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HUMAN HEALTH RISK ASSESSMENT

NORTHEAST CORNER OF SOUTH CENTRAL AND VICTORIA STREET
CARSON, CALIFORNIA

CONTENTS

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

ABS	Soil Absorption Factor
ADAF	Age-Dependent Adjustment Factor
ALM	Adult Lead Model
ATSDR	Agency for Toxic Substances & Disease Registry
bgs	below ground surface
Cal/EPA	California Environmental Protection Agency
CFR	Code of Federal Regulations
COPC	Chemical of Potential Concern
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
DTSC	Department of Toxic Substances Control
ESA	Environmental Site Assessment
GIABS	Fraction of Contaminant Absorbed in Gastrointestinal Tract
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
IARC	International Agency for Research on Cancer
IQ	Intelligence Quotient
IUR	Inhalation Unit Risk
MRL	Minimal Risk Level
NCP	National Contingency Plan
NHL	Non-Hodgkin Lymphoma
OEHHA	Office of Environmental Health Hazard Assessment
PEF	Particulate Emission Factor
PPRTV	Provisional Peer Reviewed Toxicity Value
RBA_{oral}	Oral relative bioavailability
RBTC	Risk-Based Target Concentration
RfC	Reference Concentration
RfD	Reference Dose
RSL	Regional Screening Level
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbons
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

UNITS OF MEASURE

atm	atmosphere
cm	centimeter
cm^2	square centimeter
dL	deciliter
kg	kilogram
L	liter
m^3	cubic meters
mg	milligram
mm	millimeter
mol	mole
µg	microgram

1. DEVELOPMENT OF RISK-BASED TARGET CONCENTRATIONS

In order to evaluate the potential human health risk to future on-Site populations, risk-based target concentrations (RBTCs) were developed for selected chemicals detected in soil gas and soil at the Site according to California Environmental Protection Agency (Cal/EPA) and United States Environmental Protection Agency (USEPA) risk assessment guidance as follows:

- Cal/EPA 2011a. Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air;
- Cal/EPA 2014. Human Health Risk Assessment (HHRA) Note Number 1, Issue: Recommended Department of Toxic Substances Control (DTSC) Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities;
- Cal/EPA 2015. Preliminary Endangerment Assessment Guidance Manual;
- Cal/EPA 2017. HHRA Note Number 3, Issue: DTSC-Modified Screening Levels;
- USEPA 1989. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A);
- USEPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final; and
- USEPA 2009. Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment).

The RBTC represents the concentration of a chemical that is protective of human health. As a conservative measure, the RBTCs were calculated to correspond to a target cancer risk of one in a million (1×10^{-6}) and a target non-cancer hazard quotient (HQ) of one. The National Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] § 300) is commonly cited as the basis for target risk and hazard levels. According to the NCP, lifetime incremental cancer risks posed by a site should not exceed 1×10^{-6} to one hundred in a million (1×10^{-4}), and noncarcinogenic chemicals should not be present at levels expected to cause adverse health effects (i.e., HQ greater than one). As a risk management policy, the Cal/EPA generally considers 1×10^{-6} to be a point of departure for purposes of making risk management decisions, with most approved remediation achieving incremental risk levels of ten in a million (1×10^{-5}) or lower.

The following sections discuss the various components required for developing RBTCs. Section 1.1 identifies the chemicals for which RBTCs were developed. Section 1.2 discusses the exposure assessment. Section 1.3 presents the fate and transport modeling used to predict the concentration of volatile chemicals and particulates in air. The toxicity of the chemicals evaluated is discussed in Section 1.4. Section 1.5 explains the methodology for calculation of RBTCs and presents the media and chemical-specific RBTCs.

1.1 Selection of Chemicals to be Evaluated

Analytes identified as chemicals of potential concern (COPCs) and for which RBTCs were developed are listed in Table 1. COPCs were selected based on the analytical data collected by Haley Aldrich in relation to a Phase II site investigation in August through October, 2017 (Haley Aldrich 2017).

Among the 141 soil samples collected at 0 to 10 feet below ground surface (feet bgs) across the Site (excluding four samples collected at deeper depths) and analyzed for metals, total petroleum hydrocarbons (TPH), and volatile organic compounds (VOCs), 17 analytes detected in at least one soil sample were identified as soil COPCs, including 13 metals and four TPH fractions. For TPH, the soil samples were analyzed for eight fractions with different carbon ranges, and five fractions were detected. However, based on Cal/EPA (2015) and USEPA (2017a), RBTCs were calculated only for the four TPH fractions that have toxicity values derived in the Regional Screening Level (RSL) table (USEPA 2017b).

Among the 68 soil gas samples collected at five and 15 feet bgs across the Site and analyzed for VOCs and inorganic compounds, 11 VOCs detected in at least one soil gas sample were identified as soil gas COPCs. All 11 COPCs were detected in the five feet bgs samples, six of which were also detected in the 15 feet bgs samples.

1.2 Exposure Assessment

To evaluate the human health risks posed by a site, it is necessary to identify the populations that may potentially be exposed to the chemicals present and to determine the pathways by which these exposures may occur. A Conceptual Site Model (CSM) describing the potentially exposed populations and exposure pathways identified for the Site is presented in Figure 1.

Rationale for the selection of potentially exposed populations is presented in Section 1.2.1 and for the relevant (i.e., complete) exposure pathways in Section 1.2.2. Section 1.2.3 presents the exposure assumptions, and Section 1.2.4 provides the intake estimation to quantify the exposures.

1.2.1 Potentially Exposed Human Populations

The Site is a former oil field and is currently vacant. It is understood that the Site may be redeveloped for residential use. Thus, to evaluate an unrestricted redevelopment scenario, RBTCs were developed for future on-Site construction workers conducting Site redevelopment activities and future on-Site residents occupying the Site after redevelopment.

1.2.2 Exposure Pathways

Based on the CSM, potential exposure pathways and routes for construction workers and residents are as follows:

- Direct contact with surface and subsurface soils (0–10 feet bgs, when soils from depths of up to 10 feet bgs could be brought to the surface during excavation or other activities) via ingestion, dermal contact, inhalation of vapors migrating from soil to outdoor or trench air, and inhalation of windblown particulates.
- Inhalation of vapors (either through migration of soil gas from the subsurface into indoor air [home] or trench air [construction trench]).

For soil gas, only inhalation of VOCs in indoor air was modeled for the future resident populations, since outdoor concentrations of VOCs will be lower than indoor air concentrations due to higher mixing in the ambient environment. For construction workers, inhalation of VOCs migrating from soil gas or soil in a construction trench while conducting excavation activities was modeled for conservativeness as the mixing with ambient air is limited in that scenario.

Neither direct contact with groundwater nor vapor migration from groundwater were considered as possible exposure pathways. According to the Phase I Environmental Site

Assessment (ESA) (Haley Aldrich 2017), groundwater in the uppermost aquifer at the Site is located at approximately 205 feet bgs. No groundwater was encountered on-Site at a boring advanced to 28 feet bgs. Also, municipally-supplied water is available for potable uses in this area. Given these reasons, groundwater is unlikely to represent a major source of vapor intrusion, and direct contact with groundwater during domestic use is unlikely.

1.2.3 Exposure Assumptions

Standard exposure assumptions recommended by Cal/EPA (2014) were used for construction workers and residents. The exposure parameters are presented in Table 2.

1.2.4 Estimate Intake

In order to quantify exposures, an upper-bound estimate of the theoretical intake was developed for each of the potentially exposed human populations via each of the exposure pathways identified in the CSM. This section provides the equations and assumptions used to develop the intake factors used in the calculation of the RBTCs. The exposure assumptions and calculated intake factors are presented in Table 2.

<u>Ingestion of Soil</u>

The intake factor for soil ingestion was calculated using the following equation (USEPA 1989):

$$\mathrm{IF_{soil.ing}} = \frac{\mathrm{IR_S} * \mathrm{EF} * \mathrm{ED} * \mathrm{CF}}{\mathrm{BW} * \mathrm{AT}}$$

Where:

$IF_{soil.ing}$	=	Intake Factor for soil ingestion (kilogram [kg] of soil/kg body weight-day)
IR_s	=	Soil Ingestion Rate (milligram [mg] of soil/day)
EF	=	Exposure Frequency (day/year)
ED	=	Exposure Duration (year)
BW	=	Body Weight (kg)
AT	=	Averaging Time (day)
CF	=	Conversion Factor (kg of soil/mg of soil)

<u>Dermal Contact with Soil</u>

The intake factor for dermal contact with soil was calculated using the following equation (USEPA 2004):

$$\mathrm{IF_{soil.derm}} = \frac{\mathrm{AF} * \mathrm{SA_s} * \mathrm{EF} * \mathrm{ED} * \mathrm{CF}}{\mathrm{BW} * \mathrm{AT}}$$

Where:

$IF_{soil.derm}$	=	Intake Factor for dermal contact with soil (kg of soil/kg body weight-day)
AF	=	Adherence Factor (mg of soil/square centimeter [cm^2])
SA_s	=	Skin Surface Area for soil contact (cm^2/day)
EF	=	Exposure Frequency (day/year)
ED	=	Exposure Duration (year)
BW	=	Body Weight (kg)
AT	=	Averaging Time (day)
CF	=	Conversion Factor (kg of soil/mg of soil)

Inhalation of Air

The intake factor for inhalation of volatile chemicals or windblown particulates migrating from soil or soil gas to indoor, outdoor, or trench air was calculated using the following equation (USEPA 2009):

$$IF_{inh} = \frac{ET * EF * ED}{AT * CF}$$

Where:

IF_{inh}	=	Intake Factor for air inhalation (unitless)
ET	=	Exposure Time (hour/day)
EF	=	Exposure Frequency (day/year)
ED	=	Exposure Duration (year)
AT	=	Averaging Time (day)
CF	=	Conversion Factor (hour/day)

1.3 Fate and Transport Modeling

1.3.1 Vapors

Volatile compounds detected in soil gas and soil can potentially migrate through the unsaturated zone to indoor or outdoor air. This migration is quantified for the purposes of this assessment through an intermedia transfer factor. When the transfer factor is multiplied by the source concentration of a chemical in soil or soil gas, the product is the resulting steady-state concentration that is predicted in indoor or outdoor air.

Ramboll developed transfer factors for volatile compounds from soil or soil gas to indoor, outdoor, or trench air (for exposure of future on-Site construction workers and residents) for the following scenarios:

- Transport of soil gas from five feet bgs into a residential slab-on-grade building with engineered fill.
- Transport of soil gas from 15 feet bgs into a residential slab-on-grade building with engineered fill.
- Transport of soil gas from five feet bgs into a five-foot deep construction trench.
- Transport of soil from one centimeter (cm) bgs into outdoor air.
- Transport of soil from one cm bgs into a 10-foot deep construction trench.

Soil gas transfer factors were estimated using the screening-level model described by Johnson and Ettinger (1991). Specifically, the DTSC Screening-Level Model for Soil Gas Contaminants[1] was used. Soil transfer factors were estimated using the Jury model as outline in the Soil Screening Users Guidance (USEPA 2002).

These models are conservative because they assume that the chemical source has infinite mass and it does not include other attenuation processes that typically would reduce the amount of vapor migration, such as biodegradation, leaching from infiltration, and lateral diffusion.

The calculation of transfer factors was based on parameters describing the properties of the chemicals evaluated, the vadose zone, the surface barrier, and the air dispersion zone. The

[1] https://www.dtsc.ca.gov/AssessingRisk/upload/HERO_Soil-Gas_Screening_Model_March2014.xlsm

physical-chemical properties used in these calculations are shown in Table 3. Based on guidance from USEPA (2017a), only chemicals that easily volatilize were included in the evaluation of vapor migration. These include chemicals with a Henry's Law constant of greater than 1 x 10^{-5} atmosphere-cubic meter per mole (atm-m^3/mol) or a vapor pressure of greater than 1 millimeter of mercury (mm Hg). Physical and chemical properties in the DTSC Screening-Level Model for Soil Gas Contaminants were updated to newer values from Cal/EPA (2011) or USEPA (2017b) when available and as shown in Table 3.

