and beneath and beyond the EA Properties. This incomplete remedial effort allows further migration and persistence of the VOC plume on the EA Properties. This progress suggests that the pilot remedial technology selected and implemented (EISB) by Hi-Shear effectively reduces VOCs in groundwater containing the dissolved constituents; however, since it was a limited pilot study, it was not implemented in the regional groundwater downgradient from the Hi-Shear Property and did not remediate groundwater on the EA Properties or beyond. Though concentrations of TCE in groundwater have decreased in groundwater monitoring well MW-8, near the northern edge of the EA Properties, concentrations have not decreased in well MW-12 on EA Property 1.

5 Evidence of Releases, Data Gaps, and Proposed Investigation

The following sections discuss evidence of apparent releases at the EA Properties, data gaps, and a proposed investigation addressing the data gaps to facilitate removal action final design.

5.1 Sources of VOC Impacts

The primary VOC impacts to the EA Properties appear to be from two distinct sources. The principal source of regional groundwater impacts on the EA Properties is from the High Shear Property. The primary source of soil, soil vapor (at shallow depths), and the perched groundwater impacts on the EA Properties appear to be the former degreaser area in the unoccupied building on EA Property 1. The evidence for these potential EA Property 1 sources is described below. While other sources could be present, and could become apparent with more characterization and data, these sources are evidenced by the history of chemical use as well as the available sampling data.

5.1.1 Evidence of a Release to Regional Groundwater

As described in the Groundwater RAW (Terraphase 2022), substantial releases primarily consisting of TCE and PCE occurred on the Hi-Shear Property. These releases have impacted regional groundwater that has migrated downgradient onto the EA Properties. The highest groundwater concentration of TCE within the EA Properties was detected in monitoring well MW-12, located on EA Property 1, with the most recent 2020 sampling of MW-12 showing a TCE detection of 10,000 μg/L. Significant concentrations of PCE, however, do not appear to be migrating within the regional groundwater onto the EA Properties from the High-Shear Property, as only low concentrations were detected in well MW-12 (100 μg/L) in the most recent 2020 sampling event.

5.1.2 Evidence of a Release at the EA Properties

Four lines of evidence indicate that releases potentially occurred at EA Property 1. These lines of evidence include (1) use of PCE and 1,1,1-TCA in degreasing operations, (2) elevated detections of PCE and 1,1-DCE (degradation product of 1,1,1-TCA) in soil, (3) elevated detections of PCE and 1,1-DCE in soil vapor, and (4) elevated detections of PCE and 1,1-DCE in perched groundwater.

- As described in Section 2.1, PCE and 1,1,1-TCA were used in the degreasing operations in the currently unoccupied building at EA Property 1 (Figure 3) beginning around 1967. Previous investigation data including soil, soil vapor, and perched groundwater suggest that a release occurred within this area of degreasing operations.
- PCE and 1,1-DCE are both detected in soil, soil vapor, and perched groundwater in the vicinity of the former degreasers on EA Property 1. Though 1,1-DCE was not known to be used as a solvent in the degreasers, it is a common degradation product of 1,1,1-TCA and is often considered to be an indicator of a past 1,1,1-TCA release (Schuetz, Durant, Hansen, and Bjerg 2011).

- PCE was detected in soil in the vicinity of the previous degreasing operations at up to 1.6 mg/kg (boring MIP 7) and 1,1--DCE was also detected in soil in the same boring in the upper 20 feet bgs (Figures 8 and 9). PCE and 1,1-DCE were also detected at concentrations of 1.1 and 0.6 mg/kg in soil samples collected from boring MIP-8, which was advanced in the vicinity of the former degreaser.
- PCE and 1,1-DCE were also detected at elevated concentrations in soil vapor samples collected in the vicinity of the former degreasing operations. PCE was detected at elevated concentrations at location VP-49 at 5 feet bgs, located northeast of the former degreasers and near the former sewer line. PCE was detected at elevated concentrations of 17,700,000 and 27,900,000 µg/m3 at 5 feet and 15 feet bgs in VP-49 in 2016 sampling and 593,000 and 1,860,000 µg/m3 at 5 and 15 feet bgs, respectively, in 2020 sampling. 2020 concentrations are shown on Figure 10. The concentrations in VP-49 decreased to 11,500,000 and 5,880,000 µg/m3 at 25 and 45 feet bgs, respectively. 1,1-DCE was also detected at 5,070,000 µg/m3 at 5 feet bgs in 2016, with a maximum concentration of 13,600,000 µg/m3 at 15 feet bgs. PCE and 1,1-DCE were also detected at elevated concentrations in vapor probe VP-107 (located north of the unoccupied building on EA Property 1), VP-114 (located southeast of the building), and VP-108 (located east of the building along the former sewer line; Figures 10 and 16), with PCE and 1,1-DCE detected at 26,800,000 and 22,800,000 µg/m3, respectively, in VP-114 at 45 feet bgs, and 13,700,000 µg/m3 in VP-50 at 45 feet bgs (Figure 11). The highest concentrations of PCE and 1,1-DCE are detected in the DCH sublease portion of EA Property 1 in the vicinity of the former degreasers.
- In addition to the soil and soil vapor data, perched groundwater data also support a release in the vicinity of the former degreasers on EA Property 1. The highest concentrations were detected in vapor wells VP-50 and VP-114, with PCE and 1,1-DCE detected at 36,600 and 56,000 µg/L in VP-50 (Figures 6 and 7).

These four lines of evidence suggest that a release of PCE and 1,1,1-TCA occurred in the vicinity of the former degreasers on EA Property 1. The apparent releases have caused a potential VI concern with the LARWQCB, could potentially migrate to regional groundwater, and require a removal action.

In recent reports published for EA Property 1 (*Preliminary Site Conceptual Model* [MK Environmental Consulting 2021] and *Preliminary Site Conceptual Model Report* [BBJ Group, LLC 2021]), the authors contend that apparent releases at EA Property 1, as evidenced by elevated soil vapor and perched groundwater concentrations, are likely related to chemicals that have migrated from the former Nike Missile Base. However, no evidence of chemical usage or releases of chemicals on the former Nike Missile Base was provided. Instead, general practices at Nike Missile sites are presented, but not directly linked to the former Nike Missile Base south of EA Property 1.

This RAW includes proposed additional soil, soil vapor and groundwater characterization on the former Nike Missile Base to better understand potential releases in this area. We also understand that additional characterization work has been proposed by Esterline Technologies Corporation (BBJ Group 2021) on the former Nike Missile Base; however, this work has not yet been approved by the LARWQCB.

5.2 Data Gaps and Proposed Investigation

Data gaps exist on EA Property 1 that limit the certainty of understanding of soil, soil vapor, and groundwater. Additional data are needed to better understand and define the nature and extent of impacts, particularly in relation to the sources identified in Section 5.1, and to implement removal actions to address the chemical impacts. The data gaps and proposed investigation activities are discussed below by media.

5.2.1 Soil and Soil Vapor

As described above, impacts to soil and soil vapor are present on EA Property 1. The sources of impacts on EA Property 1 are in the vicinity of the former degreasers and sewer line (Figure 3). Recent soil samples on EA Property 1 identified chemical impacts centered around boring locations MIP-7 and MIP-8. Currently, soil samples in the vicinity of the former degreasers have only been collected to 20 feet bgs. Additional soil data is needed to define the vertical extent of soil impacts and to inform the remedial design. Additional soil vapor data is also needed to further the understanding of soil vapor impacts in the southern portion of EA Property 1 and on the former Nike Missile Base, to provide additional data on the extent of a release from the former degreasers, and to identify if releases of PCE, or 1,1,1-TCA occurred from the former sewer line associated with the former degreaser area. Sampling will be conducted in the southern portion of EA Property 1, around the unoccupied building, and along the former sewer line that may have run from the building to Crenshaw Boulevard (Figure 19). These additional data will inform the depth of the removal action on and around EA Property 1 and will provide information on the aerial extent of the contamination and thus the lateral scope of the removal action. It may also identify other potential source areas, such as the sewer line. If additional sources are discovered, the scope of the removal action may require modification.

The sampling plan will include 11 locations for soil and soil vapor sampling at the locations shown on Figure 19. At each location, the borings will initially be advanced using direct-push equipment with MIPs. An MIP is a subsurface field screening tool with semi-quantitative capabilities for screening soil and groundwater for various volatile hydrocarbons, including chlorinated solvents such as PCE. The MIP investigation will involve the simultaneous collection of depth-specific, semi-quantitative VOC concentration data and electrical conductivity data, which will be used for lithologic evaluation and correlation. A direct push drill rig will be used to advance each MIP boring. The MIP is located at the end of a rod string and uses a small heater block to volatilize VOCs from soil and groundwater as the tool is advanced. The vapors are drawn through a permeable membrane port at the center of the heat pad and carried to the surface with an inert carrier gas via tubing to be analyzed with a gas chromatograph instrument in the field. The gas chromatograph includes an electron capture detector (ECD), halogen specific detector (XSD), photoionization detector, and flame ionization detector. Each of these instruments is capable of detecting the presence of contamination as follows:

- A flame ionization detector is best suited for straight-chain hydrocarbons.
- A photoionization detector is best suited for aromatic hydrocarbons.
- An ECD is best suited for chlorinated hydrocarbons.
- An XSD is best suited for degradation products of chlorinated hydrocarbons.

The MIP and electrical conductivity data are used to evaluate hydrostratigraphic features and identify the occurrence and relative concentrations of contaminants of concern within those features. The vertical and horizontal impacts of chlorinated solvents at this Site will be evaluated using the responses from the ECD and XSD instruments to make decisions in the field during the investigation.

Soil borings will be advanced until either perched or regional groundwater is encountered. Soil samples will be collected to confirm the MIP readings at approximately 10-foot intervals or where evidence of chemical impacts are identified by the MIP. Following advancing the MIP borings and collection of soil samples for laboratory analysis, soil-vapor probes will be installed at 5, 15, 30, 45, 65, and 85 feet below ground surface, unless groundwater is encountered. If groundwater is encountered, vapor probe depths may be adjusted and installed above groundwater. Soil and soil-vapor samples will be analyzed for VOCs using USEPA Methods 8260B and TO-15, respectively.

5.2.2 Groundwater

Sparce groundwater data is available on the EA Properties. Perched groundwater has been encountered between 45 and 65 feet bgs in soil vapor probes advanced in the southern portion of EA Property 1 and off Site to the south and east, yet no groundwater monitoring wells have been completed in the perched groundwater zone. As for regional groundwater, only two shallow zone monitoring wells are completed on the EA Properties—well MW-8 on EA Property 3 and well MW-12 on EA Property 1. No shallow regional groundwater data is available on the remainder of the EA Properties.

To address these data gaps in groundwater, additional sampling will be performed in the perched and regional groundwater as described below.

5.2.2.1 Perched Groundwater Sampling Plan

Five soil borings will be advanced south of the unoccupied building on EA Property 1 and on the former Nike Missile Base to confirm the extent of the perched groundwater on EA Property 1 and further characterize perched groundwater. The borings will be advanced to perched groundwater or to 70 feet bgs. If perched groundwater is not encountered by 70 feet bgs, the boring will be terminated. If perched groundwater is encountered, grab groundwater samples will be collected and analyzed for VOCs using USEPA Method 8260B. The locations of the soil borings are shown on Figure 20.

Following advancing the soil borings and collection of grab groundwater samples, three groundwater monitoring wells will be installed in the perched groundwater zone. Each groundwater monitoring well will be 2-inch-diameter Schedule 40 PVC casing with a 10-foot screened interval. It is estimated that the total depth of the wells will be between 45 and 65 feet bgs, depending on the encountered depth of perched groundwater. The monitoring wells will be developed and sampled following installation and will be sampled following the remedial action described in Section 7 to confirm progress of remediation. The locations of the groundwater monitoring wells are shown on Figure 20.

5.2.2.2 Regional Groundwater Sampling Plan

To better characterize the distribution of contaminants in regional groundwater and contaminant mass flux through the EA Properties from the Hi-Shear Source, two transects of grab groundwater samples will be advanced and grab groundwater samples will be collected. The transects of borings will be advanced using direct push equipment along the western boundary of the EA Properties, adjacent to the High-Shear Source and along the eastern boundary of the EA Properties along Crenshaw Boulevard. The proposed locations are shown on Figure 20. Grab groundwater samples will be collected from each boring and analyzed for VOCs using USEPA Method 8260B.

In addition, five additional borings will be advanced using direct-push equipment with MIP, as described above. The borings will be advanced in the vicinity of the former degreasers and the sewer line extending to Crenshaw Boulevard to further define the degreaser source area and determine if the former sewer line is an additional source area as shown on Figure 20. Based on the readings from the MIP, soil samples may be collected for laboratory analysis. The borings will be advanced to regional groundwater at approximately 85 feet bgs and grab groundwater samples will be collected for laboratory analysis. The samples will be analyzed for VOCs using USEPA Method 8260B.

Five groundwater monitoring wells will also be installed to better define groundwater conditions—three on EA Property 1, one on EA Property 2, and one on the former Nike Missile Base, as shown on Figure 20. The monitoring wells will be installed to approximately 95 to 100 feet bgs with 2-inch Schedule 40 PVC casing and a 10-foot screened interval. The wells should then be added to the routine groundwater sampling plan for the Skypark Commercial Properties to be conducted by Hi-Shear.

6 Removal Action Objectives and Goals

RAOs have been developed for the soil, soil vapor and perched and regional groundwater that are consistent with NCP criteria and the CWC and were used to identify the recommended response actions proposed in this EA Properties RAW. RAOs are qualitative statements that identify the scope of remediation necessary to protect human health and the environment and attain regulatory compliance. The Site RAOs serve as the basis to develop quantitative remediation goals to address COCs in the subject media. Remediation goals provide a basis for confirming that the RAOs have been achieved.

6.1 Removal Action Objectives

The RAOs set forth in this RAW include:

- Reduce, to acceptable levels, the potential for VI risk to receptors present on the EA Properties and in adjacent and impacted properties by remediating VOCs in soil, soil vapors, perched groundwater, and regional groundwater beneath the EA Properties;
- Further reduce contaminant mass and migration in and from EA Property soil, soil vapors, perched groundwater, and regional groundwater migrating from Hi-Shear Property, to limit potential current and future impacts to regional groundwater to acceptable levels, i.e., MCLs; and
- Achieve water quality objectives in the regional groundwater beneath the EA Properties, i.e., MCLs, within a reasonable time frame.

6.2 Remedial Goals

Remedial goals, a subset of RAOs, consist of levels of risk or chemical concentrations that are protective of human health or the environment. Remedial goals are often used at sites to guide remedies that are selected to reduce chemical concentrations to levels that pose acceptable incremental cancer risks or noncancer hazards.

As previously considered in the Groundwater RAW, remedial goals for the COCs found in regional groundwater are their respective MCLs. This goal could be achieved over a longer time frame with monitored natural attenuation (MNA) as regional groundwater is not currently being consumed by receptors. Substantial mass reductions through active remedial efforts will facilitate achieving water quality objectives over a reasonable time period and diminish the threat of affecting more groundwater resources. Substantial reductions in mass and concentration are necessary to abate the current threat of VI caused by the elevated concentrations.

Soil vapor remedial goals reflect potential threats to receptors in the buildings in the EA Properties by VI. Commercial/industrial ESLs (SFRWQCB 2020) for the COCs serve as tools to set screening levels and can be modified as site-specific information on the buildings and receptors are considered.

Perched groundwater in itself is not a resource, as it would not be expected to yield sufficient groundwater to achieve the yield criteria in SWRCB Resolution 88-63, which requires a sustained yield of 200 gallons per day to be considered drinking water. Regardless, affected perched groundwater contains COCs that volatilize and could pose a potential VI risk or could migrate to regional groundwater. As a result, perched groundwater COC mass is being proposed to be substantially reduced to abate these threats.

7 Engineering Evaluation and Cost Analysis of Removal Alternatives

An engineering evaluation of potential available removal action alternatives was used to screen their potential application to this removal action using NCP guidelines (40 CFR § 300.415). In accordance with 40 CFR § 300.415(4)(i) of the NCP, an estimated relative cost comparison and selection of the optimal remedial action technologies are included in this evaluation. A similar evaluation was presented in the Groundwater RAW (Terraphase 2022). As this RAW addresses removal actions, future additional considerations could amend and modify the selection process. The public and stakeholders of this removal effort will be afforded the opportunity to provide comments to this NCP evaluation. The NCP criteria for the remedial technology include:

- Overall protection of human health and the environment
- Long-term effectiveness and permanence
- Short-term effectiveness
- Reduction of toxicity, mobility, and/or volume of the contaminants of concern
- Implementability
- Compliance with regulatory requirements
- Cost of remedy

Section 7.1 provides a description of the identified potential alternatives to address the COCs that have impacted areas in the EA Properties' vadose zone. Section 7.2 provides a description of the identified potential alternatives to address the COCs that have impacted areas in the EA Properties' perched groundwater. Section 7.3 provides a description of the identified potential alternatives to address the COCs that have impacted areas in the EA Properties' regional groundwater migrating from the Hi-Shear Property. Section 7.4 and Table 1 provides a description of potential alternatives to address the vadose zone and perched and regional groundwater contamination at the EA Properties area, and sets forth an evaluation of the retained alternatives using the NCP criteria, and a screening-level estimation of the respective alternatives' costs. A summary of the recommended removal action alternatives is presented in Section 7.4.

7.1 Removal Alternatives to Address COCs in the Vadose Zone

The following removal action alternatives were considered to address VOC contamination of the EA Properties' vadose zone:

1. No Action
2. MNA
3. SVE
4. Thermal Technologies with SVE

The alternatives are described in detail in Table 1 and a summary of each alternative is included in the following subsections with an analysis of their applicability to the Site (including LARWQCB's requirements).

7.1.1 Alternative 1: No Action

This alternative does not implement a remedial action. The NCP requires consideration of a "no action" alternative; however, in this case, none of the RAOs would be attained within a reasonable period of time as impacts to public health could occur as a result of the vapors present. No action also does nothing to diminish toxicity, mobility, or the volume of contaminants and is not effective in protecting public health. While the cost for the No Action alternative is very low, it would not be acceptable to the LARWQCB, stakeholders, and the community as the VOC concentrations in the vadose zone would continue to pose an unmitigated and unacceptable threat of VI risk to occupants of buildings within the EA Properties and to the regional groundwater.

7.1.2 Alternative 2: MNA

MNA relies on naturally occurring processes, such as biodegradation, dispersion, and diffusion to reduce contaminant impacts. This technology reduces contaminant impacts more slowly than other more active remedial technologies and can be employed when there is extended time to achieve the vapor mitigation objectives while not posing an unacceptable risk to public health. MNA is often applied after active remedies have already substantially reduced the impacts and risks of contaminants. Continued soil vapor monitoring verifies that natural attenuation of VOCs continues in the vadose zone via biological and chemical degradation over time. This alternative by itself will not be protective of human health and the environment, will not timely reduce soil vapor or indoor air concentrations, nor will it timely comply with RAOs. However, MNA is very implementable, and the cost is low compared to other alternatives since only routine soil vapor and indoor air monitoring will be performed.

This alternative alone would not be acceptable to the LARWQCB, stakeholders, and the community by itself as the VOC concentrations in some areas of the vadose zone would continue to pose an unmitigated and unacceptable threat of risk from VI into buildings occupied within the EA Properties and to the regional groundwater.

Given these judgements, this alternative is not retained as an alternative, but would follow active remediation.

