REPORT

DRAFT
REMEDIAL ACTION MEMORANDUM
356 PACIFIC STREET
HONOLULU, HAWAII
TAX MAP KEY 1-5-010:009

CHEVRON FACILITY NO. 359067

April 23, 2019

Chevron Environmental Management Company
145 S. State College Boulevard
P.O. Box 2292
Brea, CA 92822-2292

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Prepared for:

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April 2019

CONTENTS

TABLES

FIGURES

APPENDIX

ACRONYMS AND ABBREVIATIONS

%v	percent by volume
$\mu g/m^3$	microgram per cubic meter
1-MN	1-methylnaphthalene
2-MN	2-methylnaphthalene
B[a]P	benzo(a)pyrene
bgs	below ground surface
CCH DPP	City and County of Honolulu Department of Planning and Permitting
CCPI	Castle and Cooke Properties, Inc.
CERCLIS	CERCLA Information System
COC	constituent of concern
COPC	constituent of potential concern
DOH	Department of Health, State of Hawaii
DU	decision unit
EAL	Environmental Action Level
EHE	Environmental Hazard Evaluation
EHMP	Environmental Hazard Management Plan
HAR	Hawaii Administrative Rules
IC	institutional control
LEL	lower explosive limit
LNAPL	light non-aqueous phase liquid
LUST	Leaking Underground Storage Tank
msl	mean sea level
PAH	polynuclear aromatic hydrocarbon
RAA	remedial alternatives analysis
RAM	remedial action memorandum
RAO	remedial action objective
SCP	State Contingency Plan
Site	356 Pacific Street, Honolulu, Hawaii
SVOC	semi-volatile organic compound
TGM	Technical Guidance Manual
TPH	total petroleum hydrocarbons
TPH-D	total petroleum hydrocarbons quantified as diesel
TPH-G	total petroleum hydrocarbons quantified as gasoline
TPH-MO/TPH-O	total petroleum hydrocarbons quantified as motor oil/oil (terms used interchangeably)
TTLR	tank truck loading rack
Unocal	Union Oil Company of California
VOC	volatile organic compound

1.0 STATEMENT OF APPROVAL

1.1 INTRODUCTION

A Draft Remedial Action Memorandum (RAM) has been prepared by AECOM on behalf of Chevron Environmental Management Company for the property located at 356 Pacific Street, Honolulu, Hawaii (Site), facility number 359067 (Figure 1). The Site is located in the Iwilei district of Honolulu, is approximately 28,580 square feet in size (CCH DPP 2011) and is currently used for parking (Figure 2). The Tax Map Key Number is 1 5 010:009. The Draft RAM was developed based on the current plans for future Site redevelopment as a high-rise mixed commercial/residential development as provided by the current property owner, Castle & Cooke Properties, Inc.

1.2 ASSESSMENT OF THE PROPERTY

Union Oil Company of California (Unocal) acquired the Site on July 27, 1940 and constructed a tank truck loading rack (TTLR) facility, which was operated between 1941 and 1985 (Figure 2). During this time, the TTLR received fuel and other petroleum products via pipelines from the bulk storage terminal located at 411 Pacific Street (i.e., the former ConocoPhillips Honolulu terminal). TTLR operations were discontinued in the mid-1980s and all of the above ground structures were removed, with the exception of the garage which was removed in 2010 (CCH DPP 2011). In 2010, the State of Hawaii Department of Health (DOH) issued a Letter of Interest to Chevron Products Company (as successor in interest to Unocal, the former operator) to address subsurface petroleum impacts. Castle & Cooke Properties, Inc. purchased the property in 1994.

Total petroleum hydrocarbons as gasoline (TPH-G), total petroleum hydrocarbons as diesel (TPH-D), and petroleum hydrocarbons as oil (TPH-O) were found in Site soils in excess of the Commercial/Industrial DOH environmental action levels and are the primary constituents of concern (COCs). Additional COCs, if future residents were to come in contact with subsurface soils, include arsenic, lead and a few polynuclear aromatic hydrocarbons (PAH). Direct exposure to subsurface light non-aqueous phase liquid (LNAPL) is also a potential concern during construction or maintenance activities in certain portions of the Site. Vapor intrusion is the most likely concern for humans under a future mixed use redevelopment. Leaching of COCs to groundwater is reduced under current use due to the presence of asphalt pavement and/or building foundations. Likewise, under the proposed future mixed use development, the building footprint will minimize the leaching of COCs to groundwater. Groundwater at the Site generally occurs between 3.5 and 5 feet below ground surface and is not a drinking water source. Given that the groundwater flow direction does not appear to flow toward surface water bodies, constituents in groundwater are expected to pose a low hazard to aquatic life. Methane, benzene and TPH-G are the COCs in soil gas. While there is no established methane threshold within soil gas, these concentrations all exceeded a 5 percent by volume (%v) concentration, which is the lower explosive limit for methane. Because pressure driven flow and an ignition source are needed for methane to pose an explosion hazard, methane would be considered to pose a low hazard under the current paved parking lot. However, if future utilities were to create preferential pathways into vaults, a process for mitigating methane hazards should be implemented.

While the Environmental Hazard Evaluation (EHE) for the Site (AECOM 2018a) did not identify any significant health hazards under current Site conditions, because the contamination is currently under asphalt and no buildings are present on the Site, potential hazards exist from the subsurface contamination if the Site is to be redeveloped. Based on the current plans for future Site redevelopment as a high-rise mixed commercial/residential development, a response action is considered necessary to protect human health and the environment.

1.3 DESCRIPTION OF PREFERRED REMEDIAL ALTERNATIVE

The preferred alternative (Opportunistic Remediation/Vapor Barrier/Institutional Controls) includes removal of contaminated soil or (LNAPL) if encountered during construction, installation of a vapor barrier beneath future building with a venting system and institutional controls. Prior to construction, the existing Site EHE/Environmental Hazard Management Plan (EHMP) will be revised to include an Exposure Prevention Management Plan which will provide guidelines to minimize exposure to construction workers, nearby workers and the general public foot traffic, as well as detail procedures and guidelines to provide sufficient controls to protect human health and the environment. The three components of the selected alternative are further described in the following sections.

1.3.1 Opportunistic Remediation

Soil with obvious contamination such as LNAPL, odors, or sheen will be removed from under the building footprint during future building construction. In accordance with the Programmatic EHE/EHMP (DOH 2013), the soil will be evaluated using visual or olfactory indications of petroleum presence (i.e., LNAPL, sheens, staining, odors) via a representative sample of soil squeezed using a nitrile-gloved hand. In addition, removal of subsurface pipelines that obstruct building development during the construction phase of the project is proposed and all of the Site's current monitoring wells would be abandoned prior to commencement of building construction.

1.3.2 Vapor Barrier

A vapor intrusion barrier will be installed beneath the building foundation to prevent exposure of future residents and workers to soil gas. Penetrations for utilities would be sealed and tested. Passive venting would also be included to capture any accumulated soil vapor from beneath the building and a separate vent riser for the venting system is recommended for venting the elevator shaft. Elevator shaft and/or sub-slab soil gas vapor monitoring events will be performed at least quarterly for a minimum of one year post-building and discontinued when sufficient data indicate that the vapor barrier performance is protective human health after building construction. The details regarding the need for additional monitoring regarding the effectiveness of passive venting will be described in a revision of the site EHE/EHMP (AECOM 2018a).

1.3.3 Institutional Controls

Institutional controls (ICs) for any remaining post-construction contaminated soil and groundwater will be managed as described in the final Site EHMP.

ICs for the vapor barrier will include controls to prevent penetration of the vapor barrier (and repair in case of inadvertent damage) during any subsurface work. Annual inspections and periodic site reviews will be performed to confirm and document that the vapor barrier continues to perform as designed. Because the EHMP may need to be periodically updated to account for any potential land use changes, other ICs to address residual contamination will be documented in the final Site EHMP.

1.3.4 Basis for Selection

The preferred alternative (Alternative 4) was considered the most appropriate option, based on the following:

- Meets the remedial action objective for the Site
- Provides long-term protection to human health and the environment at a significantly lower cost than full excavation
- Minimizes impacts on human health and the environment during implementation.
- Complies with applicable requirements
- Reduces contaminated media volume through opportunistic remediation (excavation and/or LNAPL recovery)
- Provides a technically and administratively feasible solution.

1.4 DECLARATION

The proposed remedial alternative for the 356 Pacific Street Site (359067) has been judged by the State of Hawaii Department of Health Hazard Evaluation and Emergency Response Office to be: 1) protective of human health and the environment; 2) in compliance with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action; 3) cost effective; and 4) in compliance with the Hawaii Environmental Response Law (Hawaii Revised Statues 128D), and the Hawaii State Contingency Plan (Hawaii Administrative Rules 11-451).

By: ____________________________ Date: 4/29/19

Program Manager
Hazard Evaluation & Emergency Response (HEER) Branch
State of Hawaii Department of Health

2.0 INTRODUCTION AND PURPOSE

This Draft Remedial Action Memorandum (RAM) presents the proposed (preferred) remedial alternative selected for the property located at 356 Pacific Street, Honolulu, Hawaii, facility number 359067 (Figure 1) based on a detailed analysis of five different alternatives (AECOM 2018a). The environmental hazards were identified in the *Revised Environment Hazard Evaluation and Interim Environmental Hazard Management Plan* prepared by AECOM on behalf of Chevron Environmental Management Company (AECOM 2018a). The Site is located in the Iwilei district of Honolulu, is approximately 28,580 square feet in size (CCH DPP 2018) and is currently used for parking (Figure 2); the Tax Map Key Number is 1-5-010:009. According to the City and County of Honolulu Department of Planning and Permitting (CCH DPP), the Site is zoned as (IMX-1) Industrial Mixed Use (CCH DPP 2018). However, the City Council's approval of the Honolulu Rail Transit has resulted in the possibility for land use changes that will allow high-rise mixed commercial/residential development.

The Draft RAM is based on the information presented in the EHE and Interim EHMP described above and the Remedial Alternatives Analysis (RAA) Report dated August 2018. This document summarizes pertinent site information, provides a concise summary of environmental investigation data and the associated environmental hazards. It documents the basis for remediation, and describes the rationale for selection of the preferred remedial alternative.

Specifically, based upon the analysis of five remedial action alternatives considered in the RAA, the preferred alternative for the Site is Alternative 4: Opportunistic Remediation/Vapor Barrier/Institutional Controls. The vapor barrier includes associated venting systems (a separate active system for the elevator shaft and a passive system for the rest of the property). Alternative 4 was selected based on the following:

- Alternative 4 would meet the remedial action objectives (RAOs) for the Site and provide long-term protection to human health and the environment.
- Alternative 4 would be protective of future residents and workers and at a significantly lower cost than full excavation of the Site.
- Alternative 4 would have minimal impacts on human health and the environment during implementation.
- Alternative 4 would comply with applicable requirements.
- Alternative 4 would reduce contaminated media volume by opportunistic remediation (excavation and/or LNAPL recovery).
- Alternative 4 is both technically and administratively feasible.

3.0 BACKGROUND

This section describes the Site characteristics, including setting, land use history, and previous investigations. This section also discusses the constituents of potential concern (COPCs) for each environmental media.

3.1 SITE DESCRIPTION

The subject property is located in the Iwilei district of Honolulu, is approximately 28,580 square feet in size (CCH DPP 2018) and is currently used for parking (Figure 2). According to the CCH DPP, the Site is zoned as Industrial Mixed Use (CCH DPP 2018). It is bordered on the west by Pacific Street, on the south by a parcel owned by Castle and Cooke Properties, Inc. (CCPI) that is currently leased by Regal Cinemas, on the east by Dole Cannery Complex, and on the north by Iwilei Road (Figure 2). A topographic survey conducted in 2013 indicated that the Site elevation is approximately 4.5 to 5.5 feet above mean sea level (msl).

There are two groundwater aquifers. The upper aquifer is basal (fresh water in contact with seawater), unconfined, and sedimentary. The lower aquifer is basal, is currently used as drinking water, considered to be irreplaceable, contains fresh water (chloride concentration less than 250 milligrams per liter, and has low vulnerability to contamination (Mink and Lau 1990). Historically, shallow groundwater at the Site occurred between approximately 5 and 6 feet bgs (Dames & Moore 1988; Treadwell & Rollo 2000). Due to ground surface reconstruction and repaving, groundwater at the Site generally occurs between 3.5 and 5 feet bgs. It is not used for drinking water. The nearest drinking water wells (Kalihi Pump Station) are approximately 0.9 mile north of the Site. The nearest major bodies of surface water are Kapalama Canal and Honolulu Harbor, approximately 0.2 mile (320 meters) to the south southwest, and Nuuanu Stream, roughly 0.4 mile (640 meters) to the east. However, there are no nearby surface water bodies to the west, which based on information from the October 2017 groundwater monitoring program, is the predominant groundwater flow direction.

3.2 SITE BACKGROUND

Union Oil Company of California (Unocal) acquired the Site on July 27, 1940. In 1941, Unocal constructed a TTLR facility, which was operated between 1941 and 1985 (Figure 2). During this time, the TTLR received fuel and other petroleum products via pipelines from the bulk storage terminal located at 411 Pacific Street (i.e., the former ConocoPhillips Honolulu terminal). TTLR operations were discontinued in the mid-1980s and all of the above ground structures were removed, with the exception of the garage which was removed in 2010 (CCH DPP 2018). CCPI (AECOM 2018b) purchased the property from Unocal in 1994 and is the current owner of the property and has used the Site for parking up to present. In November 2010, the DOH issued a Letter of Interest to Chevron Products Company (as successor in interest to Unocal, former operator) and CCPI (current property owner) (DOH 2010) to address petroleum impacts and the potential for commingling of impacts or plumes originating from surrounding properties.

A Pipeline Investigation conducted at the Site in 2014 revealed 11 pipelines were located at two excavation locations at depths between 2.5 and 3.5 feet below ground surface (URS 2015). The pipelines were abated of any asbestos-containing material coating where present and the exposed pipelines were tapped and drained of any residual fluids, then grouted, sealed, and abandoned in place.

3.3 INVESTIGATION HISTORY

Relevant information regarding past investigations and COPCs identified in previous investigations conducted at the Site and in the vicinity are summarized in the following subsections. In the descriptions below, historic analytical results were compared to the DOH EALs for commercial/industrial sites greater than 150 meters to the nearest surface water body that are considered non-drinking water resources. For the revised EHE/EHMP (AECOM 2018a) recent EALs for residential sites greater than 150 meters to the nearest surface water body were used (DOH 2017a).

3.3.1 March 1988 Soil Sampling

During a soil investigation (Dames & Moore 1988), Borings, B-1 through B-4, were advanced to a maximum of 6.5 feet bgs and two soil samples collected from each boring to evaluate for the presence of petroleum in Site soils. Location B-2 was positioned near the former 280-gallon diesel UST, location B-3 was near the former 1,000-gallon waste oil UST, and location B-4 was near an oil sump. Two locations, B-1 and B-2, contained benzene [1,400 micrograms per kilogram (µg/kg) and 13,000 µg/kg] and all four locations contained TPH-D and TPH-G above the associated commercial/industrial DOH EALs. Additionally, the analytical results indicated that the hydrocarbons present in the samples appear to be two separate types of hydrocarbons in the carbon range of C8 through C20.

3.3.2 April and May 2000 Soil, Groundwater, and Soil Gas Sampling

As part of a larger investigation in the vicinity conducted by Treadwell & Rollo (2000), borings TRW-01, TRB-02, TRB-03, TRW-04, TRB-05, and TRW-06 were advanced at the Site. Three to four soil samples were collected from each boring up to 7.5 feet bgs. Concentrations of benzene, benzo(a)pyrene (B[a]P), 1-methylnaphthalene (1-MN), 2-methylnaphthalene (2-MN), naphthalene, TPH-G, TPH-D, and TPH-O in soil were detected above associated commercial/industrial EALs.

Groundwater grab samples were collected from locations TRW-01, TRB-02, TRB-03, and TRB-05. Concentrations of anthracene, B[a]P, 2-MN, naphthalene, phenanthrene, pyrene, TPH-G, TPH-D, and TPH-O in groundwater were detected above associated commercial/industrial EALs.

Soil gas samples were collected from all six locations at depths between 2.5 and 3.0 feet bgs. Concentrations of benzene, ethylbenzene, and TPH-G in soil gas were detected above associated commercial/industrial EALs. Concentrations of methane in soil gas were detected at levels above 10 percent of the lower explosive limit (LEL).

Borings TRW-01, TRW-04, and TRW-06 were converted to 2-inch monitoring wells TRW-01, TRW-04, and TRW-06 and developed. Light non-aqueous phase liquid (LNAPL) was not observed in the three monitoring wells. Groundwater samples were collected from the three monitoring wells in May 2000. Concentrations of ethylbenzene, 2-MN, naphthalene, phenanthrene, TPH-G, TPH-D, and TPH-O in groundwater were detected above associated commercial/industrial EALs (Treadwell & Rollo 2000).

3.3.3 September 2004 through March 2007 Groundwater Sampling

Groundwater samples were collected from wells TRW-04 and TRW-06 between September 2004 and March 2007. The purpose of the sampling was to determine if there was contamination from the former Gasco facility at 616 Iwilei Road migrating to the Site and to evaluate the effectiveness of the soil vapor extraction system in operation at the former Gasco facility. The samples were analyzed for benzene, ethylbenzene, toluene, xylenes, naphthalene, and semi-volatile organic compounds (SVOCs). Concentrations of naphthalene in TRW-06 were detected above the associated commercial/industrial EAL on three occasions (September 2004, December 2004, and March 2007) (ESI 2012).

3.3.4 August 2010 through July 2011 Lowe’s Construction Work

Between August 2010 and July 2011, Lowe’s performed construction work near the Site in conjunction with development of the retail store at 411 and 439 Pacific Street. Construction activities included widening Pacific Street and Iwilei Road and installing utilities adjacent to the Site. In excavations on the Site, next to Pacific Street and Iwilei Road, petroleum-impacted soil was encountered at the capillary fringe of the water table. Soil, water, and LNAPL samples collected from the excavations confirmed that subsurface petroleum impacts were present. TPH-G, TPH-D, TPH-O, naphthalene, benzo(a)pyrene, lead, and arsenic were detected in soil samples at concentrations above DOH EALs. B[a]P and chrysene were detected in groundwater samples at concentrations above EALs (ESI 2012).

3.3.5 Investigations Supporting Storm Drain Upgrades and Utility Installation

As part of the construction of the Lowe's retail store at 411 and 439 Pacific Street, storm drain upgrades in Pacific Street and Iwilei Road were required, as well as utility installation beneath Pacific Street and construction of sidewalks along Pacific Street and Iwilei Road (ESI 2010b).

3.3.5.1 September 2010 Soil Sampling

In September 2010, ESI collected four soil samples during off-site construction at Lowe's. Boring SS-E-04 was advanced near the southwest corner of the Site and a soil sample was collected from the capillary fringe. Concentrations of TPH-D and TPH-G were detected above the associated commercial/industrial DOH EALs. Concentrations of TPH-O, volatile organic compounds (VOCs), and SVOCs were not detected above commercial/industrial DOH EALs (ESI 2010a).