Site-specific vadose zone soil parameters and conservative assumptions, which were used to calculate the effective diffusion coefficients, are shown in Table 4. The soil properties were conservatively selected based on a review of site boring logs (Haley Aldrich 2017), which indicated silty clay to clayey silt soil from the ground surface until 7 to 10 feet deep and sandier soils with some silt or clay until 15 feet bgs. The clayey soils were modeled as clay loam, and the sandier soils were modeled as sandy loam. For simplicity, the soil types were selected as follows:

- Soil gas to indoor air for residents: The upper vadose zone at the Site was assumed to consist of up to three distinct layers. For a future building with engineered fill, the upper two layers consist of a 10 cm layer of sand on top of a 30 cm layer of engineered fill as outlined in Cal/EPA (2005). The remaining layer was conservatively assumed to be sandy loam.
- Soil gas or soil to trench air for construction workers: The soil type was conservatively assumed to be sandy loam.
- Soil to outdoor air for residents: Two soil layers, clay loam (0-7 feet bgs) and sandy loam (7-15 feet bgs), were modeled.

For residential indoor air scenario, the building parameters were based on residential defaults, and are also shown in Table 4. For the residential outdoor air scenario, dispersion was calculated using the Q/C model (as described in USEPA 2002) with site-specific input values as shown in Table 4.

For construction workers, two different construction trench scenarios were included to ensure that the most conservative scenario was modeled for transport of vapor compounds from both soil gas and soil, and the trench parameters are also shown in Table 4. For soil gas modeling, the trench was assumed to be five feet deep to allow for the trench to sit directly on top of the potential soil vapor sources located at the soil gas sample locations at five feet bgs, and the derived RBTCs based on this scenario were also conservatively applied to the soil gas samples at 15 feet bgs. For soil modeling, the trench was conservatively assumed to be 10 feet deep due to less dispersion. For both trench scenarios, dispersion was calculated using a box model and including reduced airflow in the breathing zone of the construction workers inside the trench.

The transfer factors for volatile compounds migrating from soil gas or soil to indoor, outdoor, or trench air are presented in Tables 5 and 6.

1.3.2 Windblown Dust

It is assumed that residents and construction workers may be exposed to airborne particulates on a daily basis under the current Site conditions. Consistent with Cal/EPA recommendations (Cal/EPA 2014), a particulate emission factor (PEF) of 1.4 x 10^9 cubic meter per kilogram (m^3/kg) was used to estimate airborne concentrations of a chemical from corresponding soil concentrations for residents. This PEF reflects an airborne concentration of dust of approximately 0.74 microgram per cubic meter ($\mu g/m^3$). For construction workers, a PEF of 1.0 x 10^6 m^3/kg was used to estimate airborne concentrations, resulting an airborne concentration of dust of approximately 1,000 $\mu g/m^3$.

1.4 Toxicity Assessment

The purpose of a toxicity assessment is to present the weight-of-evidence regarding the potential for a chemical to cause adverse effects in exposed individuals, and to quantitatively characterize, where possible, the relationship between exposure to a chemical and the increased likelihood and/or severity of adverse effects (i.e., the dose-response assessment).

Chemicals are usually evaluated for their potential health effects in two categories, carcinogenic and non-carcinogenic. Different methods are used to estimate the potential for carcinogenic and non-carcinogenic health effects to occur. Several chemicals produce non-carcinogenic effects at sufficiently high doses but only some chemicals are associated with carcinogenic effects. Most regulatory agencies consider carcinogens to pose a risk for cancer at all exposure levels (i.e., a "no-threshold" assumption); that is, any increase in dose is associated with an increase in the probability of developing cancer. In contrast, non-carcinogens generally are thought to produce adverse health effects only when some minimum exposure level is reached (i.e., a threshold dose).

Oral cancer slope factors (CSFs), which are expressed in units of (milligram per kilogram per day)$^{-1}$ (mg/kg-day)$^{-1}$, and inhalation unit risks (IURs), which are expressed in units of ($\mu g/m^3$)$^{-1}$, are chemical specific and experimentally derived potency values that are used to calculate the risk of cancer resulting from exposure to potentially carcinogenic chemicals. The CSFs and IURs are defined as upper-bound estimates of the probability of an individual developing cancer per unit intake of a potential carcinogen over a lifetime. With CSFs and IURs, a higher value implies a more potent carcinogenic potential.

Non-cancer oral reference doses (RfDs), which are expressed in units of mg/kg-day, and inhalation reference concentrations (RfCs), which are expressed in units of $\mu g/m^3$, are experimentally derived “no-effect” levels that are used to quantify the extent of toxic effects other than cancer due to exposure to chemicals. The RfDs and RfCs are intended to represent the dose or concentration of a chemical that is not expected to cause adverse health effects, assuming daily exposure over the exposure duration, even in sensitive individuals, with a substantial margin of safety. With RfDs and RfCs, a lower value implies a more potent toxicant.

The toxicity values used in this evaluation are summarized in Table 7. The hierarchy of sources used for the chronic toxicity values is consistent with those recommended by the Cal/EPA (2017) for risk assessments. Based on Cal/EPA (2015), toxicity values for TPHs were selected based on aliphatics and aromatics in the medium and high carbon ranges as presented in the RSL Table (USEPA 2017b).

For construction workers, who were assumed to be present on-Site for one year, subchronic toxicity values were used whenever available for the evaluation of adverse non-cancer effects in accordance with recommendations by USEPA (2017a). The general hierarchy of sources used for the subchronic toxicity values are as below:

- USEPA Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV) (USEPA 2018);
- Agency for Toxic Substances & Disease Registry (ATSDR). Minimal Risk Levels (MRLs) (ATSDR 2017); and
- USEPA’s Health Effects Assessment (HEAST) Summary Tables (USEPA 2011a).

In the absence of subchronic toxicity values, chronic toxicity values were used as a surrogate.

Specific dermal route toxicity values have not yet been developed for any chemicals. Consistent with Cal/EPA and USEPA guidance, potential health effects associated with dermal exposure are calculated using the oral toxicity values.

Trichloroethylene (TCE) is a carcinogen with a mutagenic mode of action for kidney tumors. In order to adjust for the potential increased susceptibility from early-life exposure, when assessing the cancer risk for TCE to residents, the oral CSF and IUR for TCE presented in Table 7 need to be adjusted for their kidney cancer contribution as recommended by USEPA (2011b) using time-weighted age-dependent adjustment factors (ADAFs). For the oral CSF of 0.046 (mg/kg-day)$^{-1}$ published by USEPA (2017b), 0.0093 (mg/kg-day)$^{-1}$ is from the kidney cancer contribution and 0.0367 (mg/kg-day)$^{-1}$ is from the non-Hodgkin lymphoma (NHL) plus liver cancer contribution. For the IUR of 4.1E-06 (µg/m^{3})$^{-1}$ published by USEPA (2017b), 1.0E-06 (µg/m^{3})$^{-1}$ is from the kidney cancer contribution and 3.1E-06 (µg/m$^{3)-1}$ is from the NHL plus liver cancer contribution. Based on the exposure durations for child and adult residents as well as ADAFs of 10 for <2 years, 3 for 2–<16 years, and 1 for ≥16 years, time-weighted ADAFs for child and adult residents were calculated to be 5.3 and 2.0, respectively. These ADAFs were applied only to the kidney contribution of the oral CSF and IUR.

Lead exposure/toxicity is evaluated by modeling blood lead levels, and therefore RBTCs were not calculated for lead. For lead, the DTSC screening level for residential soil of 80 mg/kg was derived using LeadSpread 8 and corresponds to a concentration in soil that will result in a 90th percentile estimate of one microgram per deciliter (µg/dL) increase in blood lead in a child (Cal/EPA 2011b). According to Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA), one µg/dL is the estimated incremental increase in children's blood lead that would reduce an intelligence quotient (IQ) by up to one point (Cal/EPA 2007). For nonresidents, the lead soil screening level was developed to be protective of the fetus of a pregnant adult worker. The DTSC screening level for commercial/industrial soil of 320 mg/kg was derived using a modified version of USEPA's Adult Lead Model (DTSC-modified ALM) and corresponds to a concentration in soil that will result in a 90th percentile estimate of one µg/dL increase in the blood lead of a fetus (Cal/EPA 2011b).

1.5 Calculation of Risk-Based Target Concentrations

Using the exposure scenarios and the pathway-specific parameters discussed above, Ramboll developed RBTCs for all the chemicals except lead identified in Section 1.1. As a conservative measure, the RBTCs were calculated to correspond to a target cancer risk of 1×10^{-6} and a target noncancerous HQ of one. Since the RBTCs correspond to the low end of the target risk range considered by USEPA and Cal/EPA to be protective of human health, the presence of a chemical at a concentration in excess of the RBTC does not indicate that adverse impacts to human health are occurring or will occur but suggests that further evaluation may be warranted.

For chemicals that have both carcinogenic and noncarcinogenic effects, the RBTCs were calculated separately for both health effect endpoints. The more stringent (i.e., lowest and most conservative) value was used for comparison with Site data.

Soil Gas RBTC

The equation used to calculate soil gas RBTCs for vapor migration into indoor air for residents or trench air for construction workers for the carcinogenic endpoint is as follows:

$$RBTC_{SG.c} = \frac{TR}{IF_{vapor.inh} * \alpha * IUR * CF}$$

Where:

$RBTC_{SG.c}$	=	Risk-Based Target Concentration, soil gas (microgram per liter [µg/L]), carcinogenic endpoint
TR	=	Target Risk (unitless)
$IF_{vapor.inh}$	=	Intake Factor for vapor inhalation (unitless)
IUR	=	Inhalation Unit Risk $(\mu g/m^3)^{-1}$
ɑ	=	Transfer Factor for soil gas migrating to indoor air or trench air (µg/L per µg/L)
CF	=	Conversion Factor (µg/mg or L/m^3)

The equation used to calculate soil gas RBTCs for vapor migration into indoor air for residents or trench air for construction workers for the noncarcinogenic endpoint is as follows:

$$RBTC_{SG.nc} = \frac{THQ * RfC_{inh}}{IF_{vapor.inh} * \alpha * CF}$$

Where:

$RBTC_{SG.nc}$	=	Risk-Based Target Concentration, soil gas (µg/L), noncarcinogenic endpoint
THQ	=	Target Hazard Quotient (unitless)
$IF_{vapor.inh}$	=	Intake Factor for vapor inhalation (unitless)
RfC_{inh}	=	Inhalation Reference Concentration $(\mu g/m^3)$
ɑ	=	Transfer Factor for soil gas migrating to indoor air or trench air (µg/L per µg/L)
CF	=	Conversion Factor (µg/mg or L/m^3)

The RBTCs for VOCs in soil gas migrating to trench air are presented in Table 8 for construction workers, and the RBTCs for VOCs in soil gas migrating to indoor air are presented in Table 9 for residents.

<u>Soil RBTC</u>

The equation used to calculate soil direct contact RBTCs for residents or construction workers for the carcinogenic endpoint due to exposure via the ingestion, dermal contact, and inhalation of soil vapor or particulate migrating to outdoor air or trench air is as follows:

$$RBTC_{soil.c} = \frac{TR}{(IF_{soil.ing} * RBA_{oral} + ABS/GIABS * IF_{soil.derm)} * CSF_{oral} + (IF_{vapor.inh} * \alpha + IF_{part.inh} /PEF) * IUR * CF}$$

Where:

$RBTC_{soil.c}$	=	Risk-Based Target Concentration, soil direct contact, carcinogenic endpoint (mg/kg)
TR	=	Target Risk (unitless)
$IF_{soil.ing}$	=	Intake Factor for soil ingestion (kg of soil/kg body weight-day)
$IF_{soil.derm}$	=	Intake Factor for dermal contact with soil (kg of soil/kg body weight-day)
$IF_{vapor.inh}$	=	Intake Factor for vapor inhalation (unitless)
$IF_{part.inh}$	=	Intake Factor for soil particulate inhalation (unitless)

CSF_{oral}	=	Oral Cancer Slope Factor (mg/kg body weight-day)$^{-1}$
IUR	=	Inhalation Unit Risk (µg/m^3)$^{-1}$
RBA_{oral}	=	Oral Relative Bioavailability
ABS	=	Soil Absorption Factor (unitless)
GIABS	=	Fraction of contaminant absorbed in gastrointestinal tract (unitless)
ɑ	=	Transfer Factor for soil vapor migrating to outdoor air or trench air (mg/m^3 per mg/kg)
PEF	=	Particulate Emission Factor, resident (m^3/kg of soil)
CF	=	Conversion Factor (µg/mg)

The equation used to calculate soil direct contact RBTCs for residents or construction workers for the noncarcinogenic endpoint due to exposure via the ingestion, dermal contact, and inhalation of soil vapor or particulate migrating to outdoor air or trench air is as follows:

$$\mathrm{RBTC_{soil.nc}} = \frac{\mathrm{THQ}}{(\mathrm{IF_{soil.ing}} * RBA_{oral} + \mathrm{ABS/GIABS} * \ \mathrm{IF_{soil.derm}})/\mathrm{RfD_{oral}} + (\mathrm{IF_{vapor.inh}} * \alpha \ + \ \frac{\mathrm{IF_{part.inh}}}{\mathrm{PEF}})/\mathrm{RfC_{inh}} * \mathrm{CF}}$$

Where:

$RBTC_{soil.nc}$	=	Risk-Based Target Concentration, soil direct contact, noncarcinogenic endpoint (mg/kg)
THQ	=	Target Hazard Quotient (unitless)
$IF_{soil.ing}$	=	Intake Factor for soil ingestion (kg of soil/kg body weight-day)
$IF_{soil.derm}$	=	Intake Factor for dermal contact with soil (kg of soil/kg body weight-day)
$IF_{vapor.inh}$	=	Intake Factor for vapor inhalation (unitless)
$IF_{part.inh}$	=	Intake Factor for soil particulate inhalation (unitless)
RfD_{oral}	=	Oral Reference Dose (mg/kg body weight-day)
RfC_{inh}	=	Inhalation Reference Concentration (µg/m^3)
RBA_{oral}	=	Oral Relative Bioavailability
ABS	=	Soil Absorption Factor (unitless)
GIABS	=	Fraction of contaminant absorbed in gastrointestinal tract (unitless)
ɑ	=	Transfer Factor for soil vapor migrating to outdoor air or trench air (mg/m^3 per mg/kg)
PEF	=	Particulate Emission Factor, resident (m^3/kg of soil)
CF	=	Conversion Factor (µg/mg)

Oral relative bioavailability (RBA_{oral}), soil absorption factors (ABS), and fraction of contaminant absorbed in gastrointestinal tract (GIABS) are presented in Table 7.