7.1.3 Alternative 3: SVE

SVE uses blowers to create subsurface air vacuum to remove volatile and some semi-volatile compounds from the soil and removes vapor-phase VOCs or semivolatile organic compounds. The VOCs extracted from the vadose zone would be treated or destroyed, depending on local regulations and system requirements. SVE is one of the most commonly employed remedies and has demonstrated good value to remove COC mass from the vadose zone. At numerous remedial sites in California, under Terraphase management, SVE removed VOCs from impacted vadose zone soil while effectively eliminating the potential exposure pathway of vapor migration of VOCs to indoor air and the receptors therein (i.e., on-and off-site workers). SVE creates vacuums which pull affected vapors to the points of extraction, preventing the migration of COCs to buildings and receptors. An SVE system would include vapor extraction wells, a blower package equipped with a positive-displacement blower, and granular activated carbon vessels used to remove VOCs from the SVE system exhaust. The effectiveness of an SVE system is generally limited primarily by soil conditions (moisture content, porosity and permeability, organic content) and groundwater conditions. Pilot-scale tests are generally appropriate for SVE system implementation to ensure that a designed system is effective in removing contaminant mass from the vadose zone and allows the remedial strategy to be evaluated and the system altered as needed to maximize effectiveness.

This alternative will likely be acceptable to the LARWQCB and the community as the SVE alternative will provide protection of human health and the environment while also removing COC mass from the vadose zone to abate the long-term threats it presents. SVE is a widely accepted method by the LARWQCB for remediation of VOCs in the vadose zone. SVE is generally effective in the long term; however, this alternative is estimated to require approximately 4 years of operation followed by a period of monitoring for concentration rebound assessment. SVE technologies are not effective in reducing concentrations of VOCs in groundwater; therefore, separate remedies are proposed for the EA Properties’ perched and regional groundwater contamination. As an alternative for the EA Properties’ vadose zone, SVE would have a moderate cost compared with other technologies of approximately $1,371,000 (inclusive of related data gap investigation work). Thus, this alternative is retained for further consideration.

7.1.4 Alternative 4: Thermal Technologies with SVE

Thermal treatment is predominantly a mass transfer technology that involves heating the aquifer and vadose zone to volatilize and mobilize VOCs from the formation, including groundwater into vapors, which are then extracted by a SVE system. Given the higher relative cost and impacts from high energy use, this technology is most often limited to smaller areas where DNAPL has been observed. Thermal technologies include steam enhanced extraction, dynamic underground stripping (steam injection and electrical resistance heating), electrical heating (applying electrical energy to heat the subsurface by electrical resistance heating, six-phase soil heating, or radio-frequency heating), and thermal conduction.

Thermal technologies with SVE would likely be acceptable to the RWQCB or community as this method will provide protection of human health and the environment as VI potential will be reduced and VOCs mass in vadose zone soil and also groundwater will be reduced. Similar to SVE, this alternative will require approximately 4 years of operation followed by a period of monitoring for concentration rebound assessment. Thermal technologies require considerable energy and cause significant greenhouse gas production. As an alternative for the EA Properties area, a thermal system would require significant infrastructure, and would be highly disruptive to existing property uses because of the existing structures throughout the EA Properties and have a relatively high cost compared with other technologies. Given these limitations, this alternative is not retained for further evaluation.

7.1.5 Vadose Zone Retained Alternatives

The alternatives retained for further analysis are:

- Alternative 1 – No Action
- Alternative 3 – SVE

7.2 Removal Action Alternatives - EA Properties Perched Groundwater

Apparent releases of VOCs to the subsurface from the EA Properties area have resulted in contamination to the perched groundwater zone. The treatment of the VOCs in perched groundwater at EA Properties is necessary to control and abate the on-going degradation of the perched groundwater and potential for the perched groundwater to impact regional groundwater. Also, given the relative proximity of perched groundwater, volatilization of COCs can impact soil vapor which can creates VI risks. The following removal action alternatives were considered to address the VOCs in the EA Properties' perched groundwater source area:

1. No Action Alternative
2. MNA
3. Thermal Technologies with SVE
4. ISCO using Ozone and Hydrogen Peroxide
5. EISB

The alternatives are described in detail in Table 1 and a summary of each are included in the following subsections with an analysis of their applicability to the Site (including LARWQCB's requirements).

7.2.1 Alternative 1: No Action

This alternative does not implement a remedial action. The NCP requires consideration of a "no action" alternative; however, in this case, none of the RAOs would be attained within a reasonable period of time. The time to achieve remedial goals in the impacted perched groundwater through a No Action alternative would span several decades or more. No Action does nothing to timely diminish toxicity, mobility, or the volume of contaminants in the perched groundwater zone and is not effective in timely protection of public health. While the cost for the No Action alternative is very low, it would be unacceptable to the LARWQCB and the community as the VOC concentrations in perched groundwater exceed MCLs and the impacted groundwater plume threatens to migrated to residental areas which, over time, could create an unacceptable risk of VI.

7.2.2 Alternative 2: MNA

MNA relies on naturally occurring processes, such as biodegradation, dispersion, and diffusion to reduce contaminant impacts. This technology reduces contaminant impacts more slowly than other more active remedial technologies and can be employed when there is extended time to achieve the water quality objectives. MNA is often applied after active remedies have already reduced the impacts and risks of contaminants. Monitoring verifies that natural attenuation of VOCs continues in the aquifer via biological and chemical degradation over time. This alternative by itself will not be protective of human health and the environment, will not timely reduce groundwater concentrations, nor timely comply with RAOs. However, MNA is easily implementable and the cost is relatively low compared to other alternatives since only routine groundwater monitoring will be performed. This alternative alone will not be acceptable to the LARWQCB or community as the VOC concentrations in groundwater exceed MCLs and the impacted groundwater plume will continue to extend into lower aquifer zones which may contribute to the larger Hi-Shear plume, and potential VI risks at the EA Properties would remain unmitigated. However, MNA may be implemented following an active perched groundwater remedy to ultimately achieve RAOs after concentrations of VOCs have been diminished sufficiently.

This alternative is not retained as a standalone perched groundwater remedy but will be used in conjunction with an active groundwater remedy.

7.2.3 Alternative 3: Thermal Technologies with SVE

Thermal treatment is predominantly a mass transfer technology that involves heating the aquifer and vadose zone to volatilize and mobilize VOCs from the formation, including groundwater into vapors, which are then extracted by a SVE system. This technology is most often applied to areas where DNAPL has been observed. Thermal technologies include steam enhanced extraction, dynamic underground stripping (steam injection and electrical resistance heating), electrical heating (applying electrical energy to heat the subsurface by electrical resistance heating, six-phase soil heating, or radio-frequency heating), and thermal conduction.

Thermal technologies with SVE would likely be acceptable to the LARWQCB or community as this method will provide protection of human health and the environment as VI potential will be reduced and VOCs mass in vadose zone soil and also groundwater would be reduced. Similar to SVE, this alternative will require approximately 4 years of operation followed by a period of monitoring for concentration rebound assessment. Thermal technologies require considerable energy and cause significant greenhouse gas production. As an alternative for the EA Properties area, a thermal system would require significant infrastructure, and would be highly disruptive to existing property uses because of the existing structures throughout the EA Properties. Given these limitations, this alternative is not retained for further evaluation.

7.2.4 Alternative 4: ISCO

ISCO consists of the injecting oxidizing compounds such as hydrogen peroxide and ozone into the contaminated groundwater plume. These oxidizers destroy VOCs on contact; therefore, the effectiveness of this approach is dependent on subsurface distribution across the VOC impacted areas and effective radii of influence of injection areas sufficient to treat impacted areas of the perched groundwater plume. Parameters which generally affect the efficiency of ISCO are the concentrations of organic matter (i.e., soil oxidant demand), the effective porosity and the hydraulic conductivity (distribution of the oxidizing compounds in the groundwater), the pH of the oxidizing compound, the half-life of the oxidant (i.e., hydrogen peroxide is on the order of hours while activated persulfate and permanganate are more persistent and may remain in the groundwater for days to weeks), and the heterogeneity of the aquifer system (the even distribution of the product increases the effectiveness of the in-situ treatment).

Critical to the success of this remedial approach is the volume of compound injected into the groundwater and possible multiple injection rounds (short half-life of the oxidant). The oxidizing compounds can be injected into the groundwater through temporary injection points, vertical wells, horizontal or inclined wells, or infiltration galleries/permeable reactive barriers. As a result, this alternative would not be cost-effective as a remedy for the regional groundwater. However, this alternative would be a cost-effective remedy for perched groundwater systems such as at the EA Properties with a relatively limited lateral extent of contamination.

Given the theoretical effectiveness of ISCO using hydrogen peroxide and/or ozone (used to estimate the cost for this RAW) at removing VOC mass from the perched groundwater zone within acceptable time periods, and its moderate cost compared with other technologies of approximately $1,656,500 (inclusive of related data gap investigation work), this alternative is retained for further evaluation.

7.2.5 Alternative 5: EISB

Previous regional groundwater remedial action at the adjacent Hi-Shear Source included EISB pilot tests with limited injections. Although the Hi-Shear Source is located adjacent to the Site, an on-site pilot test would be required to test the applicability of the remediation method on the perched groundwater zone. During EISB at the Hi-Shear Source, the efficacy of reductive dechlorination by bacteria (the breakdown of PCE to TCE, TCE to cis-1,2-DCE, cis-1,2-DCE to VC, and then to the final step of ethene) was shown to be increased by adding non-native bacteria to the subsurface to work symbiotically with the indigenous bacteria. In-situ bioremediation typically includes adding nutrients to increase the bacterial activity in the groundwater zone. Materials used often include an organic carbon source, nutrients, electron acceptors, and/or microbial cultures such as dehalococcoides.

This technology addresses the dissolved plume, with suitable conditions to establish EISB being maintained for approximately 3–6 years after its application, depending on the nature of the geochemistry of the EA Properties' perched groundwater and the nature and quantity of the substrate used to establish the EISB conditions. Aquifers that are under anaerobic conditions are conducive to EISB remediation. Implementation of EISB may include installation of injection wells or use of direct-push application; no ongoing operation and maintenance of the remedial system is required after the injection event until the substrate becomes spent by the biological activities induced. Groundwater monitoring is required after the injection of the substrate to monitor VOC concentrations and to ensure that correct geochemical conditions exist in the perched groundwater zone for efficacious removal of VOC mass by EISB.

For EISB to be effective, the organic carbon source, nutrients, electron acceptors, and/or microbial cultures must be properly maintained and distributed to enhance subsurface conditions for a sufficient time to fully dechlorinate the VOCs. The microbial cultures consume only dissolved chemicals, requiring repeated applications to address DNAPL, which is dissolved over time.

However, EISB Implementation in perched water can be problematic as depth and transport can vary and is sometimes difficult to understand and predict in perched water, making the establishment of conditions suitable to support a biological treatment uncertain.

To enhance bioremediation of VOCs in the EA Properties' perched groundwater, a bioaugmentation culture (e.g., KB-1®) could be used in conjunction with EISB. Bioaugmentation cultures have been used for over two decades to enhance bioremediation of chlorinated solvents. These cultures introduce key microorganisms to contaminated sites where they are absent or are in low concentrations. Bioaugmentation with KB-1® is an effective solution to enhance remediation of a growing range of chlorinated solvents and other recalcitrant compounds including:

- Chlorinated ethenes (PCE, TCE, all DCE isomers, VC)
- Chlorinated ethanes (1,1,1-trichloroethane, 1,2-dichloroethane, 1,1,2,2-tetrachloroethane, and others)
- Chlorinated methanes (chloroform, dichloromethane)
- Chlorinated propanes (1,2,3-trichloropropane and 1,2-dichloropropane)
- Chlorofluorocarbons

This technology is included in the LARWQCB general Waste Discharge Requirements (WDR) permit for the application of substrates for groundwater remediation and would be protective of human health and the environment, comply with RAOs, provide long-term effectiveness, and reduce VOCs in groundwater to MCLs, if properly implemented.

However, given the challenges and uncertainty to establish a viable biologically sustainable environment for EISB in perched groundwater, this alternative is not retained for further consideration.

7.2.6 EA Properties Perched Groundwater Retained Alternatives

Based on the evaluation presented in Section 7.2, the following alternatives are retained for further NCP analysis to address the Hi-Shear Source:

- Alternative 1 – No Action
- Alternative 2 – ISCO

7.3 Removal Action Alternatives - Regional Groundwater

The VOCs present in regional groundwater on the EA Properties from the releases of VOCs to the soils and groundwater within the Hi-Shear Source area have resulted in a plume that extends from the Hi-Shear Property downgradient and through the EA Properties. The treatment of the VOCs in EA Properties regional groundwater is necessary to control and abate the on-going degradation of the waters found in the Hi-Shear Plume beneath the EA Properties to reduce the risks to occupants within the EA Properties and to meet water quality objectives in the regional groundwater within this area. The following removal action alternatives were considered to address the VOCs in the Hi-Shear Source:

- Alternative 1 – No Action

- Alternative 2 – MNA
- Alternative 3 – EISB

The alternatives are described in the following sections with an analysis of their applicability to the Site (including LARWQCB's requirements).

7.3.1 No Action

This alternative does not implement a remedial action. The NCP requires consideration of a no action alternative; however, in this case, none of the RAOs would be attained within a reasonable period of time. The time to achieve MCLs in the impacted groundwater through a No Action alternative would span several decades or more. No Action does nothing to timely diminish toxicity, mobility, or the volume of contaminants and is not effective in timely protecting public health. While the cost for the No Action alternative is very low, it would be unacceptable to the LARWQCB and the community as the VOC concentrations in groundwater exceed MCLs and the impacted groundwater plume extends into residential areas which, over time, could create an unacceptable risk of VI.

7.3.2 MNA

MNA relies on naturally occurring processes, such as biodegradation, dispersion, and diffusion to reduce contaminant impacts. This technology reduces contaminant impacts more slowly than other more active remedial technologies and can be employed when there is extended time to achieve the water quality objectives. MNA is often applied after active remedies have already reduced the impacts and risks of contaminants. Continued groundwater monitoring verifies that natural attenuation of VOCs continues in the aquifer via biological and chemical degradation over time. This alternative by itself will not be protective of human health and the environment, will not timely reduce groundwater concentrations, nor timely comply with the RAOs. However, MNA is very implementable and the cost is low compared to other alternatives since only routine groundwater monitoring will be performed. This alternative alone will not be acceptable to the LARWQCB or community as the VOC concentrations in groundwater exceed MCLs and the impacted groundwater plume will continue to extend into residential areas and potential VI risks would remain. However, MNA may be implemented following an active groundwater remedy to ultimately achieve water quality objectives (MCLs) after the higher concentrations have been diminished.

This alternative is not retained as a standalone groundwater remedy but will be used in conjunction with an active groundwater remedy. Based on the experience at the Hi-Shear Property, EISB was successful in reducing chemical mass in groundwater where DNAPL was not believed to be present and, given a similar magnitude of COC concentrations dissolved in groundwater at the EA Properties, an active remedy is recommended to be employed prior to implementing MNA.

7.3.3 EISB

Previous regional groundwater remedial action at the Hi-Shear Source included EISB pilot tests with limited injections and demonstrated success. EISB is considered to treat the elevated concentration of TCE present on EA Property 1 in the vicinity of monitoring well MW-12 (TCE concentration equals

10,000 µg/L). During EISB, the process of reductive dechlorination by bacteria (the breakdown of PCE to TCE, TCE to cis-1,2-DCE, cis-1,2-DCE to VC, and then to the final step of ethene) was shown to be increased by adding non-native bacteria to the subsurface to work symbiotically with the indigenous bacteria. In-situ bioremediation typically also includes adding nutrients. Materials used often include an organic carbon source, nutrients, electron acceptors, and/or microbial cultures such as dehalococcoides. This technology addresses the dissolved plume, with suitable conditions to establish EISB being maintained for approximately 3 years after its application, depending on the nature of the geochemistry and the nature and quantity of the substrate used to establish the EISB conditions. Aquifers that are under anaerobic conditions are conducive to EISB remediation. Implementation of EISB may include installation of injection wells (Hi-Shear has already installed an array of injection wells) or use of direct-push application; no ongoing operation and maintenance, other than monitoring, is required after the injection event until the substrate becomes spent by the biological activities induced. For EISB to be effective, the organic carbon source, nutrients, electron acceptors, and/or microbial cultures must be properly maintained and distributed to enhance subsurface conditions for a sufficient time to fully dechlorinate the VOCs. The microbial cultures consume only dissolved chemicals, requiring repeated applications to address DNAPL, which is dissolved over time.

Similar considerations and evaluations were performed for the Site in 2012 and 2016 (Alta 2012 and 2016b) which identified EISB as the preferred technology for the groundwater beneath and migrating from the Hi-Shear Property. This technology is retained for EA Property 1 as it was demonstrated to be successful to reduce the groundwater COCs during the previous applications at the Hi-Shear Property, despite its incomplete application and implementation.

To enhance bioremediation of VOCs in EA Property 1 regional groundwater, a bioaugmentation culture (e.g., KB-1®) should be used in conjunction with EISB. Bioaugmentation cultures have been used for over two decades to enhance bioremediation of chlorinated solvents. These cultures introduce key microorganisms to contaminated sites where they are absent or are in low concentrations. Bioaugmentation with KB-1® is an effective solution to enhance remediation of a growing range of chlorinated solvents and other recalcitrant compounds including:

- Chlorinated ethenes (PCE, TCE, all DCE isomers, VC)
- Chlorinated ethanes (1,1,1-trichloroethane, 1,2-dichloroethane, 1,1,2,2-tetrachloroethane, and others)
- Chlorinated methanes (chloroform, dichloromethane)
- Chlorinated propanes (1,2,3-trichloropropane and 1,2-dichloropropane)
- Chlorofluorocarbons

This technology is included in the LARWQCB general WDR permit for the application of substrates for groundwater remediation and would be protective of human health and the environment, comply with RAOs, provide long-term effectiveness, and reduce VOCs in groundwater to MCLs, if properly implemented.

Based on an estimate of 20 dual-nested injection wells to be installed in the vicinity of monitoring well MW-12, and subject to revision based on removal action characterization results, the estimated cost to implement EISB on the EA Properties, subject to the completion of the related data gap investigation, is $2,212,000.

Given the history of demonstrated success of this technology on the Hi-Shear Property and its successful application to other similar remedies, this alternative is retained for consideration.

7.3.4 Regional Groundwater Retained Alternatives

Based on the evaluation presented in Section 7.3, retained alternatives for further NCP analysis to address regional groundwater on the EA Properties are:

- Alternative 1 – No Action
- Alternative 2 – EISB

A summary of the retained alternatives is presented in Table 1.

7.4 Comparative Analysis of Removal Action Alternatives

The removal action alternatives for both the EA Properties' vadose zone and perched and regional groundwater were evaluated with respect to the NCP Threshold, Primary Balancing, and Modifying criterion. The narrative analysis is presented in Table 1. The evaluations are based on published documentation, experience at similar sites, site-specific RAOs, prior similar screening and experience at the Site and the adjoining Hi-Shear Source area, and Terraphase's professional judgment. The estimated costs for full-scale implementation of the proposed alternatives for the EA Properties' vadose zone and perched and regional groundwater are presented in Table 1 as rough order of magnitude engineer estimates and are intended for use in this comparative analysis of the alternatives. The results of the data gap investigations and other considerations and assumptions could increase or decrease the scope and cost assumed in these evaluations. The analysis of removal action alternatives is discussed below for the EA Properties' vadose zone and perched and regional groundwater.

The purpose of this section is to provide a comparative analysis against each of the evaluation criterion of the retained alternatives presented in Section 7. This effort will further clarify the advantages and disadvantages of each retained alternative relative to one another and facilitate the selection and assembly of the recommended removal action.

Pursuant to the NCP and EE/CA guidance, the identified alternatives are analyzed using the following NCP evaluation criteria: effectiveness, implementability, and cost. The effectiveness of each alternative was evaluated by each alternative's protectiveness of human health and the environment; reduction of toxicity, mobility, or volume through treatment; long-term effectiveness and permanence; and short-term effectiveness. The implementability criterion addresses the technical feasibility of implementing the response (including availability of services and materials), the administrative feasibility, and state and local community acceptance. Projected costs were calculated using direct capital costs, indirect capital costs, and annual post-removal site control costs. The projected costs presented for the removal action alternatives are estimates only for the purpose of comparing alternatives and should not be considered design-level cost estimates.