3.3.5.2 February to March 2011 Pipeline Investigations

On February 1, 2011, URS observed ESI's contractor excavating four pits, to a maximum depth of 5 feet bgs, at the Site adjacent to Iwilei Road. Eight soil samples were collected from the pits for waste profiling. The pits were then backfilled in preparation for the installation of a new storm drain. TPH-G, TPH-D, TPH-O, naphthalene, benzo(a)pyrene, lead, and arsenic were detected at concentrations above DOH EALs. Groundwater was observed in the pits between approximately four and five feet bgs, which had a LNAPL sheen (ESI 2012).

On February 14, 2011, URS observed ESI's contractor excavating an approximate 3-feet by 15-feet area on the western portion of the Site in an orientation diagonal to Pacific Street. The contractor exposed more than 25 pipelines of various diameters buried at depths ranging from four inches to three feet bgs. Some of the pipelines appeared to be covered in a protective wrapping. Based on the orientation and location of the pipelines exposed in 2011, a portion of them could be the 11 pipelines that were apparently abandoned in 1985 by purging the product and filling with a cement slurry (ESI 2012). On February 25, 2011, URS observed that all of these pipelines were cut to investigate the contents. Two of the pipelines contained an oil/water mixture that was removed.

3.3.6 ESI Phase I

ESI prepared a Phase I ESA for the Site dated December 3, 2012. At the time of the initial Site inspection on March 19, 2010, the Site consisted of a covered parking area, the entrance to the parking structure on the adjacent parcel, and an asphalt parking lot. During the Site inspection, minor petroleum staining was observed on the asphalt pavement where vehicles were normally parked. In addition, a groundwater monitoring well and two storm drain inlets were observed. During the follow-up inspections on May 12 and November 2, 2012, the covered parking area and storm drain inlets had been removed, and the storm drain system along the Site on Pacific Street and Iwilei Road had been demolished and replaced.

According to ESI's Phase I, former Site structures included a TTLR, a barrel storage shed, and a covered storage area. A 280-gallon diesel fuel UST had been in operation at the Site and a 1,000-gallon waste oil UST is also purported to have been used. There is evidence that USTs have also been operated on nearby sites as there are 30 Leaking Underground Storage Tank (LUST) sites within one-half mile of the Property. Based on the distances from the Site and downgradient or crossgradient locations, ESI determined that it is likely that only one LUST site, Polynesian Hospitality, has the potential to have impacted the environmental integrity of the Site. Polynesian Hospitality has received a determination of No Further Action from the DOH.

Based on the results of the Phase I ESA, ESI concluded that there is evidence that historical operations conducted at the Site and at surrounding properties (i.e., the former ConocoPhillips Honolulu terminal, the BEI Hawaii facility, the Polynesian Hospitality site, and the former Gasco facility) have likely impacted the environmental integrity of the Site; and that there is subsurface contamination at, beneath, and adjacent to the Site. These include releases of petroleum products,

products associated with manufactured gas plants, and potentially pesticides and industrial chemicals resulting from industrial operations conducted at the Site and at the nearby parcels. ESI considered these operations to be recognized environmental conditions. Based on available information, it was determined that the extent of contamination at the Site has not yet been fully delineated (ESI 2012).

3.3.7 URS Phase II Environmental Site Assessment

A Phase II ESA documenting Site investigations into soil gas, subsurface soil and groundwater was prepared in October 2014 (URS 2014) and was reviewed and accepted by the DOH in a October 28, 2014, letter (DOH, 2014a). The objective of the Phase II ESA was to evaluate whether any of the constituents identified in prior investigations are present in the subsurface at the Site at concentrations above applicable regulatory standards (i.e., DOH EALs). URS collected soil gas, subsurface soil and groundwater samples for laboratory analysis in an effort to characterize conditions in the Site's subsurface. Additionally, characterizing the perimeter of the Site was of importance in an effort to delineate commingled plumes in the area. These efforts were conducted at the Site between September 2013 and March 2014.

Eleven temporary soil gas probes were installed at the Site to collect soil gas samples. These locations were co-located with eleven soil borings that were advanced via direct push method. The soil borings were then converted to monitoring wells.

Due to the proximity of the ocean, groundwater level at the Site is generally flat and flow directions are tidally influenced. The potentiometric contours indicate there is an apparent yet subtle groundwater divide, where groundwater flows to the northwest and to the southwest on either side of the divide. Given the scale, location and proximity to the ocean, it is presumed that this is occurring within the same groundwater body and may be governed by local hydrogeological processes.

For subsurface soil collection, multi-increment (MI) sampling methodology was used. Increments were collected every two inches over a 5-foot interval soil core acquired by direct push. Each five foot long core was treated as a separate Decision Unit (DU) and used to help evaluate the lateral and vertical extent of impacts. Three subsurface DU layers were designated: DU Layer 1 (0-5 feet bgs), DU Layer 2 (5-10 feet bgs) and DU Layer 3 (10-15 feet bgs).

All analytical results (soil gas, subsurface soil, and groundwater) were compared to the DOH Tier 1 EALs for commercial/industrial sites less than 150 meters from the nearest surface water body, where groundwater is not a current or potential drinking water resource. Soil PAH homologue data were requested for potential source identification of pyrogenic (combustion-derived) PAH compounds. PAH compounds in oils, i.e., petrogenic (petroleum-derived) PAHs, are known to have different constituent composition and distribution patterns from pyrogenic PAHs.

In general, there were high concentrations of TPH-G and benzene in soil gas, TPH impacts across the full spectrum in soil, and mixed results from the PAH homologue analyses. The PAH homologue analyses indicate that there may be mixed sources of PAH of both petrogenic and pyrogenic origins at the Site.

3.3.7.1 Soil Gas

In soil gas, TPH-G was detected in soil gas samples at concentrations that ranged from 1,500,000 micrograms per cubic meter (µg/m^3) to 16,000,000 µg/m^3, all of which exceeded the DOH Tier 1 EAL of 370,000 µg/m^3. Benzene was detected in all soil gas samples, with three samples exceeding the DOH Tier 1 EAL of 1,000 µg/m3. Ethylbenzene was detected in all soil gas samples with one sample exceeding the DOH Tier 1 EAL of 3,300 µg/m^3 that was the current EAL at the time of the assessment. Methane was detected in four soil gas samples exceeding the 5%v concentration, which is the LEL for methane.

With the exception of ethylbenzene, these constituents significantly exceeded their respective EALs and, for methane, the LEL at the locations described above.

3.3.7.2 Soil

In soil, TPH-G was detected above its DOH Tier 1 EAL of 500 mg/kg in 25 of the 33 soil samples; TPH-D was detected above its DOH Tier 1 EAL of 500 mg/kg in 27 of the 33 soil samples; and TPH-MO was detected above its DOH Tier 1 EAL of 2,500 mg/kg in 19 of the 33 soil samples (note that TPH-D and TPH-MO samples were analyzed using United States Environmental Protection Agency (U.S. EPA) Method 8015M with silica gel cleanup treatment prior to analysis). Volatile organic compounds (VOCs) were not detected above their respective laboratory RL in any of the soil samples. The PAHs 1-MN, 2-MN, 2,4-dichlorophenol, anthracene, and B[a]P exceeded their respective DOH Tier 1 EALs in several samples. Dissolved lead exceeded its DOH EAL of 800 mg/kg in three samples.

Although these constituents exceeded their respective EALs at the locations described above, what was notable is the presence of TPH-G, -D, and -MO throughout the Site. The PAH exceedances were limited to four sample locations. Dissolve lead was similarly limited to two sample locations. None of the PAHs or dissolved lead exceeded their respective EALs below 10 feet bgs (i.e., DU layer 3). When compared to the data from the Treadwell & Rollo (2000) investigation, most of the Phase II concentrations of TPH-G, TPH-D, and TPH-MO are comparable or have decreased moderately since 2000.

3.3.7.3 Groundwater

In groundwater, TPH-G exceeded its DOH Tier 1 EAL of 5,000 µg/L and TPH-D exceeded its DOH Tier 1 EAL of 2,500 µg/L in monitoring well (MW)-9 at concentrations of 9,800 µg/L and 3,900 µg/L, respectively. There were no other exceedances of TPH-G, -D or -O in any of the other groundwater samples. (Note that TPH-D and TPH -MO samples were analyzed using U.S. EPA Method 8015B with silica gel cleanup treatment prior to analysis). VOCs and PAHs did not exceed their respective DOH Tier 1 EALs in any of the groundwater samples. Dissolved arsenic exceeded the DOH Tier 1 EAL of 69 µg/L in MW-7 (69.8 µg/L).

Although these constituents exceeded their respective EALs at the locations described above, what is notable are the relatively low concentrations (i.e., below their respective EALs) of all constituents that were analyzed throughout the Site. When compared to the data from the Treadwell & Rollo (2000) investigation, most of the concentrations of TPH-G, TPH-D, and TPH-MO have decreased markedly since 2000 suggesting that contaminants are naturally attenuating.

3.3.7.4 Soil PAH Homologue Data

Soil sample extracts were further analyzed to acquire PAH homologue data for potential source identification of pyrogenic PAH due the Site's proximity to a former manufactured gas plant located at 616 Iwilei Road (i.e., the former Gasco facility). Sources of PAHs can be either petrogenic, from petroleum-related activities or pyrogenic, from the incomplete combustion of diesel fuel and engine oil, wood, coal, biomass of forest, grass fires, waste incinerators, and fossil fuels that are used in industrial operations and power plants. As such, the relative distributions and patterns of parent and alkylated PAHs in environmental samples are useful in differentiating between petrogenic (petroleum-derived) and pyrogenic (combustion-derived) sources of PAHs.

There were mixed results that came out of the PAH homologue data. Alkylated naphthalene congeners indicated a pattern of petrogenic origin throughout the Site as the graphs generated exhibit the characteristic "bell shaped" distribution profile or pattern due to the relative abundance or higher concentration of alkylated PAHs (i.e., C2 and C3 PAHs) over the corresponding parent PAH.

The ratios for Phenanthrene to Anthracene and for benzo(a)anthracene to Benzo(a)(anthracene)+Chrysene gave different outcomes with respect to the origins of the PAHs (petrogenic or pyrogenic). The Phenanthrene to Anthracene ratios showed that most of the pyrogenic samples are associated with locations on the north side of the Site near Iwilei Road, close to the boundary of the former Gasco facility. There were some pyrogenic samples found throughout the Site, however, there are no petrogenic samples found at locations B1, B7, and B8 on the north side of the Site. All of the ratios for Benzo(a)anthracene to Benzo(a)(anthracene)+Chrysene indicated that all samples have a pyrogenic origin.

Although a review of sample chromatograms from the laboratory analytical data set failed to indicate the presence of PAHs, almost all of the chromatograms showed an unresolved complex mixture of hydrocarbons, so that any distinct single peak representing a PAH was not visible. The samples analyzed for diesel had varying concentrations of hydrocarbons, but they did not show the standard fingerprint of diesel.

Based on these results, some sample locations appear to display mixed sources of PAH indicating the possible co-existence of pyrogenic and petrogenic PAHs at the Site.

3.3.8 URS Pipeline Investigation

A Pipeline Investigation was conducted at the Site in September and October 2014 to assess any subsurface petroleum pipelines entering the property from Pacific Street and connecting to the former TTLR and to a former warehouse (URS 2015). The objectives of the investigation were to assess the locations of subsurface pipelines within the Site and, further, to assess their condition and content. During this investigation, 11 pipelines were located at two excavation locations at depths between 2.5 and 3.5 feet below ground surface. The pipelines were tested for ACM and abated of any ACM coating where it was present. The exposed pipelines were tapped and drained of any residual fluids. Approximately 25 gallons of residual fluids were recovered, of which, four gallons were of oil. Upon completion of the pipeline assessment efforts, the pipelines were grouted and sealed, and were abandoned in place.

Based on historical drawings and prior excavations, the 11 pipelines investigated on the Site are the pipelines that were installed to receive petroleum products from the Unocal bulk storage terminal located at 411 Pacific Street (i.e., the former ConocoPhillips Honolulu terminal). The pipelines exited from 411 Pacific Street and ran under Pacific Street to the Site.

3.3.9 2015, 2016 and 2017 Annual Groundwater Monitoring Reports

In 2015, volatile organic compounds and PAHs did not exceed their respective DOH Tier 1 EALs in any of the groundwater samples (Chevron 2015). TPH data was collected with and without a silica gel step. Without the silica gel step, the TPH-D DOH Tier 1 EAL of 2,500 µg/L was exceeded in MW-2 through MW-6, MW-8, MW-9, MW-11, and TRW-04. The DOH Tier EAL of TPH-MO (2,500 µg/L) was exceeded in monitoring wells MW-2, MW-3, MW-4, MW-6, and TRW-04 without the silica gel step. If the silica gel step was performed, only the TPH-D concentration in TRW-04 exceeded the DOH Tier 1 EAL.

In 2016, a visual inspection of 13 monitoring wells (MW-1 through MW-13, TRW-01 and TRW-04) indicated that all were in good condition except TRW-04. Volatile organic compounds and all PAHs, except 1-methylnaphthalene and anthracene, did not exceed their respective DOH Tier 1 EALs in any of the groundwater samples (Chevron 2017). The TPH-D DOH Tier 1 EAL of 2,500 µg/L was exceeded in MW-10, MW-4, and MW-5. Measurable LNAPL was noted in MW-10 (0.09 foot) and TRW-01 (0.01 feet). The monitored natural attenuation evaluation indicated that the LNAPL is stable and many of the parameters suggest anaerobic degradation is occurring.

In 2017, volatile organic compounds and all PAHs, except 1-methylnaphthalene and anthracene, did not exceed their respective DOH Tier 1 EALs in any of the groundwater samples (Chevron 2018). TPH-D and total TPH exceeded the DOH Tier 1 EAL for middle distillates TPH. Measurable LNAPL was not noted in either MW-10 (<0.01 feet) and TRW-01 (<0.01 feet). The monitored natural attenuation evaluation indicated that the LNAPL is stable and many of the parameters suggest anaerobic degradation is occurring.

3.4 PRELIMINARY CONSTITUENTS OF POTENTIAL CONCERN (COPCS) AND COPCS

This section details the available data for each medium. Preliminary COPCs were identified in the EHE/EHMP using the generic media-specific Tier 1 DOH Environmental Action Levels (EALs) for unrestricted (residential) sites greater than 150 meters to the nearest surface water body that is a non-drinking water resource (DOH 2017a) were used in the identification of preliminary COPCs for detected constituents.

Because the Tier 1 EALs are based on the lowest EALs using a variety of endpoints and not all these endpoints are applicable under current and future conditions, an evaluation of hazards by EAL endpoints was performed under current and likely future conditions to refine the list of preliminary COPCs to COPCs. The following endpoints are considered by DOH during the derivation of Tier 1 EALs and were refined to define the COPCs under Site-specific conditions:

Soil	Groundwater	Soil Gas
• Direct exposure – commercial/industrial • Soil leaching to non-drinking water source • Gross contamination for exposed soils – commercial/industrial • Vapor emissions – residential and commercial/industrial • Direct exposure – construction workers	• Discharge to surface water habitats – chronic aquatic value protective of aquatic organisms (a comparison to fresh and saltwater) • Gross contamination for non-drinking water source • Vapor emissions to indoor air – residential and commercial/industrial	• Vapor Intrusion – residential and commercial/industrial

3.4.1 Soil

Usable soil data were identified in the Revised EHE/Interim EHMP (AECOM 2018a) and included 2000 and 2010 soil borings as well as 2014 soil data from three subsurface decision units (DU): DU Layer 1 (0 to 5 feet bgs), DU Layer 2 (5 to 10 feet bgs) and DU Layer 3 (10 to 15 feet bgs). Summary statistics and the list of preliminary soil COPCs are provided in Table 1.

Preliminary Soil COPCs

- Arsenic
- Lead
- Five polynuclear aromatic hydrocarbons (PAHs) (1-methylnaphthalene [1-MN], 2-methylnaphthalene [2-MN], anthracene, naphthalene, and benzo[a]pyrene)
- Total petroleum hydrocarbons (TPH), total petroleum hydrocarbons-gasoline range organics (TPH-G), total petroleum hydrocarbons-diesel range organics (TPH-D), total petroleum hydrocarbons-motor oil range (TPH-MO) (also referred to as TPH-oil)
- 2,4-dichlorophenol

Although identified as a preliminary COPC, 2,4-dichlorophenol is used primarily as an intermediate in the preparation of the herbicide 2,4-dichlorophenoxyacetic acid (commonly known as 2,4-D) and is not commonly associated with petroleum sites.

An evaluation of hazards by EAL endpoints was performed under current and likely future conditions to refine this list of preliminary soil COPCs to soil COPCs. For current conditions, only the gross contamination (isolated soil) EALs are pertinent. Therefore, only TPH-G, TPH-D, and TPH-O were retained as soil COPCs under current conditions (Table 2). For future conditions, the COPCs by endpoint and receptor are identified (Table 3).

3.4.2 Groundwater and LNAPL

Because of removal actions and the age and volatility of the COPCs, the 2013 groundwater data and beyond for the active monitoring wells were identified in the Revised EHE/Interim EHMP (AECOM 2018a) as best representative of current Site conditions. Groundwater COPCs are similar to soil COPCs (dissolved arsenic, a few PAHs and TPH as gasoline, diesel and oil.

The preliminary groundwater COPCs were arsenic, three PAHs (1-MN, 2-MN, anthracene), TPH, TPH-G, TPH-D and TPH-oil (with or without silica gel cleanup) (Table 4). Table 5 summarizes the groundwater COPCs by endpoint.

Although historically LNAPL has been noted in measurable quantities in two wells, during the October 2017 monitoring event, subject wells MW-10 and TRW-01 contained <0.01 foot of LNAPL. To be conservative, the historical extent of LNAPL has been retained for the purposes of the RAA.

3.4.3 Soil Gas

Usable soil gas data from 11 locations collected during the 2013 investigation were considered (Table 6). TPH-G and benzene soil gas concentrations exceed the DOH EALs and methane and TPH-G has the potential to pose an explosive hazard. The preliminary COPCs and COPCs are the same.

3.5 MAGNITUDE AND EXTENT OF CONTAMINATION

To define the magnitude and extent of contamination, the environmental fate and transport mechanisms were considered, and comparisons of Site analytical data to Tier 1 DOH EALs were used.