In a residential scenario, for carcinogenic effects, an age-adjusted approach was adopted to take into the differences in exposure parameters for adult and child residents (USEPA 2017a, Cal/EPA 2015). The 26-year residential exposure duration for carcinogenic effects was a composite of exposure assumptions for six years as a child and 20 years as an adult. The intake factors associated with each exposure duration were combined with toxicity values (adjusted by ADAFs if needed), and then were summed to calculate the carcinogenic RBTCs for an age-adjusted resident. For noncarcinogenic effects, the RBTCs for a child resident with an exposure duration of six years and an adult resident with an exposure duration of 20 years were calculated separately.

The RBTCs for soil direct contact are presented in Table 4.10 for construction workers and Table 11 for residents. The residential RBTCs are more conservative for most metals with the exception of chromium (total) and vanadium. For these metals, the lowest (or most conservative) RBTCs are those for construction workers. This is due to a very conservative soil ingestion rate (330 mg/day) and high dust concentration (1,000 μg/m^3) assumed for the calculation of the construction worker RBTCs. The calculation of the RBTC assumes no worker protection (e.g., direct hand to mouth contact, no gloves, no respirator or other protection against dust) and eight hours exposure per day. As this is not representative of typical worker conditions during construction on large redevelopment properties, the residential land use option has been selected as the most conservative land use option for the Site.

Overall, the soil gas RBTCs are summarized in Table 12 and the soil RBTCs are summarized in Table 13. For soil RBTCs, there are two exceptions for lead and arsenic. For lead, the screening level of 80 mg/kg for residential soil from Cal/EPA (2017) was used for residents, and the screening level of 320 mg/kg for industrial soil from Cal/EPA (2017) was used for construction workers. For arsenic, the soil RBTCs developed for both construction workers and residents were well below the regional background soil level of 12 mg/kg for southern California, and Arsenic concentrations were evaluated against both the Department of Toxic Substances Control (DTSC) default background soil concentration of 12 mg/kg and the site-specific calculated background concentration of 19 mg/kg (Attachment A). To calculate the site-specific Arsenic background concentration, Ramboll used the methodology developed by the DTSC. The methodology consisted in using graphical and statistical approaches to assess the distribution of the arsenic data, identify the outliers and determine the cleanup goal. Both approaches indicate that the cleanup level for arsenic at the site is 19 mg/kg. Either the default background soil concentration of 12 mg/kg or the site-specific Arsenic background concentration of 19 mg/kg should be used as a clean-up criteria for comparison with Site data. In addition to arsenic, the soil vanadium RBTC for construction workers (34 mg/kg) was below the arithmetic mean of background concentrations in California soils (112 mg/kg, Bradford 1996); therefore, the consistency with background concentrations should be considered when comparing this RBTC with the Site data. Lastly, a ratio of 75% aliphatic and 25% aromatic, which is based on an appropriate composition for crude oil (International Agency for Research on Cancer [IARC] 1989), should be applied to the TPH concentrations in order to compare with the soil RBTCs developed specific to aliphatic or aromatic fraction of certain carbon ranges.

2. REFERENCES

Agency for Toxic Substances & Disease Registry (ATSDR). 2017. Minimal Risk Levels (MRLs). June.

Bradford, G.R., A.C. Chang, A.L. Page, D. Bakhtar, J.A. Frampton, and H. Wright. 1996. Background Concentrations of Trace and Major Elements in California Soils. Kearney Foundation Special Report. University of California, Division of Agriculture.

California Environmental Protection Agency (Cal/EPA). 2005. Human-Exposure-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil. January.

Cal/EPA. 2007. Development of Health Criteria for School Site Risk Assessment Pursuant to Health and Safety Code Section 901(g): Child-Specific Benchmark Change in Blood Lead Concentration for School Site Risk Assessment. April.

Cal/EPA. 2011a. Department of Toxic Substances Control. Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance). October.

Cal/EPA. 2011b. User's Guide to LeadSpread 8 and Recommendations for Evaluation of Lead Exposures in Adults. September.

Cal/EPA. 2014. Human and Ecological Risk Office (HERO) Human Health Risk Assessment (HHRA) Note Number 1, Issue: Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities. September.

Cal/EPA. 2015. Preliminary Endangerment Assessment Guidance Manual. October.

Cal/EPA. 2017. Human and Ecological Risk Office (HERO) Human Health Risk assessment (HHRA) Note Number 3, Issue: DTSC-Modified Screening Levels (DTSC-SLs). August.

Code of Federal Regulations (CFR). Title 40, Environmental Protection Agency. Part 300, National Oil and Hazardous Substances Pollution Contingency Plan. (40 CFR § 300).

Haley Aldrich. 2017. ASTM Phase I Environmental Site Assessment and Phase II Assessment. Northeast Corner of South Central Avenue and Victoria Street. APNs: 7319-003-104, -105, and -106. Carson California. October.

International Agency for Research on Cancer (IARC). 1989. IARC Monographs on the Evaluation of Carcinogenic Risk to Humans, Occupational Exposures in Petroleum Refining, Crude Oil and Major Petroleum Fuels, Volume 45. March.

Johnson, P.C. and R.A. Ettinger. 1991. Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings. Environ. Sci. Technol. 25:1445-1452.

United States Environmental Protection Agency (USEPA). 1989. Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response. EPA-540/1-89/002. Washington, D.C. December.

USEPA. 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. December.

USEPA. 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final. July.

USEPA. 2009. Risk Assessment Guidance for Superfund Volume I: Human health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). Final. Office of Superfund Remediation and technology Innovation. EPA-540-R-070-002. OSWER 9285.7-82. January.

USEPA. 2011a. Health Effects Assessment Summary Tables (HEAST). December. Available at: http://epa-heast.ornl.gov/

USEPA. 2011b. Toxicological Review of Trichloroethylene. EPA/635/R-09/011F. September.

USEPA. 2017a. Regional Screening Levels (RSLs) User's Guide. November.

USEPA. 2017b. Regional Screening Levels (RSLs) Tables. November.

USEPA. 2018. Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV). Available at https://hhpprtv.ornl.gov/. Accessed on January 5, 2018.

TABLES

Table 1. Chemicals for Evaluation
Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Chemical	Soil Gas		Soil
	5 feet	15 feet	
Volatile Organic Compounds (VOCs)			
Benzene	X		
Ethylbenzene	X		
Isopropylbenzene	X		
p-Isopropyltoluene	X	X	
Naphthalene	X	X	
Tetrachloroethene	X	X	
Toluene	X	X	
Trichloroethene	X	X	
1,2,4-Trimethylbenzene	X		
m,p-Xylenes	X	X	
o-Xylene	X		
Total Petroleum Hydrocarbons (TPHs)			
Total Petroleum Hydrocarbons (C9-C16)			X
Total Petroleum Hydrocarbons (C9-C18)			X
Total Petroleum Hydrocarbons (C17-C32)			X
Total Petroleum Hydrocarbons (C19-C32)			X
Metals			
Antimony			X
Arsenic			X
Barium			X
Cadmium			X
Chromium (total)			X
Cobalt			X
Copper			X
Lead			X
Mercury			X
Nickel			X
Selenium			X
Vanadium			X
Zinc			X

Table 2. Exposure Assumptions
Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Exposure Factors	Units	Symbol	Construction Worker		Child Resident		Adult Resident	
			Value	Source	Value	Source	Value	Source
Receptor-Specific Exposure Factors								
Target Risk	unitless	TR	1E-06	--	1E-06	--	1E-06	--
Target Hazard Quotient	unitless	THQ	1	--	1	--	1	--
Population-Specific Exposure Assumptions								
Exposure Time	hours/day	ET	8	Cal/EPA 2014, a	24	Cal/EPA 2014	24	Cal/EPA 2014
Exposure Time -- Trench	hours/day	ET_T	4	Site-specific, b	--	--	--	--
Exposure Frequency	days/year	EF	250	Cal/EPA 2014	350	Cal/EPA 2014	350	Cal/EPA 2014
Exposure Frequency -- Trench	days/year	ED_T	125	Site-specific, c	--	--	--	--
Exposure Duration	years	ED	1	Cal/EPA 2014	6	Cal/EPA 2014	20	Cal/EPA 2014
Body Weight	kg_{BW}	BW	80	Cal/EPA 2014	15	Cal/EPA 2014	80	Cal/EPA 2014
Averaging Time for Cancinogens	days	AT_c	25,550	Cal/EPA 2014	25,550	Cal/EPA 2014	25,550	Cal/EPA 2014
Averaging Time for Noncarcinogens	days	AT_{nc}	365	Cal/EPA 2014	2,190	Cal/EPA 2014	7,300	Cal/EPA 2014
Soil Ingestion								
Soil Ingestion Rate	mg_{soil}/day	IR_s	330	Cal/EPA 2014	200	Cal/EPA 2014	100	Cal/EPA 2014
Conversion Factor	kg_{soil}/mg_{soil}	CF	1E-06	--	1E-06	--	1E-06	--
Intake Factor for Soil Ingestion, cancer	kg_{soil}/kg_{BW}/day	$IF_{soil.ing\_c}$	4.0E-08	USEPA 1989	1.1E-06	USEPA 1989	3.4E-07	USEPA 1989
Intake Factor for Soil Ingestion, noncancer	kg_{soil}/kg_{BW}/day	$IF_{soil.ing\_nc}$	2.8E-06	USEPA 1989	1.3E-05	USEPA 1989	1.2E-06	USEPA 1989
Soil Dermal Contact								
Skin Surface Area for Soil Contact	cm^2/day	SAs	6,032	Cal/EPA 2014	2,900	Cal/EPA 2014	6,032	Cal/EPA 2014
Adherence Factor	mg_{soil}/cm^2	AF	0.8	Cal/EPA 2014	0.2	Cal/EPA 2014	0.07	Cal/EPA 2014
Conversion Factor	kg_{soil}/mg_{soil}	CF	1E-06	--	1E-06	--	1E-06	--
Intake Factor for Soil Dermal Contact, cancer	kg_{soil}/kg_{BW}/day	$IF_{soil.derm\_c}$	5.9E-07	USEPA 2004	3.2E-06	USEPA 2004	1.4E-06	USEPA 2004
Intake Factor for Soil Dermal Contact, noncancer	kg_{soil}/kg_{BW}/day	$IF_{soil.derm\_nc}$	4.1E-05	USEPA 2004	3.7E-05	USEPA 2004	5.1E-06	USEPA 2004
Inhalation of Soil Particulates								
Particulate Emission Factor	m^3/kg_{soil}	PEF	1.0E+06	Cal/EPA 2014	1.4E+09	Cal/EPA 2014	1.4E+09	Cal/EPA 2014
Conversion Factor	hour/day	CF	24	--	24	--	24	--
Intake Factor for Soil Particulate Inhalation, cancer	unitless	$IF_{part.inh\_c}$	3.3E-03	USEPA 2009	8.2E-02	USEPA 2009	2.7E-01	USEPA 2009
Intake Factor for Soil Particulate Inhalation, noncancer	unitless	$IF_{part.inh\_nc}$	2.3E-01	USEPA 2009	9.6E-01	USEPA 2009	9.6E-01	USEPA 2009