Cost estimates are based on currently available costs and approximate time and materials requirements developed for the sole purpose of comparing alternatives. The EE/CA cost estimates should not be considered design-level estimates. They are representative within −30 to 50 percent and were prepared with consideration to the guidance provided in *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA 2000).

7.4.1 Vadose Zone Alternatives

Below, the retained alternatives for the EA Properties' vadose zone are considered in accordance with NCP criteria. The retained alternatives are:

- Alternative 1 – No Action
- Alternative 3 – SVE

7.4.1.1 Effectiveness

This section evaluates the alternative's ability to meet the RAOs as identified in Section 6; in particular, its ability to achieve the criteria of protectiveness of human health and the environment and to achieve the RAOs and the Remedial Goals. Other factors that affect the overall protectiveness of a removal action include preference for treatment to reduce contaminant toxicity, mobility, or volume for principal threats, short-term effectiveness, and long-term effectiveness/permanence. Judgements and details regarding the effectiveness evaluation criteria are presented in the following subsections.

Overall Protection of Human Health and the Environment

Under Alternative 1, No Action, no active efforts will be made to remediate the EA Properties' vadose zone. Therefore, VOC concentrations in soil vapor and potentially indoor air will remain elevated and could continue to migrate further and continue to pose a potential risk to human health and the environment.

Under Alternative 3, SVE will provide protection of human health and the environment as VI potential will be reduced and VOCs mass in vadose zone soil (unsaturated zone) will be reduced. SVE will reduce VI potential and reduce VOC concentrations in vadose zone soil.

Of the alternatives evaluated, Alternative 3 provides the highest level of protection to human health and the environment.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1, No Action, does not actively reduce the toxicity, mobility, or volume of VOCs in groundwater. The VOCs will persist in the vadose zone and therefore soil gas and potentially indoor air for decades and will continue to pose an unacceptable risk to human health and the environment for an unknown period of time.

Alternatives 3, SVE, will actively reduce the toxicity, mobility, and volume of VOCs in the vadose zone.

Short-Term Effectiveness

Alternative 1, No Action, has poor short-term effectiveness because potential risk from VOCs in the vadose zone is not actively reduced. The length of time until protection is achieved would be decades under this alternative.

Alternative 3, SVE, offers short-term effectiveness; once implemented, it would immediately begin to reduce high VOC concentrations in the vadose zone and would mitigate VI potential to indoor spaces at the EA Properties 1, and reduce the threat of impacts on the regional groundwater.

Long-Term Effectiveness

Alternative 1, No Action, does not provide long term effectiveness or a permanent remedy for elevated VOCs in the vadose zone; although concentrations would be expected to decrease over time, the length of time until protection is achieved would be decades under this alternative which would likely pose an unacceptable risk to human health and the environment.

Alternatives 3, SVE, provides a moderate level of long-term effectiveness by reducing VOCs in the vadose zone. This alternative would require approximately 4 years of operation followed by a period of monitoring for concentration rebound assessment. This alternative effectively eliminates the unacceptable risks to human health and the environment at the EA Properties and to the regional groundwater.

7.4.1.2 Implementability

This section provides an evaluation of the technical feasibility of implementing the alternative and the materials and services that would be required for its implementation.

Technical Implementation Considerations

No technical implementation considerations are associated with Alternative 1, No Action, because no action is taken.

Alternatives 3 is implementable. Alternative 3 poses no challenges to implementation.

Administrative Feasibility

No administrative feasibility considerations are associated with Alternative 1, No Action, because no action is taken.

Permits will be required from the South Coast Air Quality Management District and City of Torrance to implement Alternative 3, but these permits are common and pose no hinderance to implement these alternatives. Access for well installation from existing City of Torrance tenants and/or from the City of Torrance may be necessary.

State Acceptance

The likelihood of state acceptance of Alternative 1, No Action, is unlikely given no active efforts would be made to minimize contaminated areas or migration pathways, and potential VI risks would remain and potentially worsen.

The likelihood of state acceptance of Alternatives 3 is considered high due to the proven applicability and efficacy of SVE in removal of VOCs to effectively mitigate VI risks and reduce risks to the regional groundwater. Final state acceptance would be determined following public comment.

Community Acceptance

Community acceptance of Alternative 1, No Action, is unlikely given no active efforts to minimize contaminated areas or migration pathways would be made, and potential VI risks would remain and worsen which may impact workers within buildings at the EA Properties.

It is anticipated that Alternatives 3 would receive community acceptance; however, final acceptance will be determined following the community review and comment period following the completion of the RAW.

7.4.1.3 Cost

An evaluation of the costs associated with implementing the removal action alternatives are based on currently available costs and approximate time and materials requirements developed for the sole purpose of comparing alternatives. The EE/CA cost estimates should not be considered design-level estimates. They are representative within −30 to 50 percent and were prepared with consideration to the guidance provided in *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA 2000).

There are no capital, operation, or maintenance costs associated with Alternative 1, No Action. The only costs are administrative/regulatory approval costs that are negligible.

As shown in Table 3, the estimated cost to implement Alternative 3, SVE, is $1,371,000. The estimated total include the data gaps investigation, labor, equipment, and materials for the installation of SVE wells, blower and vapor extraction systems, air treatment systems, soil vapor monitoring and rebound testing, LARWQCB oversight costs, and vapor well abandonment, as well as an estimate of the professional and technical services necessary to support the design and implementation of the system. This estimate will be modified to reflect data and information gained from the data gaps investigation. The costs assume installation of 24 SVE wells, operation, maintenance, and monitoring of the system for a period of 4 years and monitoring of soil vapor and indoor air conditions for 1 year after the cessation of operation of the system.

7.4.2 EA Properties Perched Groundwater Alternatives

Below, the retained alternatives to address the EA Properties' perched groundwater area are considered in accordance with the NCP criteria. The retained alternatives are:

- Alternative 1 – No Action
- Alternative 4 – ISCO Using Hydrogen Peroxide and Ozone

7.4.2.1 Effectiveness

This section evaluates the alternative's ability to address the Hi-Shear Source area to achieve RAOs as identified in Section 5; in particular, its ability to achieve the criteria of protectiveness of human health and the environment and the RAOs and Remedial Goals. Other factors that affect the overall protectiveness of a removal action include preference for treatment to reduce contaminant toxicity, mobility, or volume for principal threats, short-term effectiveness, and long-term effectiveness/permanence. Details regarding the effectiveness evaluation criteria are presented in the following subsections.

Overall Protection of Human Health and the Environment

Under Alternatives 1, No Action, no active efforts will be made to remediate groundwater. Therefore, VOCs in groundwater will remain elevated and could continue to migrate further and pose a potential risk to human health and the environment.

Alternative 4, ISCO Using Hydrogen Peroxide and Ozone, would reduce VOC concentrations. Hydrogen peroxide and ozone would be injected into an injection well network at the Site. The reactive chemicals interact with contaminated groundwater and would decrease dissolved concentrations of VOCs.

Conclusion: Alternatives 4 provides the highest level of protection to human health and the environment.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1, No Action, do not actively reduce the toxicity, mobility, or volume of VOCs in groundwater. The VOCs will persist in groundwater for decades and will continue to pose an unacceptable potential risk to human health and the environment.

Alternatives 4 (ISCO) will actively reduce the toxicity, mobility, and volume of VOCs in groundwater.

Conclusion: Alternative 4 provides the greatest ability to reduce toxicity, mobility, or volume though treatment.

Short-Term Effectiveness

Alternative 1, No Action, has poor short-term effectiveness because potential risks from VOCs in groundwater are not reduced. The length of time until protection is achieved would be decades under this alternative, and the perched groundwater VOC plume would continue to migrate, expand, and pose potential risks to receptors and resources.

Alternative 4 (ISCO) would provide short-term effectiveness once implemented.

Conclusion: Alternative 4 provides the greatest short-term effectiveness.

Long-Term Effectiveness

Alternative 1, No Action, does not provide long term effectiveness or a permanent remedy for elevated VOCs in perched groundwater.

Alternatives 4 (ISCO) provides high long-term effectiveness; once implemented, it will begin to reduce high VOC concentrations in groundwater.

Conclusion: Alternative 4 provides the greatest long-term effectiveness.

7.4.2.2 Implementability

This section provides an evaluation of the technical and administrative feasibility of implementing the alternative and the materials and services that would be required for its implementation.

Technical Implementation Considerations

No technical implementation considerations are associated with Alternatives 1 because no action is taken.

Alternatives 4 (ISCO) is a technically feasible alternatives which has been implemented at many other sites.

Administrative Feasibility

No administrative feasibility considerations are associated with Alternative 1, No Action, because no action is taken.

Permits will be required to implement Alternative 4 (ISCO); however, these permits are common and pose no particular hinderance to implement these alternatives. Access to properties for well installation from existing City of Torrance tenants and/or from the City of Torrance may be necessary.

State Acceptance

The likelihood of State acceptance of Alternative 1, No Action, is unlikely given no active efforts would be made to minimize contaminated areas or migration pathways, and potential VI risks from groundwater would remain and potentially worsen over time.

The likelihood of state acceptance of Alternative 4 (ISCO) is high as this technology has been implemented at numerous similar sites across the state without issue.

Community Acceptance

Community acceptance of Alternative 1, No Action, is unlikely given no active efforts to minimize contaminated areas or migration pathways would be made, and potential VI sources in groundwater would remain and worsen which may impact workers within buildings at the EA Properties.

It is anticipated that Alternative 4 (ISCO) would receive community acceptance as this technology effectively reduces VOC concentrations in groundwater and mitigates soil vapor and VI risks; however, final acceptance will be determined following the community review and comment period following the completion of the RAW.

7.4.2.3 Cost

The evaluation of the costs associated with implementing the removal action alternatives are based on currently available costs and approximate time and materials requirements developed for the sole purpose of comparing alternatives. The EE/CA cost estimates should not be considered design-level estimates. They are representative within −30 to 50 percent and were prepared with consideration to the guidance provided in *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA 2000).

There are no capital, operation, or maintenance costs associated with Alternative 1.

The estimated capital cost to implement Alternative 4, ISCO, is $1,656,500. The costs include the labor, equipment, and materials for ozone injections, ongoing perched groundwater monitoring, LARWQCB oversight costs, well abandonment, as well as an estimate of the professional and technical services necessary to support the data gaps investigation and remedial implementation. Based on the existing data, the cost assumes that 10 new injections wells will be installed in the perched groundwater zone, once it is adequately characterized, which could modify this estimate. The cost also assumes that the ozone system will operate for 3 years. Further, the costs assumes that groundwater monitoring will be performed for 5 years and that LARWQCB oversight and monitoring will be required throughout this period of time.

7.4.3 Selected EA Properties Regional Groundwater Alternative and Cost

EISB is the chosen alternative for the EA Properties' regional groundwater. EISB was considered in accordance with the NCP criteria in the Groundwater RAW (Terraphase 2022) and this evaluation is not repeated in this RAW.

Based on an estimate of 20 dual-nested injection wells to be installed in the vicinity of monitoring well MW-12, and subject to revision based on removal action characterization results, the estimated capital cost to implement EISB on the EA Properties is $2,712,000. The costs include the labor, equipment, and materials for EISB injections, groundwater monitoring costs, LARWQCB oversight costs, and well abandonment costs, as well as an estimate of the professional and technical services necessary to support the implementation, but is subject to further evaluation at the conclusion of the data gap investigation work. Based on the existing data, the costs assume that 20 new injection wells will be installed on the EA Properties following additional groundwater characterization proposed in Section 5. The wells will be abandoned upon completion of the EISB treatment. The cost also assumes one initial injection in all 20 injection wells, and three additional injection events (approximately 3 years apart) using half of the injection wells and volume (50 percent event) utilized in the previous event,, with 13 total years of monitoring and LARWQCB oversight while the treatment is active. Some injection wells may only require one or two applications, while others, where DNAPL is present, may require three or more applications. EISB would be acceptable to the LARWQCB and the community since it has already been implemented at the Site and shown to be effective. Further, the costs assumes that groundwater monitoring will be performed throughout the time of These costs could require revision, subject to results obtained from the removal action characterization effort to fill data gaps.

7.5 Recommended Removal Action Alternatives

The following subsections discuss the selected remedial alternative for the EA Properties' treatment to reduce groundwater and vadose zone VOC concentrations, and therefore abate potential risks to receptors.

To abate the EA Properties' vadose zone VOCs, SVE is recommended. Subject to final design revisions resulting from data gained from Removal Action characterization, a SVE system will be installed and operated for a period of no less than 4 years. Following the cessation of operation of the SVE system, monitoring of soil vapor and indoor air concentrations will commence and continue until the applicable state agencies and stakeholders are satisfied that all VI risks have been sufficiently mitigated.

To abate the EA Properties' perched groundwater VOCs, ISCO will be implemented in the perched groundwater zone following additional perched groundwater characterization proposed in Section 5. using a newly installed array of injection wells. Injections would take place over the course of 3 years which would be followed by a period of 5 years of groundwater monitoring to ensure that concentrations have been effectively reduce at or below RAOs.

EISB is the selected remedial alternative to address the EA Properties' regional groundwater. This substrate injection effort will be performed following additional groundwater characterization at the EA Properties using new substrate injection wells. This alternative assumes four EISB injections in 20 dual nested wells, along with quarterly performance groundwater monitoring for the first year, 2 years of bi-annual monitoring, and then annually for the remainder of the estimated 13-year active treatment period. EISB has been shown to be an effective remedy to address the regional groundwater VOC impacts at the Site. If properly implemented, EISB will treat the dissolved VOCs in the regional aquifer on the EA Properties.

Alta previously conducted a comprehensive investigation at the Hi-Shear Property and performed feasibility studies, including an aquifer test (2013). Alta implemented EISB pilot tests in 2013 and 2015 (near well MW-15) and one injection event in 2017. The pilot tests and the 2017 injection event resulted in significant reduction of VOC concentrations in localized areas on the Hi-Shear Property. Most notably, at well MW-15, TCE concentrations were reduced from 56,000 µg/L in August 2011 to 22 µg/L in December 2019. Based on the success of EISB at the Hi-Shear Property, EISB would also likely be successful on the EA Properties.

These removal actions are designed to achieve the RAOs and the remedial goals, by abating potential VI and further migration of the EA Properties' perched groundwater and regional groundwater to adjoining areas, and by achieving MCLs of the COCS in the impacted groundwater. The remedial action is intended to reduce the VI potential at the Site, mitigate adverse impacts on water quality in the perched and regional groundwater zone, and achieve water quality objectives. Below, the implementation of these selected removal actions is presented in greater detail.

8 Removal Action Implementation

A regional groundwater plume emanates from the Hi-Shear Source areas and has migrated onto the EA Properties and beyond (east of Crenshaw Boulevard into the City of Lomita). The regional groundwater contamination on the Hi-Shear Property itself, as well as the regional groundwater migrating off EA Properties towards Crenshaw Boulevard, with be addressed by the recently submitted Groundwater RAW (Terraphase 2022).

In addition, as discussed, separate releases of VOCs (PCE and 1,1,1-TCA) appear to have occurred on EA Property 1, resulting in impacts to soil, soil vapor, and perched groundwater. Proposed remedies for the EA Property 1 regional groundwater impacted by the Hi-Shear Source areas to address the soil, soil vapor, and perched groundwater in and around EA Property 1 are discussed below.

The remedies in this RAW will be implemented following additional data gap investigations proposed in Section 5.2. These investigations are necessary to better understand the extent of impacts and define the scope and size of the respective remedies. Based on the extent of impacts identified, the size of each remedy may change. For the purposes of this RAW, each remedy is briefly described below with assumptions. Each remedy will likely be refined following the data gap investigation. Following completion of the data gap investigation, an amendment to the RAW will be submitted that includes the final design parameters.

- **Regional Groundwater.** The EA Properties' EISB design, as currently proposed, will involve the delivery of electron donors and bioaugmentation culture through an estimated 20 dual-nested wells in the vicinity of monitoring well MW-12 (Figure 21) to establish and then maintain prolonged dechlorinating biological activity. The injection wells will be installed in a similar fashion to the Hi-Shear injection wells discussed in the Groundwater RAW, with shallow injection wells screened from approximately 85 to 95 feet bgs and deeper injection wells screened from approximately 100 to 110 feet bgs. The injections will involve delivery of emulsified soybean oil and/or other organic substrates to achieve an injection total organic carbon concentration range of 3,000 to 5,000 milligrams per liter to account for its dilution and dispersion throughout the Hi-Shear Source areas after injections. The EISB amendments will include soybean oil, emulsifiers, nutrients, and other soluble organic carbon substrates that will be delivered to the Site in tanker trucks, intermediate bulk containers (totes), drums, and sacks and will be mixed on Site in designated mixing tanks (i.e., Baker tanks or similar). Based on prior injection work at the Hi-Shear Property, injection rates of 40 gallons per minute are possible in the treatment zone. Therefore, once mixed, the electron donor solutions will be manifolded and pumped under positive pressure into multiple existing injection wells. Injection pressures at the well head will be monitored and are not expected to exceed 40 pounds per square inch. To assess the radius of influence, the depth to water, pH, temperature, electrical conductivity, dissolved oxygen, and oxygen reduction potential will be measured in nearby injection and groundwater monitoring wells. Four Injection events will be performed on average every 3 years.

- **Vadose Zone SVE.** An SVE system will be installed in the vicinity of the former degreasers in the DCH sublease area of EA Property 1 (Figure 22). The SVE system is assumed to cover an area of 7,200 square feet and presently is proposed to include 24 SVE wells, 12 screened between approximately 5 and 25 feet bgs and 12 screened between approximately 25 and 45 feet bgs. The SVE system would operate for approximately 4 years and operation will be followed by a rebound assessment. The system parameters are estimates and may be revised following implementation of the data gap investigation.
- **Perched Groundwater.** Perched groundwater will be treated in the southern portion of EA Property 1 and onto the former Nike Missile Base where VOC concentrations (primarily PCE and 1,1-DCE) exceed 5,000 µg/L (Figure 22). Perched groundwater will be treated using ISCO. For the purposes of this RAW, it is presently assumed that 10 injection wells will be installed in perched groundwater and injections will occur over 3 years.

9 Public Participation/Community Involvement

In compliance with LARWQCB and NCP community involvement requirements (NCP Criteria No. 9 – Community Acceptance), the groundwater RAW will be subject to a 30-day public comment period. A notice of the availability of the RAW for public review and comment will be submitted to the LARWQCB for approval. The approved notice will be published and sent to the LARWQCB-required mailing list recipients. The RAW and other supporting documents will be available at the LARWQCB's office and in the local information repository. Once the public comment period is completed, the LARWQCB will review and respond to comments. The RAW will be revised as necessary pending accepted comments.

10 Reporting

Upon completion of the data gap investigation, a report will be prepared documenting the results of the investigation, along with an amendment to this RAW (that includes the final design parameters) for the LARWQCB review and approval.

Upon approval of the RAW amendment and implementation within each media being treated, a report documenting the field activities will be prepared, which will include the details of SVE and injection well installation, implementation of the remedies and results.

WDR reports will be submitted to the LARWQCB in accordance with the new WDR permit for EISB injections. Remedial progress reports will be submitted to the LARWQCB as a part of the groundwater monitoring reporting and will include a progress evaluation of the remediation efforts.

Based on the evaluation of the effectiveness of the remedies, if appropriate, a human health risk assessment will be performed to determine current risk levels and inform additional remediation, if warranted. Based on the results of the human health risk assessment, as discussed above, additional injections will likely need to be performed in the Hi-Shear Source area and additional WDR groundwater monitoring will be conducted. The groundwater monitoring results will be evaluated for the appropriateness of requesting regional groundwater closure.