3.5.1 Contaminant Fate and Transport

In general, the primary potential fate and transport mechanisms for the Site under current conditions are:

- Infiltration, percolation, and leaching of contaminants from subsurface soil to groundwater
- Migration of dissolved contaminants from groundwater to surface water
- Volatilization of constituents emanating from the subsurface to ambient air

The presence of asphalt across the Site will tend to minimize all of these potential transport mechanisms. The primary fate of the historic petroleum released to the subsurface is downward migration through the vadose zone until the saturated soil is encountered. Where the volume of petroleum hydrocarbons released into the subsurface is small relative to the retention capacity of the soil then the hydrocarbons will tend to sorb onto soil particles and become immobilized. Given the shallow depth to groundwater at this Site, migration of dissolved contaminants from groundwater off-site is a potential fate and transport process. However, given that predominant groundwater flow direction is generally to the west away from nearby surface water bodies, and the gradient is generally flat, the likelihood of Site groundwater affecting aquatic life is considered low under current and likely future Site conditions. In addition, volatilization into soil vapor is an important fate process for the light end hydrocarbons. Uptake into biota and associated food chain transfer for TPH is not identified as a risk or hazard, given the low bioaccumulation potential for TPH, and TPH is typically biodegradable over time, which can also result in the formation of methane gas under anaerobic conditions.

3.5.2 Soil

The number of COPCs is greatest in the shallowest depths in DU-1 (representative of the 0 to 5 feet bgs layer), while the number of COPCs and relative magnitude of the concentrations generally decline in DU-3 (representative of the 10 to 15 feet bgs layer). For the purposes of the RAA, the soils across the entire property boundary excluding the sidewalk/street, an area of approximately 26,000 square feet, were assumed to exceed the residential EALs. It was assumed that impacted soils in DU-3 (the 10 to 15 feet bgs layer) would be isolated under the building or roadway asphalt and since only commercial businesses will be present on the ground floor, it was assumed that the soils in DU-3 could remain in place.

3.5.3 Dissolved Phase Groundwater and LNAPL

Because it is recommended that groundwater vapor intrusion hazards be evaluated using soil gas vapor intrusion hazards from groundwater, COCs are discussed under the soil gas medium. TPH, TPH as gasoline, TPH as diesel and TPH as oil are the primary groundwater COCs and, generally, they encompass the entire proposed building footprint of the Site.

LNAPL has historically been centrally located within the Site boundary and has also been observed at the northern border near Iwilei Road. The LNAPL located at the northern border near the road will lie outside the building footprint and was not addressed in the RAA. Although, during the October 2017 monitoring event, MW-10 and TRW-01 contained <0.01 foot of LNAPL, to be conservative, the historical extent of LNAPL was considered in the RAA.

3.5.4 Soil Gas

The soil gas evaluation includes consideration of residential Tier 1 EALs. However, the current building development plan calls for commercial businesses on the ground floor and several floors of parking followed by residences on the upper floors, thereby minimizing the potential for vapor intrusion hazards to affect residents. Based on the current development plans, the highest TPH soil gas concentration is situated where the elevator will be built. Elevator shafts are a point of entry into buildings. Other entry points such as cracks or perforations in concrete slabs, basement floors and walls, openings around sump pumps, elevator shafts, or where pipes and electrical wires go through the foundation are not a concern for future residents, but may be a concern for future commercial workers located in businesses on the ground floor.

In addition to vapor inhalation hazards, soil gas can pose a potential explosion hazard. While there is no established methane threshold within soil gas, these concentrations all exceeded a 5%v concentration, which is the LEL for methane. Methane was detected in soil gas samples SG-4, SG-4A, SG-9, SG-10, and SG-11 (and duplicate) ranging from 7.17 to 13.5%v. TPH-G concentrations at three of these same locations are also at potentially explosive levels.

3.6 CURRENT AND FUTURE LAND USE

The Site is currently used by CCPI as a parking lot. The planned future land use is mixed residential/commercial land use. The proposed building plans are presented on Figure 3.

4.0 ENVIRONMENTAL HAZARD EVALUATION

The objective of the EHE was to evaluate the existing Site soil, groundwater and soil gas data against relevant environmental criteria to assess whether environmental hazards exist under current and likely future conditions. A conceptual site model (CSM) was developed to evaluate how human and ecological receptors might come in contact with site-related constituents under current and likely future conditions (Figure 4). No significant terrestrial ecological habitat is currently present on-Site because the Site primarily consists of paved surfaces and terrestrial habitat will also not be present under future redevelopment as mixed use residential.

4.1 CONSTITUENTS OF CONCERN

The constituents retained after the Tier 1 unrestricted use screening were defined as preliminary COPCs and further refined to COPCs in Section 3.4. Based on supplemental site information such as groundwater flow direction and historic site usage, COCs were selected to be addressed in the RAA and Draft RAM under future Site-specific conditions.

These COPCs were further refined to COCs based on supplemental site information such as groundwater flow direction, receiving water habitat, and historic site usage.

The final list of soil and soil gas COCs are listed in Table 7. The only soil COPC that was not retained as a soil COC was naphthalene where the concentrations only exceeded the indoor air EAL because soil gas data is considered a better measure of this exposure pathway and naphthalene concentrations in soil gas were lower than the naphthalene soil gas EAL. The soil gas COPCs and soil gas COCs were the same. No groundwater COCs were identified as posing a vapor intrusion hazard because it is recommended that TPH groundwater vapor intrusion hazards be evaluated using soil gas. The concentrations of anthracene and 2-MN exceed the freshwater aquatic EALs of 0.18 and 42 µg/L, respectively, but not the marine acute EALs of 13 and 86 µg/L, respectively which are considered a more appropriate benchmarks to assess aquatic hazards to the nearby surface water bodies and were not retained as groundwater COCs. Groundwater COPCs that were identified based on gross contamination and the remaining COCs based on discharge to marine surface water endpoints (Table 8) will be managed in terms of direct discharge to stormwater drains or the environment during construction as described in the EHMP and groundwater COCs were not retained for consideration in the RAA or Draft RAM given that the groundwater flow direction does not appear to flow toward nearby surface water bodies.

4.2 POTENTIAL RECEPTORS AND EXPOSURE PATHWAYS

Current Parking User: Currently, the Site is used for parking. Because the constituents are in the subsurface soil and groundwater and under asphalt, there is no direct contact exposure (i.e., dermal or incidental ingestion). Exposure to outdoor air would be of minimal duration and vapors emanating from soil or groundwater would be minimized by the asphalt. As such, quantitative evaluation under current Site usage is not warranted.

Future Construction/Maintenance Worker: Direct contact with subsurface soil and inhalation of groundwater vapors in a trench environment are considered potentially complete exposure pathways for future construction workers.

Future Residents/Commercial Workers: The primary complete exposure pathway for future building workers or residents under a mixed use redevelopment is inhalation of vapor in indoor air. Direct contact with surface soil (and direct contact with subsurface soils could be possible if subsurface soils are redistributed during development). However, direct exposure is unlikely given the type of development under consideration.

Aquatic Life: Aquatic life in Kapalama Canal and Honolulu Harbor are of concern if groundwater were to flow to these surface waters. Direct contact and uptake through food ingestion are the primary exposure pathways of concern. Only various forms of TPH, three low molecular weight PAHs, and arsenic (minor exceedance) were identified as groundwater COCs. Uptake into biota and associated food chain transfer was not identified as a risk or hazard given the low bioaccumulation potential for TPH and these three PAHs, as well as the minimal exceedance for arsenic in Well MW-7 in 2013 which was not replicated in 2015 or 2016 (i.e., arsenic was not detected in this well in June 2015, October 2016 or October 2017).

4.3 SOIL HAZARDS

Direct exposure to soil constituents by future commercial and construction workers, vapor intrusion into a future residence or commercial/industrial building, leaching to groundwater and exposed or isolated gross contamination are all potential endpoints of concern. Table 7 presents the soil COCs when compared to the various applicable EAL endpoints. Figure 5 and Figure 6 present the gross contamination soil hazards for current (isolated soils) and future (exposed soils) Site conditions, respectively. Figure 7 presents the soil hazards for resident, commercial worker, and leaching endpoints. Because it is recommended that TPH soil vapor intrusion hazards be evaluated using soil gas, soil gas COCs are presented in Table 7. However, vapor intrusion hazards from soil and groundwater COCs are discussed under the soil gas medium in Section 4.5. Under future conditions, only vapor exposure to future building occupants and direct contact by construction or maintenance workers during subsurface activities are considered potentially complete exposure pathways.

4.4 GROUNDWATER/LNAPL HAZARDS

Groundwater. The endpoints of concern for groundwater include vapor intrusion into a future mixed use residential/commercial/industrial building, which is addressed via soil gas, migration of groundwater to surface water and potential hazards to aquatic marine habitats, and gross contamination under commercial and residential settings. Table 8 presents the groundwater COCs when compared to the various applicable EAL endpoints. Figure 8 presents the gross contamination and acute aquatic groundwater hazards for future Site conditions. Given that the groundwater flow direction does not appear to flow toward nearby surface water bodies, migration of groundwater COCs to surface water is not considered a potential hazard and was not further addressed in the RAA or Draft RAM.

LNAPL. During the Phase II Environmental Site Assessment, LNAPL was noted in measurable quantities in two wells. MW-10 contained 0.1 foot of LNAPL, while TRW-01 contained 0.25 foot (Figure 8). LNAPL appears to have limited potential mobility at these two locations since no LNAPL has been noted in any of the perimeter wells located to the south (e.g., MW-4 and MW-5). Although during the October 2017 monitoring event, MW-10 and TRW-01 contained <0.01 foot of LNAPL, to be conservative, the historical extent of LNAPL has been retained for the purposes of the RAA.

4.5 VAPOR INTRUSION HAZARDS

Table 7 presents the soil gas COCs for vapor inhalation. In addition, methane and TPH-G concentrations may potentially pose an explosion hazard.

Vapor Intrusion: Soil gas is considered a better measure of exposure to vapor indoors than exceedances of groundwater or soil vapor intrusion EALs. The extent of soil gas inhalation hazards is presented in Figure 9. Based on the current development plans, the highest TPH soil gas concentration is situated where the elevator will be built. Elevator shafts represent a point of entry into buildings and are addressed in the preferred alternative.

Potential Explosion Hazard: While there is no established methane threshold within soil gas, selected soil gas concentrations exceeded a 5 percent per volume concentration, which is the LEL for methane. Methane was detected in soil gas samples SG-4, SG-4A, SG-9, SG-10, and SG-11 (and duplicate) (Figure 9) ranging from 7.17 to 13.5%v. TPH-G concentrations at three of these same locations (SG-9, SG-10, and SG-11 and duplicate) are also at potentially explosive levels. Section 9.4 of the DOH Technical Guidance Manual (TGM) (DOH 2014) indicates that mitigation measures should be put in place for methane concentrations of this magnitude that underlie a building structure. More recent guidance by the ASTM International (ASTM 2016) indicates that several different factors should be taken into consideration when evaluating methane hazards, rather than relying solely through a concentration-based screening level. Specifically, in addition to elevated methane concentrations, pressure (pressure-driven flow and/or advective transport) and volume (typically as accumulation in confined spaces, such as buried vaults, where a source of ignition may be present) must also be present for a potential explosive hazard to exist. Thus, the placement of a vapor barrier with passive venting under the building should address the potential for methane and TPH-G to pose explosion hazards. Only location SG-4/SG-4A occurs outside the building footprint. The localized methane concentrations at SG-4/SG-4A occur approximately 60 feet from the planned building footprint, are outside the historic pipeline corridor where a preferential pathway could result in accumulation into a confined space, and are unlikely to be subject to pressure-driven flow or advective transport. Future subsurface activities in this area would be managed through the EHMP (AECOM 2018a).

5.0 REMEDIAL STRATEGY

The State Contingency Plan (SCP) requires that all response actions comply with applicable requirements [Hawaii Administrative Rules (HAR) 11-451-8(e)]. "Applicable requirements" are defined as "federal, state, and local requirements that are legally applicable to a hazardous substance or pollutant or contaminant, response action, location, or other circumstance found at a facility, vessel, or site." [HAR 11-451-3]. Table 9 identifies the action-specific applicable requirements for the proposed alternative selected as part of the RAA process.

5.1 REMEDIAL ACTION OBJECTIVES

The primary basis for the RAOs is the EHE, which serves as the basis for the evaluation of risks under the "no action" alternative, for risk management decisions regarding remediation, for identification of COCs, and for development of cleanup goals protective of human health and the environment that the selected remedy should achieve. Development of RAOs also includes consideration of applicable requirements. The primary RAOs are:

- Protection of human health and the environment through the reduction of soil exposure or removal of exposure pathways between contaminants and receptors.
- Protection of human health through the reduction of vapor intrusion exposure or removal of exposure pathways between volatile contaminants and receptors.
- Minimize potential adverse impacts to the local community and the environment during remedial action implementation, including proper waste handling and disposal.

5.2 GENERAL RESPONSE ACTIONS

The RAA considered a general hierarchy of response actions to analyze and prioritize the remedial action alternatives, in accordance with HAR 11-451-8(c) and TGM Section 16.2.2.1. In descending order of preference, this hierarchy is:

- Reuse or recycling
- Destruction or detoxification
- Separation, concentration, or volume reduction
- Immobilization of hazardous substances
- On-site or off-site disposal, isolation, or containment
- ICs or long term monitoring

Table 10 provides a list of the general response actions and whether they are applicable to the Site.

5.3 EVALUATION OF REMEDIAL ACTION ALTERNATIVES

Five proposed remedial action alternatives were evaluated against effectiveness, implementability, and cost.

- Effectiveness

  The effectiveness of a response action alternative considers both short-term and long-term results and refers to the degree to which the action:

  - Reduces the toxicity, mobility, and/or volume of the hazardous substance or contaminated media through treatment.
  - Minimizes short-term impacts during implementation and quickly achieves protection of human health and the environment.

  - Minimizes residual risks from any remaining contamination and affords reliable long-term protection.
  - Complies with applicable requirements established for the Site.
- Implementability

  Implementability means the technical and administrative feasibility of implementing the alternative.

  - Technical feasibility includes:
    - Availability of equipment, facilities, and specialists
    - Compatibility of the technology with site conditions
  - Administrative feasibility includes:
    - Availability of necessary approvals
    - The degree of community acceptance
- Cost

  The life-cycle costs for each of the alternatives were estimated in the RAA to include capital costs, including both direct (contractor costs) and indirect (engineering costs), operation and maintenance annual costs if applicable, contingencies, contractor markup, sales tax, and agency oversight costs. The developed cost estimates were designed to be conservative; as such, the expected accuracy range of the cost estimates are –30 to +50 percent of the actual cost.

A comparison of the five remedial action alternatives considered in the RAA, including total cost is provided in Table 11 and is summarized after a description of each alternative in this section.

5.3.1 Alternative 1: No Action

The "no action" alternative does not require any remedial actions at the Site. Inclusion of the no action alternative is recommended in order to establish a baseline for evaluation of the other alternatives. Although existing administrative and soil management controls may be implemented, they would not be required, nor would any additional controls or long-term monitoring of the Site.

Because Alternative 1 is the baseline condition for the Site where no active removal/remediation or engineering controls are implemented, this alternative has moderate effectiveness in the short-term (no short-term impacts but never achieves protection) and low effectiveness in the long-term. If the current use of the Site were to remain as a parking lot, and not a mixed-use residential/commercial development, this alternative may be appropriate. However, with the planned future use, it is unlikely to receive necessary regulatory approvals or public acceptance. Alternative 1 would not be compliant with applicable requirements or meet RAOs due to vapor intrusion risk to future residents and workers.

The highest-rated screening criteria for Alternative 1 as provided in Table 11 are technical feasibility (because it is easy to implement No Action), and cost (no cost involved). Alternative 1 rated low to moderate for all other evaluation criteria because it does not address contaminated media or long-term exposure risk, and it will never achieve protection of human health and the environment.

5.3.2 Alternative 2A: Excavation and Off-Site Disposal

This alternative would include excavation of soil above DOH Tier 1 EALs from 0 to 10 feet bgs within the Site boundary, but not extending into the sidewalk or street [approximately 26,000 square feet], transport of soils off-Site for disposal at a local landfill on Oahu and abandonment of groundwater wells. Clean fill would be imported to the Site and backfilled prior to construction of the building. This alternative would also require a sheetpile wall for stability during excavation and dewatering. In addition, this alternative includes removal of pipelines that obstruct building development during the construction phase of the project. Because the Site would be left in an “unrestricted use” condition, no ICs would be required.

Alternative 2A is the most aggressive of the alternatives evaluated. Therefore, for much of the criteria evaluated, the effectiveness is rated high, as it would excavate the Site’s soil, leaving it in an “unrestricted use” condition. This alternative would comply with applicable requirements, meet RAOs, and have high long-term effectiveness because the contaminated soil would be removed. However, with this alternative, there are also short-term risks involved during implementation including potential exposure to the public and construction workers during excavation and potential release during transport of material off-Site for disposal.

Alternative 2A uses standard construction methods and is fairly simple to implement; however, a sheetpile wall and dewatering would be required. Overall, Alternative 2A is highly expensive to implement.

5.3.3 Alternative 2B: Excavation Under Building/Vapor Barrier and Off-Site Disposal

The alternative includes the same disposal and excavation elements as Alternative 2A, except excavation would only occur under the building, including street level retail space [approximately 16,500 square feet], and a sheetpile wall is not anticipated to be required for this alternative, because the excavation sidewalls would likely be sloped back, therefore, the full depth to 10 feet bgs would not be excavated at the excavation limits along Pacific Street and Iwilei Road.

This alternative also includes installation of a vapor intrusion barrier beneath the building foundation to prevent exposure of future residents and workers to soil gas. The vapor barrier would extend to the full footprint of the building. Penetrations for utilities would be sealed and tested. Passive venting would also be included to capture any accumulated soil vapor from beneath the building. In addition, a separate vent riser for the venting system is recommended for venting the elevator shaft because those soil gas concentrations in this area may be higher than under the remaining building area. To address the potentially higher soil gas concentrations from the elevator shaft area, active venting was recommended. For cost comparison purposes, the costs for a separate active system for the elevator shaft and a passive system for the rest of the property are assumed for this alternative in the RAA.

Because contaminated soil would be left in place in the area surrounding the building, this alternative would include ICs until it is determined the contamination no longer poses an environmental hazard. For costing purposes, it was conservatively assumed ICs would remain in place 30 years. The primary IC is to confirm that the vapor barrier continues to perform as designed. Because the EHMP may need to be periodically updated to account for any potential land use changes, other ICs to address residual contamination would be documented in the final EHMP.

No long-term air monitoring or groundwater monitoring was proposed for this alternative.

Alternative 2B is the next most aggressive alternative and also receives high ratings for effectiveness criteria, as it would excavate the Site’s soil underneath the future building and includes installation of a vapor barrier. Overall, Alternative 2B is highly expensive to implement, but less so than Alternative 2A.

5.3.4 Alternative 3: Opportunistic Remediation/Institutional Controls

This alternative includes removal of contaminated soil or LNAPL, if encountered during construction; i.e., if soil with obvious contamination such as LNAPL, odors, or sheen is observed. In accordance with the Programmatic EHE/EHMP (DOH 2013), in order to assess the soil, visual or olfactory indications of petroleum presence (i.e., LNAPL, sheens, staining, odors) would be considered and a handful of soil should be squeezed using a nitrile-gloved hand. As described for Alternative 2A, removal of subsurface pipelines that obstruct building development during the construction phase of the project is proposed and all of the Site’s current monitoring wells would be abandoned prior to commencement of building construction. For costing purposes, a nominal quantity of up to 1,000 cubic yards (in place) was assumed to require excavation and is considered representative of site conditions; however, the extent of excavation required for the planned site redevelopment activities is unknown.