Table 2. Exposure Assumptions
Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Exposure Factors	Units	Symbol	Construction Worker		Child Resident		Adult Resident	
			Value	Source	Value	Source	Value	Source
Inhalation of Vapors Migrating from Soil Gas or Soil to Indoor Air, Outdoor Air or Trench Air								
Conversion Factor	hour/day	CF	24	--	24	--	24	--
Intake Factor for Vapor Inhalation, cancer	unitless	$IF_{vapor.inh\_c}$	8.2E-04	USEPA 2009	8.2E-02	USEPA 2009	2.7E-01	USEPA 2009
Intake Factor for Vapor Inhalation, noncancer	unitless	$IF_{vapor.inh\_nc}$	5.7E-02	USEPA 2009	9.6E-01	USEPA 2009	9.6E-01	USEPA 2009

Notes:
-- = Not applicable
Cal/EPA = California Environmental Protection Agency
DTSC = Department of Toxic Substances Control
USEPA = United States Environmental Protection Agency
cm^2/day = square centimeter per day
kg_{BW} = kilogram of body weight
kg_{soil}/kg_{BW}/day = kilogram of soil per kilogram of body weight per day
kg_{soil}/mg_{soil} = kilogram of soil per milligram of soil
mg_{soil}/cm^2 = milligram of soil per square centimeter
mg_{soil}/day = milligram of soil per day
m^3/kg_{soil} = cubic meter per kilogram of soil

a. The exposure time for a commercial worker was used.
b. It was assumed that the time a construction worker would be present in a trench would not exceed 50% of the workday.
c. It was assumed that the frequency a construction worker would be present in a trench would not exceed 50% of the days spent on-site.

Sources:

California Environmental Protection Agency (Cal/EPA). 2014. Human and Ecological Risk Office (HERO) Human Health Risk Assessment, Note Number 1, Issue: Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities. September.

United States Environmental Protection Agency (USEPA). 1989. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A). Interim Final. EPA/540/1-89/002. Office of Emergency and Remedial Response. Washington, D.C. December.

USEPA. 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final. July.

USEPA. 2009. Risk Assessment Guidance for Superfund. Vol. 1: Part F, Supplemental Guidance for Inhalation Risk Assessment. Final. January.

Table 3. Physical/Chemical Properties of Volatile Chemicals[a,b]
Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Chemical	Molecular Weight MW (g/mol)	Organic Carbon Partition Coefficient, K_{oc} (cm^3/g)	Diffusivity in Air, D_a (cm^2/s)	Diffusivity in Water, D_w (cm^2/s)	Pure Component Water Solubility, S (mg/L)	Henry's Law Constant at 25° C H (atm-m^3/mol)	Normal Boiling Point, T_B (°K)	Critical Temperature, T_C (°K)	Enthalpy of Vaporization at the Normal Boiling Point, ΔHv,b (cal/mol)
Volatile Organic Compounds (VOCs)									
Benzene	78.11	1.46E+02	8.95E-02	1.03E-05	1.79E+03	5.55E-03	353.24	562.16	7342.00
Ethylbenzene	106.17	4.46E+02	6.85E-02	8.46E-06	1.69E+02	7.88E-03	409.34	617.20	8501.00
Isopropylbenzene	120.19	6.98E+02	6.03E-02	7.86E-06	6.13E+01	1.15E-02	425.56	631.10	10335.30
p-Isopropyltoluene [c]	134.22	1.12E+03	5.70E-02	8.12E-06	2.34E+01	1.10E-02	449.65	---	---
Naphthalene	128.18	1.54E+03	6.05E-02	8.38E-06	3.10E+01	4.40E-04	491.14	748.40	10373.00
Tetrachloroethene	165.83	9.49E+01	5.05E-02	9.46E-06	2.06E+02	1.77E-02	394.40	620.20	8288.00
Toluene	92.14	2.34E+02	7.78E-02	9.20E-06	5.26E+02	6.64E-03	383.78	591.79	7930.00
Trichloroethene	131.39	6.07E+01	6.87E-02	1.02E-05	1.28E+03	9.85E-03	360.36	544.20	7505.00
1,2,4-Trimethylbenzene	120.20	6.14E+02	6.07E-02	7.92E-06	5.70E+01	6.16E-03	442.30	649.17	9368.80
m,p-Xylenes [d]	106.17	3.75E+02	6.82E-02	8.42E-06	1.62E+02	6.90E-03	411.52	616.20	8525.00
o-Xylene	106.17	3.83E+02	6.89E-02	8.53E-06	1.78E+02	5.18E-03	417.60	630.30	8661.00
Total Petroleum Hydrocarbons (TPHs)									
Medium Aromatic (C9-C16) [e]	135.19	2.01E+03	5.64E-02	8.07E-06	2.78E+01	4.79E-04	---	---	---
Medium Aliphatic (C9-C18) [e]	128.26	7.96E+02	5.14E-02	6.77E-06	2.20E-01	3.40E+00	---	---	---
High Aliphatic (C19-C32) [e]	170.34	4.82E+03	3.62E-02	6.43E-06	3.70E-03	8.18E+00	---	---	---

Notes:

--- = Not available
atm-m^3/mol = atmosphere-cubic meter per mole
cal/mol = calorie per mole
cm^3/g = cubic centimeter per gram
cm^2/s = square centimeter per second
g/mol = gram per mole
°K = degrees Kelvin
mg/L = milligram per liter
Cal/EPA = California Environmental Protection Agency
USEPA = United States Environmental Protection Agency

a. Volatile compounds defined by USEPA (2017) as chemicals with vapor pressure greater than 1 millimeter (mm) Hg or Henry's Law constant greater than 0.00001 atm-m^3/mole.
b. Physical/chemical properties were obtained from Cal/EPA (2011) unless noted.
c. Physical/chemical properties were obtained from EPIsuite 4.11 (USEPA 2012), except sec-butylbenzene was used as a surrogate for diffusivities.
d. p-Xylene was used as a surrogate for m,p-xylenes.
e. Physical/chemical properties were obtained from USEPA (2017).

Sources:

California Environmental Protection Agency (Cal/EPA). 2011. Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance). Final. Department of Toxic Substances Control. October.

United States Environmental Protection Agency (USEPA). 2012. Estimation Programs Interface Suite™ for Microsoft® Windows, v 4.11. Washington, DC, USA.

USEPA. 2017. Regional Screening Level (RSL) Table, November.

Table 4. Modeling Parameters
Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Parameter	Value	Units	Notes
Source/Receptor Parameters			
Soil gas sampling depth, shallow	5	feet	Site-specific estimate.
Soil gas sampling depth, deep	15	feet	Site-specific estimate.
Soil gas sampling depth, trench	1	cm	Conservative assumption
Depth to top of soil contamination	1	cm	Conservative assumption
Soil temperature at source	24	Celsius	Default value (Cal/EPA 2011)
Soil Parameters for Indoor Air Scenario			
Soil type in Horizon A (0-10 cm below foundation)	Sand	--	Engineered fill is assumed to underlie building foundation.
Thickness	10	cm	Default value for engineered fill layer (Cal/EPA 2005)
Bulk density	1.66	g/cm^3	Default value for engineered fill layer (Cal/EPA 2005)
Total porosity	0.375	unitless	Default value for engineered fill layer (Cal/EPA 2005)
Water content	0.0535	unitless	Default value for engineered fill layer (Cal/EPA 2005)
Soil type in Horizon B (10-40 cm below foundation)	Fill	--	Engineered fill is assumed to underlie building foundation.
Thickness	30	cm	Default value for engineered fill layer (Cal/EPA 2005)
Bulk density	1.8	g/cm^3	Default value for engineered fill layer (Cal/EPA 2005)
Total porosity	0.3	unitless	Default value for engineered fill layer (Cal/EPA 2005)
Water content	0.15	unitless	Default value for engineered fill layer (Cal/EPA 2005)
Soil type in Horizon C (>40 cm below foundation)	Sandy Loam	--	Conservative estimate based on site boring logs.
Thickness	13.2	feet	Site-specific estimate.
Bulk density	1.62	g/cm^3	Default value for sandy loam (Cal/EPA 2011).
Total porosity	0.387	unitless	Default value for sandy loam (Cal/EPA 2011).
Water content	0.103	unitless	Default value for sandy loam (Cal/EPA 2011).
Soil Parameters for Trench Outdoor Air Scenario			
Soil type in Horizon A	Sandy Loam	--	Conservative estimate based on site boring logs.
Thickness	15	feet	Site-specific estimate.
Bulk density	1.62	g/cm^3	Default value for sandy loam (Cal/EPA 2011).
Total porosity	0.387	unitless	Default value for sandy loam (Cal/EPA 2011).
Water content	0.103	unitless	Default value for sandy loam (Cal/EPA 2011).
foc	0.006	unitless	Default value (USEPA 2002)
Soil Parameters for Residential Outdoor Air Scenario			
Soil type in Horizon A	Clay Loam	--	Conservative estimate based on site boring logs.
Thickness	7	feet	Conservative estimate based on site boring logs.
Bulk density	1.48	g/cm^3	Default value for clay loam (Cal/EPA 2011).
Total porosity	0.442	unitless	Default value for clay loam (Cal/EPA 2011).
Water content	0.168	unitless	Default value for clay loam (Cal/EPA 2011).
foc	0.006	unitless	Default value (USEPA 2002)
Soil type in Horizon B	Sandy Loam	--	Conservative estimate based on site boring logs.
Thickness	8	feet	Conservative estimate based on site boring logs.
Bulk density	1.62	g/cm^3	Default value for sandy loam (Cal/EPA 2011).
Total porosity	0.387	unitless	Default value for sandy loam (Cal/EPA 2011).
Water content	0.103	unitless	Default value for sandy loam (Cal/EPA 2011).
foc	0.006	unitless	Default value (USEPA 2002)
Building Foundation Parameters			
Depth to Bottom of Foundation, Slab-on-grade	15	cm	Default value (USEPA 2004)
Foundation crack ratio	0.005	unitless	Default value (Cal/EPA 2011)
Average vapor flow rate into building	5	$L/min/m^2$	Default value (USEPA 2004)
Foundation thickness	10	cm	Default value (USEPA 2004)

Table 4. Modeling Parameters
Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Parameter	Value	Units	Notes
Air Dispersion Parameters			
Residential Indoor Air Scenario			
Air exchange rate	0.5	1/hour	Residential default value (Cal/EPA 2011)
Length of building	1000	cm	Default value (USEPA 2004)
Width of building	1000	cm	Default value (USEPA 2004)
Mixing height of building, Slab-on-grade	244	cm	Residential default value (Cal/EPA 2011)
Residential Outdoor Air Scenario			
Site Area	7.5	acre	Site-specific value
Site windspeed	0.94	m/s	Site-specific estimate
Q/C	43.1	g/m^2-s per kg/m^3	Site-specific value calculated from Appendix D of USEPA (2002)
Shallow Trench Outdoor Air Scenario			
Depth of construction trench	5	feet	Conservative assumption
Lengh of construction trench	5	feet	Conservative assumption
Width of construction trench	2.5	feet	Conservative assumption
Windspeed in breathing zone	0.19	m/s	Conservative estimate based on 1/5 of site windspeed
Q/C	26.8	g/m^2-s per kg/m^3	Calculated from box model
Deep Trench Outdoor Air Scenario			
Depth of construction trench	10	feet	Conservative assumption
Lengh of construction trench	10	feet	Conservative assumption
Width of construction trench	5	feet	Conservative assumption
Windspeed in breathing zone	0.094	m/s	Conservative estimate based on 1/10 of site windspeed
Q/C	13.4	g/m^2-s per kg/m^3	Calculated from box model

Notes:
-- =Not applicable
cm = centimeter
g/cm^3 = gram per cubic centimeter
g/m^2 per kg/m^3 = (gram per square meter) per (kilogram percubic meter)
L/min/m^2 = liter per minute per 100 square meter
Cal/EPA = California Environmental Protection Agency
USEPA = United States Environmental Protection Agency

Sources:

Cal/EPA. 2005. Human-Exposure-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil. January.

Cal/EPA. 2011. Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance). Final. Department of Toxic Substances Control. October.

USEPA. 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. December.

USEPA. 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings Office of Emergency and Remedial Response. February.