11 Cost and Schedule

This section presents the remedial action estimated cost and schedule. Cost estimates are based on currently available costs and approximate time and materials requirements developed for the sole purpose of comparing alternatives. The EE/CA cost estimates should not be considered design-level estimates. They are representative within −30 to 50 percent and were prepared with consideration to the guidance provided in *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA 2000).

11.1 Cost

The estimated cost to implement the additional investigation activities is $359,000 and are presented in Table 2. The costs are based on the data gaps and the number of investigation borings, monitoring wells, and samples for laboratory analysis identified and proposed in Section 5.

The estimated cost for the SVE vadose zone alternative is approximately $1,371,000. A cost breakdown is presented in Table 3. This cost includes a vadose zone investigation; permitting; SVE system installation, operation, and maintenance for 3 years; semi-annual sampling of SVE wells; well abandonment; and LARWQCB oversight.

The estimated cost for the perched groundwater alternative is approximately $1,656,500. A cost breakdown is presented in Table 4. This cost includes a perched groundwater investigation; permitting; ozone system installation, operation, and maintenance for 3 years; groundwater monitoring and sampling; well abandonment; and LARWQCB oversight.

The estimated cost for the regional groundwater alternative is approximately $2,712,000. A cost breakdown is presented in Table 4. This cost includes a regional groundwater investigation, permitting, injection well installation, four injection events, groundwater monitoring and sampling, well abandonment, and LARWQCB oversight.

11.2 Schedule

The following presents a generalized project schedule.

- **Data Gap Investigation**
  - Permitting and contracting – 2 months
  - Investigation implementation – 3 months
  - Data analysis, final design and reporting – 3 months
- **Vadose Zone Remedy Implementation**
  - Permitting and contracting – 2 months (will be implemented after LARWQCB approval of data gap investigation and remedial design)
  - SVE well installation – 3 months
  - SVE system installation – 6 months

- SVE and system operations – 3 years
- Rebound testing – 2 months

- **Perched Groundwater Remedy Implementation**
  - Permitting and contracting – 2 months (will be implemented after LARWQCB approval of data gap investigation and remedial design)
  - Injection well installation – 2 months
  - System operations – 3 years
  - Groundwater monitoring – 5 years (3 years during system operation and 2 years following system operation
- **Regional Groundwater Remedy Implementation**
  - Permitting and contracting – 2 months (will be implemented after LARWQCB approval of data gap investigation and remedial design)
  - Injection well installation – 4 months
  - Material staging – 3 weeks
  - Initial Injections – 7 weeks
  - Post-injection sampling – four quarterly events, four bi-annual events, and 10 years of annual monitoring thereafter
  - Four injection events will be performed, estimated every 3 years; however, the number of injection wells will be reduced by 50 percent from the last injection event, resulting in an estimated quantity of substrate equaling approximately the substrate needed for two full events (The timing of subsequent injection events after the first event is estimated and will be based on the results of the fourth quarterly sampling event following the last injection event)

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Tables

Table 1
Summary Evaluation of Remedial Alternatives
Removal Action Workplan for the East Adjacent Properties
24701, 24707, 24747, 24751, and 24777 Crenshaw Blvd. and 2530 and 2540 Skypark Dr., Torrance, California

Alternative	Threshold Criteria[1]		Primary Balancing Criteria[1]					Modifying Criteria[1]		Alternative Retained	Summary
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9		
	Overall Protection of Human Health and the Environment	**Compliance with Remedial Action Objectives (RAOs)[2]**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Cost[3]**	**State Acceptance**	**Community Acceptance**		
Vadose Zone											
No Action	Will not be protective of human health and the environment.	Will not remediate vadose zone within a reasonable time period and will not minimize potential to cause vapor intrusion risk.	Will not remediate vadose zone and potential for vapor intrusion will not be mitigated.	Will not reduce the toxicity, mobility, and volume of the volatile organic compounds (VOCs) in soil and soil vapor.	Not effective, as RAOs would not be achieved.	Implementable	No cost	Will not be accepted by RWQCB based on elevated VOC concentrations in soil and soil vapor. Elevated concentrations will not be reduced in a reasonable timeframe, and vapor intrusion risks will not be addressed.	Will not be accepted by community based on elevated VOC concentrations in soil and soil vapor. Elevated concentrations will not be reduced in a reasonable timeframe, and vapor intrusion risks will not be addressed.		Will not be accepted by RWQCB based on elevated concentrations in soil and soil vapor. Elevated concentrations will not be reduced in a reasonable timeframe and vapor intrusion risks not being addressed. This alternative is not retained.
Soil Vapor Extraction (SVE)	Will provide protection of human health and the environment as vapor intrusion potential will be reduced and VOCs mass in vadose zone soil (unsaturated zone) will be reduced.	Will reduce vapor intrusion potential and reduce VOC concentrations in vadose zone soil.	Effective in the long term; however; this alternative will require approximately 4 years of operation followed by a period of monitoring for rebound assessment.	Will reduce vapor toxicity, mobility, volume and vapor intrusion potential, but will not substantially reduce the toxicity, mobility, and volume of the VOCs in groundwater. Will not address groundwater impacts.	Would be effective to remediate individual vadose zone source areas or to mitigate vapor intrusion.	Implementable.	$1,371,000	A proven technology; would likely be accepted to reduce vapor intrusion potential and remediate VOC mass in the vadose zone. Would be applicable to Site areas with vapor impacts.	Likely acceptable but disturbance will be caused by construction and infrastructure. Subject to tenant/landowner acceptance.	✓	SVE alone can provide reduction in vapor intrusion potential and reduction in VOC mass in the vadose zone.

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	Threshold Criteria[1]		Primary Balancing Criteria[1]					Modifying Criteria[1]			
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9		
Alternative	**Overall Protection of Human Health and the Environment**	**Compliance with Remedial Action Objectives (RAOs)[2]**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Cost[3]**	**State Acceptance**	**Community Acceptance**	**Alternative Retained**	**Summary**
Perched Groundwater											
No Action	Will not be protective of human health and the environment.	Will not remediate perched groundwater within a reasonable time period and will not minimize potential to cause vapor intrusion risk.	Will not remediate perched groundwater and potential for vapor intrusion will not be mitigated.	Will not reduce the toxicity, mobility, and volume of the volatile organic compounds (VOCs) perched groundwater.	Not effective, as RAOs would not be achieved.	Implementable	No cost	Will not be accepted by RWQCB as potential to impact regional groundwater and soil vapor would persist. Elevated concentrations will not be reduced in a reasonable timeframe, and vapor intrusion risks will not be addressed.	Will not be accepted by community based on elevated VOC concentrations in perched groundwater and soil vapor. Elevated concentrations will not be reduced in a reasonable timeframe, and vapor intrusion risks will not be addressed.		Will not be accepted by RWQCB based on potential to impact regional groundwater and vapor intrusion risk. Elevated concentrations will not be reduced in a reasonable timeframe and vapor intrusion risks not being addressed. This alternative is not retained.
In-Situ Chemical Oxidation (ISCO)	Would be protective of human health and the environment in areas where it is implemented. Effective in treating high concentration source areas in the vadose zone or groundwater.	Would comply with RAOs and RWQCB requirements if implemented in high concentration source areas.	Would be particularly effective to remove DNAPL and mass in perched groundwater.	Would be effective in reducing the toxicity, mobility, and volume of the CVOCs, particularly valuable in select areas where DNAPL has been identified.	Would be effective in reducing high perched groundwater concentrations.	Implementable.	$1,656,500	A proven technology. Would likely be accepted for select areas where high concentration source areas have been identified.	A proven technology. Would likely be accepted for select areas where high concentration source areas have been identified. However, requires infrastructure and may not be acceptable to tenants.	✓	Would served as an effective remedy for perched groundwater.

Table 1
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24701, 24707, 24747, 24751, and 24777 Crenshaw Blvd. and 2530 and 2540 Skypark Dr., Torrance, California

Alternative	Threshold Criteria[1]		Primary Balancing Criteria[1]					Modifying Criteria[1]		Alternative Retained	Summary
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9		
	Overall Protection of Human Health and the Environment	Compliance with Remedial Action Objectives (RAOs)[2]	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short-Term Effectiveness	Implementability	Cost[3]	State Acceptance	Community Acceptance		
Regional Groundwater											
No Action	Will not be protective of human health and the environment.	Will not remediate groundwater to achieve water quality objectives within a reasonable time period and will not minimize potential to cause vapor intrusion risk.	Will not remediate impacted water resources and potential for vapor intrusion will not be mitigated.	Will not reduce the toxicity, mobility, and volume of the volatile organic compounds (VOCs) in groundwater.	Not effective, as RAOs would not be achieved.	Implementable	No cost	Will not be accepted by RWQCB based on elevated VOC concentrations in groundwater. Elevated concentrations will not be reduced in a reasonable timeframe, and vapor intrusion risks will not be addressed.	Will not be accepted by community based on elevated VOC concentrations in groundwater. Elevated concentrations will not be reduced in a reasonable timeframe, and vapor intrusion risks will not be addressed.		Will not be accepted by RWQCB based on elevated concentrations in groundwater. Elevated concentrations will not be reduced in a reasonable timeframe and vapor intrusion risks are not addressed. This alternative is not retained.
Enhanced In-Situ Bioremediation (EISB)	Effective in treating the groundwater plume and will provide protection of human health and the environment.	If implemented correctly, would reduce VOCs to attain both water quality objective RAOs and to diminish potential for vapor intrusion risks.	If this technology were applied to the entire plume area, long-term permanence could be achieved. Would not be effective in areas where DNAPL was identified.	EISB would result in reduction of toxicity, mobility, and volume of VOCs in the groundwater. Would be less effective in areas where DNAPL was identified.	EISB meets short-term effectiveness as it enhances the dichlorination of the VOC- impacted groundwater.	Implementable; however, due to depth to groundwater and the large groundwater plume area, it requires a large array of injection wells for applying the substrates. Building footprints pose obstacles preventing application of substrate. amendment.	$2,712,000	A proven technology that has already been implemented at the Site. Will likely be accepted.	Will likely be accepted.	✓	EISB has been successful in the previous localized applications at the Site.

1. Criteria are based on those described in the National Oil and Hazardous Substances Pollution Contingency Plan, Title 40 Code of Federal Regulations Section 300.415 (NCP).
2. The remedial objectives are relevant to this evaluation and are considered herein.
3. The estimated costs are a rough order of magnitude and are provided for evaluation purposes. These costs are not intended to represent the actual cost to implement the alternative and will be modified based on subsequent removal action characterization..

Table 2
Data Gap Investigation Cost Estimate
Removal Action Workplan for the East Adjacent Properties
24701, 24707, 24747, 24751, and 24777 Crenshaw Blvd. and 2530 and 2540 Skypark Dr., Torrance, California

Line Item	Estimated Unit Cost ($)	Estimated Quantity	Units	Subtotal	Notes and Assumptions
Vadose Zone Investigation					
Permitting and Prefield Activities	$15,000	1	lump sum	$15,000	Permitting with LA County Environmental Health, coordination with City of Torrance and tenants, correspondence with RWQCB, subcontractor contracting and coordination, and health and safety planning.
Additional Soil Vapor Probes and Soil Sampling	$65,000	1	lump sum	$65,000	11 soil borings to 85 feet bgs. Collection of soil samples at 10-foot intervals and installation of soil vapor probes at 6 intervals per boring.
Laboratory Analytical	$21,000	1	lump sum	$21,000	
RWQCB Oversight	$10,000	1	lump sum	$10,000	
Vadose Zone Investigation Total				***$111,000***	
Perched Groundwater Investigation					
Permitting and Prefield Activities	$15,000	1	lump sum	$15,000	Permitting with LA County Environmental Health, coordination with City of Torrance and tenants, correspondence with RWQCB, subcontractor contracting and coordination, and health and safety planning.
Direct Push Soil Borings to Perched Groundwater	$20,000	1	lump sum	$20,000	Five soil borings to perched groundwater and collection of grab groundwater samples.
Laboratory Analytical	$1,500	1	lump sum	$1,500	
RWQCB Oversight	$10,000	1	lump sum	$10,000	
Perched Groundwater Investigation Total				***$46,500***	
Regional Groundwater Investigation					
Permitting and Prefield Activities	$30,000	1	lump sum	$30,000	Permitting with LA County Environmental Health, coordination with City of Torrance and tenants, correspondence with RWQCB, subcontractor contracting and coordination, and health and safety planning.
Direct Push Soil Borings and Regional Grab Groundwater Sampling	$90,000	1	lump sum	$90,000	20 soil borings to regional groundwater (90 feet bgs) and collection of grab groundwater samples.
Perched Groundwater Monitoring Wells	$25,000	1	lump sum	$25,000	Installation of two groundwater monitoring wells.
Regional Groundwater Monitoring Wells	$45,000	1	lump sum	$45,000	Installation of four groundwater monitoring wells.
Laboratory Analytical	$2,000	1	lump sum	$2,000	
RWQCB Oversight	$10,000	1	lump sum	$10,000	
Regional Groundwater Investigation Total				***$202,000***	
Total				**$359,500**	-

Table 3
Soil Vapor Extraction Cost Estimate
Removal Action Workplan for the East Adjacent Properties
24701, 24707, 24747, 24751, and 24777 Crenshaw Blvd. and 2530 and 2540 Skypark Dr., Torrance, California

Line Item	Estimated Unit Cost ($)	Estimated Quantity	Units	Subtotal	Notes and Assumptions
Regulatory, permitting, design and project management	$150,000	--	lump sum	$150,000	-
Vadose Zone Investigation	$111,000	--	lump sum	$111,000	
SVE Well Installation	$10,000.00	20	days	$200,000	10 SVE wells will be installed to 45 feet below ground surface
SVE System Installation and Operation	$600,000	1	lump sum	$600,000	Installation of a system with an area of 120 feet by 60 feet
SVE System Operations and Maintenance	$50,000	3	year	$150,000	Operation and maintenance for 3 years
Monitoring and Sampling	$15,000	6	event	$90,000	Semiannual sampling of SVE wells
Well abandonment	$4,000	10	well	$40,000	Abandon after active treatment completed
RWQCB Oversight	$10,000	3	year	$30,000	Abandon after active treatment completed
Total				**$1,371,000**	**-**

Table 4
Ozone-Based In-Situ Chemical Oxidation
Removal Action Workplan for the East Adjacent Properties
24701, 24707, 24747, 24751, and 24777 Crenshaw Blvd. and 2530 and 2540 Skypark Dr., Torrance, California

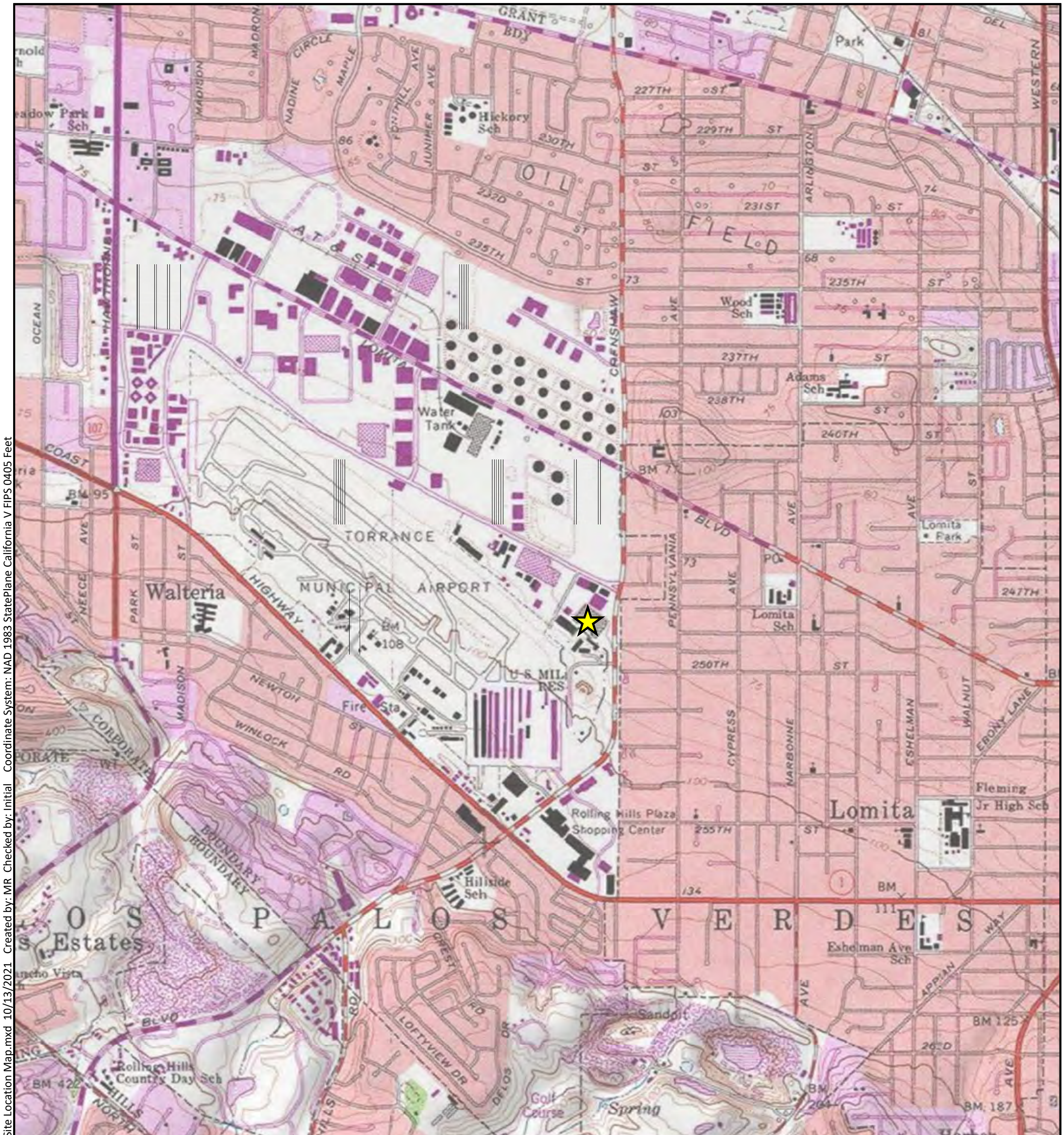
Line Item	Estimated Unit Cost ($)	Estimated Quantity	Units	Subtotal	Notes and Assumptions
Regulatory, permitting, design and project management	$150,000	-	lump sum	$150,000	-
Perched Groundwater Investigation	$46,500	-	lump sum	$46,500	-
Ozone sytem equipment and Piping	$300,000	1	event	$300,000	
Ozone wells	$20,000	10	well	$200,000	Four-inch diameter wells installed to 65 feet bgs
System Rental and Operation	$20,000	36	month	$720,000	System operation for 36 months
Hydrogen peroxide	$4	gallon	10000	$40,000	
Monitoring and Sampling	$10,000	10	event	$100,000	5 monitoring wells, $2,000/well, 10 events in 5 yrs.
Well Abandonment	$7,000	10	injection well	$70,000	Overdrill each injection well
RWQCB Oversight	$10,000	3	year	$30,000	
Total				**$1,656,500**	**-**

Table 5
Enhanced In-Situ Bioremediation - Regional Groundwater
Removal Action Workplan for the East Adjacent Properties
24701, 24707, 24747, 24751, and 24777 Crenshaw Blvd. and 2530 and 2540 Skypark Dr., Torrance, California

Line Item	Estimated Unit Cost ($)	Estimated Quantity	Units	Subtotal	Notes and Assumptions
Regulatory, permitting, design and project management	$200,000	-	lump sum	$200,000	-
Regional Groundwater Investigation	$202,000	-	lump sum	$202,000	-
Injection Well Installation	$25,000	20	Well	$500,000	Installation of 20 dual-nested injection wells (40 screens)
First Injection Event	$200,000	1	event	$200,000	Injection though 40 screens
Injection equipment	$300,000	1	lump sum	$300,000	-
LARWQCB Oversight	$10,000	13	year	$130,000	LARWQCB oversight for 13 years
Monitoring and Sampling	$20,000	19	event	$380,000	10 monitoring wells, $2,000/well, 8 events in 3 yrs., then annual for 11 yrs.
Additional injection events	$200,000	3	event	$600,000	Injection though 40 screens
Well Abandonment	$10,000	20	injection well	$200,000	Overdrill each injection well
Total				**$2,712,000**	**-**