Because contaminated soil would be left in place in the area surrounding the building, this alternative would include ICs until it is determined the contamination no longer poses an environmental hazard. For costing purposes, it was conservatively assumed ICs would remain in place for 30 years. The purpose of the ICs is to prevent exposure to the subsurface soil, groundwater and soil gas by preventing unacceptable exposure levels to workers and residents to residual contamination during excavation or other intrusive activities, restrictions on soil reuse and land use controls. In addition, the ICs also include contingencies regarding regulatory compliance associated with discharge or disposal of any contaminated media during subsurface work. As noted in Table 7-1 of the TGM (DOH 2017b), soil gas monitoring may or may not be required for post-remediation confirmation of a previously identified vapor intrusion hazard. For this Site, elevator shaft and/or sub-slab soil gas vapor monitoring events will be performed at least quarterly for a minimum of one year post-building construction and discontinued when sufficient data indicates that the vapor barrier performance is protective of human health, because only opportunistic remediation will take place and it is assumed that contamination will remain in place. However, because of the potential for alternative petroleum sources in indoor air (e.g., a multi-floor parking structure starting at the second floor), and in accordance with Section 7.7.1 of the TGM (DOH 2017b), which discourages indoor air monitoring for petroleum sites, indoor air monitoring is not proposed. Because the EHMP may need to be periodically updated and to account for any potential land use changes, other ICs to address residual contamination would be documented in the final EHMP.

Because excavation of the building is not anticipated to extend deeper than 5 feet bgs, excavation would not be expected below this depth except for the elevator shafts and unless significant contamination is encountered. Sheetpile is not anticipated to be needed for this work, as excavation would be limited.

Alternative 3 offers moderate effectiveness for each individual effectiveness criterion. It would generally comply with applicable requirements and may meet RAOs, but because there is no vapor barrier, it may not protect future residents and workers from vapor intrusion. This alternative also leaves contaminated media in place, only removing a limited quantity of soil or LNAPL that is encountered during excavation work for the building construction. Implementability for this alternative is moderate for both technical and administrative feasibility. The cost is low, and much lower than for Alternatives 2A or 2B.

5.3.5 Alternative 4: Opportunistic Remediation/Vapor Barrier/Institutional Controls

Alternative 4 includes all the elements of Alternative 3, but also includes installation of a vapor intrusion barrier, with associated venting systems beneath the building foundation as described for Alternative 2B (Figure 10). Groundwater monitoring is not included for Alternative 4. Like Alternative 3, elevator shaft and/or sub-slab soil gas vapor monitoring events will be performed at least quarterly for a minimum of one year post-building construction and discontinued when sufficient data indicates that the vapor barrier performance is protective of human health. The passive venting system will be designed so that it will be able to be converted to active venting. The details regarding the need for additional monitoring regarding the effectiveness of passive venting will be described in the EHMP.

This alternative also includes installation of a vapor intrusion barrier beneath the building foundation to prevent exposure of future residents and workers to soil gas. The vapor barrier would extend to the full footprint of the building and be keyed into the foundation per the manufacturer's installation specifications. Penetrations for utilities would be sealed and tested. Passive venting would also be included to capture any accumulated soil vapor from beneath the building, including a separate vent riser for the venting system for venting the elevator shaft. Active venting is also recommended for the elevator area.

The vapor intrusion barrier considered for costing purposes is manufactured by LandScience and is known as Geo-Seal, a vapor barrier comprised of a high-density polyethylene (HDPE) base layer, overlain by a spray-applied core, which seals around penetrations and seals the seams of the base layer. Over the core, a proprietary protection layer is placed to enhance curing of the membrane and increase puncture resistance. A venting system is installed just below the barrier within a thin gravel or sand layer.

Because contaminated soil would be left in place, this alternative would include ICs until it is determined the contamination no longer poses an environmental hazard. For costing purposes, it was conservatively assumed ICs would remain in place 30 years. Like Alternative 3, the purpose of the ICs is to prevent exposure to the subsurface soil, groundwater and soil gas by controlling excavation or other intrusive activities. In addition, the primary IC for the vapor barrier is to control penetration of the vapor barrier (and repair in case of inadvertent damage) during any subsurface work. Annual inspections and periodic site reviews would be performed to confirm and document that the vapor barrier continues to perform as designed. Because the EHMP may need to be periodically updated to account for any potential land use changes, other ICs to address residual contamination would be documented in the final EHMP.

Alternative 4 is similar to Alternative 3 in many respects, but it adds a vapor intrusion barrier for added protection for future residents and workers to prevent inhalation exposure to COCs. Therefore, it has higher long-term effectiveness. This alternative would comply with applicable requirements, meet RAOs, and it would also reduce toxicity, mobility and volume. The cost is moderate and is higher than Alternative 3 due to the added cost of the vapor barrier.

6.0 PREFERRED ALTERNATIVE

Based upon the analysis of the five proposed remedial action alternatives, the preferred alternative for the Site is Alternative 4: Opportunistic Remediation/Vapor Barrier/Institutional Controls. The vapor barrier includes associated venting systems (a separate active system for the elevator shaft and a passive system for the rest of the property). The components of this alternative are described in detail in Section 5.3.5.

Alternative 4 was selected based on the following:

- Alternative 4 would meet the RAOs for the Site and provide long-term protection to human health and the environment.
- Alternative 4 would be protective of future residents and workers and at a significantly lower cost than full excavation of the Site.
- Alternative 4 would have minimal impacts on human health and the environment during implementation.
- Alternative 4 would comply with applicable requirements.
- Alternative 4 would reduce contaminated media volume by opportunistic remediation (excavation and/or LNAPL recovery).
- Alternative 4 is both technically and administratively feasible.

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Tables

Table 1

Soil Data Summary Statistics and Preliminary Constiuents of Potential Concern

Analyte	Tier 1 EALs	Units	No. of Samples	Detection Rate	Detected Values		Non-detect Method Detection Limits	
					Min	Max	Min	Max
Inorganic								
arsenic	24	mg/kg	44	86%	0.794	**36**	2	2
barium	1,000	mg/kg	44	82%	14.4	678	20	20
cadmium	14	mg/kg	44	36%	0.541	3.21	0.5	1
chromium	1,100	mg/kg	44	100%	4.2	91.2	--	--
cyanide	4.8	mg/kg	8	0%	--	--	0.05	0.05
lead	200	mg/kg	44	93%	0.717	**2,440**	0.5	0.602
mercury	4.7	mg/kg	44	30%	0.137	2	0.05	0.12
selenium	78	mg/kg	36	0%	--	--	0.75	10
silver	78	mg/kg	44	59%	0.258	1.08	0.25	1
sulfide	--	mg/kg	8	25%	0.5	28	0.5	5
Polycyclic Aromatic Hydrocarbons								
1-methylnaphthalene	16	mg/kg	36	97%	0.23	**58**	0.13	0.13
2-methylnaphthalene	17	mg/kg	36	97%	0.2	**95**	0.13	0.13
acenaphthene	120	mg/kg	56	57%	0.07	7.58	0.005	21
acenaphthylene	130	mg/kg	46	7%	0.79	1.9	0.005	21
anthracene	4.2	mg/kg	47	9%	0.65	**7.3**	0.005	*21*
benzo(a)anthracene	11	mg/kg	47	15%	0.15	6.4	0.005	*21*
benzo(a)pyrene	3.6	mg/kg	55	18%	0.14	**3.8**	0.005	*21*
benzo(b)fluoranthene	11	mg/kg	39	0%	--	--	0.005	2.5
benzo(b,k)fluoranthene	--	mg/kg	8	0%	--	--	0.41	21
benzo(e)pyrene	--	mg/kg	3	0%	--	--	0.005	2
benzo(g,h,i)perylene	35	mg/kg	47	6%	0.69	1.5	0.005	21
benzo(k)fluoranthene	39	mg/kg	39	0%	--	--	0.005	2.5
benzothiophene	--	mg/kg	3	0%	--	--	0.005	2
chrysene	30	mg/kg	47	21%	0.13	10	0.005	21
dibenz(a,h)anthracene	1.1	mg/kg	47	0%	--	--	0.005	*21*
fluoranthene	120	mg/kg	55	33%	0.025	6.13	0.005	21
fluorene	93	mg/kg	48	90%	0.007	11	0.13	0.62
indeno(1,2,3-cd)pyrene	11	mg/kg	47	0%	--	--	0.005	*21*
naphthalene	7	mg/kg	62	66%	0.006	**20**	0.025	1.3
perylene	--	mg/kg	3	0%	--	--	0.005	2
phenanthrene	460	mg/kg	48	90%	0.006	36	0.13	0.62
pyrene	44	mg/kg	47	40%	0.032	20	0.005	21
Semivolatile Organic Compounds								
2,4,5-trichlorophenol	4.5	mg/kg	8	0%	--	--	0.41	*21*
2,4,6-trichlorophenol	2.5	mg/kg	8	0%	--	--	0.41	*21*
2,4-dichlorophenol	0.073	mg/kg	41	10%	**0.22**	**1.8**	0.025	*21*
2,4-dimethylphenol	57	mg/kg	8	0%	--	--	0.41	21
2,4-dinitrophenol	25	mg/kg	8	0%	--	--	2	*100*
2,4-dinitrotoluene	1.7	mg/kg	8	0%	--	--	0.41	*21*
2,6-dinitrotoluene	0.35	mg/kg	8	0%	--	--	*0.41*	*21*
2-methylphenol	--	mg/kg	8	0%	--	--	0.41	21
2-nitroaniline	--	mg/kg	8	0%	--	--	2	100
3- & 4-methylphenols	--	mg/kg	8	0%	--	--	0.41	21
3,3'-dichlorobenzidine	1.2	mg/kg	8	0%	--	--	*2*	*100*
3-nitroaniline	--	mg/kg	8	0%	--	--	2	100
4,6-dinitro-2-methylphenol	--	mg/kg	8	0%	--	--	2	100
4-bromophenyl phenyl ether	--	mg/kg	8	0%	--	--	0.41	21
4-chloro-3-methylphenol	--	mg/kg	8	0%	--	--	0.41	21
4-chloroaniline	2.6	mg/kg	8	0%	--	--	0.41	*21*
4-nitroaniline	--	mg/kg	8	0%	--	--	2	100
4-nitrophenol	--	mg/kg	8	0%	--	--	2	100
benzoic acid	--	mg/kg	8	0%	--	--	2	100
benzyl alcohol	--	mg/kg	8	0%	--	--	0.41	21
bis(2-chloroethoxy) methane	--	mg/kg	8	0%	--	--	0.41	21
bis(2-ethylhexyl) phthalate	37	mg/kg	8	0%	--	--	0.41	21

Table 1
Soil Data Summary Statistics and Preliminary Constiuents of Potential Concern

Analyte	Tier 1 EALs	Units	No. of Samples	Detection Rate	Detected Values Min	Detected Values Max	Non-detect Method Detection Limits Min	Non-detect Method Detection Limits Max
butyl benzyl phthalate	--	mg/kg	8	0%	--	--	0.41	21
carbazole	--	mg/kg	3	0%	--	--	0.005	0.5
diethyl phthalate	17	mg/kg	8	0%	--	--	0.41	*21*
dimethyl phthalate	74	mg/kg	8	0%	--	--	0.41	21
di-n-butyl phthalate	--	mg/kg	8	0%	--	--	0.41	21
di-n-octyl phthalate	--	mg/kg	8	0%	--	--	0.41	21
hexachlorobenzene	0.22	mg/kg	8	0%	--	--	*0.41*	*21*
hexachlorobutadiene	1.3	mg/kg	8	0%	--	--	0.0064	0.77
hexachlorocyclopentadiene	--	mg/kg	8	0%	--	--	2	100
hexachloroethane	2	mg/kg	8	0%	--	--	0.41	*21*
isophorone	47	mg/kg	8	0%	--	--	0.41	21
n-nitrosodimethylamine	--	mg/kg	8	0%	--	--	0.41	21
n-nitrosodiphenylamine	--	mg/kg	8	0%	--	--	0.41	21
n-nitrosodipropylamine	--	mg/kg	8	0%	--	--	0.41	21
pentachlorophenol	0.98	mg/kg	8	0%	--	--	*2*	*100*
phenol	9.3	mg/kg	41	0%	--	--	0.025	*21*
Total Petroleum Hydrocarbons								
tph	220	mg/kg	8	88%	**300**	**4,640**	100	100
tph-diesel	220	mg/kg	69	96%	73	**38,000**	10	50
tph-gasoline	100	mg/kg	69	88%	5.9	**6,800**	0.25	10
tph-oil	500	mg/kg	53	92%	46	**16,000**	58	*2,100*
Volatile Organic Compounds								
1,2,4-trichlorobenzene	0.18	mg/kg	36	0%	--	--	0.0022	*2*
1,2,4-trimethylbenzene	--	mg/kg	8	13%	0.43	0.43	0.05	0.05
1,2-dichlorobenzene	7.5	mg/kg	44	2%	0.45	0.45	0.0011	1
1,3,5-trimethylbenzene	--	mg/kg	8	13%	0.33	0.33	0.05	0.05
acetone	10	mg/kg	36	0%	--	--	0.055	*50*
benzene	0.77	mg/kg	45	2%	0.21	0.21	0.0011	*1*
cyclohexane	--	mg/kg	1	100%	1.8	1.8	--	--
ethylbenzene	17	mg/kg	45	7%	0.19	2.2	0.0011	1
isopropylbenzene	--	mg/kg	9	67%	0.071	9.5	0.05	0.05
m,p-xylenes	24	mg/kg	36	0%	--	--	0.0022	2
methyl tert-butyl ether	2.3	mg/kg	9	0%	--	--	0.05	0.05
n-butylbenzene	--	mg/kg	9	78%	0.082	5.8	0.05	0.05
n-propylbenzene	--	mg/kg	9	78%	0.12	21	0.05	0.05
o-xylene	24	mg/kg	36	0%	--	--	0.0011	1
sec-butylbenzene	--	mg/kg	9	78%	0.065	14	0.05	0.05
styrene	10	mg/kg	45	7%	0.053	0.11	0.0011	1
toluene	32	mg/kg	45	4%	0.093	0.11	0.0011	1
total xylenes	24	mg/kg	9	22%	0.089	0.31	0.05	0.05

Notes
Bold indicates the maximum detected concentration exceeds the Tier 1 EAL. *Italicized* constiuents indicate the maximum detection limit exceeds the Tier 1 EAL.
Tier 1 EALs are from HDOH Fall 2017 for greater than 150 meters to the nearest surface water body and non-drinking water resources.
Total chromium EAL was selected. TPH was assumed comparable to tph-diesel.
All soil analytical results are reported in mg/kg.
If duplicates exist the following rule was used as a single data point.; if there is at least one detect then the maximum detected concentration was selected , if both results were non-detect then the minimum method reporting limit was selected.

% = percent
-- = no data or not established
max = maximum
mg/kg = milligrams per kilogram
min = minimum
MRL = method reporting limit
No. = number
(VI) = chromium VI EAL selected.
Std Dev = standard deviation

Table 2
Soil COPCs Based on Comparisons of Maximum Soil Concentrations to Applicable HDOH EAL Endpoints - Current Conditions

Constituent	Maximum Concentration (mg/kg)	Location of Maximum Concentration	Depth (feet bgs)	Date Sample Collected	Gross Contamination[2] Isolated Soils (mg/kg)
Arsenic	36	SS-H-10	1	1/2/2011	5,000
Lead	2,440	URS-B9-DU2	5 - 10	10/21/2013	5,000
1-Methylnaphthalene	58	URS-B10-DU1	0-5	10/21/2013	2,500
2-Methylnaphthalene	95	URS-B10-DU1	0-5	10/21/2013	2,500
Anthracene	7.3	URS-B10-DU1	0-5	10/21/2013	2,500
Benzo(a)pyrene	3.8	URS-B10-DU1	0-5	10/21/2013	2,500
Naphthalene	20	TRB-02	4.5	4/4/2000	2,500
2,4-Dichlorophenol	1.8	URS-B7-DU2	5 - 10	10/21/2013	2,500
tph [1]	4,640	SS-H-17	4	1/2/2011	5,000
tph-gasoline	6,800	URS-B7-DU2	5 - 10	10/21/2013	**2,000**
tph-diesel	38,000	TRB-02	6.5	4/4/2000	**5,000**
tph-oil	16,000	URS-B10-DU1	0-5	10/21/2013	**5,000**

Notes:
[1] = Unspecified. Assumed to be representative of TPH-D for screening purposes.
[2] = Tier 2 EALs for commercial workers extracted from Table F-3 in HDOH 2017.
Bold = the associated maximum detected concentration exceeds the EAL shown
bgs = below ground surface
EAL = Environmental Action Level
HDOH = State of Hawaii Department of Health
mg/kg = milligrams per kilogram
TPH = total petroleum hydrocarbons
TPH-D = total petroleum hydrocarbons - diesel
TPH-G = total petroleum hydrocarbons - gasoline
TPH-O = total petroleum hydrocarbons - oil

Table 3
Soil COPCs Based on Comparisons of Maximum Soil Concentrations to Applicable HDOH EAL Endpoints - Future Conditions

Constituent	Maximum Concentration (mg/kg)	Location of Maximum Concentration	Depth (feet bgs)	Date Sample Collected	HDOH EALs[2]										
					Leaching to Groundwater[3] (mg/kg)	Direct Exposure[4]			Vapor Emissions to Indoor Air[7]		Gross Contamination[8]				
						Residential[6] (mg/kg)	Construction Worker[5] (mg/kg)	Commercial Worker[6] (mg/kg)	Residential (mg/kg)	Commercial (mg/kg)	Unrestricted Exposed Soils (mg/kg)	Unrestricted Isolated Soils (mg/kg)	Commercial Exposed Soils (mg/kg)	Commercial Isolated Soils (mg/kg)	Saturation Limit (mg/kg)
Arsenic	36	SS-H-10	1	1/2/2011	na	**24**	110	95	NV	NV	1,000	2,500	2,500	5,000	na
Lead	2,440	URS-B9-DU2	5 - 10	10/21/2013	na	**200**	**800**	**800**	NV	NV	**1,000**	2,500	2,500	5,000	na
1-Methylnaphthalene	58	URS-B10-DU1	0-5	10/21/2013	**16**	170	450	640	390	390	500	1,000	1,000	2,500	na
2-Methylnaphthalene	95	URS-B10-DU1	0-5	10/21/2013	**17**	**39**	580	330	**50**	370	500	1,000	1,000	2,500	na
Anthracene	7.3	URS-B10-DU1	0-5	10/21/2013	**4.2**	3500	72,000	37,000	**4.2**	**4.2**	500	1,000	1,000	2,500	na
Benzo(a)pyrene	3.8	URS-B10-DU1	0-5	10/21/2013	78	**3.6**	15	39	NV	NV	500	1,000	1,000	2,500	na
Naphthalene	20	TRB-02	4.5	4/4/2000	54	28	96	130	**7.0**	58	500	1,000	1,000	2,500	na
2,4-Dichlorophenol	1.8	URS-B7-DU2	5 - 10	10/21/2013	**0.073**	38	870	430	NV	NV	500	1,000	1,000	2,500	na
tph[1]	4,640	SS-H-17	4	1/2/2011	5,000	**220**	**680 (>sat)**	**680 (>sat)**	use soil gas[9]	use soil gas[9]	**500**	5,000	**680**	5,000	na
tph-gasoline	6,800	URS-B7-DU2	5 - 10	10/21/2013	**5,000**	**450**	**2,000 (>sat)**	**2,000 (>sat)**	use soil gas[9]	use soil gas[9]	**100**	**2,000**	**500**	**2,000**	**2,000**
tph-diesel	38,000	TRB-02	6.5	4/4/2000	**5,000**	**220**	**680 (>sat)**	**680 (>sat)**	use soil gas[9]	use soil gas[9]	**500**	**5,000**	**680**	**5,000**	na
tph-oil	16,000	URS-B10-DU1	0-5	10/21/2013	**5,000**	**9,400**	270,000	120,000	NV	NV	**500**	**5,000**	**2,500**	**5,000**	na