Table 5. Transfer Factors for Vapors from Soil Gas to Indoor Air and Trench Air
Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Chemical Group	Chemical	TF for Soil Gas Migrating to Indoor Air (µg/L per µg/L)		TF for Soil Gas Migrating to Trench Air (µg/L per µg/L)
		5 feet	15 feet	
VOC	Benzene	7.7E-04	4.2E-04	3.4E-03
VOC	Ethylbenzene	6.3E-04	3.3E-04	2.6E-03
VOC	Isopropylbenzene	5.7E-04	3.0E-04	2.3E-03
VOC	p-Isopropyltoluene	5.5E-04	2.8E-04	2.1E-03
VOC	Naphthalene	5.8E-04	3.0E-04	2.3E-03
VOC	Tetrachloroethene	5.0E-04	2.6E-04	1.9E-03
VOC	Toluene	6.9E-04	3.7E-04	2.9E-03
VOC	Trichloroethene	6.3E-04	3.4E-04	2.6E-03
VOC	1,2,4-Trimethylbenzene	5.8E-04	3.0E-04	2.3E-03
VOC	m,p-Xylenes	6.3E-04	3.3E-04	2.6E-03
VOC	o-Xylene	6.3E-04	3.4E-04	2.6E-03

Notes:
µg/L = microgram per liter
µg/m^3 = microgram per cubic meter
TF = Transfer Factor
VOC = Volatile Organic Compound

Table 6. Transfer Factors for Vapors from Soil to Outdoor Air and Trench Air
Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Chemical Group	Chemical	TF for Soil Migrating to Outdoor Air (mg/m^3 per mg/kg)	TF for Soil Migrating to Trench Air (mg/m^3 per mg/kg)
		Resident 26 years	Construction Worker 1 Year
TPH	Medium Aromatic (C9-C16)	2.8E-05	5.8E-04
TPH	Medium Aliphatic (C9-C18)	1.4E-03	3.0E-02
TPH	High Aliphatic (C19-C32)	1.1E-03	2.3E-02

Notes:

mg/m^3 per mg/kg = milligram/cubic meter per milligram/kilogram

TF = Transfer Factor

TPH = Total Petroleum Hydrocarbon

a. The transfer factors for child residents are also used for the years 0-6 of age-adjusted resident calculations.

Table 7. Toxicity Values
Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Chemical Group	Chemical	Oral Cancer Slope Factor (mg/kg-day)$^{-1}$		Inhalation Unit Risk (μg/m^3)$^{-1}$		Chronic Oral RfD (mg/kg-day)		Chronic Inhalation RfC (μg/m^3)		Subhronic Oral RfD (mg/kg-day)		Subchronic Inhalation RfC (μg/m^3)		GIABS	Soil Dermal Absorption Factor ABS_{soil}		Oral Relative Bioavailability[a]	Mutagen[b]
VOC	Benzene	0.1	Cal/EPA 2017a	0.000029	Cal/EPA 2017a	0.004	Cal/EPA 2017a	3	Cal/EPA 2017a	0.01	PPRTV	80	PPRTV	1	--	--	1	--
VOC	Ethylbenzene	0.011	USEPA 2017	2.5E-06	USEPA 2017	0.1	USEPA 2017	1000	USEPA 2017	0.05	PPRTV	9000	PPRTV	1	--	--	1	--
VOC	Isopropylbenzene	--	--	--	--	0.1	USEPA 2017	400	USEPA 2017	0.4	HEAST	90	HEAST	1	--	--	1	--
VOC	p-Isopropyltoluene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--
VOC	Naphthalene	0.12	USEPA 2017, c	0.000034	USEPA 2017	0.02	USEPA 2017	3	USEPA 2017	0.6	ATSDR 2017	3	USEPA 2017, d	1	0.15	Cal/EPA 2015	1	--
VOC	Tetrachloroethene	0.54	Cal/EPA 2017a	6.1E-06	Cal/EPA 2017a	0.006	Cal/EPA 2017a	40	Cal/EPA 2017a	0.008	ATSDR 2017	41	ATSDR 2017	1	--	--	1	--
VOC	Toluene	--	--	--	--	0.08	Cal/EPA 2017a	300	Cal/EPA 2017a	0.8	PPRTV	5000	PPRTV	1	--	--	1	--
VOC	Trichloroethene	0.046	USEPA 2017	4.1E-06	USEPA 2017	0.0005	USEPA 2017	2	USEPA 2017	0.0005	ATSDR 2017	2.1	ATSDR 2017	1	--	--	1	x
VOC	1,2,4-Trimethylbenzene	--	--	--	--	0.01	USEPA 2017	60	USEPA 2017	0.01	USEPA 2017, d	60	USEPA 2017, d	1	--	--	1	--
VOC	m,p-Xylenes	--	--	--	--	0.2	USEPA 2017, e	100	USEPA 2017, e	0.4	PPRTV, e	400	PPRTV, e	1	--	--	1	--
VOC	o-Xylene	--	--	--	--	0.2	USEPA 2017	100	USEPA 2017	0.4	PPRTV, e	400	PPRTV, e	1	--	--	1	--
TPH	Medium Aromatic (C9-C16)	--	--	--	--	0.004	USEPA 2017	3	USEPA 2017	0.004	PPRTV	1000	PPRTV	1	--	--	1	--
TPH	Medium Aliphatic (C9-C18)	--	--	--	--	0.01	USEPA 2017	100	USEPA 2017	0.1	PPRTV Appendix	100	PPRTV	1	--	--	1	--
TPH	High Aromatic (C17-C32)	--	--	--	--	0.04	USEPA 2017	140	USEPA 2017, c	0.4	PPRTV	1400	PPRTV, c	1	0.1	USEPA 2017	1	--
TPH	High Aliphatic (C19-C32)	--	--	--	--	3	USEPA 2017	10500	USEPA 2017, c	30	PPRTV	105000	PPRTV, c	1	--	--	1	--
Metal	Antimony	--	--	--	--	0.0004	USEPA 2017	--	--	0.0004	PPRTV	1	ATSDR 2017	0.15	0.01	Cal/EPA 2015	1	--
Metal	Arsenic	9.5	Cal/EPA 2017a	0.0033	Cal/EPA 2017a	0.0000035	Cal/EPA 2017a	0.015	Cal/EPA 2017a	3.5E-06	Cal/EPA 2017a, d	0.015	Cal/EPA 2017a, d	1	0.03	Cal/EPA 2015	0.6	--
Metal	Barium	--	--	--	--	0.2	USEPA 2017	0.5	USEPA 2017	0.2	ATSDR 2017	5	HEAST	0.07	0.01	Cal/EPA 2015	1	--
Metal	Cadmium	--	--	0.0018	Cal/EPA 2017a	0.0000063	Cal/EPA 2017a, f	0.01	Cal/EPA 2017a, f	0.0005	ATSDR 2017	0.01	Cal/EPA 2017a, d	1	0.001	Cal/EPA 2015	1	--
Metal	Chromium (total)	--	--	--	--	1.5	Cal/EPA 2017a, g	--	--	1.5	HEAST, g	5	ATSDR 2017, g	0.013	0.01	Cal/EPA 2015	1	--
Metal	Cobalt	--	--	0.009	USEPA 2017	0.0003	USEPA 2017	0.006	USEPA 2017	0.003	PPRTV	0.02	PPRTV	1	0.01	Cal/EPA 2015	1	--
Metal	Copper	--	--	--	--	0.04	USEPA 2017	--	--	0.01	ATSDR 2017	--	--	1	0.01	Cal/EPA 2015	1	--
Metal	Mercury	--	--	--	--	0.00016	Cal/EPA 2017a, h	0.03	Cal/EPA 2017a, h	0.002	ATSDR 2017, h	0.03	Cal/EPA 2017a, d	0.07	0.01	Cal/EPA 2015	1	--
Metal	Nickel	--	--	0.00026	Cal/EPA 2017a	0.011	Cal/EPA 2017a	0.014	Cal/EPA 2017a	0.02	HEAST	0.2	ATSDR 2017	0.04	0.01	Cal/EPA 2015	1	--
Metal	Selenium	--	--	--	--	0.005	USEPA 2017	20	USEPA 2017	0.005	HEAST	20	USEPA 2017, d	1	0.01	Cal/EPA 2015	1	--
Metal	Vanadium	--	--	--	--	0.005	Cal/EPA 2017a	0.1	Cal/EPA 2017a	0.0007	PPRTV	0.1	Cal/EPA 2017a, d	0.026	0.01	Cal/EPA 2015	1	--
Metal	Zinc	--	--	--	--	0.3	USEPA 2017	--	--	0.3	ATSDR 2017	--	--	1	0.01	Cal/EPA 2015	1	--

Notes:
-- = Not available
mg/kg-day = milligram per kilogram per day
μg/m^3 = microgram per cubic meter
ABS_{soil} = Soil Dermal Absorption Factor
ADAF = Age-Dependent Adjustment Factor
ATSDR = Agency for Toxic Substances and Disease Registry
Cal/EPA = California Environmental Protection Agency
DTSC = Department of Toxic Substances Control
GIABS = Fraction of contaminant absorbed in gastrointestinal tract (USEPA 2017)
HEAST = Health Effects Assessment Summary Tables (USEPA 2011a)
PPRTV = Provisional Peer Reviewed Toxicity Value (cited in USEPA 2018)
RfD = Reference Dose
RfC = Reference Concentration
TPH = Total Petroleum Hydrocarbon
USEPA = United States Environmental Protection Agency
VOC = Volatile Organic Compound

a. An oral relative bioavailability of 0.6 (or 60%) was applied to oral ingestion pathway for arsenic (Cal/EPA 2017b). The oral relative bioavailability was assumed to be one (or 100%) for all the other chemicals.
b. Trichloroethylene (TCE) is a carcinogen with a mutagenic mode of action for kidney tumors. In order to adjust for the potential increased susceptibility from early-life exposure, when assessing the cancer risk for TCE to residents, the oral cancer slope factor and inhalation unit risk for TCE presented in this table need to be adjusted for their kidney cancer contribution as recommended by USEPA (2011b) using time-weighted ADAFs. For the oral cancer slope factor of 0.046 (mg/kg-day)$^{-1}$ published by USEPA (2017), 0.0093 (mg/kg-day)$^{-1}$ is from the kidney cancer contribution and 0.0367 (mg/kg-day)$^{-1}$ is from the non-Hodgkin lymphoma (NHL) plus liver cancer contribution. For the inhalation unit risk of 4.1E-06 (μg/m^3)$^{-1}$ published by USEPA (2017), 1.0E-06 (μg/m^3)$^{-1}$ is from the kidney cancer contribution and 3.1E-06 (μg/m^3)$^{-1}$ is from the NHL plus liver cancer contribution. Based on the exposure durations for child and adult residents as well as ADAFs of 10 for <2 years, 3 for 2–<16 years, and 1 for ≥16 years, time-weighted ADAFs for child and adult residents were calculated to be 5.3 and 2.0, respectively. These ADAFs were applied only to the kidney contribution of the oral cancer slope factor and inhalation unit risk.
c. Route to route extrapolation.
d. The chronic toxicity value was used as a surrogate.
e. Xylenes (total) was used as a surrogate.
f. Based on Cal/EPA (2017a), the noncancer toxicity values for cadmium were only applied to adult resident.
g. Chromium III was used as a surrogate.
h. The value for mercuric chloride was used.

Sources:

Agency for Toxic Substances & Disease Registry (ATSDR). 2017. Minimal Risk Levels (MRLs). June.
Cal/EPA. 2015. Preliminary Endangerment Assessment Guidance Manual. October.
Cal/EPA. 2017a. Human and Ecological Risk Office (HERO) Human Health Risk assessment (HHRA) Note Number 3, Issue: DTSC-Modified Screening Levels (DTSC-SLs). August.
Cal/EPA. 2017b. HERO, HHRA Note Number 6, Issue: Recommended Methodology for Evaluating Site-Specific Arsenic Bioavailability in California Soils. September.
USEPA. 2011a. Health Effects Assessment Summary Tables (HEAST). December. Available at: http://epa-heast.ornl.gov/
USEPA. 2011b. Toxicological Review of Trichloroethylene. EPA/635/R-09/011F. September.
USEPA. 2017. Regional Screening Levels (RSLs) Tables. November.
USEPA. 2018. Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV). Available at https://hhpprtv.ornl.gov/. Accessed on January 5, 2018.