Figures

File: N:\GIS\Prj\S042.002_HiShear\MXDs\(20211013) Figure 1 - Site Location Map.mxd 10/13/2021 Created by: MR Checked by: Initial Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet



0 2,000 4,000 Feet

1 inch = 2,000 feet

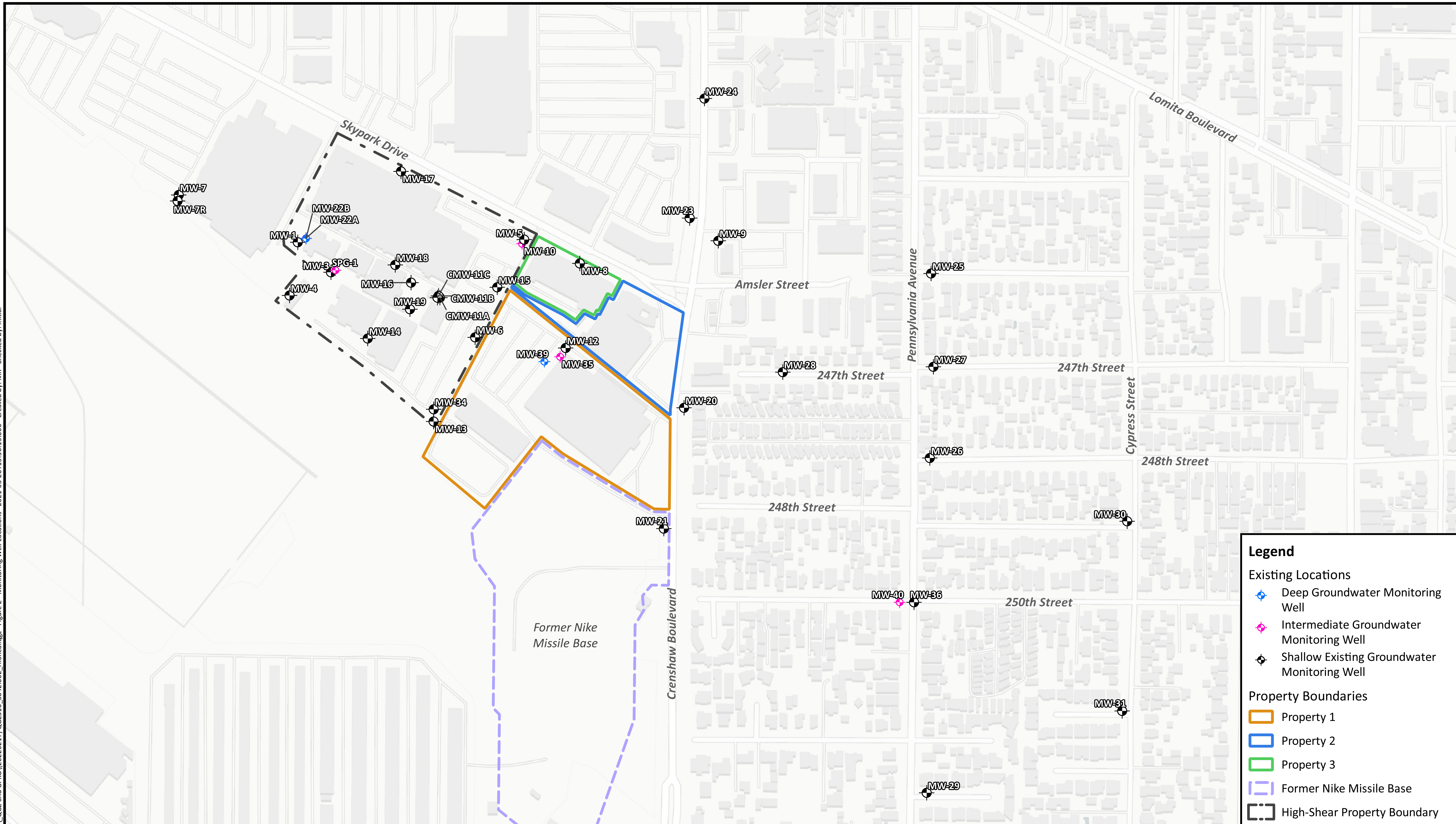
N

Legend

☆ EA Properties

Base Map: USGS Torrance (1981) 7.5 Minute Quadrangle

SAFETY FIRST	CLIENT: Rutan & Tucker	**EA Properties Location Map**
terraphase engineering	PROJECT: EA Properties RAW	
	PROJECT NUMBER: S042.002.003	**FIGURE 1**



0 100 200 300 400 ft

1 Inch = 350 Feet

N

SAFETY FIRST

terraphase engineering

CLIENT: Rutan & Tucker

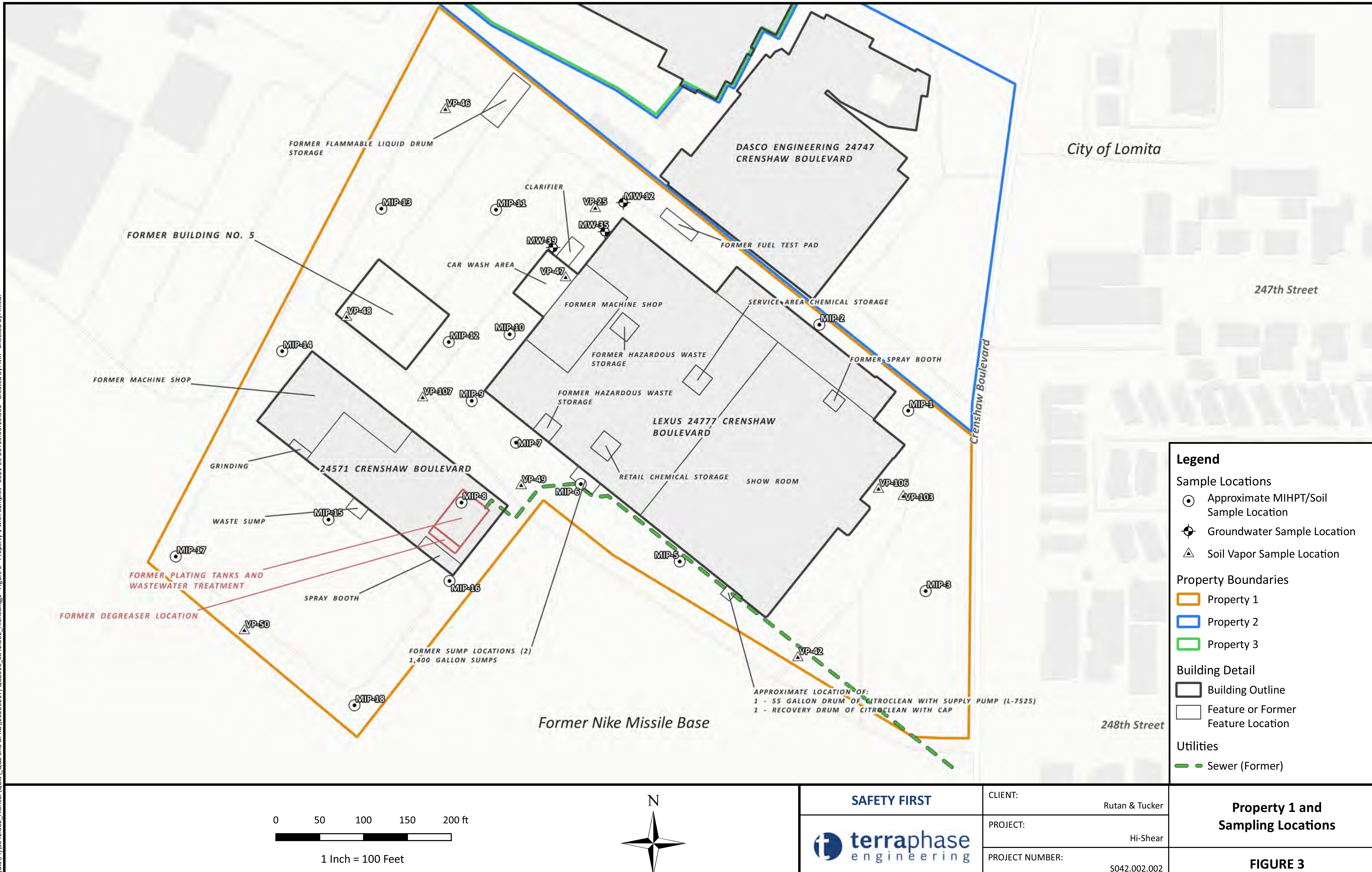
PROJECT: Hi-Shear

PROJECT NUMBER: S042.002.002

Monitoring Well Locations

FIGURE 2

N:\GIS\Prj\S042.002_HiShear\QGIS_QGZ and GPKG\(20220217) QGZ316_S042.002_HiShear.qgz Figure 2 - Monitoring Well Locations 2021-03-26T15:56:13.000 Created by: MR Checked by: initial



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CLIENT:	Rutan & Tucker
PROJECT:	Hi-Shear
PROJECT NUMBER:	S042.002.002

Property 1 and Sampling Locations

FIGURE 3

N:\GIS\Prj\S042.002_HiShear\QGIS_QGZ and GPKG\(20220217) QGZ316_S042.002_HiShear.qgz Figure 3 - Property 1 with Samples 2021-03-26T15:56:13.000 Created by: MR Checked by: initial

0 25 50 75 100 ft

1 Inch = 60 Feet

N

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PROJECT: Hi-Shear

PROJECT NUMBER: S042.002.002

Property 2 Sample Locations

FIGURE 4

N:\GIS\Prj\S042.002_HiShear\QGIS_QGZ and GPKG\(20220208) QGZ316_S042.002_HiShear.qgz Figure X - Property 2 with Samples 2021-03-26T15:56:13.000 Created by: MR Checked by: initial

0 25 50 75 100 ft

1 Inch = 40 Feet

N

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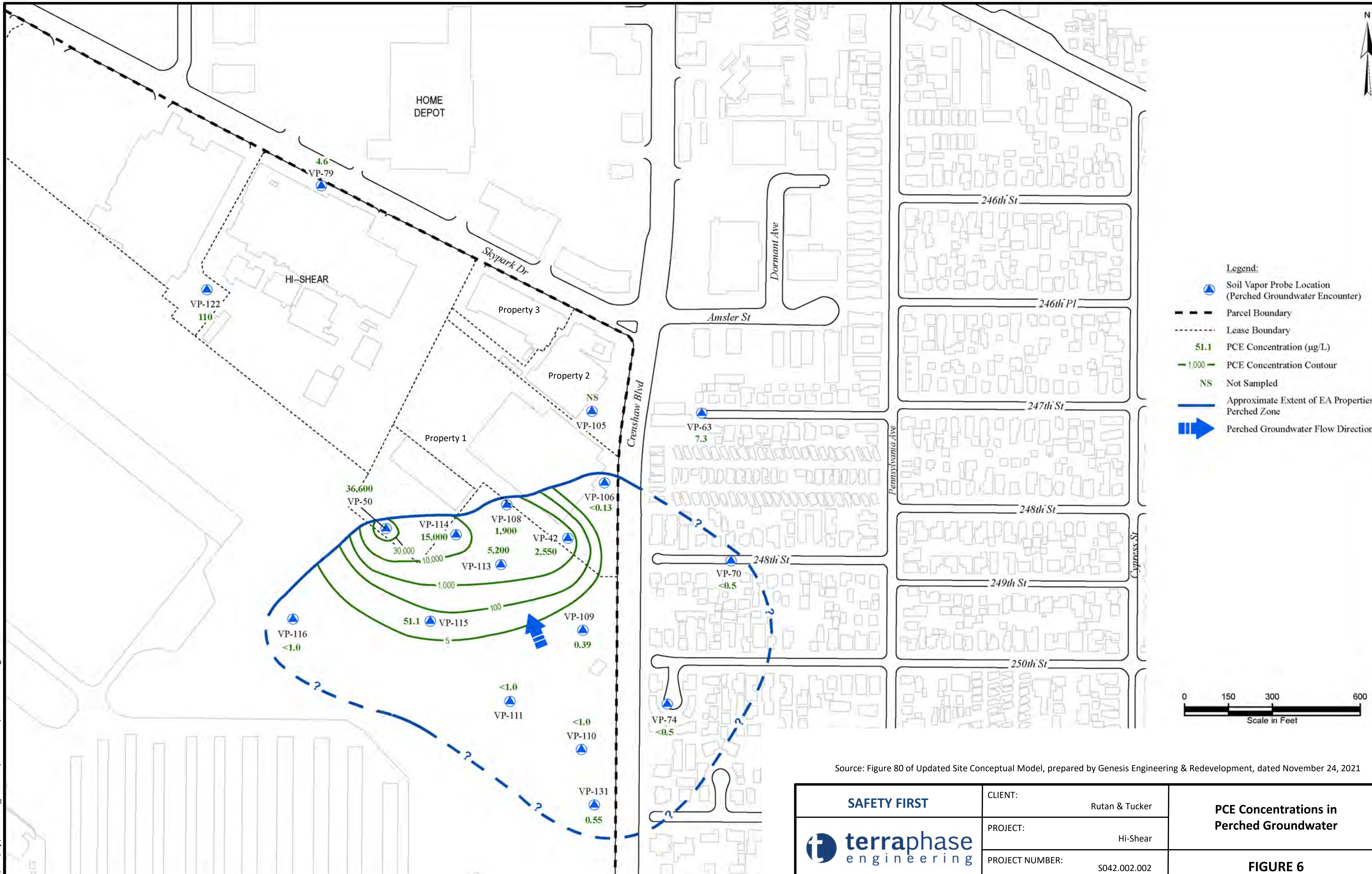
CLIENT:	Rutan & Tucker
PROJECT:	Hi-Shear
PROJECT NUMBER:	S042.002.002

Property 3 Sample Locations

FIGURE 5

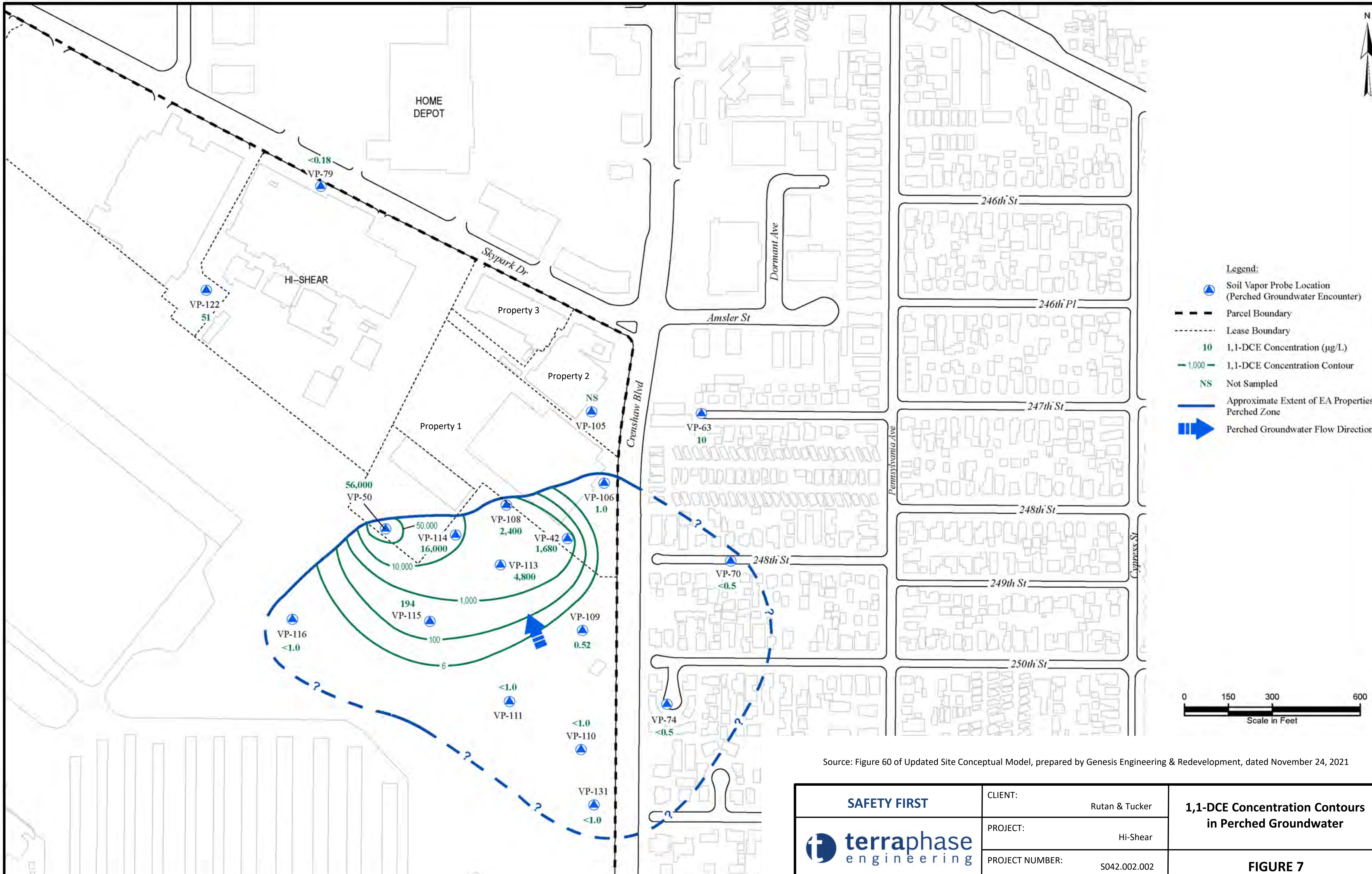
N:\GIS\Prj\S042.002_HiShear\QGIS_QGZ and GPKG\(20220208) QGZ316_S042.002_HiShear.qgz Figure X - Property 3 with Samples 2021-03-26T15:56:13.000 Created by: MR Checked by: initial



Source: Figure 80 of Updated Site Conceptual Model, prepared by Genesis Engineering & Redevelopment, dated November 24, 2021

SAFETY FIRST	CLIENT: Rutan & Tucker	PCE Concentrations in Perched Groundwater
terraphase engineering	PROJECT: Hi-Shear	
	PROJECT NUMBER: S042.002.002	FIGURE 6