Notes:
[1] = Unspecified. Assumed to be representative of TPH-D for screening purposes.
[2] = EALs based on groundwater not a drinking water source, and the nearest surface water body is >150 meters from the site.
[3] = The site is currently entirely paved minimizing leaching. Maximum concentrations in soil were compared to Leaching and Groundwater Protection EALs from Table B-1 in HDOH 2017.
[4] = The site is currently entirely paved, preventing potential direct exposures to impacted soils in the absence of disturbance.
[5] = Maximum concentrations in soil were compared to direct exposure EALs for construction workers (from surfer Table I-3) to evaluate potential hazards in the event that construction activities take place in the future.
[6] = EALs for residential/unrestricted direct exposure were obtained from Table I-1 and for commercial workers were obtained from surfer Table I-2 (excluding construction/trench worker) and are based on target 1x10^{-6} cancer risk level, except for benzo(a)pyrene which is based on 5 x10^{-5} and hazard quotient of 0.2, **and** except for TPH which is based on hazard quotient of 1. **The naphthalene and 2-methylnaphthalene EALs are based on noncarcinogenic effects. The 1-methylnaphthalene EAL is based on carcinogenic effects at the 1 x 10^{-5} level.**
[7] = Pathway is only complete for volatile chemicals. Tier 2 EALs extracted from Table C-1b in HDOH 2017 for unrestricted/residential and commercial land use.
[8] = Tier 2 EALs extracted from unrestricted land use Tables F-2 and F-3 in HDOH 2017.
[9] = HDOH guidance recommends using soil gas data to evaluate the vapor intrusion pathway for TPH (see Table 7).
Bold = the associated maximum detected concentration exceeds the EAL shown
bgs = below ground surface
COPC = constituent of potential concern
EAL = Environmental Action Level
HDOH = State of Hawaii Department of Health
mg/kg = milligrams per kilogram
na = not available
NV = no value; chemical not volatile and pathway not complete.
TPH-D = total petroleum hydrocarbons - diesel
TPH-G = total petroleum hydrocarbons - gasoline
TPH-O = total petroleum hydrocarbons - oil
(>sat) = criteria exceeds the chemical-specific saturation limit.

Table 4

Groundwater Data Summary Statistics and Preliminary Constituents of Potential Concern

Analyte	Tier 1 EALs	Units	No. of Samples	Detection Rate	Detected Values Min	Detected Values Max	Non-detect Method Detection Limits Min	Non-detect Method Detection Limits Max
Inorganic								
arsenic	69	ug/l	33	39%	8.5	**69.8**	7.2	10
barium	2,000	ug/l	33	100%	50.9	522	--	--
cadmium	3	ug/l	33	6%	0.45	0.53	0.33	*10*
chromium	16	ug/l	33	39%	1.5	11.3	1.8	10
lead	29	ug/l	33	3%	11.1	11.1	4.7	10
mercury	2.1	ug/l	33	0%	--	--	0.05	0.5
silver	1	ug/l	33	0%	--	--	*1.8*	*5*
Polycyclic Aromatic Hydrocarbons								
1-methylnaphthalene	**37**	ug/l	33	100%	0.1	**65**	--	--
2-methylnaphthalene	**42**	ug/l	33	91%	0.1	**56**	0.1	0.1
acenaphthene	200	ug/l	34	97%	0.2	5	99	99
acenaphthylene	300	ug/l	34	38%	0.2	1	0.1	99
anthracene	**0.18**	ug/l	34	41%	0.1	**0.4**	0.1	*99*
benzo(a)anthracene	4.7	ug/l	34	3%	0.1	0.1	0.1	*99*
benzo(a)pyrene	0.8	ug/l	34	3%	0.1	0.1	0.1	*99*
benzo(b)fluoranthene	0.75	ug/l	33	3%	0.1	0.1	0.1	*1*
benzo(b,k)fluoranthene	--	ug/l	1	0%	--	--	99	99
benzo(g,h,i)perylene	0.13	ug/l	34	0%	--	--	0.1	*99*
benzo(k)fluoranthene	0.4	ug/l	33	0%	--	--	0.1	*1*
chrysene	1	ug/l	34	3%	0.2	0.2	0.1	*99*
dibenz(a,h)anthracene	1.3	ug/l	34	0%	--	--	0.1	*99*
fluoranthene	13	ug/l	34	32%	0.1	0.4	0.1	99
fluorene	300	ug/l	34	91%	0.1	6	0.1	99
indeno(1,2,3-cd)pyrene	0.095	ug/l	34	0%	--	--	*0.1*	*99*
naphthalene	210	ug/l	35	97%	0.2	68	0.1	0.1
phenanthrene	300	ug/l	34	85%	0.2	57	0.1	0.2
pyrene	68	ug/l	34	53%	0.1	0.5	0.1	*99*
Semivolatile Organic Compounds								
2,4,5-trichlorophenol	17	ug/l	1	0%	--	--	*99*	*99*
2,4,6-trichlorophenol	39	ug/l	1	0%	--	--	*99*	*99*
2,4-dichlorophenol	3.0	ug/l	34	0%	--	--	0.5	99
2,4-dimethylphenol	700	ug/l	1	0%	--	--	99	99
2,4-dinitrophenol	380	ug/l	1	0%	--	--	*500*	*500*
2,4-dinitrotoluene	110	ug/l	1	0%	--	--	99	99
2,6-dinitrotoluene	110	ug/l	1	0%	--	--	99	99
2-methylphenol	--	ug/l	1	0%	--	--	99	99
2-nitroaniline	--	ug/l	1	0%	--	--	500	500
3- & 4-methylphenols	--	ug/l	1	0%	--	--	99	99
3,3'-dichlorobenzidine	41	ug/l	1	0%	--	--	*500*	*500*
3-nitroaniline	--	ug/l	1	0%	--	--	500	500
4,6-dinitro-2-methylphenol	--	ug/l	1	0%	--	--	500	500
4-bromophenyl phenyl ether	--	ug/l	1	0%	--	--	99	99
4-chloro-3-methylphenol	--	ug/l	1	0%	--	--	99	99
4-chloroaniline	460	ug/l	1	0%	--	--	*99*	99
4-chlorophenyl phenyl ether	--	ug/l	1	0%	--	--	99	99
4-nitroaniline	--	ug/l	1	0%	--	--	500	500
4-nitrophenol	--	ug/l	1	0%	--	--	500	500
benzoic acid	--	ug/l	1	0%	--	--	500	500
benzyl alcohol	--	ug/l	1	0%	--	--	99	99
bis(2-chloroethoxy) methane	--	ug/l	1	0%	--	--	99	99
bis(2-ethylhexyl) phthalate	27	ug/l	1	0%	--	--	*99*	*99*
butyl benzyl phthalate	--	ug/l	1	0%	--	--	99	99
diethyl phthalate	980	ug/l	1	0%	--	--	99	99
dimethyl phthalate	3,200	ug/l	1	0%	--	--	99	99
di-n-butyl phthalate	--	ug/l	1	0%	--	--	99	99

Table 4
Groundwater Data Summary Statistics and Preliminary Constituents of Potential Concern

Analyte		Tier 1 EALs	Units	No. of Samples	Detection Rate	Detected Values Min	Detected Values Max	Non-detect Method Detection Limits Min	Non-detect Method Detection Limits Max
di-n-octyl phthalate		--	ug/l	1	0%	--	--	99	99
hexachlorobenzene		0.0003	ug/l	1	0%	--	--	*99*	*99*
hexachlorobutadiene		11	ug/l	2	0%	--	--	5	*17*
hexachlorocyclopentadiene		--	ug/l	1	0%	--	--	500	500
hexachloroethane		100	ug/l	1	0%	--	--	99	99
isophorone		4,300	ug/l	1	0%	--	--	99	99
n-nitrosodimethylamine		--	ug/l	1	0%	--	--	99	99
n-nitrosodiphenylamine		--	ug/l	1	0%	--	--	99	99
n-nitrosodipropylamine		--	ug/l	1	0%	--	--	99	99
pentachlorophenol		13	ug/l	1	0%	--	--	*500*	*500*
phenol		300	ug/l	34	0%	--	--	0.5	99
Total Petroleum Hydrocarbons									
Total tph	a	2500	ug/l	11	100%	590	**9,700**	--	--
Total tph (sg)	a	2500	ug/l	11	91%	89	**5,600**	52	52
tph-diesel	a	2,500	ug/l	34	100%	290	**230,000**	--	--
tph-diesel (sg)	a	2,500	ug/l	11	100%	110	**4,000**	--	--
tph-diesel (c10-c40)	b	2,500	ug/l	1	100%	**200,000**	**200,000**	--	--
tph-gasoline	c	5,000	ug/l	34	100%	130	**9,800**	--	--
tph-gasoline (c7-c12)	d	5,000	ug/l	2	100%	**26,000**	**85,000**	--	--
tph-oil	e	2,500	ug/l	34	68%	250	**8,300**	190	250
tph-oil (sg)	e	2,500	ug/l	11	9%	1,900	1,900	190	220
Volatile Organic Compounds									
1,2,4-trichlorobenzene		420	ug/l	33	0%	--	--	1	5
1,2-dichlorobenzene		100	ug/l	33	33%	1	3.1	1	5
acetone		15,000	ug/l	33	18%	6	31	6	100
benzene		1,700	ug/l	33	64%	0.6	44	0.5	0.5
ethylbenzene		140	ug/l	33	48%	0.5	40	0.5	5
m,p-xylenes		230	ug/l	11	36%	1.3	5.2	1	5
o-xylene		230	ug/l	11	18%	1.7	2.7	1	5
styrene		110	ug/l	33	0%	--	--	1	5
toluene		400	ug/l	33	18%	0.5	2	0.5	5
total xylenes		230	ug/l	22	36%	0.6	12	0.5	0.5

Notes:

Tier 1 EALs are from Table B HDOH (Fall 2017) for greater than 150 meters to the nearest surface water body and non-drinking water resources.

[a] TPH-diesel historically been defined either TPH-d or TPH-g (C10-C24). Total TPH assumed to be comparable to TPH-diesel.

[b] The one location was also analyzed by TPH-diesel and TPH-oil.

[c] TPH-gasoline historically been defined either TPH-g or TPH-g (C4-C10).

[d] One location was analyzed by both TPH-gasoline and TPH-gasoline (C7-C12).

[e] TPH-oil historically been defined either TPH-mo or TPH-o (24-C36).

All groundwater analytical results are reported in ug/L.

If duplicates exist the following rule was used as a single data point; if there is at least one detect then the maximum detected concentration was selected, if both results were non-detect then the minimum method reporting limit was selected.

% = percent

-- = no data

max = maximum

min = minimum

No. = number

(sg) = silica-gel cleanup

ug/L = micrograms per liter

Table 5
Groundwater COPCs Based on Comparisons of Maximum Groundwater Concentrations to Applicable HDOH EALs

COPC	Maximum Concentration (ug/L)	Location of Maximum Concentration	Date Concentration Collected	HDOH EALs [2]				
				Vapor Emissions to Indoor Air[3]		Discharge to Marine Surface Water[4]	Gross Contamination[5]	
				Residential (ug/L)	Commercial (ug/L)	HDOH Acute WQC (ug/L)	Nuisance/Odor Threshold (ug/L)	1/2 Solubility Limit (ug/L)
arsenic	69.8	MW-7	11/20/13	NV	NV	**69**	NA	50,000 UL
1-methylnaphthalene	65	MW-4	06/16/15	26,000	26,000	**37**	100	13,000
2-methylnaphthalene	56	MW-4	06/16/15	25,000	25,000	**42** / 86	100	12,000
anthracene	0.4	MW-7, MW-9, MW-4	6/17/15, 6/17/15, 10/10/16	43	43	**0.18** / 13	NA	22
tph	9,700	MW-4	10/10/16	use soil gas[6]	use soil gas[6]	**2,500**	**5,000**	26,000
tph (sg)	5,600	MW-4	10/10/16	use soil gas[6]	use soil gas[6]	**2,500**	**5,000**	26,000
tph-diesel	230,000	TRW-01	5/17/2000	use soil gas[6]	use soil gas[6]	**2,500**	**5,000**	**26,000**
tph-diesel (sg)	4,000	MW-4	10/10/16	use soil gas[6]	use soil gas[6]	**2,500**	5,000	26,000
tph-diesel (c10-c40)	200,000	TRW-01	5/17/2000	use soil gas[6]	use soil gas[6]	**2,500**	**5,000**	**26,000**
tph-gasoline	9,800	MW-9	11/20/13	use soil gas[6]	use soil gas[6]	**5,000**	**5,000**	75,000 (50,000 UL)
tph-gasoline (c7-c12)	85,000	TRW-01	4/4/2000	use soil gas[6]	use soil gas[6]	**5,000**	**5,000**	**75,000 (50,000 UL)**
tph-oil	5,300	MW-2	6/16/2015	NV	NV	**2,500**	**5,000**	NA (50,000 UL)
tph-oil (sg)	1,900	TRW-04	6/17/2015	NV	NV	2,500	5,000	NA (50,000 UL)

Notes:

[1] = Groundwater data includes all information from 1996 through the present.

[2] = EALs are based on commercial/industrial land use where groundwater is not a drinking water source, and the nearest surface water body is > 150 meters from the site. Marine acute values were used.

[3] = Pathway is only complete for volatile chemicals. Maximum concentrations are compared to HDOH EALs in TableC-1a in HDOH 2012.

[4] = Maximum concentrations are compared to HDOH acute (Table D-4a) Water Quality Criteria for marine environments greater than 150 m from the site. Tier 1 EALs/Marine Acute EALs are provided for chemicals with Tier 1 EAL exceedances that appear in Figures 7a and 7b are provided for informational purposes. Tier 1 EALs are selected irrespective of freshwater or saltwater environs.

[5] = EALs extracted from Table G-2 in HDOH 2012.

[6] = HDOH guidance recommends using soil gas data to evaluate the vapor intrusion pathway for TPH compounds.

Bold = the associated maximum detected concentration exceeds the respective EAL shown.

COPC = constituent of potential concern
HDOH = State of Hawaii Department of Health
EAL = Environmental Action Level
mg/L = milligrams per liter
na = not available
NV = no value; chemical not volatile and pathway not complete.
sg = silica gel
TPH = total petroleum hydrocarbons; -G as gasoline; -D as diesel
UL = Upper Limit
WQC = Water Quality Criteria
-- = no exceedances

Table 6
Summary of Soil Gas Data and Preliminary COPCs

Sample ID			SG-1	SG-2	SG-3	SG-4	SG-4A	SG-5	SG-6	SG-7	SG-8	SG-9	SG-10	SG-11	SG-12 (Dup of SG-11)
Sample			9/20/2013	9/20/2013	9/20/2013	9/20/2013	9/20/2013	9/20/2013	9/20/2013	9/20/2013	9/20/2013	9/20/2013	9/20/2013	9/20/2013	9/20/2013
Analyte	**HDOH EAL[1] (µg/m^3)**	**Unit**													
Methane															
Methane	**0.5**	%v	ND (<0.500)	ND (<0.500)	ND (<0.500)	**12.9**	**13.5**	ND (<0.500)	ND (<0.500)	ND (<0.500)	ND (<0.500)	**11.4**	**9.92**	**6.6**	**7.17**
Volatile Organic Compounds (U.S. EPA TO-15)															
Benzene	**720**	µg/m3	110	94	170	200	130	89	ND (<160)	110	160	**22,000**	**20,000**	**4,500**	**1,900**
Toluene	2,100,000	µg/m3	24	ND (<19)	30	ND (<75)	ND (<75)	17	ND (<190)	20	28	ND(<1,900)	850	1,500	890
Ethylbenzene	22,000	µg/m3	17	52	22	230	170	13	250	14	17	2,600	2,900	6,100	2,900
p/m-Xylene	42,000 (total xylenes)	µg/m3	73	ND (<87)	88	ND (<350)	ND (<350)	55	ND (<870)	59	69	ND(<8,700)	3,400	7,400	4,000
o-Xylene		µg/m3	36	ND (<22)	43	ND (<87)	ND (<87)	27	ND (<220)	29	34	ND(<2,200)	920	1,700	1,000
Naphthalene	1,300	µg/m3	ND (<1.0)	ND (<8.5)	ND (<1.4)	ND (<34)	ND (<34)	ND (<0.85)	160	4.9	1.3	*ND(<850)*	120	85	130
Total Purgeable Hydrocarbons (U.S. EPA TO-3M)															
TPH-G	**590,000**	µg/m3	ND (<7,000)	**1,500,000**	ND (<7,000)	**4,700,000**	**4,900,000**	ND (<7,000)	**4,800,000**	ND (<7,000)	ND (<7,000)	***16,000,000***	***10,000,000***	***13,000,000***	***17,000,000***

Notes:

--: not analyzed

Bold indicates detected concentrations exceeding HDOH EALs. Bold and italics for TPH-G indicates that the concentration greater than 10% of the LEL of 1,400 ppm or 5,725,971 µg/m^3.

[1] HDOH EALs: State of Hawaii Department of Health Environmental Action Levels for soil gas for commerical/industrial sites greater than 150 meters to the nearest surface water body that is a non-drinking water resource (HDOH, updated Fall 2017).

DUP: field duplicate

%v: percent volume

µg/m^3: micrograms per cubic meter

ID: identification

J: reported concentration is estimated

ND (<#): Not detected at or above the reporting limit given in parentheses, except for naphthalene the method detection limit is given in parentheses.