Table 8. Risk-Based Target Concentrations - Construction Workers Exposed to Soil Gas Migrating to Trench Air
Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Chemical Group	Chemical	All Depths		
		$RBTC_{SG-TA-C}$ (µg/L)	$RBTC_{SG-TA-NC}$ (µg/L)	Minimum RBTC (µg/L)
VOC	Benzene	1.3E+01	4.2E+02	1.3E+01
VOC	Ethylbenzene	1.9E+02	6.1E+04	1.9E+02
VOC	Isopropylbenzene	--	6.9E+02	6.9E+02
VOC	p-Isopropyltoluene	--	--	--
VOC	Naphthalene	1.6E+01	2.3E+01	1.6E+01
VOC	Tetrachloroethene	1.1E+02	3.8E+02	1.1E+02
VOC	Toluene	--	3.0E+04	3.0E+04
VOC	Trichloroethene	1.2E+02	1.5E+01	1.5E+01
VOC	1,2,4-Trimethylbenzene	--	4.6E+02	4.6E+02
VOC	m,p-Xylenes	--	2.7E+03	2.7E+03
VOC	o-Xylene	--	2.7E+03	2.7E+03

Notes:
-- = Not calculated
µg/L = microgram per liter
$RBTC_{SG-TA-C}$ = Risk-Based Target Concentration, cancer, inhalation of soil gas migrating to trench air
$RBTC_{SG-TA-NC}$ = Risk-Based Target Concentration, noncancer, inhalation of soil gas migrating to trench air
VOC = Volatile Organic Compound

Table 9. Risk-Based Target Concentrations - Residents Exposed to Soil Gas Migrating to Indoor Air
Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Chemical Group	Chemical	5 feet				15 feet			
		Age-Adjusted Resident	Child Resident	Adult Resident	Minimum RBTC (µg/L)	Age-Adjusted Resident	Child Resident	Adult Resident	Minimum RBTC (µg/L)
		$RBTC_{SG-IA-C}$ (µg/L)	$RBTC_{SG-IA-NC}$ (µg/L)	$RBTC_{SG-IA-NC}$ (µg/L)		$RBTC_{SG-IA-C}$ (µg/L)	$RBTC_{SG-IA-NC}$ (µg/L)	$RBTC_{SG-IA-NC}$ (µg/L)	
VOC	Benzene	1.3E-01	4.1E+00	4.1E+00	1.3E-01	2.3E-01	7.5E+00	7.5E+00	2.3E-01
VOC	Ethylbenzene	1.8E+00	1.7E+03	1.7E+03	1.8E+00	3.4E+00	3.1E+03	3.1E+03	3.4E+00
VOC	Isopropylbenzene	--	7.3E+02	7.3E+02	7.3E+02	--	1.4E+03	1.4E+03	1.4E+03
VOC	p-Isopropyltoluene	--	--	--	--	--	--	--	--
VOC	Naphthalene	1.4E-01	5.4E+00	5.4E+00	1.4E-01	2.7E-01	1.0E+01	1.0E+01	2.7E-01
VOC	Tetrachloroethene	9.2E-01	8.4E+01	8.4E+01	9.2E-01	1.8E+00	1.6E+02	1.6E+02	1.8E+00
VOC	Toluene	--	4.5E+02	4.5E+02	4.5E+02	--	8.4E+02	8.4E+02	8.4E+02
VOC	Trichloroethene	7.6E-01	3.3E+00	3.3E+00	7.6E-01	1.4E+00	6.2E+00	6.2E+00	1.4E+00
VOC	1,2,4-Trimethylbenzene	--	1.1E+02	1.1E+02	1.1E+02	--	2.1E+02	2.1E+02	2.1E+02
VOC	m,p-Xylenes	--	1.7E+02	1.7E+02	1.7E+02	--	3.1E+02	3.1E+02	3.1E+02
VOC	o-Xylene	--	1.6E+02	1.6E+02	1.6E+02	--	3.1E+02	3.1E+02	3.1E+02

Notes:
-- = Not calculated
µg/L = microgram per liter
$RBTC_{SG-IA-C}$ = Risk-Based Target Concentration, cancer, inhalation of soil gas migrating to indoor air
$RBTC_{SG-IA-NC}$ = Risk-Based Target Concentration, noncancer, inhalation of soil gas migrating to indoor air
VOC = Volatile Organic Compound

Table 10. Risk-Based Target Concentrations - Construction Workers Exposed to Outdoor Soil through Direct Contact
Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Chemical Group	Chemical	Soil Ingestion		Soil Dermal Contact		Soil Vapor Inhalation		Soil Particulate Inhalation		Combined Cancer RBTC (mg/kg)	Combined Non-Cancer RBTC (mg/kg)	Minimum RBTC (mg/kg)
		$RBTC_{soil\text{-}ing\text{-}C}$ (mg/kg)	$RBTC_{soil\text{-}ing\text{-}NC}$ (mg/kg)	$RBTC_{soil\text{-}derm\text{-}C}$ (mg/kg)	$RBTC_{soil\text{-}derm\text{-}NC}$ (mg/kg)	$RBTC_{soil.vapor\text{-}inh\text{-}C}$ (mg/kg)	$RBTC_{soil.vapor\text{-}inh\text{-}NC}$ (mg/kg)	$RBTC_{soil.part\text{-}inh\text{-}C}$ (mg/kg)	$RBTC_{soil.part\text{-}inh\text{-}NC}$ (mg/kg)			
TPH	Medium Aromatic (C9-C16)	--	1.4E+03	--	--	--	3.0E+04	--	4.4E+06	--	1.4E+03	1.4E+03
TPH	Medium Aliphatic (C9-C18)	--	3.5E+04	--	--	--	5.8E+01	--	4.4E+05	--	5.8E+01	5.8E+01
TPH	High Aromatic (C17-C32)	--	1.4E+05	--	9.7E+04	--	--	--	6.1E+06	--	5.7E+04	5.7E+04
TPH	High Aliphatic (C19-C32)	--	1.1E+07	--	--	--	8.2E+04	--	4.6E+08	--	8.1E+04	8.1E+04
Metal	Antimony	--	1.4E+02	--	1.5E+02	--	--	--	4.4E+03	--	7.1E+01	7.1E+01
Metal	Arsenic	4.3E+00	2.1E+00	5.9E+00	2.8E+00	--	--	9.3E+01	6.6E+01	2.4E+00	1.2E+00	1.2E+00
Metal	Barium	--	7.1E+04	--	3.4E+04	--	--	--	2.2E+04	--	1.1E+04	1.1E+04
Metal	Cadmium	--	1.8E+02	--	1.2E+04	--	--	1.7E+02	4.4E+01	1.7E+02	3.5E+01	3.5E+01
Metal	Chromium (total)	--	5.3E+05	--	4.7E+04	--	--	--	2.2E+04	--	1.5E+04	1.5E+04
Metal	Cobalt	--	1.1E+03	--	7.3E+03	--	--	3.4E+01	8.8E+01	3.4E+01	8.0E+01	3.4E+01
Metal	Copper	--	3.5E+03	--	2.4E+04	--	--	--	--	--	3.1E+03	3.1E+03
Metal	Mercury	--	7.1E+02	--	3.4E+02	--	--	--	1.3E+02	--	8.4E+01	8.4E+01
Metal	Nickel	--	7.1E+03	--	1.9E+03	--	--	1.2E+03	8.8E+02	1.2E+03	5.6E+02	5.6E+02
Metal	Selenium	--	1.8E+03	--	1.2E+04	--	--	--	8.8E+04	--	1.5E+03	1.5E+03
Metal	Vanadium	--	2.5E+02	--	4.4E+01	--	--	--	4.4E+02	--	3.4E+01	3.4E+01
Metal	Zinc	--	1.1E+05	--	7.3E+05	--	--	--	--	--	9.3E+04	9.3E+04

Notes:
-- = Not calculated
mg/kg = milligram per kilogram
TPH = Total Petroleum Hydrocarbon
$RBTC_{soil\text{-}ing\text{-}C}$ = Risk-Based Concentration, cancer, soil ingestion
$RBTC_{soil\text{-}ing\text{-}NC}$ = Risk-Based Concentration, noncancer, soil ingestion
$RBTC_{soil\text{-}derm\text{-}C}$ = Risk-Based Concentration, cancer, soil dermal contact
$RBTC_{soil\text{-}derm\text{-}NC}$ = Risk-Based Concentration, noncancer, soil dermal contact
$RBTC_{soil.vapor\text{-}inh\text{-}C}$ = Risk-Based Concentration, cancer, soil vapor inhalation
$RBTC_{soil.vapor\text{-}inh\text{-}NC}$ = Risk-Based Concentration, noncancer, soil vapor inhalation
$RBTC_{soil.part\text{-}inh\text{-}C}$ = Risk-Based Concentration, cancer, soil particulate inhalation
$RBTC_{soil.part\text{-}inh\text{-}NC}$ = Risk-Based Concentration, noncancer, soil particulate inhalation

Table 11. Risk-Based Target Concentrations - Residents Exposed to Outdoor Soil through Direct Contact
Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Chemical Group	Chemical	Soil Ingestion			Soil Dermal Contact			Soil Vapor Inhalation			Soil Particulate Inhalation			Age-Adjusted Resident	Child Resident	Adult Resident	Minimum RBTC (mg/kg)
		Age-Adjusted Resident	Child Resident	Adult Resident	Age-Adjusted Resident	Child Resident	Adult Resident	Age-Adjusted Resident	Child Resident	Adult Resident	Age-Adjusted Resident	Child Resident	Adult Resident				
		RBTC$_{soil\text{-}ing\text{-}C}$ (mg/kg)	RBTC$_{soil\text{-}ing\text{-}NC}$ (mg/kg)	RBTC$_{soil\text{-}ing\text{-}NC}$ (mg/kg)	RBTC$_{soil\text{-}derm\text{-}C}$ (mg/kg)	RBTC$_{soil\text{-}derm\text{-}NC}$ (mg/kg)	RBTC$_{soil\text{-}derm\text{-}NC}$ (mg/kg)	RBTC$_{soil.vapor\text{-}inh\text{-}C}$ (mg/kg)	RBTC$_{soil.vapor\text{-}inh\text{-}NC}$ (mg/kg)	RBTC$_{soil.vapor\text{-}inh\text{-}NC}$ (mg/kg)	RBTC$_{soil.part\text{-}inh\text{-}C}$ (mg/kg)	RBTC$_{soil.part\text{-}inh\text{-}NC}$ (mg/kg)	RBTC$_{soil.part\text{-}inh\text{-}NC}$ (mg/kg)	Combined Cancer RBTC (mg/kg)	Combined Non-Cancer RBTC (mg/kg)	Combined Non-Cancer RBTC (mg/kg)	
TPH	Medium Aromatic (C9-C16)	--	3.1E+02	3.3E+03	--	--	--	--	1.1E+02	1.1E+02	--	4.3E+06	4.3E+06	--	8.3E+01	1.1E+02	8.3E+01
TPH	Medium Aliphatic (C9-C18)	--	7.8E+02	8.3E+03	--	--	--	--	7.4E+01	7.4E+01	--	1.4E+08	1.4E+08	--	6.8E+01	7.3E+01	6.8E+01
TPH	High Aromatic (C17-C32)	--	3.1E+03	3.3E+04	--	1.1E+04	7.9E+04	--	--	--	--	2.0E+08	2.0E+08	--	2.4E+03	2.3E+04	2.4E+03
TPH	High Aliphatic (C19-C32)	--	2.3E+05	2.5E+06	--	--	--	--	1.0E+04	1.0E+04	--	1.5E+10	1.5E+10	--	9.9E+03	1.0E+04	9.9E+03
Metal	Antimony	--	3.1E+01	3.3E+02	--	1.6E+02	1.2E+03	--	--	--	--	--	--	--	2.6E+01	2.6E+02	2.6E+01
Metal	Arsenic	1.2E-01	4.6E-01	4.9E+00	7.6E-01	3.1E+00	2.3E+01	--	--	--	1.2E+03	2.1E+04	2.1E+04	1.1E-01	4.0E-01	4.0E+00	1.1E-01
Metal	Barium	--	1.6E+04	1.7E+05	--	3.8E+04	2.8E+05	--	--	--	--	7.1E+05	7.1E+05	--	1.1E+04	9.1E+04	1.1E+04
Metal	Cadmium	--	--	5.3E+00	--	--	1.2E+03	--	--	--	2.1E+03	--	1.4E+04	2.1E+03	--	5.2E+00	5.2E+00
Metal	Chromium (total)	--	1.2E+05	1.3E+06	--	5.3E+04	3.9E+05	--	--	--	--	--	--	--	3.6E+04	2.9E+05	3.6E+04
Metal	Cobalt	--	2.3E+01	2.5E+02	--	8.1E+02	5.9E+03	--	--	--	4.2E+02	8.5E+03	8.5E+03	4.2E+02	2.3E+01	2.3E+02	2.3E+01
Metal	Copper	--	3.1E+03	3.3E+04	--	1.1E+05	7.9E+05	--	--	--	--	--	--	--	3.0E+03	3.2E+04	3.0E+03
Metal	Mercury	--	1.3E+01	1.3E+02	--	3.0E+01	2.2E+02	--	--	--	--	4.3E+04	4.3E+04	--	8.8E+00	8.3E+01	8.8E+00
Metal	Nickel	--	8.6E+02	9.2E+03	--	1.2E+03	8.7E+03	--	--	--	1.5E+04	2.0E+04	2.0E+04	1.5E+04	4.9E+02	3.6E+03	4.9E+02
Metal	Selenium	--	3.9E+02	4.2E+03	--	1.3E+04	9.9E+04	--	--	--	--	2.8E+07	2.8E+07	--	3.8E+02	4.0E+03	3.8E+02
Metal	Vanadium	--	3.9E+02	4.2E+03	--	3.5E+02	2.6E+03	--	--	--	--	1.4E+05	1.4E+05	--	1.8E+02	1.6E+03	1.8E+02
Metal	Zinc	--	2.3E+04	2.5E+05	--	8.1E+05	5.9E+06	--	--	--	--	--	--	--	2.3E+04	2.4E+05	2.3E+04