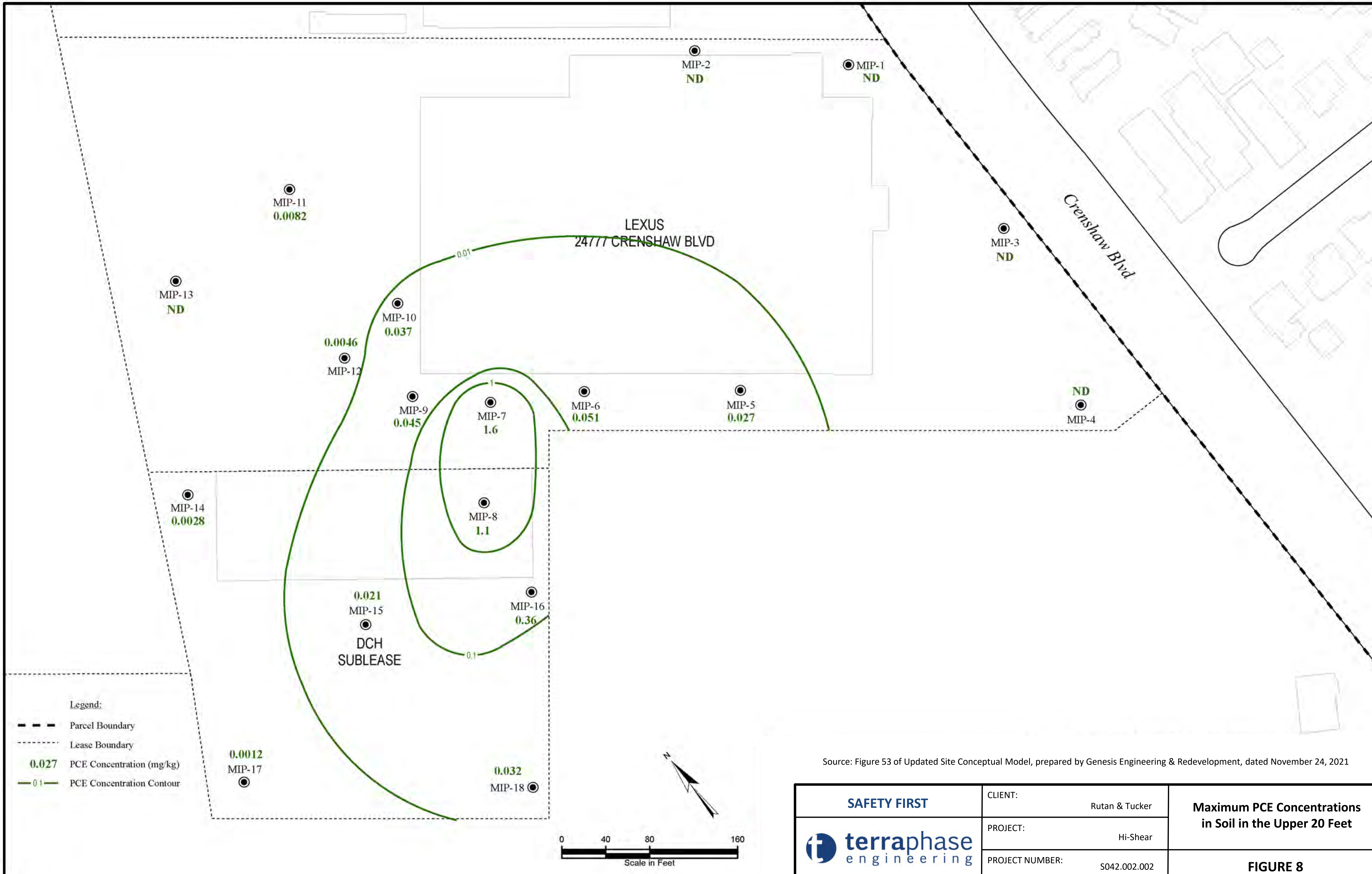
N:\GIS\Prj\S042.002_HiShear\Reference\PowerPoint Figures



Source: Figure 60 of Updated Site Conceptual Model, prepared by Genesis Engineering & Redevelopment, dated November 24, 2021

SAFETY FIRST	CLIENT: Rutan & Tucker	1,1-DCE Concentration Contours in Perched Groundwater
terraphase engineering	PROJECT: Hi-Shear	
	PROJECT NUMBER: S042.002.002	FIGURE 7

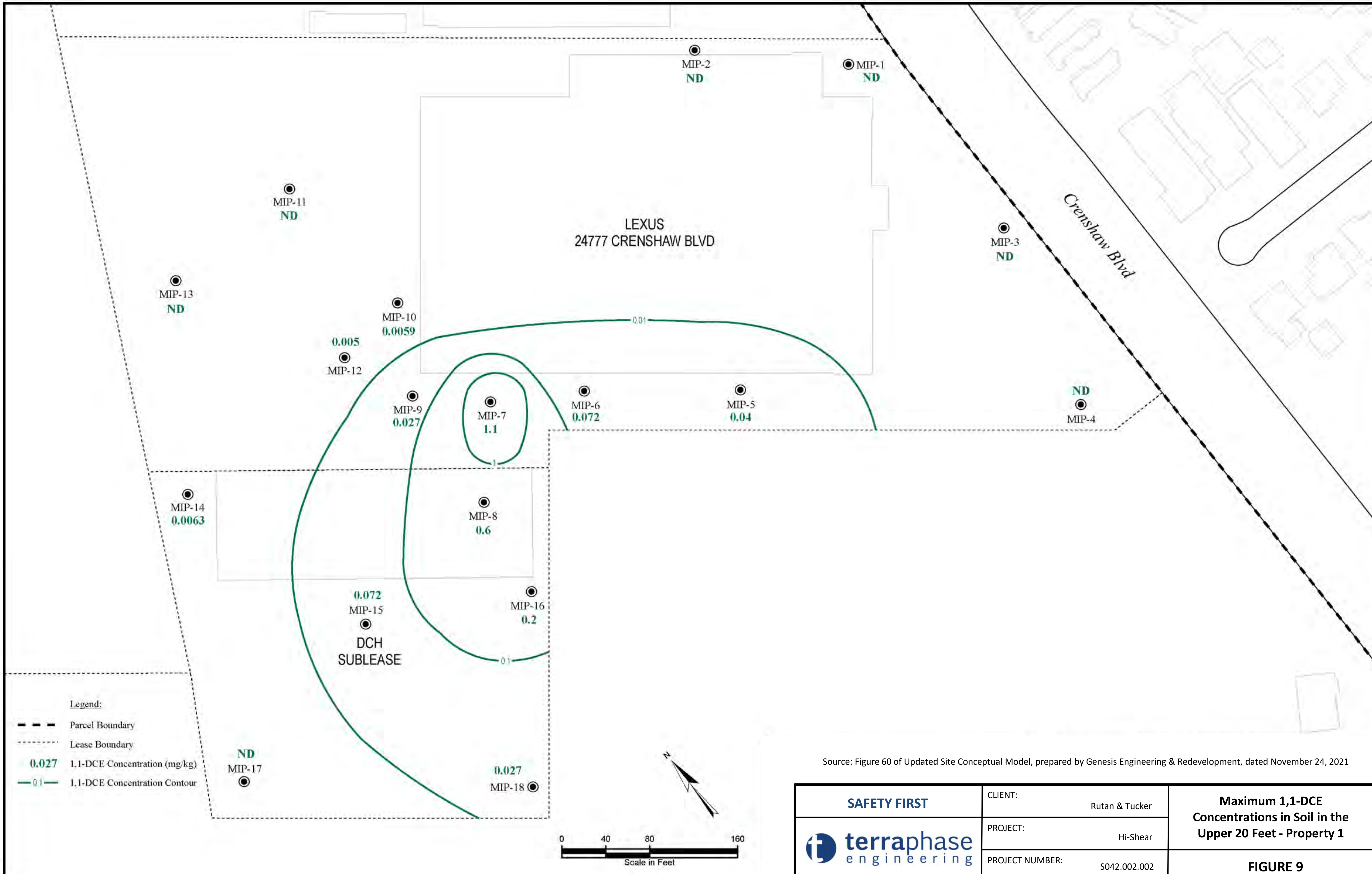
N:\GIS\Prj\S042.002_HiShear\Reference\PowerPoint Figures\Figure request 2022-02-08



Source: Figure 53 of Updated Site Conceptual Model, prepared by Genesis Engineering & Redevelopment, dated November 24, 2021

SAFETY FIRST	CLIENT: Rutan & Tucker	Maximum PCE Concentrations in Soil in the Upper 20 Feet
terraphase engineering	PROJECT: Hi-Shear	
	PROJECT NUMBER: S042.002.002	FIGURE 8

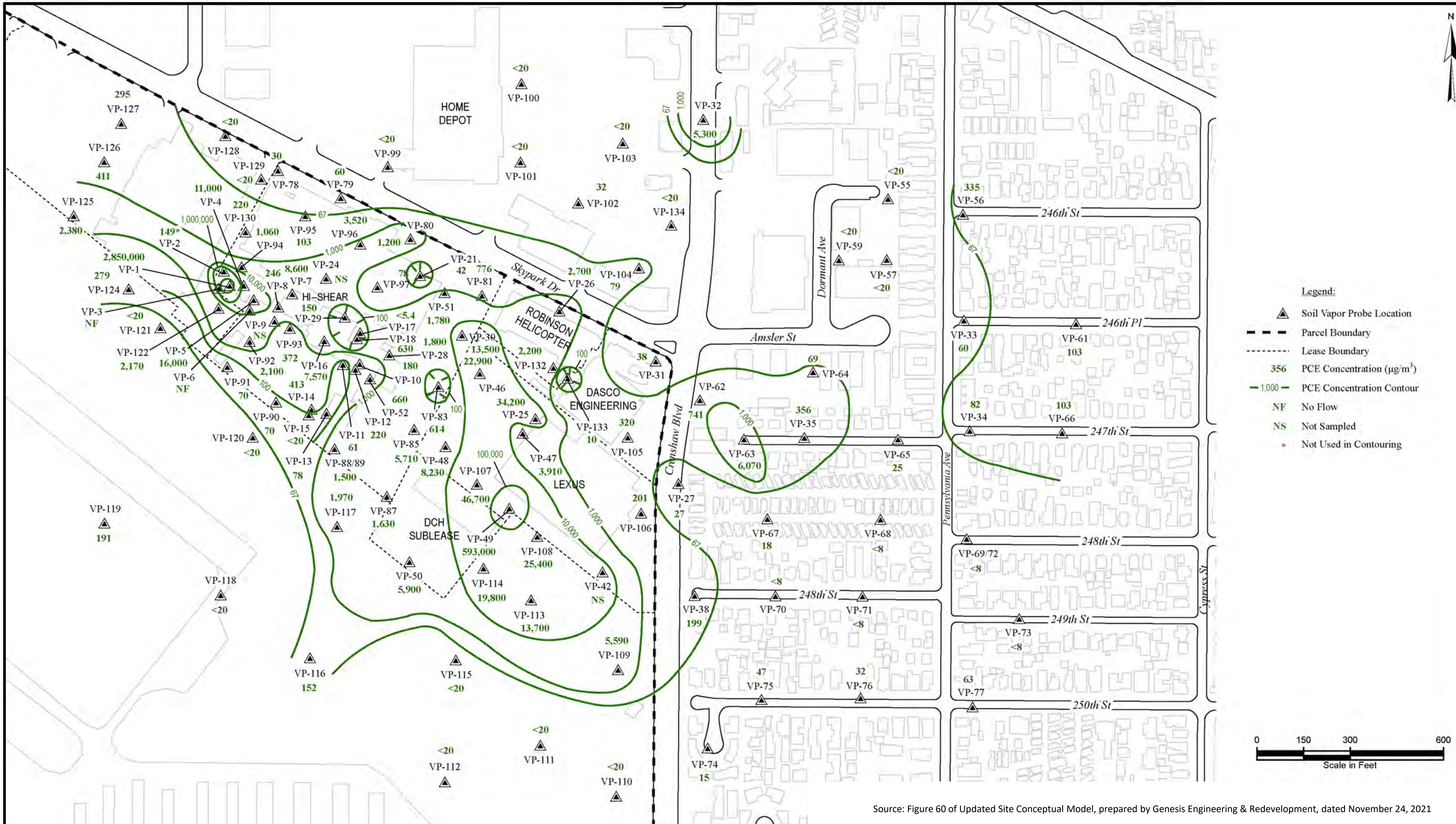
N:\GIS\Prj\S042.002_HiShear\Reference\PowerPoint Figures\Figure request 2022-02-08



Source: Figure 60 of Updated Site Conceptual Model, prepared by Genesis Engineering & Redevelopment, dated November 24, 2021

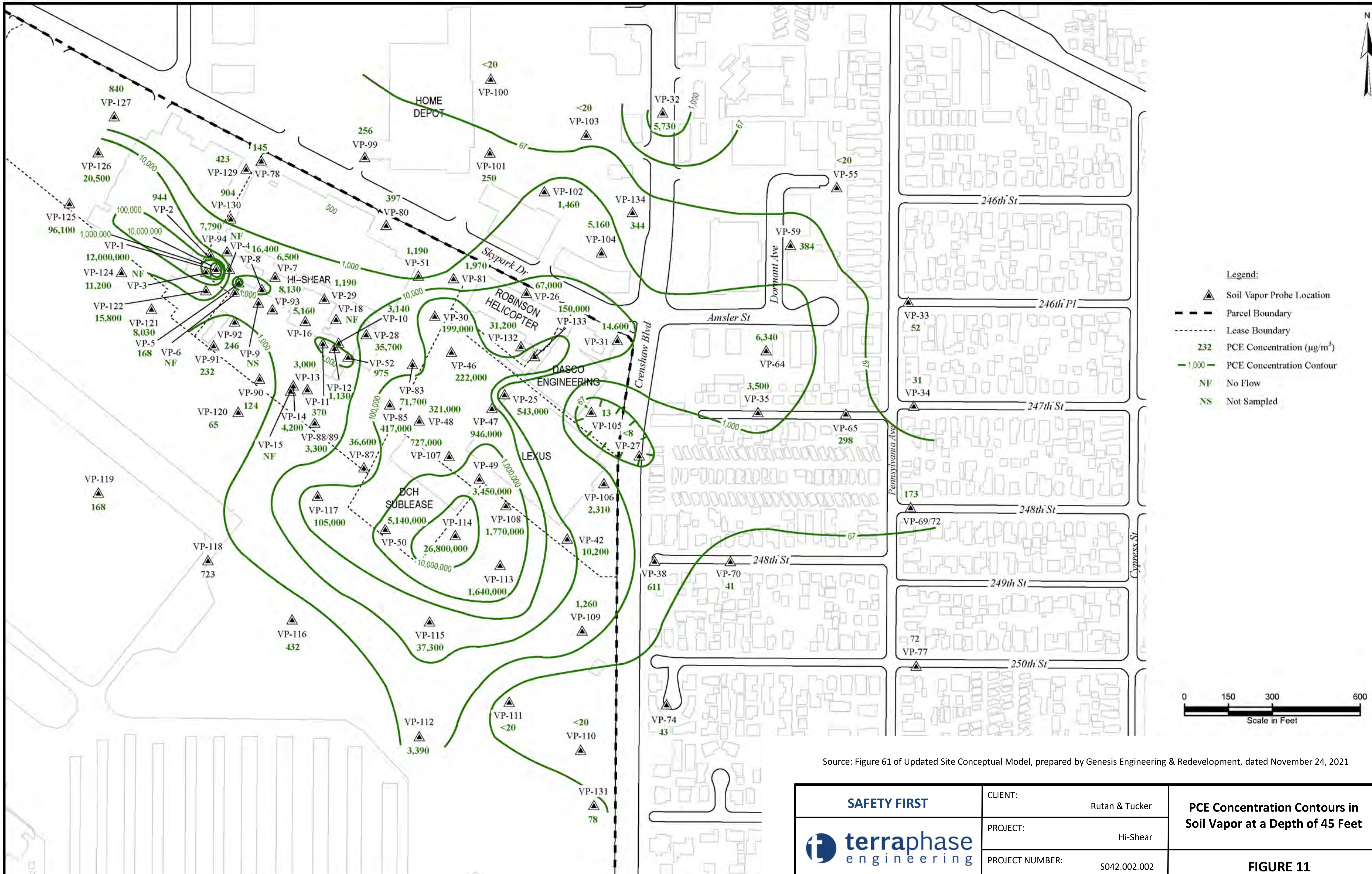
SAFETY FIRST	CLIENT: Rutan & Tucker	Maximum 1,1-DCE Concentrations in Soil in the Upper 20 Feet - Property 1
terraphase engineering	PROJECT: Hi-Shear	
	PROJECT NUMBER: S042.002.002	FIGURE 9

N:\GIS\Prj\S042.002_HiShear\Reference\PowerPoint Figures\Figure request 2022-02-08



Source: Figure 60 of Updated Site Conceptual Model, prepared by Genesis Engineering & Redevelopment, dated November 24, 2021

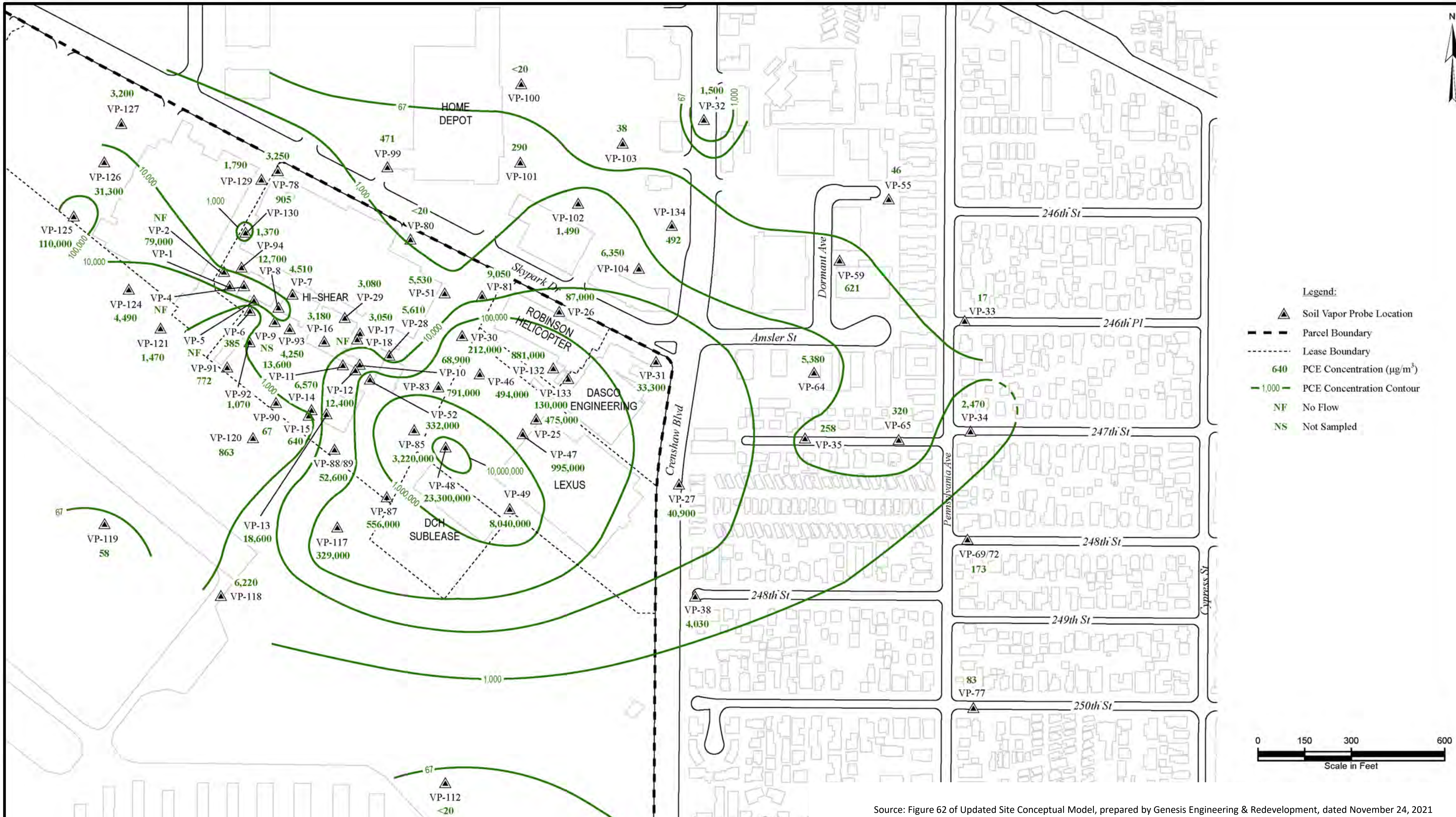
SAFETY FIRST	CLIENT: Rutan & Tucker	PCE Concentration Contours in Soil Vapor at a Depth of 5 Feet	
terraphase engineering	PROJECT: Hi-Shear		
	PROJECT NUMBER: S042.002.002	FIGURE 10	



Source: Figure 61 of Updated Site Conceptual Model, prepared by Genesis Engineering & Redevelopment, dated November 24, 2021