NS: No standard

TPH-G: total petroleum hydrocarbons quantified as gasoline

U.S. EPA: United States Environmental Protection Agency

Table 7: Summary of Constituents of Concern for Each Environmental Hazard for Soil and Soil Gas

Media	Soil Gas	Soil					
Potential Hazard	Vapor Emissions to Indoor Air and Explosivity	Leaching to Groundwater [a]	Direct Exposure [b]			Gross Contamination	
			Residential	Construction/ Maintenance Worker	Commercial Worker	Unrestricted and Commercial Exposed Soils	Unrestricted and Commercial Isolated Soils
COC	Benzene, TPH as gasoline, methane	1-MN, 2-MN, anthracene, 2,-4 dichlorophenol, TPH as gasoline, diesel and oil	Arsenic, lead, 2-MN, B(a)P, TPH [c], TPH as gasoline, diesel and oil	Lead, TPH [c], TPH as gasoline and diesel	Lead, TPH [c], TPH as gasoline and diesel	Lead (unrestricted only), TPH [c], TPH as gasoline, diesel and oil	TPH as gasoline, diesel and oil

COC = constituent of concern

B(a)P = benzo(a)pyrene

1-MN = 1-Methylnaphthalene

2-MN = 2-Methylnaphthalene

TPH = total petroleum hydrocarbons

[a] The site is currently entirely paved and is planned to be largely covered by the building footprint which will minimize leaching.

[b] The site is currently entirely paved and will be covered by pavement and the planned building footprint in the future, preventing potential direct exposures to impacted soils in the absence of disturbance.

[c] Unspecified. Assumed to be representative of TPH-D for screening purposes.

Table 8: Summary of Constituents of Concern for Each Environmental Hazard for Groundwater

Potential Hazards [a]	Discharge to Marine Surface Water	Gross Contamination	
	DOH Acute WQC	Nuisance/Odor Threshold	1/2 Solubility Limit
COC	Arsenic, 1-MN, TPH [b], TPH as gasoline, diesel and oil	TPH as gasoline, diesel and oil	TPH as gasoline and diesel

1-MN = 1-Methylnaphthalene

COC = constituent of concern

DOH = Department of Health, State of Hawaii

TPH = total petroleum hydrocarbons

WQC = water quality criteria

[a] Vapor intrusion hazards assessed through soil gas data on Table 1.

[b] Unspecified. Assumed to be representative of TPH-D for screening purposes.

Table 9: Action-Specific Applicable Requirements for the Proposed Alternative

Citation	Description	Applicability to the Site
40 CFR 261 (RCRA)	Resource Conservation and Recovery Act (RCRA) Hazardous Waste Classification Criteria	Applicable to the proposed alternative when excavation and off-site disposal of material that may include hazardous waste is needed.
29 CFR 1926.652 HAR §12-132.2-1	Safety and Health Regulations for Construction – Requirements for Protective Systems	Applicable to the proposed alternative when excavation or other disturbance of the soil occurs.
HAR § 11-60.1-33	HAR Fugitive Dust	Applicable to the proposed alternative when excavation or other disturbance of the soil occurs.
HRS 19-342J	Hazardous Waste Management Act	Applicable to the proposed alternative when excavation and off-site disposal of material that may include hazardous waste is needed.
US Clean Water Act and HRS 342D	Effluent discharge limits on wastewater discharges from an on-site treatment process	Applicable to the proposed alternative when excavation occurs, as dewatering will likely be required.
Hawaii State DOH Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan	Sets guidelines for remedial action, environmental hazard management, and abandonment of monitoring wells, etc.	Applicable to the proposed alternative.

Table 10: General Response Actions and Applicability to the Site

General Response Action	Applicability
Reusing or Recycling: Released hazardous substances may sometimes be directly reused or recycled after recovery, depending on the quality of the recovered materials.	Applicable. If LNAPL (free-product) is encountered and recovered, recycling of the product could be implemented for disposal. This GRA has been retained for further evaluation.
Destruction or Detoxification: Organic hazardous substances can be destroyed or detoxified by altering their molecular structures, and, in principle, may be converted into carbon dioxide, water, and inorganic salts.	Not Applicable. The proposed development and location of the site precludes the use of biodegradation, combustion, or incineration.
Separation, concentration, or volume reduction: Contaminated material may be completely or partially separated from material that is not contaminated, or contamination may be reduced in a large volume of material by concentrating the contaminant in a smaller volume.	Not Applicable. No technologies were identified that would separate, concentrate, or reduce volume of the contaminated soil.
Immobilization of hazardous substances: The physical state of a contaminant may be changed so it is no longer mobile in the natural environment.	Not Applicable. No technologies were identified that would effectively immobilize petroleum hydrocarbons in soil, groundwater, and soil gas.
On-site or off-site disposal, isolation, or containment: Contaminated material may be placed in an engineered facility or feature designed to minimize future release of hazardous substances and in accordance with applicable requirements.	Applicable. Off-site disposal or isolation through the use of a vapor barrier has been proven to be effective and has been used at other sites on Hawaii. This GRA has been retained for further evaluation.
Institutional controls or long-term monitoring: Site uses may be restricted through administrative methods.	Applicable. Institutional controls have been implemented at other sites to restrict access.

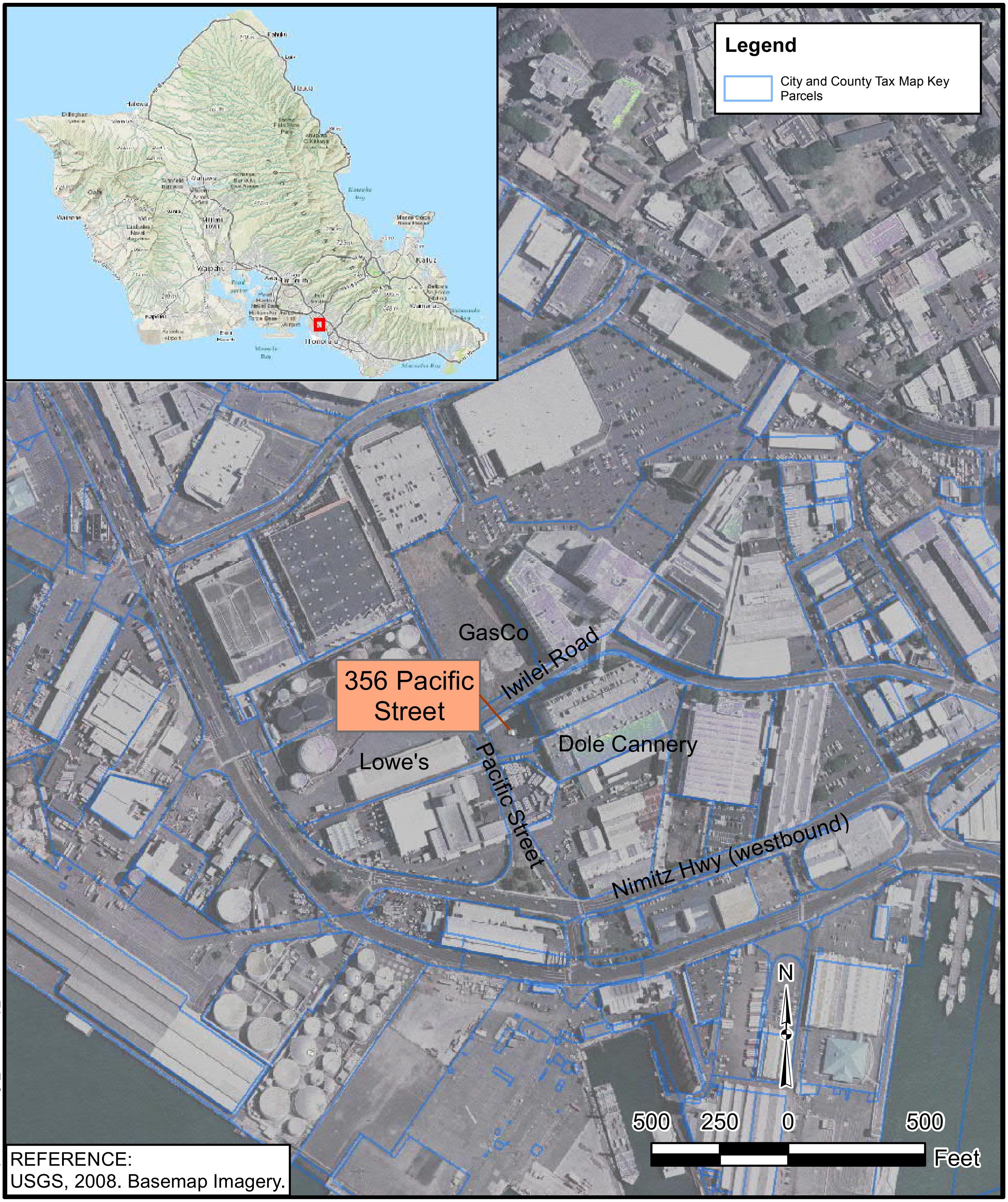
GRA general response action
LNAPL light non-aqueous phase liquid

Table 11: Evaluation of Remedial Alternatives

		Remedial Alternative			
Criteria	Alternative 1: No Action	Alternative 2A: Excavation and Offsite Disposal	Alternative 2B: Excavation Under Building/Vapor Barrier and Offsite Disposal	Alternative 3: Opportunistic Remediation/Institutional Controls	Alternative 4: Opportunistic Remediation/Vapor Barrier/ICs
Effectiveness: Reduction of Toxicity, Mobility, and Volume	Low Effectiveness – There would be no reduction to toxicity, mobility, or volume.	High Effectiveness – Excavation of the top 10 feet of soil across the site would significantly reduce the toxicity, mobility, and volume.	High Effectiveness – Excavation of the top 10 feet of soil under the building would significantly reduce the toxicity, mobility, and volume. – Vapor barrier would also prevent exposure to soil gas by future residents.	Moderate Effectiveness – Would reduce some volume by excavation of encountered contaminated soil.	Moderate Effectiveness – Would reduce some volume by excavation of encountered contaminated soil. – Vapor barrier would also prevent exposure to soil gas by future residents.
Effectiveness: Short-Term Effectiveness *(Includes minimizing short-term impacts and quickly achieving protection)*	Moderate Effectiveness – Minimizes short-term impacts because no actions would be conducted and there would be no short-term risks. – Protection would never be achieved unless the current land use remains as a parking lot.	Low Effectiveness – Excavation may present a risk to human health and environment due to dust, truck traffic during off-site disposal, and potential release of contaminated soil off site. – Protection would be quickly achieved once the construction is complete.	Low Effectiveness – Excavation may present a risk to human health and environment due to dust, truck traffic during off-site disposal, and potential release of contaminated soil off site. – Protection would be quickly achieved once the construction is complete.	Moderate Effectiveness – Limited excavation may present a risk to human health and environment due to dust, truck traffic during off-site disposal, and potential release of contaminated soil off site. – Protection would be quickly achieved once the construction is complete.	Moderate Effectiveness – Limited excavation may present a risk to human health and environment due to dust, truck traffic during off-site disposal, and potential release of contaminated soil off site. – Protection would be quickly achieved once the construction is complete.
Effectiveness: Long-Term Effectiveness *(Includes minimizing residual risks and providing reliable long-term protection)*	Low Effectiveness – Petroleum hydrocarbon contamination would remain at the site	High Effectiveness – The soil would be removed, minimizing residual risk, and leaving site in an 'unrestricted use' condition. – With the soil removed site-wide to 10 ft bgs, this alternative should provide reliable long-term protection.	High Effectiveness – Soil below the building would be removed from the site, minimizing residual risk, and a vapor barrier would be protective of future residents (reliable long-term protection).	Moderate Effectiveness – Some contaminated soil/groundwater would be removed from the site, minimizing residual risk, but this alternative may not provide reliable long-term protection due to soil gas risks.	High Effectiveness – Some contaminated soil/groundwater would be removed from the site and a vapor barrier would be protective of future residents; this alternative would minimize residual risk and provide reliable long-term protection.
Effectiveness: Compliance with Applicable Requirements	Low Effectiveness – The current use of the property minimizes exposure to humans and the environment; however, no action would not comply with applicable requirements or RAOs for the planned future development of the property.	High Effectiveness – Complies with applicable requirements and would meet RAOs. Would remove contaminated soil from 0-10 ft bgs across the site, but it's unknown what impacts groundwater may have on soil gas.	High Effectiveness – Complies with applicable requirements and would meet RAOs. Would remove contaminated soil from 0-10 ft bgs underneath the future building. A vapor barrier would prevent exposure of future residents to soil gas.	Moderate Effectiveness – Uncertainty whether soil gas levels in indoor air would be exceeded without a vapor barrier, and only minimal contaminated soil removed. – Would meet RAOs but uncertain to what degree due to soil gas risks.	High Effectiveness – Complies with applicable requirements and would meet RAOs. Although contaminated soil would be left in place, the most probable exposure to future residents would be from vapor intrusion and this alternative would remove that exposure pathway by including a vapor barrier.
Implementability: Technical Feasibility	High Implementability – Would not require any work to implement	Low Implementability – Uses standard construction equipment but would require a sheetpile wall and dewatering. – Because the site is currently a parking lot, this could be easily implemented prior to construction of a future building. – ICs would not be required.	Low Implementability – Uses standard construction equipment but would require dewatering; and shoring may be needed in some locations if sloped sidewalls are not feasible. – Because the site is currently a parking lot, this could be easily implemented prior to construction of a future building. – Vapor barriers are becoming common as more contaminated sites are being redeveloped. The technology is readily available. – ICs would be needed to restrict access.	Moderate Implementability – Uses standard construction equipment methods. – Much less soil disposal and dewatering makes this alternative much more technically feasible. – Could not be done before construction, this would need to be coordinated with building construction. – ICs would be needed to restrict access.	Moderate Implementability – Like Alternative 3, uses standard construction equipment methods. – Much less soil disposal and dewatering makes this alternative much more technically feasible. – Could not be done before construction, this would need to be coordinated with building construction. – Vapor barriers are becoming common as more contaminated sites are being redeveloped. The technology is readily available. – ICs would be needed to restrict access.
Implementability: Administrative Feasibility	Low Implementability – Necessary approvals are unlikely to be obtained. – Community acceptance is unlikely because no action would be conducted.	Moderate Implementability – Necessary approvals would be relatively easy to obtain. – Degree of community acceptance is unknown at this time.	Moderate Implementability – Necessary approvals would be relatively easy to obtain. – Degree of community acceptance is unknown at this time.	Moderate Implementability – Necessary approvals would be relatively easy to obtain. – Degree of community acceptance is unknown at this time.	Moderate Implementability – Necessary approvals would be relatively easy to obtain. – Degree of community acceptance is unknown at this time.
Total Cost*	No Cost – No cost to implement – No annual O&M costs	High Cost ($7.5 M) – Highly expensive to implement – No O&M costs	High Cost ($4.8M) – Highly expensive to implement, but less than Alternative 2A – Long-term O&M costs for ICs	Low Cost ($850K) – Lowest cost of the action alternatives – Long-term O&M costs for ICs	Moderate Cost ($1.2M) – Moderately expensive to implement – Long-term O&M costs for ICs

IC institutional control
O&M operation and maintenance
RAO remedial action objective
*The full cost breakdown can be found in the RAA (AECOM 2018a)

Figures



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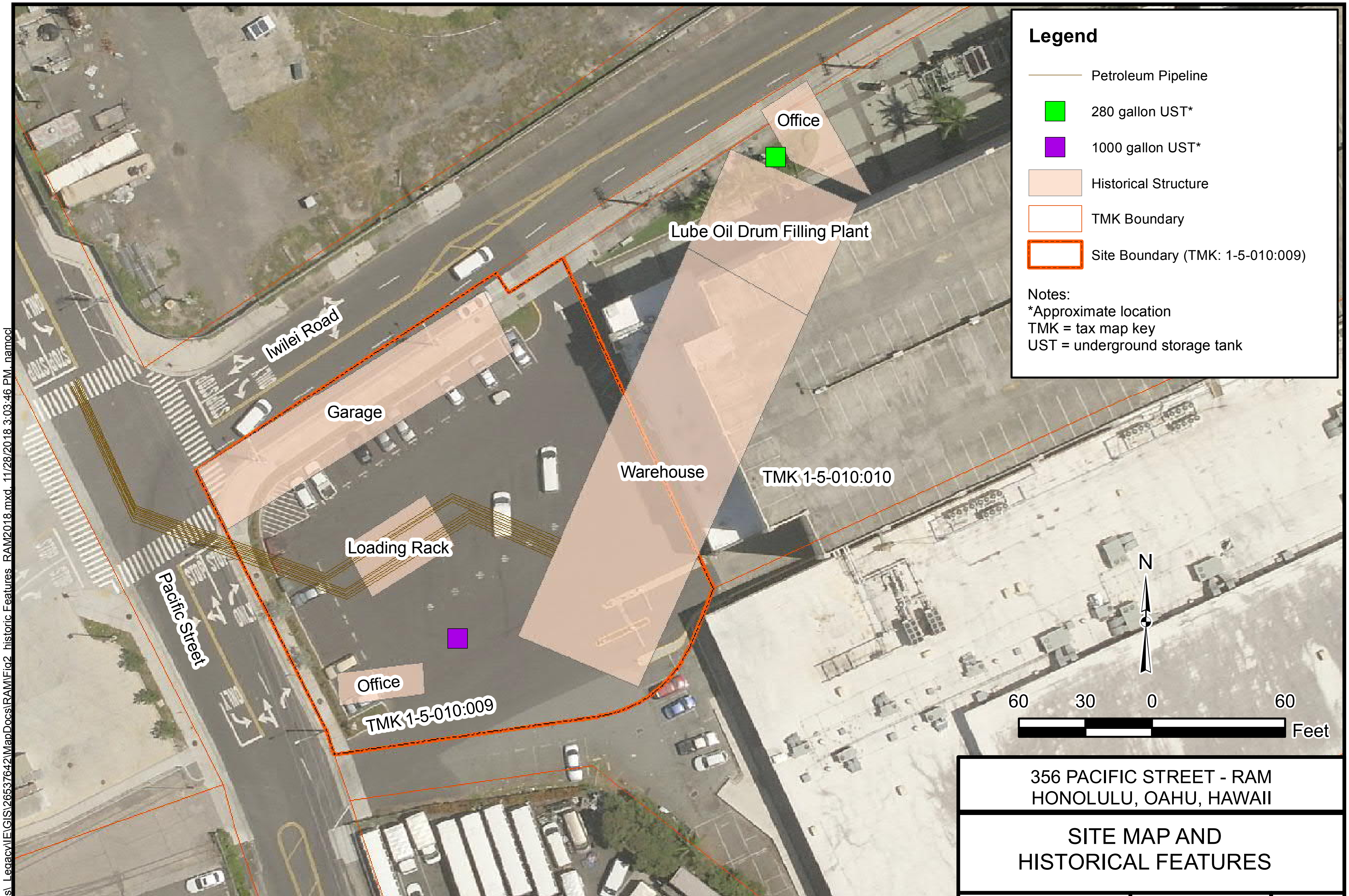
356 PACIFIC STREET - RAM
HONOLULU, OAHU, HAWAII

AECOM

LOCATION MAP

PROJ. NO. 60587347	FIGURE
DATE: APRIL 2019	1



REFERENCE:
Pictometry, 2013. Basemap Imagery.
City & County of Honolulu, 2014. TMK Boundaries.
Engineers Surveyors Hawaii, Inc., 2014. Topographic Survey Worksheet: Monitoring Wells at Dole Cannery at Iwilei, Honolulu, Oahu, Hawaii, TMK: 1-5-10: Parcel 9. March 24.