Notes:
-- = Not calculated
mg/kg = milligram per kilogram
TPH = Total Petroleum Hydrocarbon
RBTC$_{soil\text{-}ing\text{-}C}$ = Risk-Based Concentration, cancer, soil ingestion
RBTC$_{soil\text{-}ing\text{-}NC}$ = Risk-Based Concentration, noncancer, soil ingestion
RBTC$_{soil\text{-}derm\text{-}C}$ = Risk-Based Concentration, cancer, soil dermal contact
RBTC$_{soil\text{-}derm\text{-}NC}$ = Risk-Based Concentration, noncancer, soil dermal contact
RBTC$_{soil.vapor\text{-}inh\text{-}C}$ = Risk-Based Concentration, cancer, soil vapor inhalation
RBTC$_{soil.vapor\text{-}inh\text{-}NC}$ = Risk-Based Concentration, noncancer, soil vapor inhalation
RBTC$_{soil.part\text{-}inh\text{-}C}$ = Risk-Based Concentration, cancer, soil particulate inhalation
RBTC$_{soil.part\text{-}inh\text{-}NC}$ = Risk-Based Concentration, noncancer, soil particulate inhalation

Table 12. Summary of Soil Gas Risk-Based Target Concentrations - Construction Workers and Residents

Northeast Corner of South Central Avenue and Victoria Street
Carson, California

Chemical Group	Chemical	$RBTC_{SG}$ (ug/L)		
		Construction Worker	Resident	
		Soil Gas Migrating to Trench Air	Soil Gas Migrating to Indoor Air	
		All Depths	5 feet	15 feet
VOC	Benzene	1.3E+01	1.3E-01	2.3E-01
VOC	Ethylbenzene	1.9E+02	1.8E+00	3.4E+00
VOC	Isopropylbenzene	6.9E+02	7.3E+02	1.4E+03
VOC	p-Isopropyltoluene	--	--	--
VOC	Naphthalene	1.6E+01	1.4E-01	2.7E-01
VOC	Tetrachloroethene	1.1E+02	9.2E-01	1.8E+00
VOC	Toluene	3.0E+04	4.5E+02	8.4E+02
VOC	Trichloroethene	1.5E+01	7.6E-01	1.4E+00
VOC	1,2,4-Trimethylbenzene	4.6E+02	1.1E+02	2.1E+02
VOC	m,p-Xylenes	2.7E+03	1.7E+02	3.1E+02
VOC	o-Xylene	2.7E+03	1.6E+02	3.1E+02

Notes:
-- = Not calculated
µg/L = microgram per liter
$RBTC_{SG}$ = Soil Gas Risk-Based Target Concentration
VOC = Volatile Organic Compound

Table 13. Summary of Soil Risk-Based Target Concentrations - Construction Workers and Residents

Northeast Corner of South Central Avenue and Victoria Street

Carson, California

Chemical Group	Chemical	$RBTC_s$ (mg/kg)	
		Construction Worker	Resident
		Soil Direct Contact	
TPH	Medium Aromatic (C9-C16)	1.4E+03	8.3E+01
TPH	Medium Aliphatic (C9-C18)	5.8E+01	6.8E+01
TPH	High Aromatic (C17-C32)	5.7E+04	2.4E+03
TPH	High Aliphatic (C19-C32)	8.1E+04	9.9E+03
Metal	Antimony	7.1E+01	2.6E+01
Metal	Arsenic[a]	1.2E+01	1.2E+01
Metal	Barium	1.1E+04	1.1E+04
Metal	Cadmium	3.5E+01	5.2E+00
Metal	Chromium (total)	1.5E+04	3.6E+04
Metal	Cobalt	3.4E+01	2.3E+01
Metal	Copper	3.1E+03	3.0E+03
Metal	Lead[b]	3.2E+02	8.0E+01
Metal	Mercury	8.4E+01	8.8E+00
Metal	Nickel	5.6E+02	4.9E+02
Metal	Selenium	1.5E+03	3.8E+02
Metal	Vanadium	3.4E+01	1.8E+02
Metal	Zinc	9.3E+04	2.3E+04

Notes:

Cal/EPA = California Environmental Protection Agency

mg/kg = milligram per kilogram

$RBTC_s$ = Soil Risk-Based Target Concentration

TPH = Total Petroleum Hydrocarbon

a. For arsenic, the regional background soil level of 12 mg/kg for southern California was used (Chernoff et al. 2008).

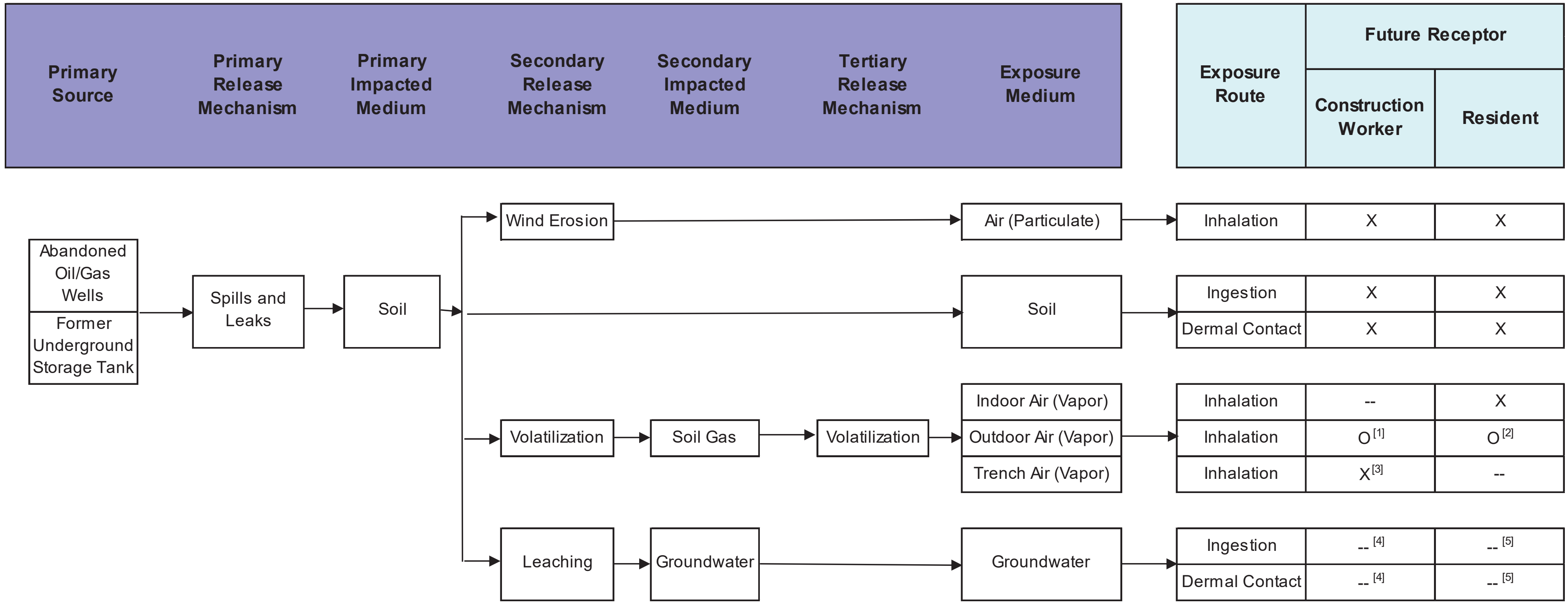
b. For lead, the screening level for residential soil from Cal/EPA (2017) was used for residents, and the screening level for industrial soil from Cal/EPA (2017) was used for construction workers.

Sources:

California Environmental Protection Agency (Cal/EPA). 2017. Human and Ecological Risk Office (HERO) Human Health Risk assessment (HHRA) Note Number 3, Issue: DTSC-Modified Screening Levels (DTSC-SLs). August.

Chernoff G, Bosan W, Oudiz D. 2008. Determination of a Southern California Regional Background Arsenic Concentration in Soil.

FIGURE



Notes:

X = Complete or potentially complete exposure pathway O = Complete, but negligible exposure pathway; not evaluated quantitatively -- = Incomplete exposure pathway

VOC = Volatile organic compound

[1] The exposure to VOCs in outdoor air is not quantitatively evaluated for construction workers because it is expected to be much lower than the exposure to VOCs in trench air.
[2] The exposure to VOCs in outdoor air is not quantitatively evaluated for residents because it is expected to be much lower than the exposure to VOCs in indoor air.
[3] To be conservative, construction workers are assumed to be exposed to vapors migrating from soil gas/soil while standing in a trench in the unsaturated zone, placing them closer to the potential sources
[4] Incidental ingestion of and dermal contact with groundwater by construction workers are not considered complete exposure pathways because depth to groundwater is at 205 feet below ground surface.
[5] Exposure via domestic use of groundwater is not evaluated because Site groundwater is not used as a domestic water supply.

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Conceptual Site Model

Northeast Corner of South Central Avenue and Victoria Street, Carson CA

Figure 1

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ATTACHMENT A
BACKGROUND CONCENTRATION

DETERMINATION OF CLEANUP GOAL FOR ARSENIC

Ramboll used a methodology developed by the Department of Toxic Substances Control (DTSC) in order to develop a cleanup goal for Arsenic at the site.

The DTSC oversees the environmental assessments of hazardous waste sites and proposed and existing schools in Southern California. During the Preliminary Environmental Assessment (PEA) or Remedial Investigation (RI) for certain sites, once arsenic has been identified as a chemical of concern, a standard approach was developed to determine if remedial action is warranted and, if so, how to develop appropriate cleanup goals. Ramboll used the approach suggested by the DTSC Human and Ecological Risk Division (HERD) for arsenic remediation on sites.

Graphical Approach

A histogram of the arsenic data demonstrated a classical lognormal distribution with a wide range of arsenic concentrations (Figure A-1). A box plot, also known as the fourth spread was used to identify 8 outliers, the one lowest value and seven largest values (Figure A-2).

In addition, Ramboll prepared a normality plot on the logarithmic values of the arsenic (Figure A-3). The plot demonstrates that the log-transformed arsenic data is normally distributed with an inflexion point at approximately 19 mg/kg. The upper bound of the arsenic data at the site is therefore 19 mg/kg. This means that all values that are greater than 19 mg/kg should be considered as a result of a contamination and need to be remediated/excavated.

Statistical Analysis

Rosner's Outlier Test

Ramboll performed a statistical outlier analysis on the arsenic concentrations collected at the site to detect the presence/absence of anomalies. Anomalous values of arsenic in soil would indicate the presence of a source that is different from background (naturally occurring conditions), thus corresponding to a contamination.