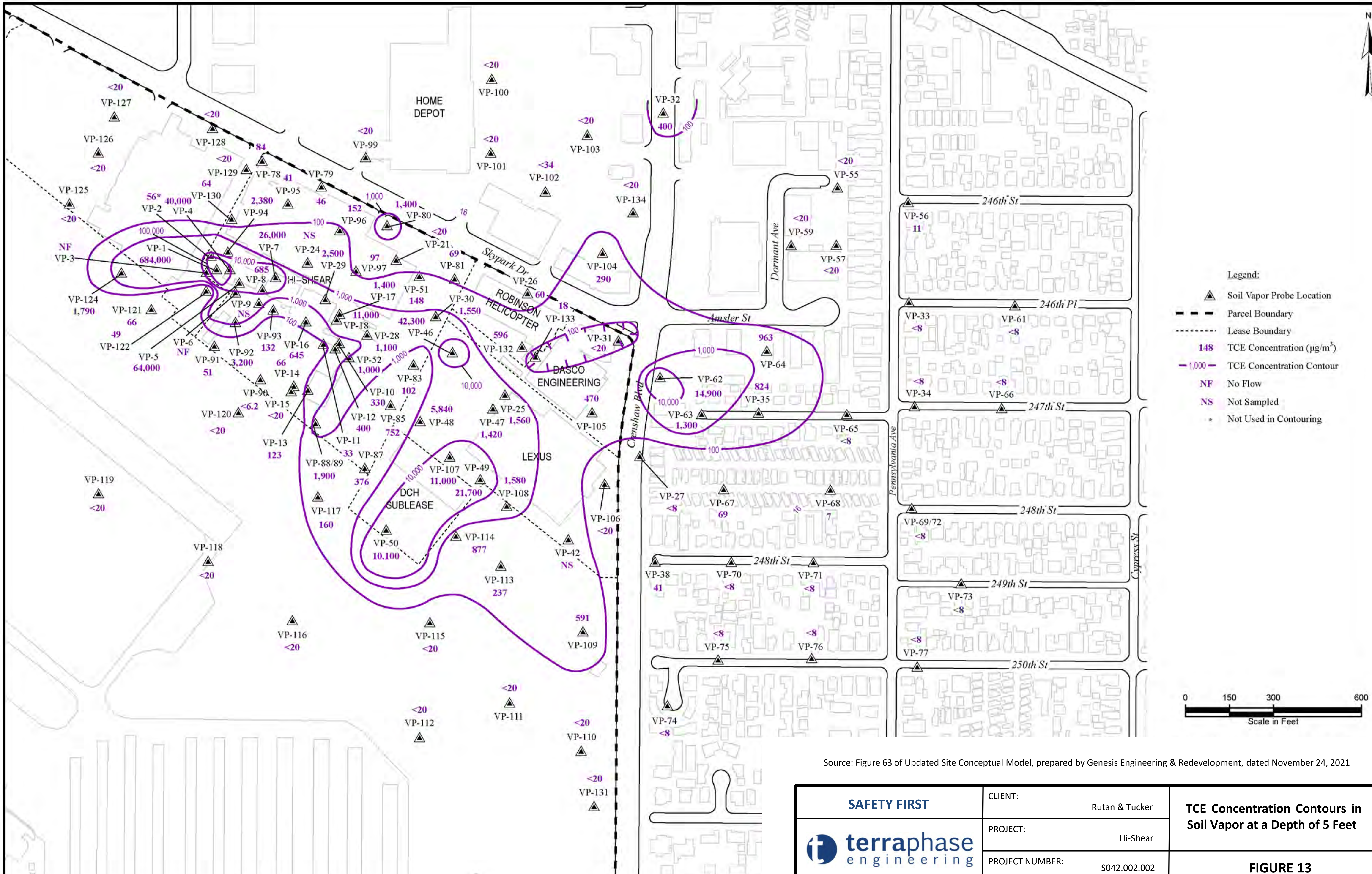
SAFETY FIRST	CLIENT: Rutan & Tucker	PCE Concentration Contours in Soil Vapor at a Depth of 45 Feet
terraphase engineering	PROJECT: Hi-Shear	
	PROJECT NUMBER: S042.002.002	FIGURE 11

N:\GIS\Prj\S042.002_HiShear\Reference\PowerPoint Figures



Source: Figure 62 of Updated Site Conceptual Model, prepared by Genesis Engineering & Redevelopment, dated November 24, 2021

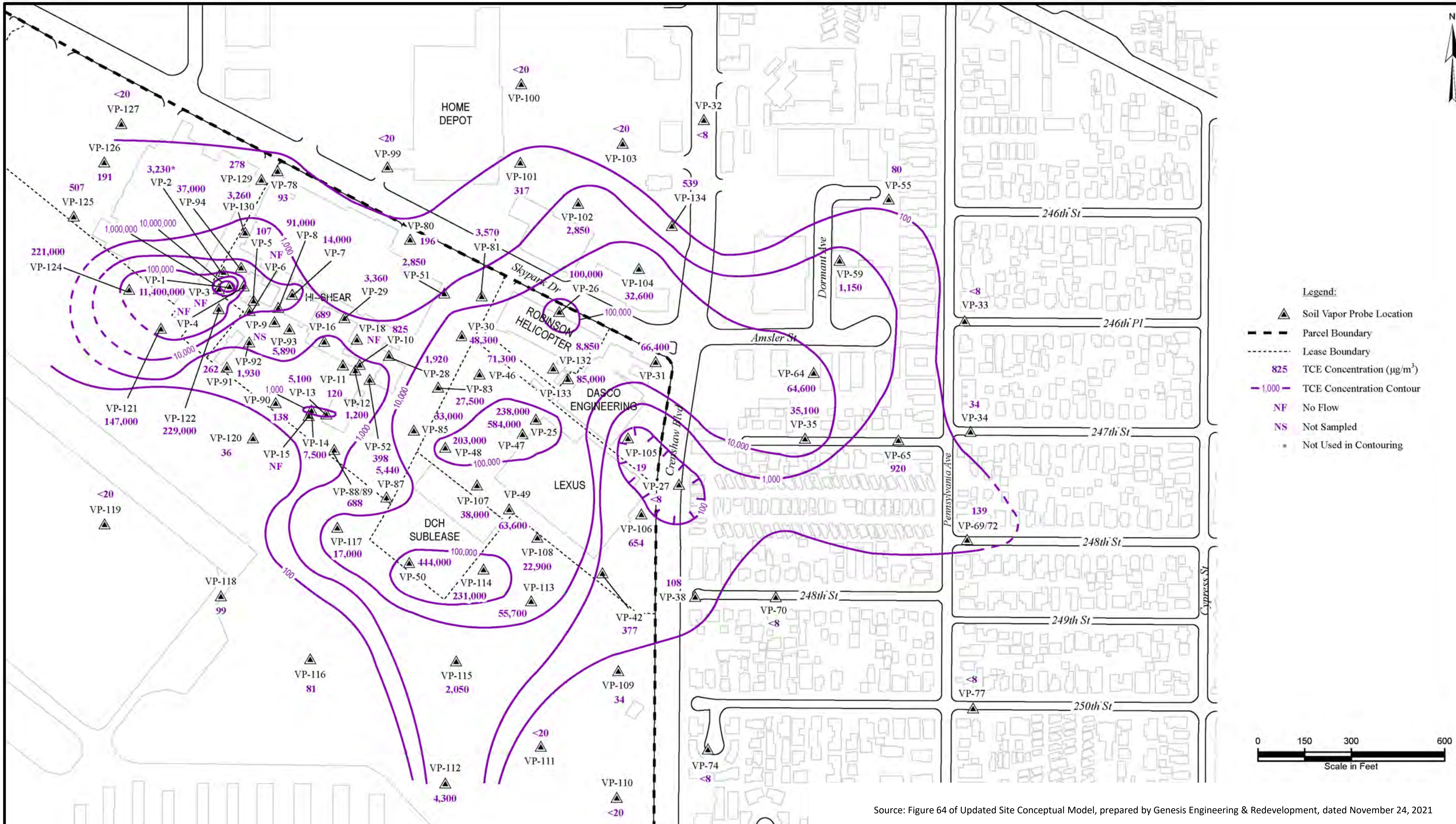
SAFETY FIRST	CLIENT: Rutan & Tucker	PCE Concentration Contours in Soil Vapor at a Depth of 85 Feet
terraphase engineering	PROJECT: Hi-Shear	
	PROJECT NUMBER: S042.002.002	FIGURE 12



Source: Figure 63 of Updated Site Conceptual Model, prepared by Genesis Engineering & Redevelopment, dated November 24, 2021

SAFETY FIRST	CLIENT: Rutan & Tucker	TCE Concentration Contours in Soil Vapor at a Depth of 5 Feet
terraphase engineering	PROJECT: Hi-Shear	
	PROJECT NUMBER: S042.002.002	FIGURE 13

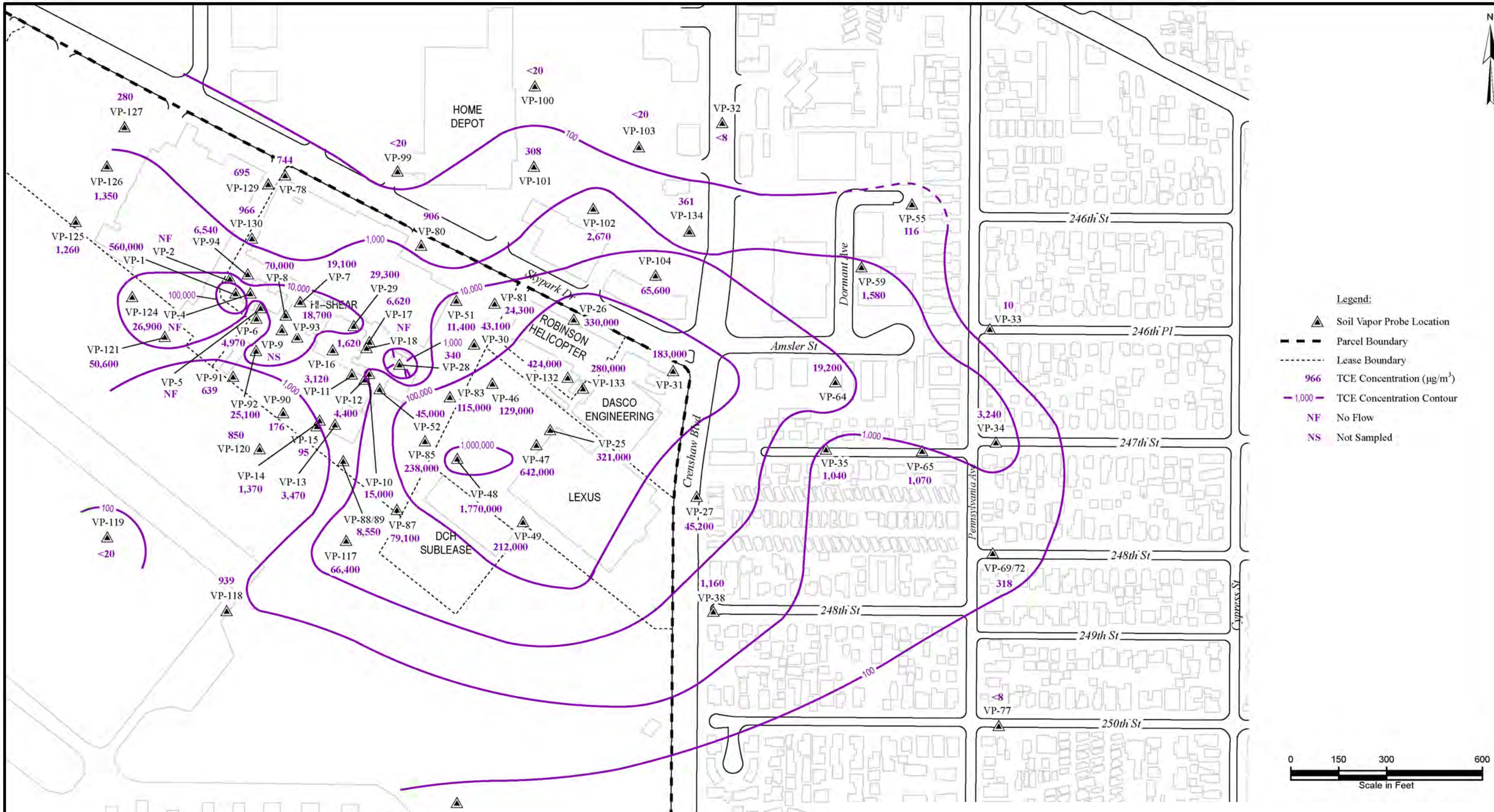
N:\GIS\Prj\S042.002_HiShear\Reference\PowerPoint Figures



Source: Figure 64 of Updated Site Conceptual Model, prepared by Genesis Engineering & Redevelopment, dated November 24, 2021

SAFETY FIRST	CLIENT: Rutan & Tucker	TCE Concentration Contours in Soil Vapor at a Depth of 45 Feet
terraphase engineering	PROJECT: Hi-Shear	
	PROJECT NUMBER: S042.002.002	FIGURE 14

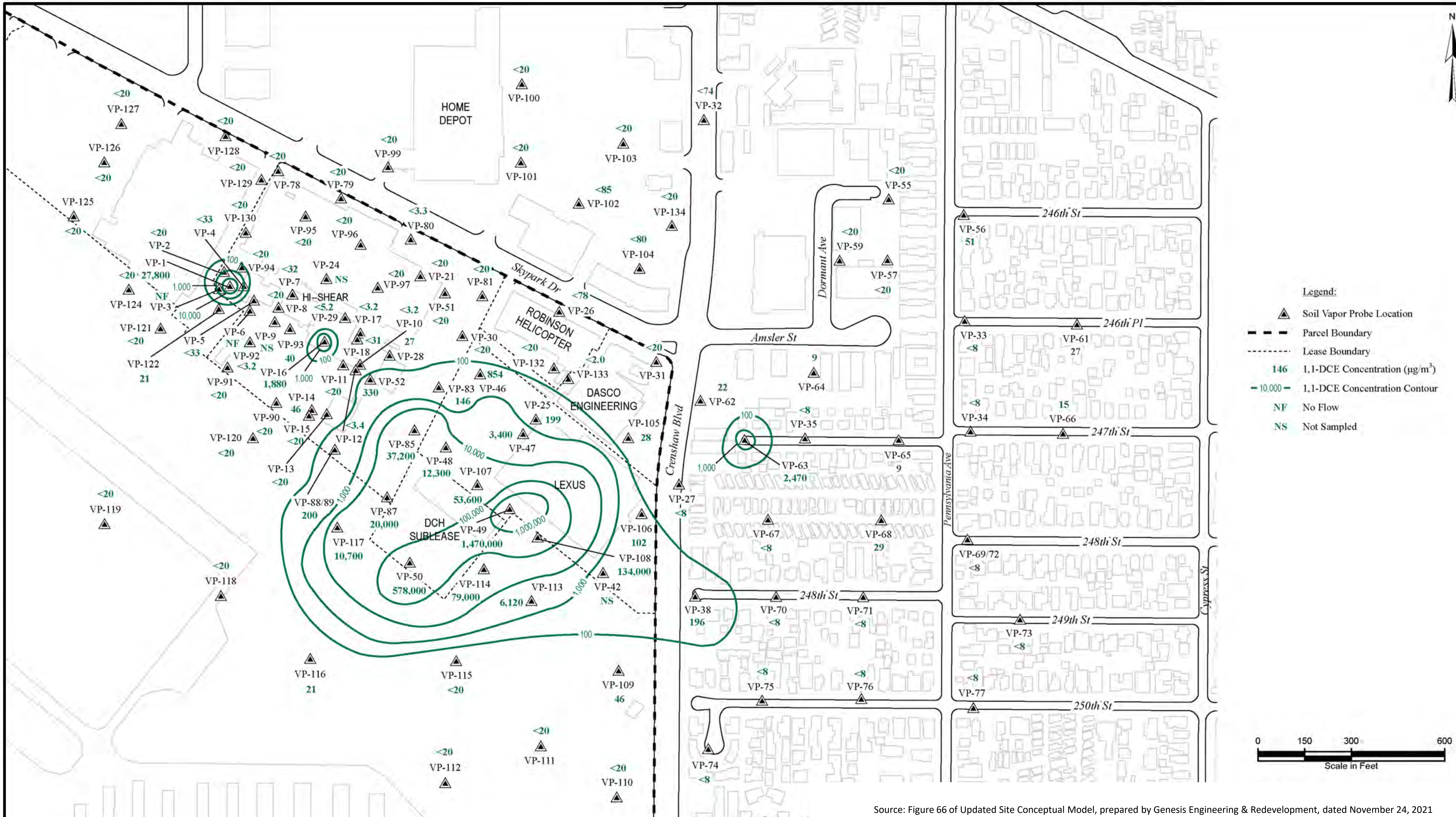
N:\GIS\Prj\S042.002_HiShear\Reference\PowerPoint Figures



Source: Figure 65 of Updated Site Conceptual Model, prepared by Genesis Engineering & Redevelopment, dated November 24, 2021

SAFETY FIRST	CLIENT: Rutan & Tucker	TCE Concentration Contours in Soil Vapor at a Depth of 85 Feet
terraphase engineering	PROJECT: Hi-Shear	
	PROJECT NUMBER: S042.002.002	FIGURE 15

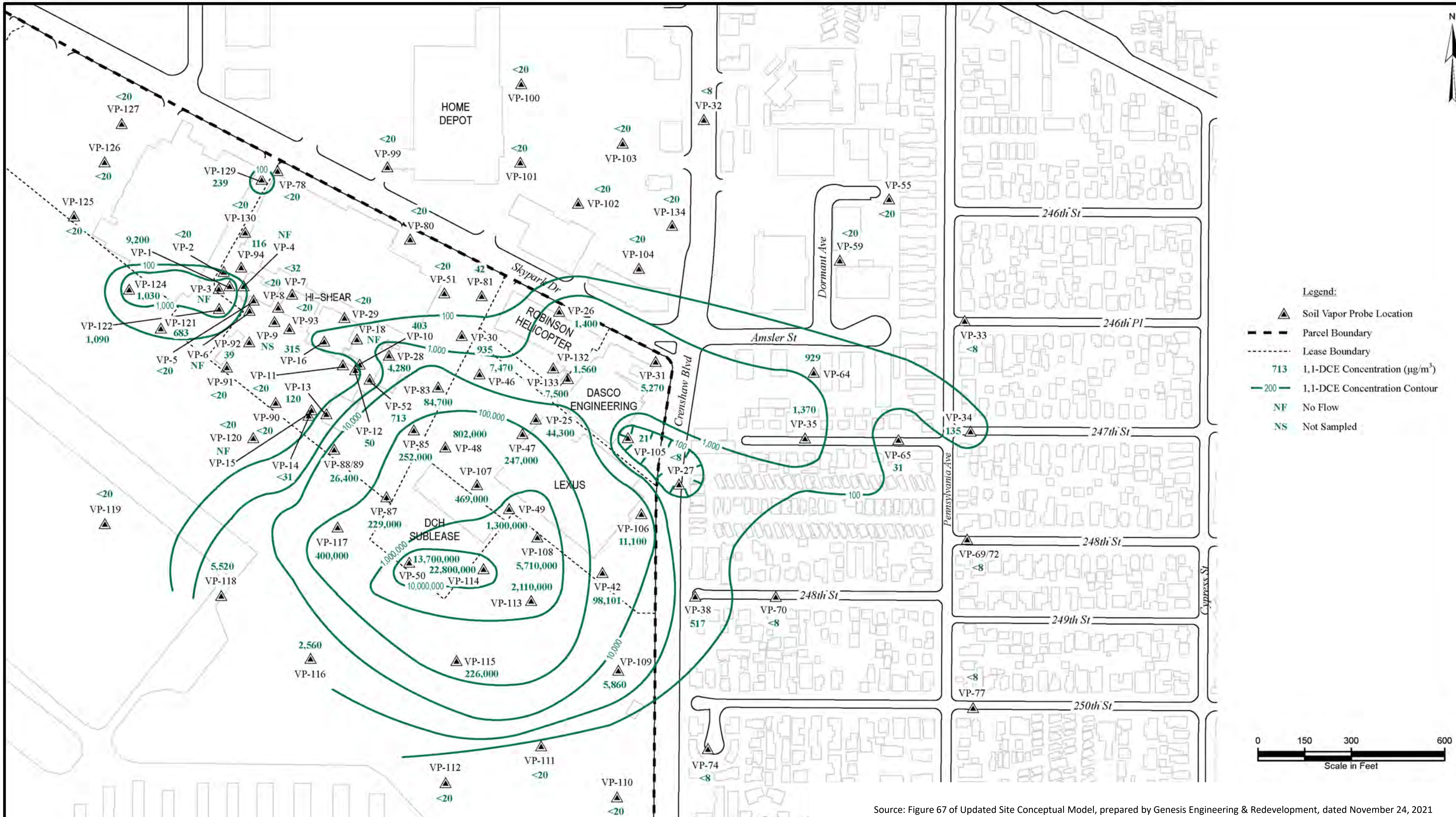
N:\GIS\Prj\S042.002_HiShear\Reference\PowerPoint Figures