356 PACIFIC STREET - RAM
HONOLULU, OAHU, HAWAII

SITE MAP AND
HISTORICAL FEATURES

AECOM

PROJ. NO.
60587347

DATE:
APRIL 2019

FIGURE
2

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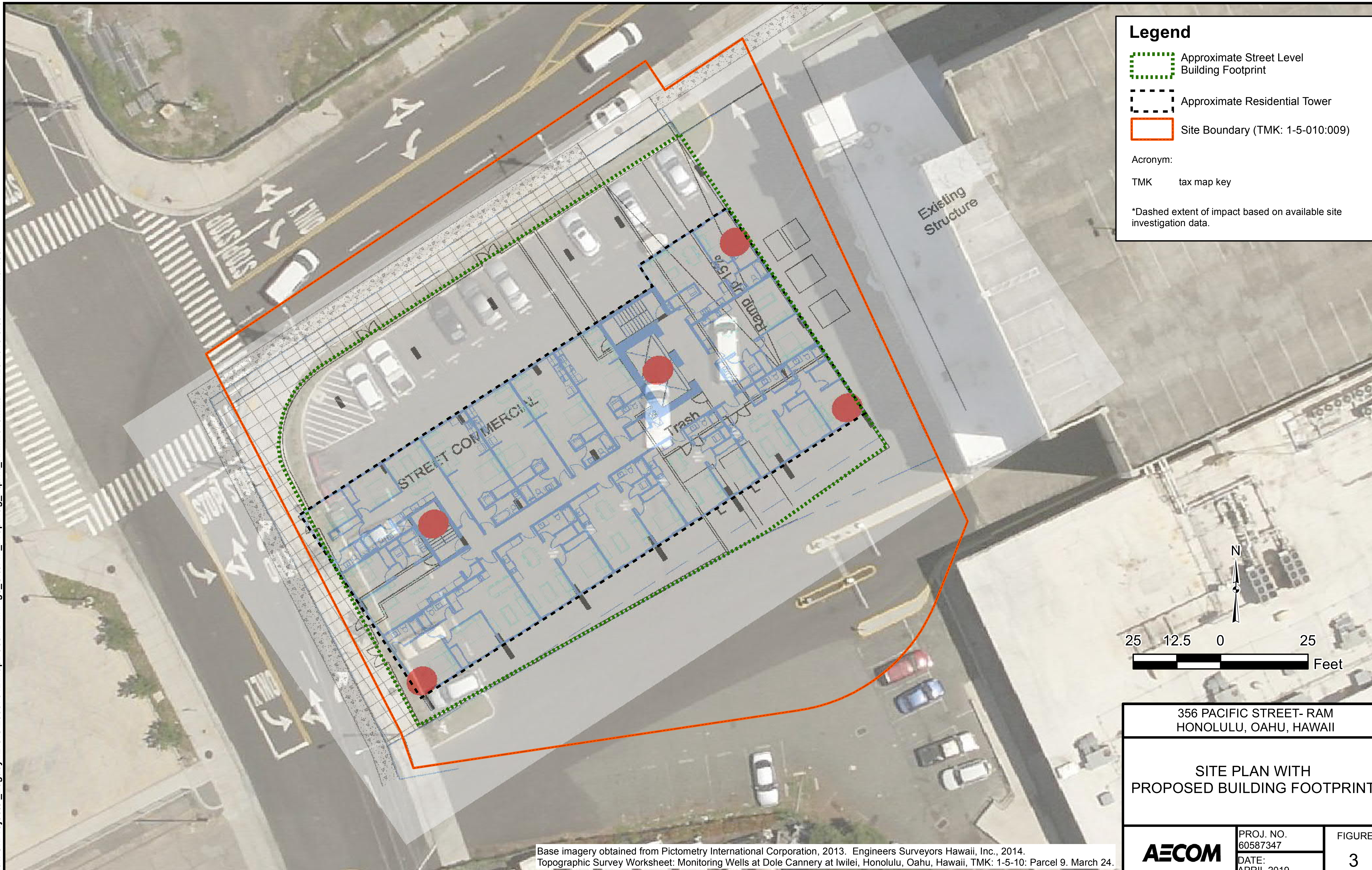


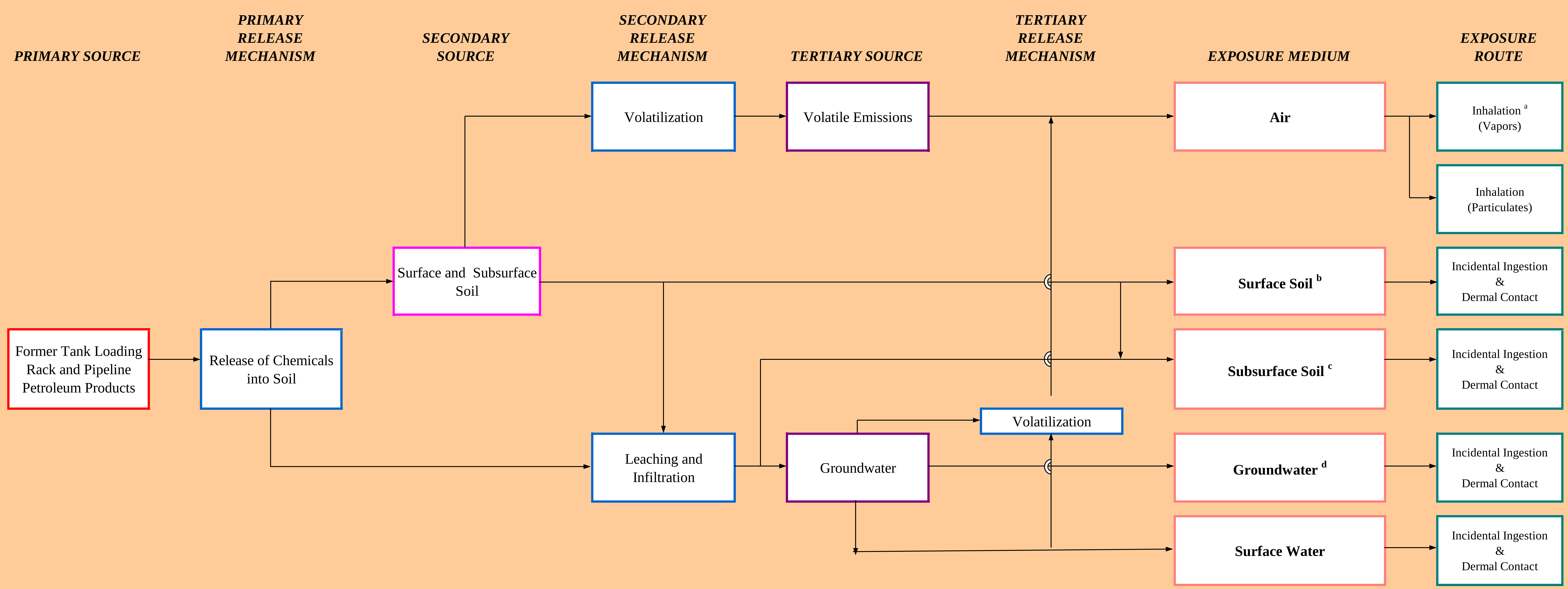
Base imagery obtained from Pictometry International Corporation, 2013. Engineers Surveyors Hawaii, Inc., 2014.
Topographic Survey Worksheet: Monitoring Wells at Dole Cannery at Iwilei, Honolulu, Oahu, Hawaii, TMK: 1-5-10: Parcel 9. March 24.

356 PACIFIC STREET- RAM
HONOLULU, OAHU, HAWAII

SITE PLAN WITH
PROPOSED BUILDING FOOTPRINT

AECOM

PROJ. NO. 60587347	FIGURE
DATE: APRIL 2019	3

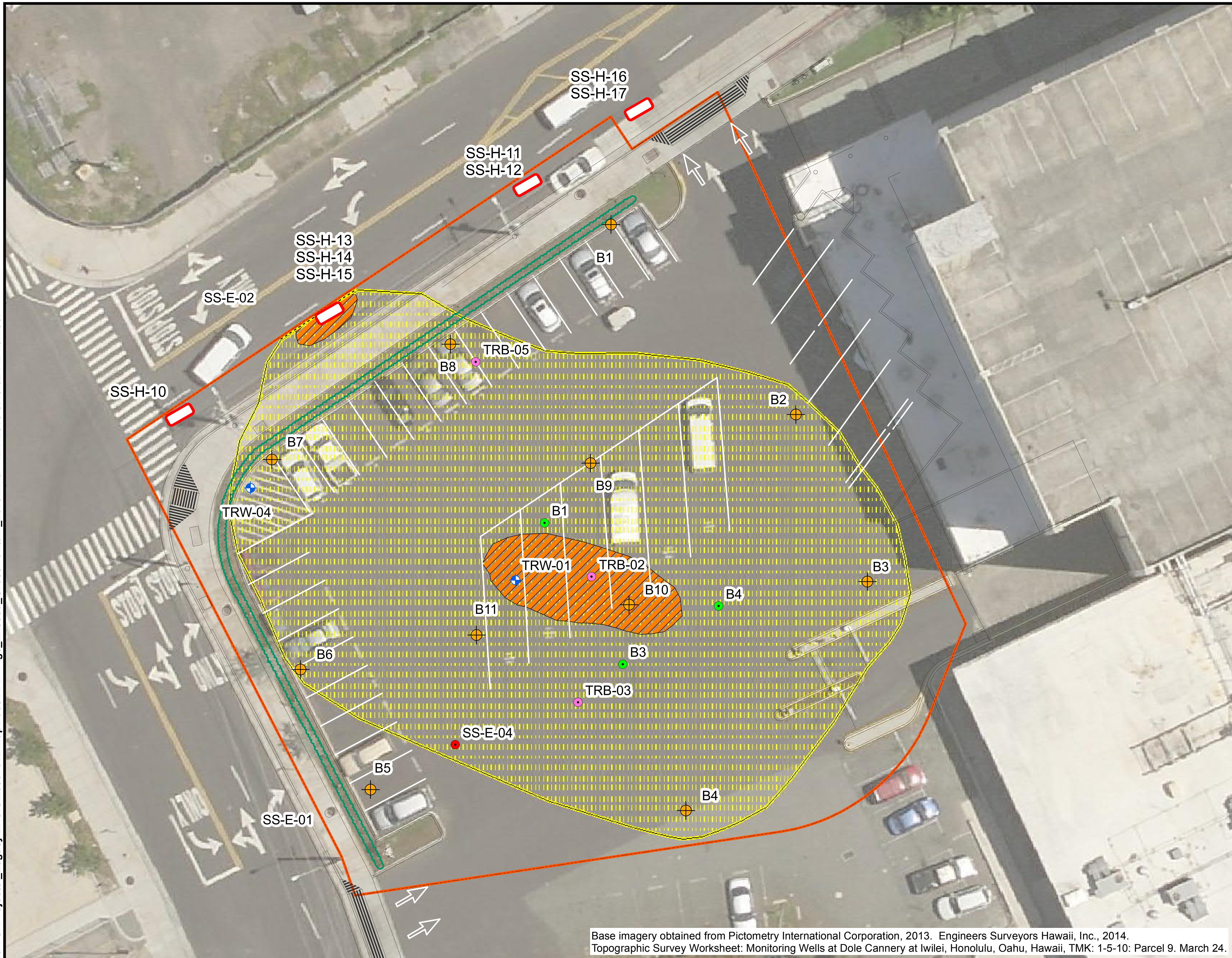


		POTENTIAL RECEPTORS				
		Human				Ecological
Exposure Medium	Exposure Route	Current/Future Parking Users	Future On-Site Construction Worker	Future On-Site Commercial/Industrial Building Workers and High Rise Residents	Future On-Site Commercial/Industrial Outdoor Workers	Aquatic Life
Air	Inhalation [a] (Vapors)	○	●	●	○	NA
Air	Inhalation (Particulates)	IC	●	○	●	NA
Surface Soil [b]	Incidental Ingestion & Dermal Contact	IC	●	○	●	NA
Subsurface Soil [c]	Incidental Ingestion & Dermal Contact	IC	●	○	●	NA
Groundwater [d]	Incidental Ingestion & Dermal Contact	IC	●	IC	IC	○
Surface Water	Incidental Ingestion & Dermal Contact	NA	NA	NA	NA	●

Legend:

● Potentially complete and significant pathway
○ Minor or insignificant pathway
IC Incomplete pathway
NA Not applicable
a) No buildings are currently on site.
b) Surface soil exposure pathways are only complete under future conditions where asphalt is removed and in the absence of clean fill or asphalt on the redeveloped site.
c) Subsurface soil direct contact pathways may be complete if this soil is daylighted during redevelopment and in the absence of clean fill or asphalt on the redeveloped site.
d) For aquatic life, the primary concern for groundwater is as a transport mechanism to surface water where the organisms reside and exposure is expected to occur.

Conceptual Site Model for 356 Pacific Street | ***Figure 4***



Legend

- Soil Sample Location
- Existing Monitoring Well
- Sample Pits
- 2010 Soil Sample Location
- 2000 Soil Sample Location
- 1988 Soil Sample Location
- Landscaped
- Site Boundary (TMK: 1-5-010:009)
- Approximate Extent of LNAPL*
- Approximate Area of Exposed Soil Gross Contamination*

Acronym:

LNAPL light nonaqueous phase liquids
TMK tax map key

*Estimated extent of impact based on available site investigation data. LNAPL was not measurable in groundwater at TRW-01 or B-10 in October 2017.

Base imagery obtained from Pictometry International Corporation, 2013. Engineers Surveyors Hawaii, Inc., 2014.
Topographic Survey Worksheet: Monitoring Wells at Dole Cannery at Iwilei, Honolulu, Oahu, Hawaii, TMK: 1-5-10: Parcel 9. March 24.

356 PACIFIC STREET- RAM
HONOLULU, OAHU, HAWAII

GROSS CONTAMINATION HAZARDS (ISOLATED SOILS) - CURRENT SITE CONDITIONS

AECOM

PROJ. NO. 60587347	FIGURE
DATE: APRIL 2019	5

Path: S:\Projects_Legacy\IE\GIS\26537642\MapDocs\RAM\Fig5_Exceed_GrossContam_2018.mxd - 12/7/2018-3:40:02 PM namocl

356 PACIFIC STREET- RAM
HONOLULU, OAHU, HAWAII

GROSS CONTAMINATION HAZARDS
(EXPOSED SOILS)
FUTURE SITE CONDITIONS

AECOM

PROJ. NO. 60587347	FIGURE
DATE: APRIL 2019	6

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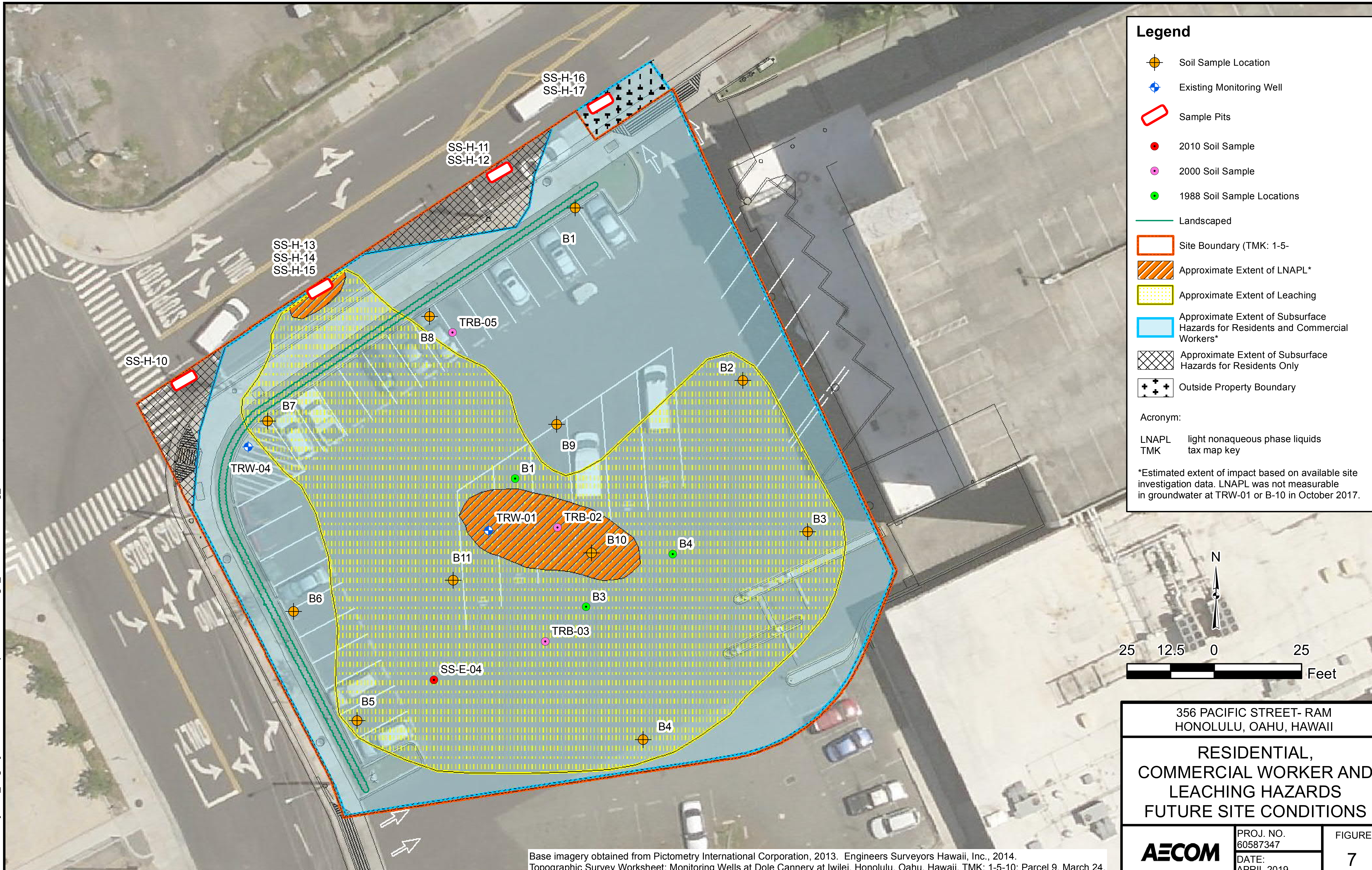