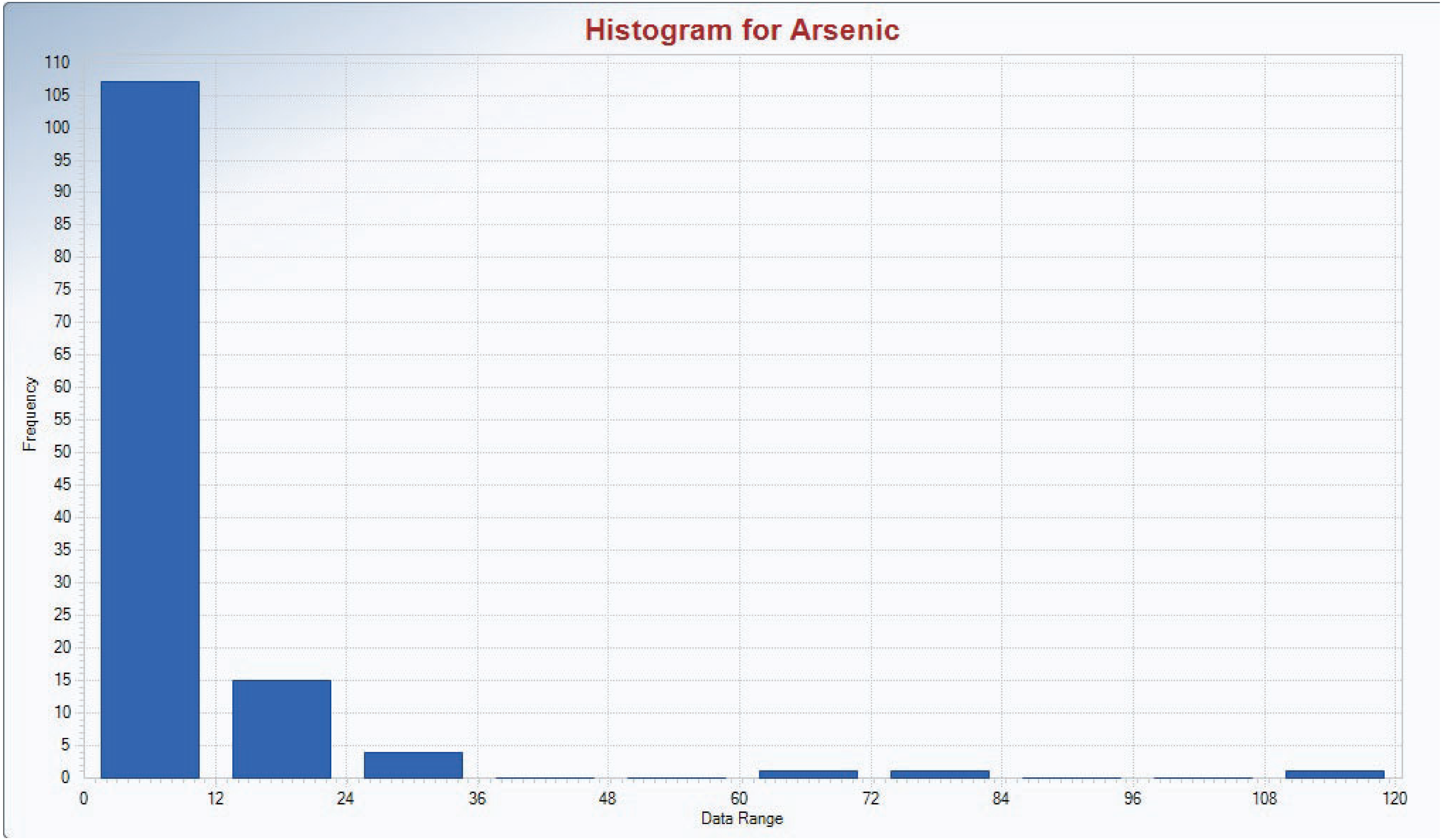
The Rosner's test is generally used if $25 < N < 500$, and identifies up to 10 extreme values (i.e. the most distant from sample's mean).

- Null hypothesis : "H0 = there is no extreme value"
- Alternative hypothesis : "H1 = there is at least one extreme value that does not belong to a same population"

Using a significance level of 5% and 1%, the results indicate that we have 7 outliers in the arsenic dataset. The following values were identified as outliers (26, 28, 29, 32, 71, 83 and 120 mg/kg). Therefore, the upper bound for the native arsenic concentration should be established at 19 mg/kg.

The studies conducted by the DTSC at several school sites in southern California established an average arsenic screening background concentration for southern California soils to be at 12 mg/kg. This information was published in the "Final Report Background Metals at Los Angeles Unified School Sites - ARSENIC" (DTSC 2005). For the purpose of the remediation of arsenic impacted soil at the site, and in order to estimate volumes of soil to be excavated, Ramboll considered two cleanup goals:

- Arsenic concentration of 12 mg/kg corresponding to the value established by the DTSC for southern California soil
- Arsenic concentration of 19 mg/kg corresponding to site specific value obtained by using the methodology developed by the DTSC.



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Histogram for Arsenic
Northeast Corner of South Central Avenue and
Victoria Street
Carson, California

FIGURE
A1

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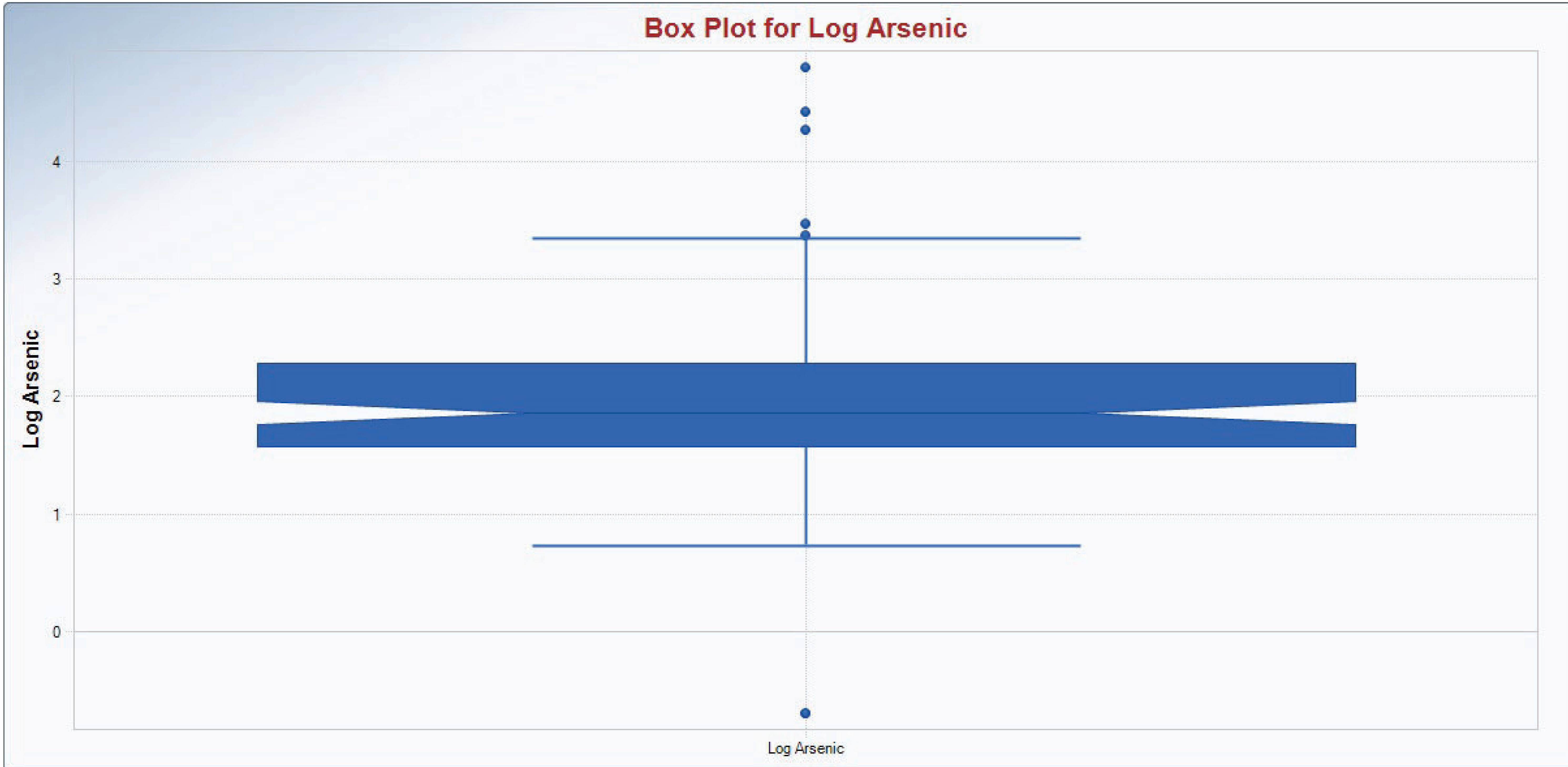

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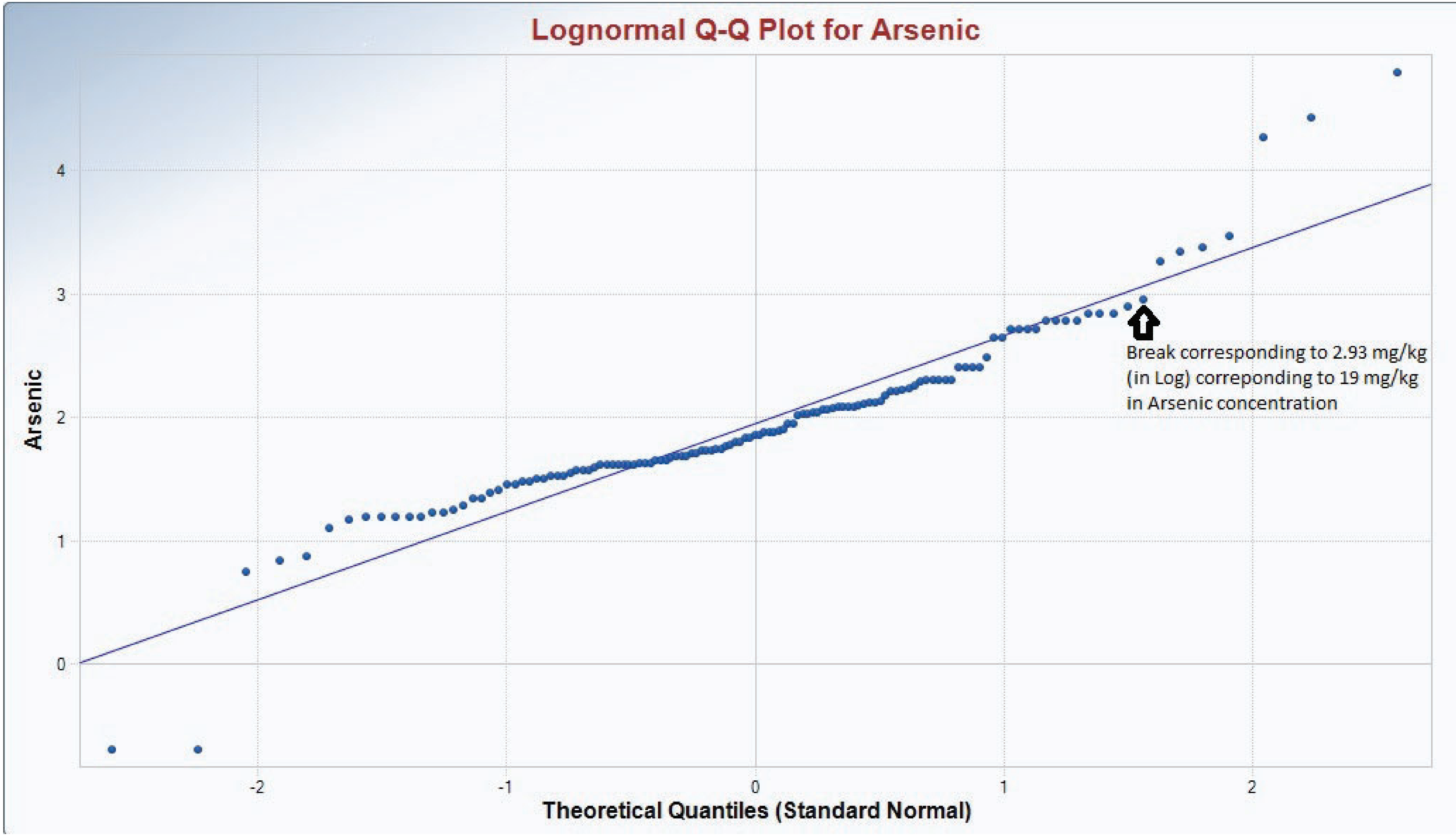
Box Plot for Arsenic
Northeast Corner of South Central Avenue and
Victoria Street
Carson, California

FIGURE
A2

PROJECT: 1690006031



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Lognormal Q-Q Plot for Arsenic
Northeast Corner of South Central Avenue and
Victoria Street
Carson, California

FIGURE
A3

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