Source: Figure 66 of Updated Site Conceptual Model, prepared by Genesis Engineering & Redevelopment, dated November 24, 2021

SAFETY FIRST	CLIENT: Rutan & Tucker	1,1-DCE Concentration Contours in Soil Vapor at a Depth of 5 Feet
terraphase engineering	PROJECT: Hi-Shear	
	PROJECT NUMBER: S042.002.002	FIGURE 16

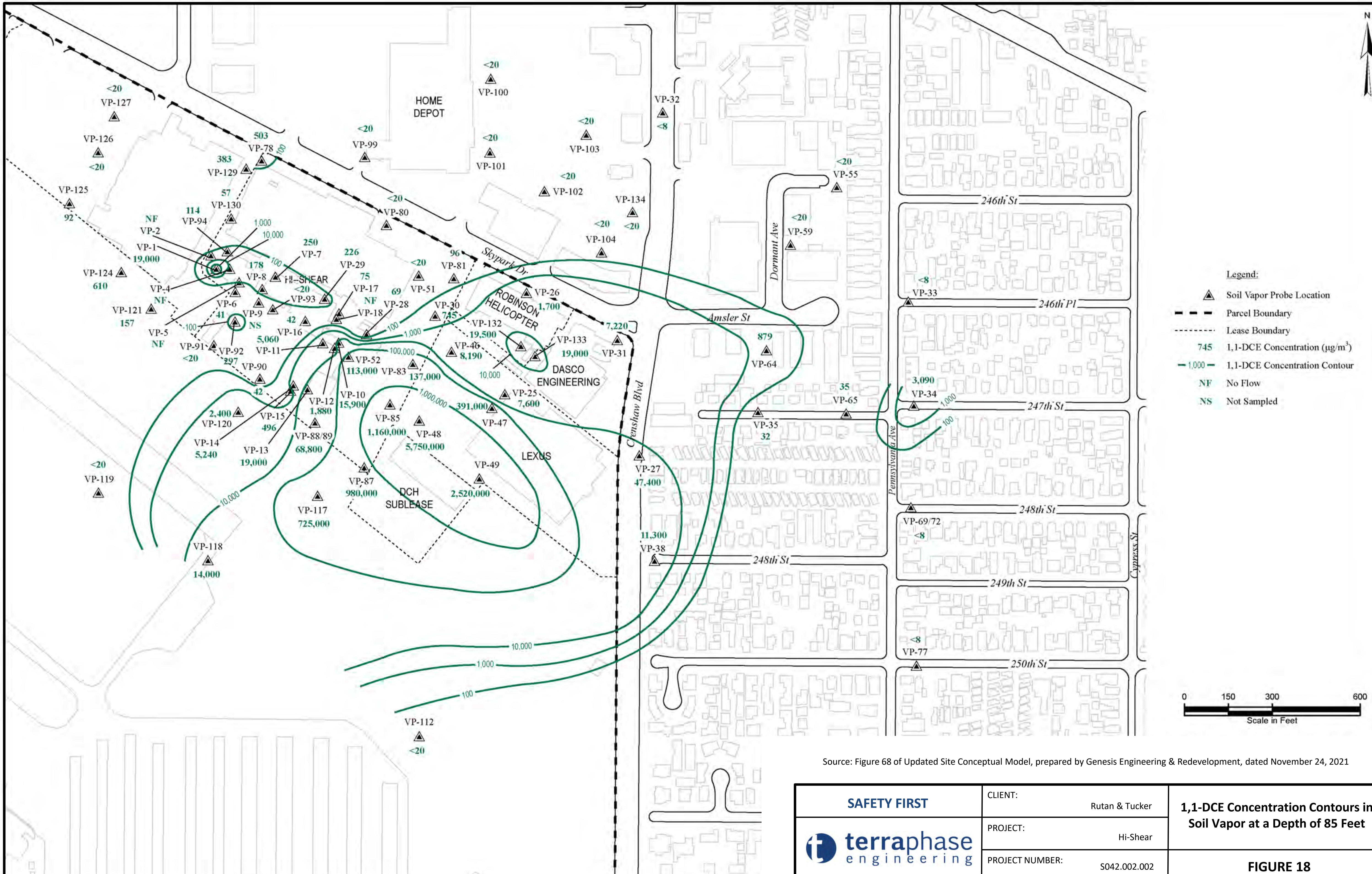
N:\GIS\Prj\S042.002_HiShear\Reference\PowerPoint Figures



Source: Figure 67 of Updated Site Conceptual Model, prepared by Genesis Engineering & Redevelopment, dated November 24, 2021

SAFETY FIRST	CLIENT: Rutan & Tucker	1,1-DCE Concentration Contours in Soil Vapor at a Depth of 45 Feet
terraphase engineering	PROJECT: Hi-Shear	
	PROJECT NUMBER: S042.002.002	FIGURE 17

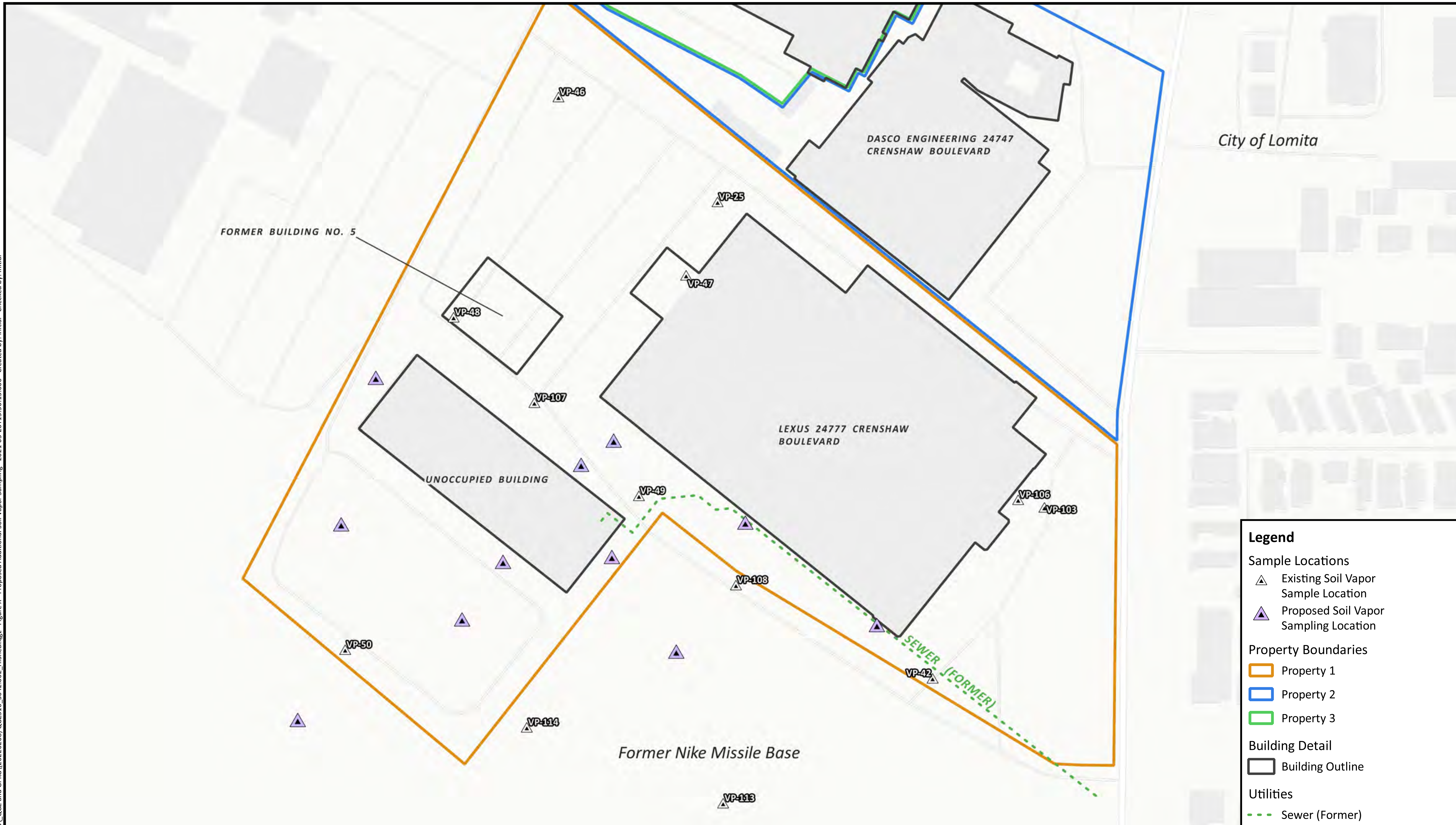
N:\GIS\Prj\S042.002_HiShear\Reference\PowerPoint Figures



Source: Figure 68 of Updated Site Conceptual Model, prepared by Genesis Engineering & Redevelopment, dated November 24, 2021

SAFETY FIRST	CLIENT: Rutan & Tucker	1,1-DCE Concentration Contours in Soil Vapor at a Depth of 85 Feet
terraphase engineering	PROJECT: Hi-Shear	
	PROJECT NUMBER: S042.002.002	FIGURE 18

N:\GIS\Prj\S042.002_HiShear\Reference\PowerPoint Figures



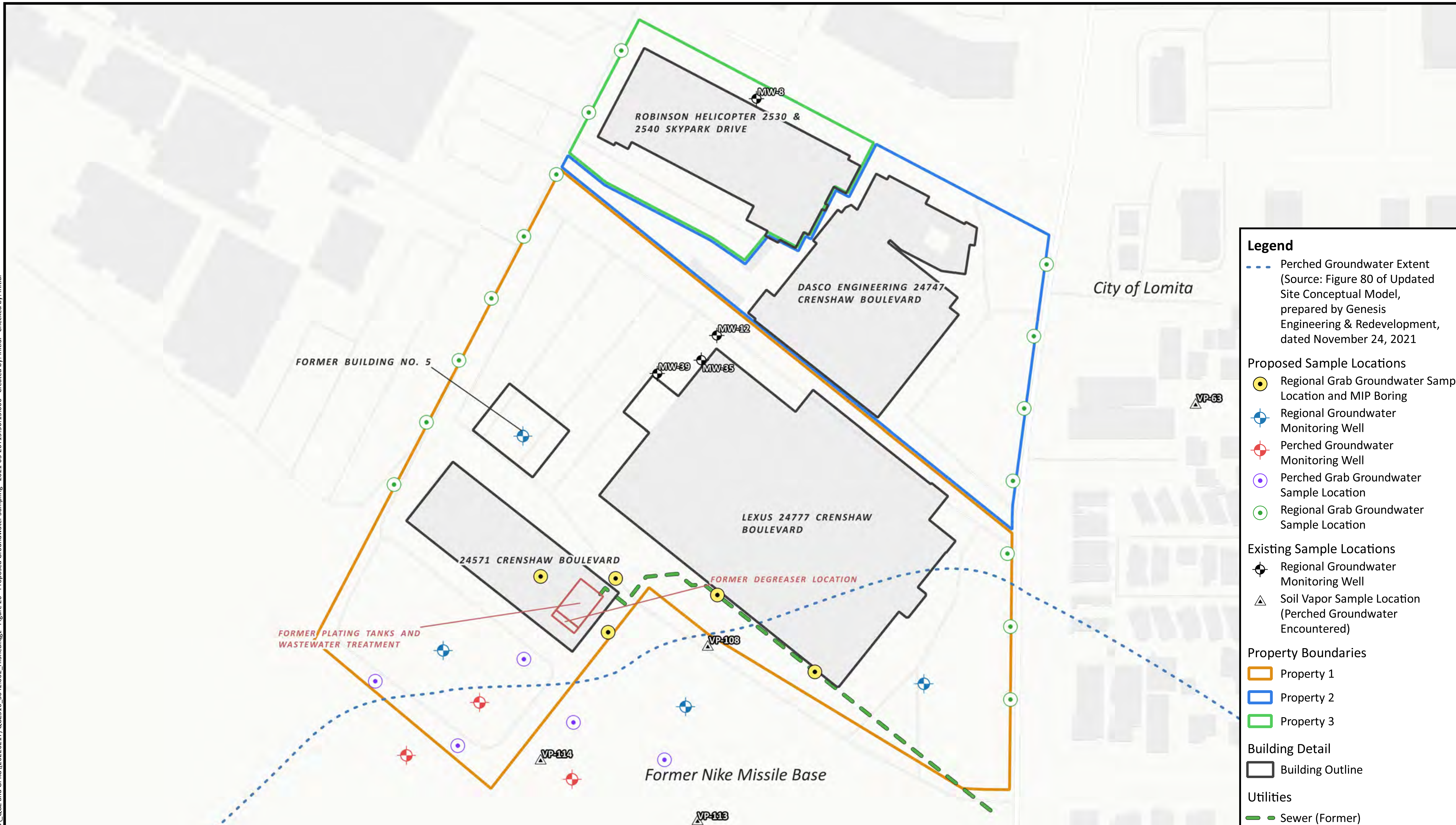
0 50 100 150 200 ft

1 Inch = 100 Feet

N

SAFETY FIRST	CLIENT: Rutan & Tucker	Proposed Additional Soil Vapor Sampling
terraphase engineering	PROJECT: Hi-Shear	
	PROJECT NUMBER: S042.002.002	FIGURE 19

N:\GIS\Prj\S042.002_HiShear\QGIS_QGZ and GPKG\(20220208) QGZ316_S042.002_HiShear.qgz Figure X - Proposed Additional Soil Vapor Sampling 2021-03-26T15:56:13.000 Created by: Initial Checked by: initial



0 50 100 150 200 ft

1 Inch = 125 Feet

N

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CLIENT:	Rutan & Tucker
PROJECT:	Hi-Shear
PROJECT NUMBER:	S042.002.002

Proposed Groundwater Sampling Locations

FIGURE 20

N:\GIS\Prj\S042.002_HiShear\QGIS_QGZ and GPKG\(20220217) QGZ316_S042.002_HiShear.qgz Figure 20 - Proposed Groundwater Sampling 2021-03-26T15:56:13.000 Created by: initial Checked by: initial

0 50 100 150 200 ft

1 Inch = 125 Feet

N

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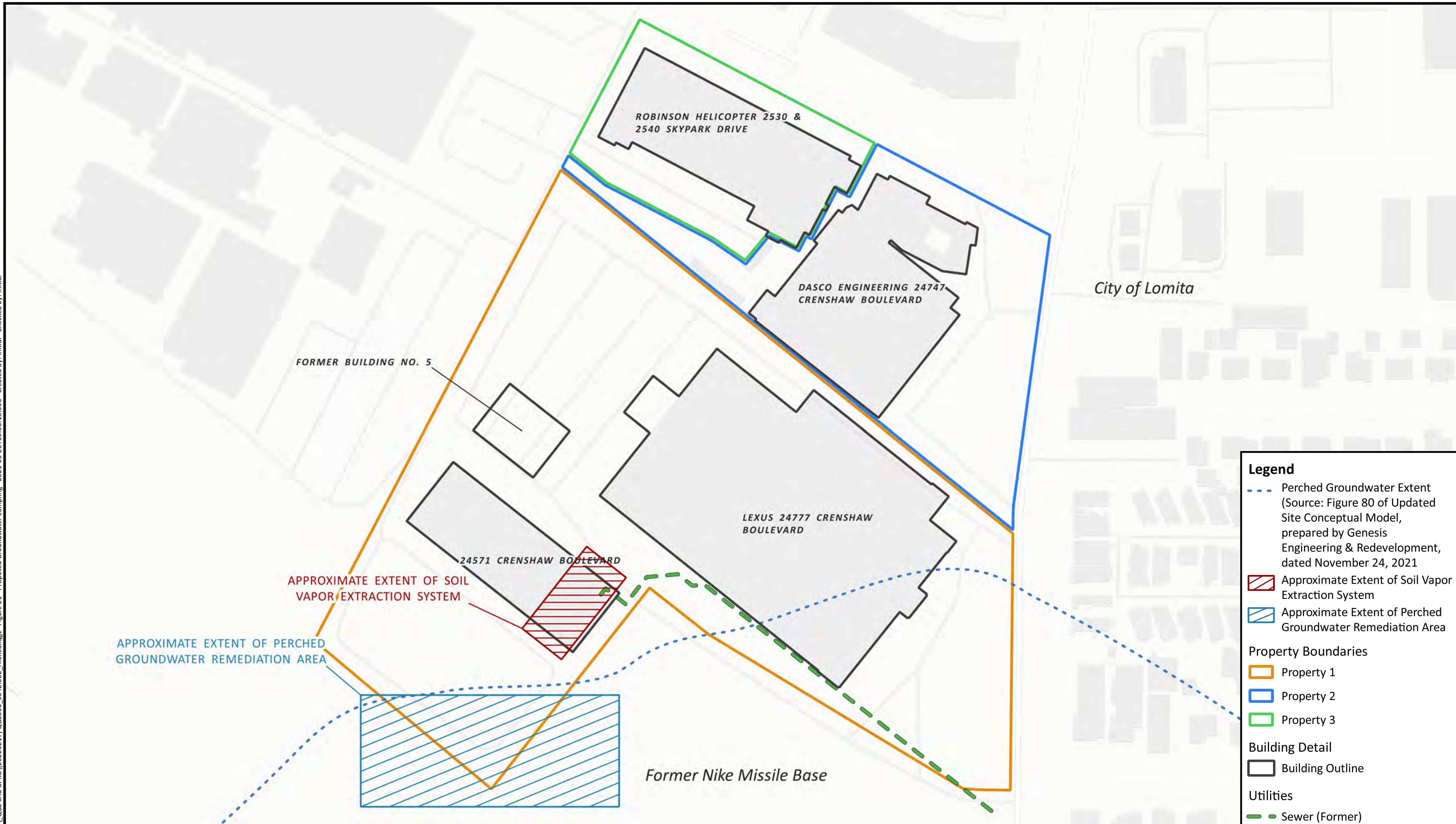
CLIENT: Rutan & Tucker

PROJECT: Hi-Shear

PROJECT NUMBER: S042.002.002

Proposed Regional Groundwater Remediation Area

FIGURE 21



0 50 100 150 200 ft

1 Inch = 125 Feet

N

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CLIENT:	Rutan & Tucker
PROJECT:	Hi-Shear
PROJECT NUMBER:	S042.002.002

Proposed Vadose Zone and Perched Groundwater Remediation Areas

FIGURE 22

N:\GIS\Prj\S042.002_HiShear\QGIS_QGZ and GPKG\(20220217) QGZ316_S042.002_HiShear.qgz Figure 21 - Proposed Groundwater Sampling 2021-03-26T15:56:13.000 Created by: initial Checked by: initial