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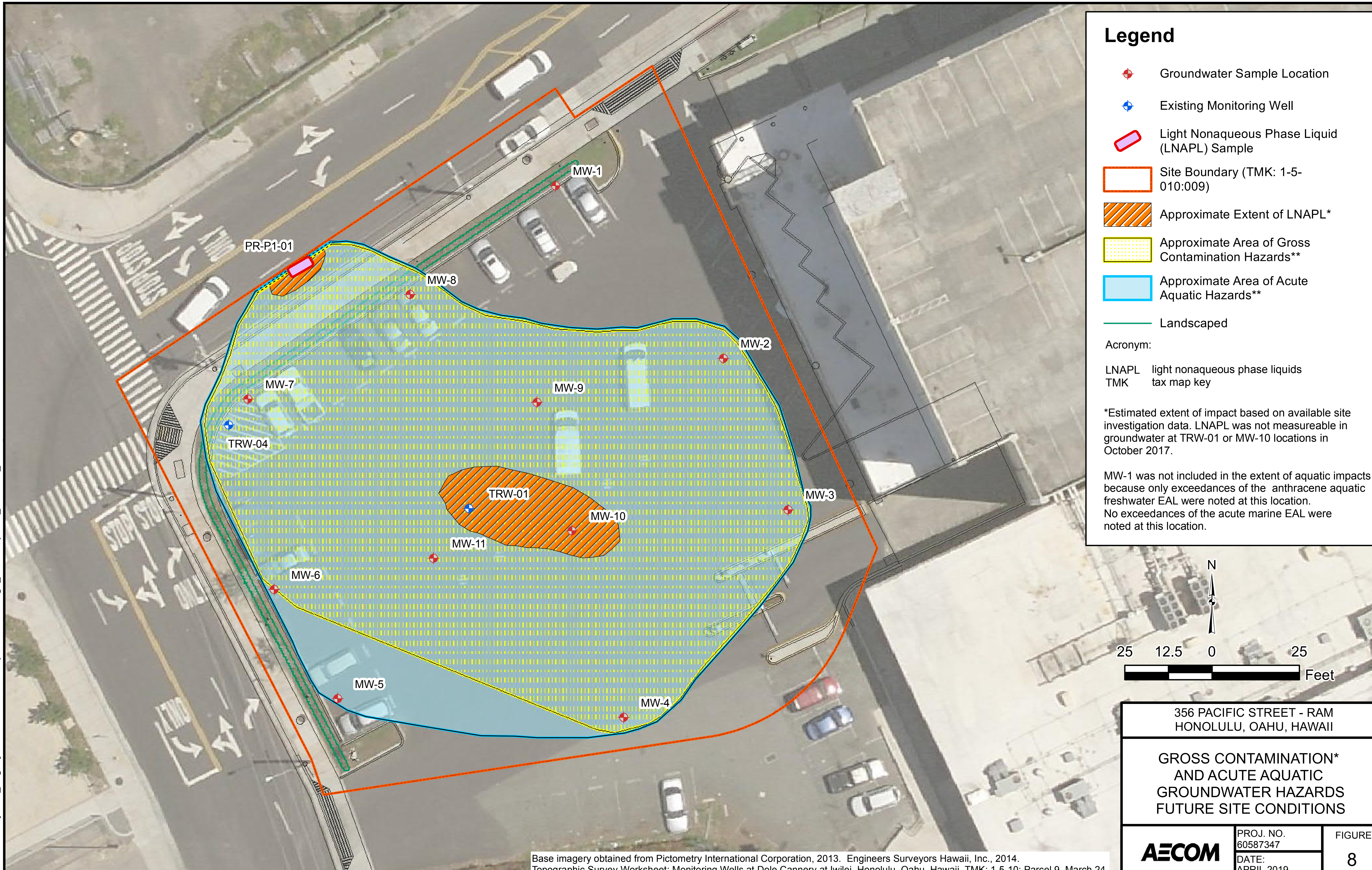

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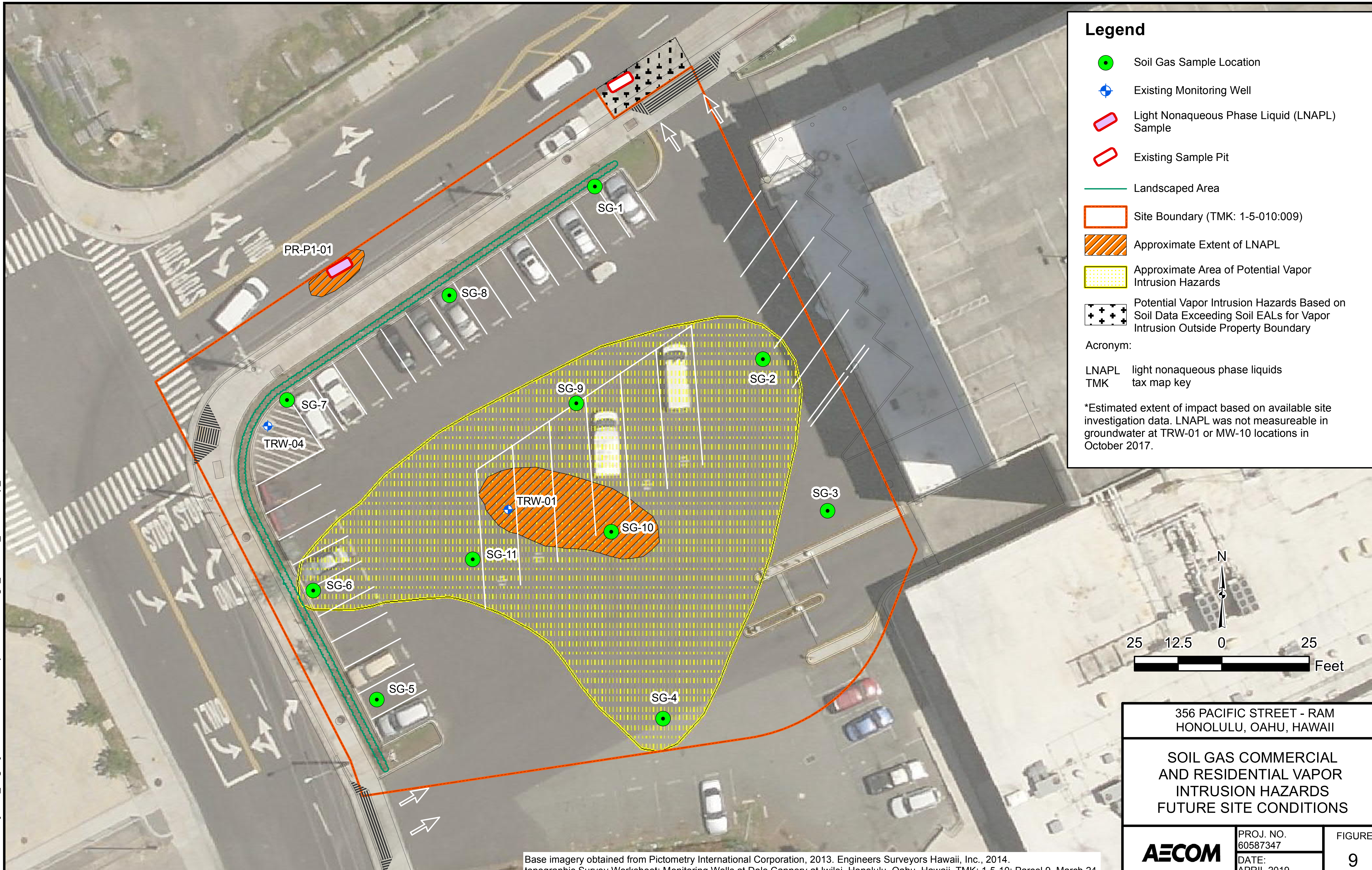

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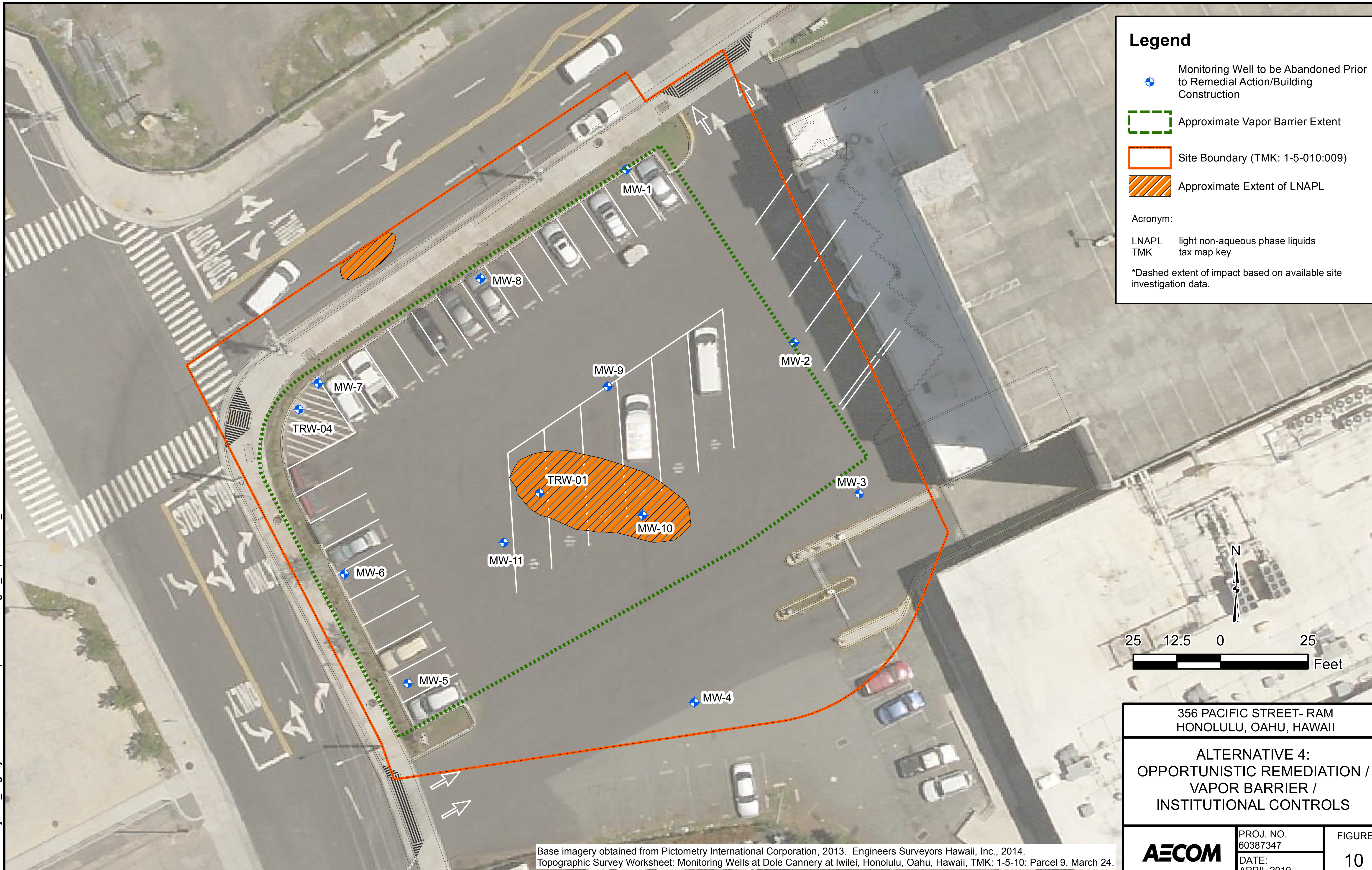

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Appendix A:
Response to Comments
on DOH Letter 2018-349 LC

DAVID Y. IGE
GOVERNOR OF HAWAII

BRUCE S. ANDERSON, Ph.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HI 96801-3378

In reply, please refer to:
File:
2018-349 LC

November 19, 2018

Mr. Karl Bewley
Chevron Environmental Management Company
145 South State College Blvd. Room 5032
Brea, CA 92821

Facility/Site: Chevron Tanker Truck Loading Rack (TTLR)

Subject: Review of: *Draft Remedial Action Memorandum, 356 Pacific Street (Facility # 359067), Honolulu, Hawaii, Tax Map Key 1-5-010:009* by AECOM on October 2018.

Dear Mr. Bewley:

The Hawaii Department of Health (HDOH), Hazard Evaluation and Emergency Response (HEER) Office has reviewed the indicated document and requests that the document be updated based upon the HDOH comment letters, Review of: *Remedial Alternatives Analysis (RAA), 356 Pacific Street (Facility # 359067), Honolulu, Hawaii* dated October 31, 2018 and Review of: *Response to Comments for the RAA, 356 Pacific Street (Facility #359067), Honolulu, Hawaii*, dated November 13, 2018. In addition, HDOH has the following comments.

1. P. 2-1, 2.3 Investigation History and Constituents of Potential Concern (COPCs) – Please include a brief summary of all the environmental investigations that have occurred at the Site. The draft Remedial Action Memorandum (RAM) is meant to be a stand-alone document, and a summary of the environmental investigations should be included.
2. P. 2-1, 2.3 Investigation History and Constituents of Potential Concern (COPCs) – Please clearly identify all chemicals of potential concern based upon current and historical operations conducted at the Site and nearby areas.
3. P. 2-1, 2.3.1 Soil and 2.3.2 Groundwater and LNAPL, and P. 3-1, 3.1 Constituents of Concern – Please clarify the difference between preliminary COPCs, COPCs, and COCs for the Site.
4. P. 3-1, 3.1 Constituents of Concern – This section does not identify specific constituents of concern (COCs). If COCs have been identified for the Site, please include them in this Section.
5. P. 3-1, 3.2 Potential Receptor and Exposure Pathways – Please include Figure 9 from the Environmental Hazard Evaluation and Interim Environmental Hazard Management Plan for the Site illustrating the conceptual site model. Please also include Figures 11-15 from the Environmental Hazard Evaluation and Interim Environmental Hazard Management Plan for the Site illustrating all hazards identified (i.e., gross contamination, leaching, acute aquatic hazards, etc.).

Please respond to these comments at your earliest convenience. Should you have any questions concerning the above, please feel free to contact me at 586-0956.

Sincerely,

Lauren Cruz

Lauren Cruz
Remedial Project Manager
Hazard Evaluation and Emergency Response Office

e-cc: Jack Kronen, AECOM
e-cc: Kevin Kennedy, Kevin S. Kennedy Consulting LLC
e-cc: Chris Lovvorn, Castle and Cooke Hawaii

Project Title: Remedial Action Memorandum,
356 Pacific Street (Facility #359067),
Honolulu, Oahu, Hawaii 96813,
Tax Map Key 1-5-010:009
Reviewer: Lauren Cruz, State of Hawaii Department of Health
Date: November 19, 2018; File: 2018-349 LC

Item	Section No.	Comment
1	Introduction	The Hawaii Department of Health (HDOH), Hazard Evaluation and Emergency Response (HEER) Office has reviewed the indicated document and requests that the document be updated based upon the HDOH comment letters, Review of: Remedial Alternatives Analysis (RAA), 356 Pacific Street (Facility # 359067), Honolulu, Hawaii dated October 31, 2018 and Review of: Response to Comments for the RAA, 356 Pacific Street (Facility #359067), Honolulu, Hawaii, dated November 13, 2018.

Response:

A RTC for HDOH's comment on the RAA has been prepared as a separate document.

Comment 1 on the RAA requested clarification that the duration of 30 years for institutional controls was for costing purposes. The following text modifications were made to Sections 4.3.3, 4.3.4 and 4.3.5 of the RAM:

Because contaminated soil would be left in place in the area surrounding the building, this alternative would include ICs until it is determined the contamination no longer poses an environmental hazard. For costing purposes, it was conservatively assumed ICs would remain in place 30 years.

Comment 2 on the RAA requested that the duration of vapor monitoring be modified and that the text indicate that the passive venting system should be designed to be able to be converted to active venting in Alternative 4.

The following text was added to Section 4.3.4 to address RAA Comment 2:

For this Site, elevator shaft and/or sub-slab soil gas vapor monitoring events will be performed at least quarterly for a minimum of one year post-building construction and discontinued when sufficient data indicates that the vapor barrier performance is protective of human health, ~~=~~ because…

The following text was modified or added to Section 4.3.5 to address RAA Comment 2:

~~Vapor, soil gas and~~G~~g~~roundwater monitoring ~~are~~ is not included for Alternative 4.

Like Alternative 3, elevator shaft and/or sub-slab soil gas vapor monitoring events will be performed at least quarterly for a minimum of one year post-building construction and discontinued when sufficient data indicates that the vapor barrier performance is protective of human health. The passive venting system will be designed so that it will be able to be converted to active venting. The details regarding the need for additional monitoring regarding the effectiveness of passive venting will be described in the EHMP.

2	p.5-4, Alternative 4	Investigation History and Constituents of Potential Concern (COPCs) ~ Please include a brief summary of all the environmental investigations that have occurred at the Site. The draft Remedial Action Memorandum (RAM) is meant to be a stand-alone document, and a summary of the environmental investigations should be included.

Response:

Section 2.3 was modified so that a complete investigation history is presented in the RAM and the discussion of COPCs moved to new Section 2.4 (see also Response to Comment 4).

Project Title: Remedial Action Memorandum,
356 Pacific Street (Facility #359067),
Honolulu, Oahu, Hawaii 96813,
Tax Map Key 1-5-010:009
Reviewer: Lauren Cruz, State of Hawaii Department of Health
Date: November 19, 2018; File: 2018-349 LC

Item	Section No.	Comment
3	P. 2-1, 2.3 Investigation History and Constituents of Potential Concern (COPCs)	Please clearly identify all chemicals of potential concern based upon current and historical operations conducted at the Site and nearby areas.

Response:

All chemicals evaluated based on data from current and historic investigations and the associated summary statistics are presented in newly added Table 1 for soil and Table 4 for groundwater. The soil gas data appears in renamed Table 6.

4	P. 2-1, 2.3.1 Soil and 2.3.2 Groundwater and LNAPL, and P. 3-1, 3.1 Constituents of Concern	Please clarify the difference between preliminary COPCs, COPCs, and COCs for the Site.

Response:

A new Section 2.4 Preliminary COPCs and COPCs was added and Section 3.1 was modified to describe the COCs. Preliminary COPCs are based on comparisons to Tier 1 EALs. Because the Tier 1 EALs are based on the lowest EALs using a variety of endpoints and not all these endpoints are applicable under current and future conditions, an evaluation of hazards by EAL endpoints was performed under current and likely future conditions to refine the list of preliminary COPCs to COPCs. The list of COPCs was further refined to a final list of COCs based on supplemental site information such as groundwater flow direction in Section 3.1. Tables 2 and 3 were added to clarify the soil COPCs under current and future conditions. Table 5 was added to clarify the groundwater COPCs. Table 7 lists the soil gas and soil COCs and Table 8 lists the groundwater COCs.

5	P. 3-1, 3.1 Constituents of Concern	This section does not identify specific constituents of concern (COCs). If COCs have been identified for the Site, please include them in this Section.

Response:

Section 3.1 has been modified to clearly identify the COCs by media. Table 7 lists the soil gas and soil COCs and Table 8 lists the groundwater COCs. Subsequent tables were renumbered.

6	P. 3-1, 3.2 Potential Receptor and Exposure Pathways	Please include Figure 9 from the Environmental Hazard Evaluation and Interim Environmental Hazard Management Plan for the Site illustrating the conceptual site model. Please also include Figures 11—15 from the Environmental Hazard Evaluation and Interim Environmental Hazard Management Plan for the Site illustrating all hazards identified (i.e., gross contamination, leaching, acute aquatic hazards, etc.).

Response:

The requested figures were added to the report with the exception of Figure 15 from the EHE/EHMP which was already in the RAM as Figure 4 in the prior version of the report.